As per NEP 2020
M.A./M.Sc. in Mathematics
(W.E.F. Academic Session 2024-2025 onwards)

Pandit Deendayal Upadhyaya Shekhawati University
Sikar (Rajasthan) 332024
E-mail: reg.shekhauni@gmail.com
Website: www.shekhauni.ac.in

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Pandit Deendayal Upadhyaya
Shekhawati University,
Sikar(Rajasthan)

Curriculum Structure									
Session 2024-2025 onwards									
Name of the Program: MA / MSc Mathematics									
Year: First						Semester: I (Pawas)			
Pawas Semester I	Course Code	Course Title	Contact Hrs per Week			Credits	Weightage (%)		
			L	T	P		CW$	MTE	ETE
	Discipline Specific Core (DSC):								
	24MMS9101T	Algebra-I	4	0	0	4	10	20	70
	24MMS9102T	Real Analysis	4	0	0	4	10	20	70
	24MMS9103T	Differential Equations-I	4	0	0	4	10	20	70
	24MMS9104T	Tensor Analysis & Riemannian Geometry	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE): (Select any one)								
	24MMS9105T	Dynamics of Rigid Bodies	4	0	0	4	10	20	70
	24MMS9106T	Calculus of Variation and Special Function-I	4	0	0	4	10	20	70
	Value Added Course(VAC):								
	---	---	--	--	--	2	--	--	--
	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):								
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		Total				22			

Summary: I Semester (Pawas)		Credits
S.N.	**Particulars**	
1.	Discipline Specific Core(DSC):	16
2.	Discipline Specific Elective (DSE):	04
3.	Value Added Course (VAC):	02
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	00
	Total	22
$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.		

Note: VAC to be selected from the list of VAC courses for PG, given on University website.

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Curriculum Structure

Session 2024-2025 onwards

Name of the Program: MA / MSc Mathematics

Year: First — **Semester: II (Vasant)**

	Course Code	Course Title	Contact Hrs per Week			Credits	Weightage (%)		
			L	T	P		CW$	MTE	ETE
Vasant Semester II	**Discipline Specific Core (DSC):**								
	24MMS9201T	Research Methodology	4	0	0	4	10	20	70
	24MMS9202T	Algebra-II	4	0	0	4	10	20	70
	24MMS9203T	Differential Equations-II	4	0	0	4	10	20	70
	24MMS9204T	Differential Geometry	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE): (Select any One)								
	24MMS9205T	Hydrodynamics	4	0	0	4	10	20	70
	24MMS9206T	Special Functions-II	4	0	0	4	10	20	70
	24MMS9207T	Topology	4	0	0	4	10	20	70
	Value Added Course(VAC):								
	---	---	--	--	--	2	--	--	--
	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):								
	---	---	--	--	--	--	--	--	--
		Total				22			

Summary: II Semester (Vasant)		Credits
S.N.	Particulars	
1.	Discipline Specific Core(DSC):	16
2.	Discipline Specific Elective (DSE):	04
3.	Value Added Course (VAC):	02
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	00
	Total	22
$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.		

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Curriculum Structure									
For Session 2024-2025 onwards									
Name of the Program: M.A / M.Sc. (Mathematics)									
Year: Second							**Semester: III (Pawas)**		
Pawas Semester III	**Course Code**	**Course Title**	**Contact Hrs per Week**			**Credits**	**Weightage (%)**		
			L	T	P		CW$	MTE	ETE
	Discipline Specific Core (DSC):								
	24MMS9301T	Functional Analysis-I	4	0	0	4	10	20	70
	24MMS9302T	Viscous Fluid Dynamics	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE): (Select any Four)								
	24MMS9303T	Continuum Mechanics	4	0	0	4	10	20	70
	24MMS9304T	Advanced Numerical Analysis	4	0	0	4	10	20	70
	24MMS9305T	Magnetohydrodynamics	4	0	0	4	10	20	70
	24MMS9306T	Combinatorics and Graph Theory	4	0	0	4	10	20	70
	24MMS9307T	Relativistic Mechanics	4	0	0	4	10	20	70
	24MMS9308T	Integral Transforms	4	0	0	4	10	20	70
	24MMS9309T	Computer Applications	3	0	2	4	10	20	70
	Value Added Course(VAC):								
	---	---	--	--	--	2	--	--	--
	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):								
	---	---	--	--	--	--	--	--	--
		Total				**26**			

Summary: III Semester (Pawas)		Credits
S.N.	**Particulars**	
1.	Discipline Specific Core(DSC):	**08**
2.	Discipline Specific Elective (DSE):	**16**
3.	Value Added Course (VAC):	**02**
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	**00**
	Total	**26**
$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.		

Note: VAC to be selected from the list of VAC courses for PG, given on University website.

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Curriculum Structure

For Session 2024-2025 onwards

Name of the Program: M.A / M.Sc. (Mathematics)

Year: Second | **Semester: IV (Vasant)**

	Course Code	Course Title	L	T	P	Credits	CW$	MTE	ETE
Vasant Semester IV			**Contact Hrs per Week**				**Weightage (%)**		
	Discipline Specific Core (DSC):								
	24MMS9401T	Functional Analysis-II	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE): Select any Two								
	24MMS9402T	Boundary Layer Theory	4	0	0	4	10	20	70
	24MMS9403T	Integral Equations	4	0	0	4	10	20	70
	24MMS9404T	Mathematical Programming OR	4	0	0	4	10	20	70
	24MMS9405T	Industrial Mathematics							
	24MMS9406T	Mathematical Theory of Statistics	4	0	0	4	10	20	70
	Value Added Course(VAC):								
	---	---	--	--	--	--	--	--	--
	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):								
	24MMS9401S	**Seminar**	--	--	--	**8**	--	--	--
		Total				**20**			

Summary: IV Semester (Vasant)		**Credits**
S.N.	**Particulars**	
1.	Discipline Specific Core(DSC):	**04**
2.	Discipline Specific Elective (DSE):	**08**
3.	Value Added Course (VAC):	**00**
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	**08**
	Total	**20**
$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.		

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Semester – I

Learning Objectives
The course aims to study the fundamental idea of Abstract Algebra and apply the concepts andprinciples to connect them with real-world problems.
Learning Outcomes
After completion of this course, students will be able to
- Understand the direct product of subgroups and Cauchy's theorem.
- Apply Sylow's and Jordan Holder's theorem.
- Understand solvable group and their properties, fundamental theorem for finite abeliangroup.
- Apply Linear transformation and diagonalization.

Course Title:	Algebra - I	Course Code: 24MMS9101T
Total Lecture hour 60		Hours
Unit I	The 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.	15
Unit II	Commutators, Derived subgroups. Normal series and Solvable groups, Composition series, Refinement theorem, and Jordan-Holder theorem for infinite groups.	15
Unit III	Polynomial rings and irreducibility criteria. Field theory — Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, and Normal extensions. Splitting fields.	15
Unit 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.	15

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

Learning Objectives
The objective of the course is to introduce Lebesgue's theory of Measure and develop a Fundamentaltool for carrying out integration that behaves well within limits.
Learning Outcomes
After completion of this course, students will be able to
- Describe the measure and its properties.
- Determine the measurable functions.
- Compute Lebesgue integrals.
- Understand convergence theorems for the integrals.

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Course Title:	Real Analysis	Course Code: 24MMS9102T
Total Lecture hour 60		Hours
Unit I	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.	15
Unit II	Measurable functions, Realization of non-negative measurable function as the limit of an increasing sequence of simple functions, Structure of measurable functions, Convergence in measure, Egoroff's theorem.	15
Unit III	Weierstrass's theorem on the approximation of continuous function by polynomials, Lebesgue integral of bounded measurable functions, and Lebesgue theorem on the passage to the limit under the integral sign for bounded measurable functions.	15
Unit IV	Summable functions, Space of square summable functions. Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem.	15

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.

Learning Objectives

The objective of the course is to apply the concepts and methods to solve problems using differential equations.

Learning Outcomes

After completion of this course, students will be able to

- Understand the concept of partial differential equations, and solution of second- order PDEusing Monge's method.
- Classify partial differential equations and transform them into canonical form.
- Use the information about the eigenvalue and the corresponding eigenfunctions for a Boundary value problem.
- Extract information from partial derivative models to interpret reality andunderstand the concept of BVPs.
- Develop the knowledge in the path of the rocket trajectory, and optimal economic growthand apply calculus of variations in the biological and medical field.

Course Title:	Differential Equations-I	Course Code: 24MMS9103T
Total Lecture hour 60		Hours
Unit I	Non-linear ordinary differential equations of particular forms. Riccati's equation - General solution and thesolution when one, two, or three particular solutions are known.	15
Unit 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.	15
Unit 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.	15
Unit IV	Partial differential equations of second order with variable coefficients- Monge's method.	15

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.

Learning Objectives
The objective of the course is to give an introduction to the basic concept and terminologyof Riemannian Geometry and Tensor.
Learning Outcomes
After completion of this course, students will be able to
- Understand the basic concept of Geodesics.
- Understand the concept of different types of tensors and their properties.
- Understand the basic concepts of covariant differentiation of tensors.

Course Title:	**Tensor Analysis & Riemannian Geometry**	**Course Code: 24MMS9104T**
Total Lecture hour 60		Hours
Unit I	Tensor Analysis— Kronecker delta. Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, and Relative tensors. Riemannian space. Metric tensor, Indicator, Permutation symbols, and Permutation tensors.	15
Unit II	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.	15
Unit III	Reimann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.	15
Unit IV	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.	15

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 UniversityPress.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	US. Milkman and G.D. Parker, Elements of Differential Geometry, PrenticeHall, 1977.

Learning Objectives
The objective of the course is to demonstrate knowledge and understanding of the fundamental concepts in motion of the rigid body with D'Alembert's principle and Lagrange's formulation of mechanics.
Learning Outcomes
After completion of this course, students will be able to:
- Understand the concept of Rigid dynamics, moment of inertia, product of inertia, momentof Ellipsoid, and principal axes.
- Understand D' Alembert's principle and derive equations of motion.
- Study the motion in two dimensions under finite forces and impulsive forces.
- Apply principles of the conservation of momentum and energy.
- Derive Lagrange's equations in generalized coordinates under finite and impulsive forces.

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Course Title:	Dynamics of Rigid Bodies	Course Code: 24MMS9105T
Total Lecture hour 60		Hours
Unit I	D'Alembert's principle. The general equations of motion of a rigid body. The motion of the center of inertiaand motion relative to the center of inertia. Motion about a fixed axis.	15
Unit II	The compound pendulum the center of percussion. Conservation of momentum (linear and angular) and energyfor finite as well as impulsive forces.	15
Unit III	Motion in three dimensions with reference to Euler's dynamical and geometrical equations. A motion under noforces, Motion under impulsive forces, Motion of a top,	15
Unit IV	Lagrange's equations for holonomous dynamical system, Energy equation for the conservative field, Small oscillations, Hamilton's equations of motion, Hamilton's principle, and principle of least action.	15
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, 1999	

Learning Objectives

The objective of the course is to apply the concepts and methods to solve problems using calculus of variation.

Learning Outcomes

After completion of this course, students will be able to

- Understand the concept of special functions and properties of special functions.
- Use the information about the eigenvalue and the corresponding eigenfunctions for a Boundary value problem.
- Extract information from partial derivative models to interpret reality andunderstand the concept of BVPs.
- Develop the knowledge in the path of the rocket trajectory, and optimal economic growth and apply calculus of variations in the biological and medical field.

Course Title:	Calculus of Variation and Special Function-I	Course Code: 24MMS9106T
Total Lecture hour 60		Hours
Unit 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 theirfirst order derivatives.	15
Unit II	Functionals dependent on higher order derivatives, Functionals dependent on the function of more than oneindependent variable. Variational problems in parametric form.	15
Unit III	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.	15
Unit IV	Legendre polynomials and functions Pn (x) and Qn (x).	15
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.	

Semester – II

Learning Objectives

- A basic understanding of how to pursue research.
- A basic understanding of how to learn mathematics.
- A basic understanding of set theory.
- A basic understanding of the software that supports the mathematical research.

Learning Outcomes

After completion of this course, students will be able to

- Understand mathematics more efficiently and clearly.
- Understand how to write a basic mathematics article.
- Make students analyze a given fact or concept and how to reach a concept.
- Make students curious enough to read the most recent trends in mathematics.
- Understand the basic ideas of how to write an algorithm and related ideas.
- Understand the effective use of open-source software to write mathematical articles.

Course Title:	Research Methodology	Course Code: 24MMS9201T
Total Lecture hour 60		Hours
Unit I	Introduction and definition of Research, characteristics of Research, Objectives of Research, Nature, and importance of Research, Research process, the difference between Research method and Research process, Scientific method, steps in Scientific method, Distinction between Scientific and Non-scientific method, Inductive and Deductive Logic.	15
Unit II	**Types and methods of Research:-** Introduction, Pure and Applied Research, Exploratory or Formulative Research, Descriptive Research, Diagnostic Research, Evaluation Studies, Action Research, Experimental Research, Historical Research, Surveys, Case study, Field studies, **Research Design:-** Introduction, Meaning & Definitions, Need and Importance, types of Research designs. Formulating of Research problem, Steps in Formulation of Research problem.	15
Unit III	**Hypothesis:-** Meaning, Significance of Hypothesis, types of Hypothesis, Sources of Hypothesis, Characteristics of Good Hypothesis. **Sampling:-** Basis, Advantages and Limitations of Sampling, Sampling Techniques, Probability, and Non- Probability Sampling methods. Sample design.	15
Unit IV	**Methods and Techniques of Data collection:-**Distinction between Primary and Secondary Data, Data Collection for Primary data. Processing of data.	15

Reference Books:

1	Srivastava, S. C.: Foundation of Social Research and Economics Techniques, Himalaya Publishing House, 1990.
2	Sharma H.D. and Mukherji S. P.: Research Methods in Economics and Business, New York: The Macmillan Company, 1992.
3	Gerber R. and Verdoom, P.J.: Research Methods in Economicsand Business, New York, The Macmillan Company, 1992.
4	Krishnaswami O.R.: Methodology of Research in SocialSciences, Himalaya Publishing House, 1993. Courtis J.K. (ed.) Research and Methodology in Accounting &Financial Management, 1980.
5	Menden HYall and Varacity: Reinmuth J.E.: Statistics forManagement and Economics (2nd Edition), 1982.

Learning Objectives

The objective of the course is to enable the students to acquire knowledge about various topics under ring theory and its applications.

Learning Outcomes

After completion of this course, students will be able to

- Identify vector spaces, their Dual spaces & Annihilator.

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- Understand the concept of Eigen values, Eigen vectors & Similar matrices.
- Understand the concept of Characteristic polynomial & minimal polynomial.
- To construct self-adjoint linear transformations and matrices.

Course Title:	Algebra-II	Course Code: 24MMS9202T
Total Lecture hour 60		Hours
Unit I	Linear transformation of vector spaces, Dual spaces, Dual basis and their properties, Dual maps, Annihilator.	15
Unit II	Matrices of linear maps, Matrices of composition maps, Matrices of dual maps, Eigen values, Eigen vectors, Rank and Nullity of linear maps and matrices, Invertible matrices, Similar matrices	15
Unit III	Determinants of matrices and their computations. Characteristic polynomial, minimal polynomial, and eigenvalues. Real inner product space, Schwartz's inequality.	15
Unit IV	Orthogonality, Bessel's inequality, Adjoint, Self-adjoint linear transformations and matrices, Orthogonal linear transformation and matrices, Principal Axis Theorem.	15

Reference Books:

1	Deepak Chatter j e e , Abstract Algebra, Prentice — Hall of India (PHI), New Delhi, 2004.
2	N.S. Gopalakrishnan, University Algebra, New Age International, 1986.
3	Qazi Zameeruddin and Surjeet Singh, Modern Algebra, Vikas Publishing, 2006.
4	G.C. Sharma, Modem Algebra, Shivlal Agrawal & Co., Agra,1998.
5	Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), NarosaPublishing House, 1999.
6	David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), JohnWiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.
7	Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra(4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
8	I.N. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006.
9	Michael Artin, Algebra (2nd edition), Pearson Prentice Hall, 2011.

Learning Objectives

The objective of the course is to apply the concepts and methods to solve problems using differential equations.

Learning Outcomes

After completion of this course, student will be able to

- Understand concept of partial differential equations, solution of second order PDE using Monge's method.
- Classify partial differential equations and transform them into canonical form.
- Use the information about the eigenvalue and the corresponding eigenfunctions for a Boundary value problem.
- Extract information from partial derivative models in order to interpret reality and understand the concept of BVPs.
- Develop the knowledge of the path of the rocket trajectory, and optimal economic growth and apply calculus of variations in biological and medical fields.

Course Title:	Differential Equations-II	Course Code: 24MMS9203T
Total Lecture hour 60		Hours
Unit I	Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem of first order partial differential equation.	15
Unit II	Linear homogeneous boundary value problems, Eigenvalues, and eigenfunctions, Sturm-Liouville boundary value problems, orthogonality of eigenfunctions, Lagrange's identity, properties of eigenfunctions, important theorems of Sturm Liouville system, Periodic	15

	functions.	
Unit III	Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigenfunction expansion). Method of separation of variables, Laplace, wave, and diffusion equations.	15
Unit IV	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.	15

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, Macmîllan & Co. Ltd., London, 1956.

Learning Objectives

The objective of the course is to give an introduction to the basic concept and terminology of Differential Geometry. Students will study plane sections, confocal conicoids, conoids, and curves in space.

Learning Outcomes

After completion of this course, students will be able to

- Understand the basic concept of plane section and circular section.
- Derive any section of a central conicoid, Generating lines and a Tangent plane.
- Understand the basics of confocal conicoids, elliptic coordinates, and parameters of confocal.
- Study conoids, inflexional tangents, and indicatrix.

Course Title:	Differential Geometry	Course Code: 24MMS9204T
Total Lecture hour 60		Hours
Unit I	Conoids, Inflexional tangents, Singular points, Indicatrix. Ruled surface, Developable surface, Tangent plane to a ruled surface. The necessary and sufficient condition is 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.	15
Unit II	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.	15
Unit III	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.	15
Unit IV	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	15

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 UniversityPress, 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	US. Milkman and G.D. Parker, Elements of Differential Geometry, PrenticeHall, 1977.

Learning Objectives

The learning objective of hydrodynamics is to understand the motion of fluids. The field of hydrodynamics has expanded so widely that it includes the flows of solids as well as fluids-continuousmatter, in short.

Learning Outcomes

- Solve hydrostatic problems.
- Describe the physical properties of a fluid.
- Calculate the pressure distribution for incompressible fluids.
- Demonstrate the application point of hydrostatic forces on plane and curved surfaces.

Course Title:	Hydrodynamics	Course Code: 24MMS9205T
Total Lecture hour 60		Hours
Unit I	Kinematics of an ideal fluid. Lagrange's and Euler's methods. Equation of continuity in Cartesian, cylindrical, and spherical polar coordinates. Boundary surface. Streamlines, path-lines and streak lines, velocity potential, irrotational motion.	15
Unit II	Euler's hydrodynamic equations, Bernoulli's theorem. Helmholtz equations. Cauchy's integral.	15
Unit III	Motion due to impulsive forces. Motion in two dimensions, Stream function, Complex potential. Sources, Sinks, Doublets, and Images in two dimensions.	15
Unit IV	Vortex motion definition, rectilinear vortices, the center of vortices, properties of vortex tube, two vortex filaments, vortex pair, vortex doublet, vortex inside and outside the circular cylinder, four vortices, motion of vortex situated at the origin and streamlines.	15

Reference Books:

1	M.D. Raisinghania, Hydrodynamics, S. Chand & Co. Ltd., N.D. 1995.
2	L. Ray and G.C. Chadda, A Text Book on Hydrodynamics, Students' Friends & Co., Agra, 1985.
3	L. 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.

Learning Objectives

The objective of the course is to analyze th e properties of special functions by their integral representation and symmetry.

Learning Outcomes

After completion of this course, students will be able to

- Find solutions of various differential equations using series solutions.
- Classify and explain the function of different types of differential equations.
- Analyse properties of various special functions by their integral representations.
- Apply special functions in various problems.

Course Title:	Special Function-II	Course Code: 24MMS9206T
Total Lecture hour 60		Hours
Unit I	Bessel functions Jn (x)	15
Unit II	Hermite polynomials Hn(X), Laguerre and Associated Laguerre polynomials.	15
Unit III	Jacobi Polynomial: Definition and its special cases, Bateman's generating function, Rodrigue's formula, orthogonality, recurrence relations, expansion in series of polynomials.	15

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Unit IV	Chebyshev polynomials Tn(x) and Un(x): Definition, Solutions of Chebyshev's equation, expansions, Generating functions, Recurrence relations, Orthogonality.	15

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.

Learning Objectives

The objective of the course is to enrich the knowledge of the students with the concept ofmetric space, elementary properties of topological spaces, and function algebra.

Learning Outcomes

After completion of this course, students will be able to

- Demonstrate knowledge of metric space with properties and examples.
- Understand concepts of topology, bases, countable space, and related theorems.
- Create new topological spaces.
- Study compactness, connectedness, and continuity-related theorems.

Course Title:	Topology	Course Code: 24MMS9207T
Total Lecture hour 60		Hours
Unit I	Topological spaces, Subspaces, Open sets, Closed sets, Neighbourhood system, Bases and sub-bases.	15
Unit II	Continuous mapping and Homeomorphism, Nets, Filters.	15
Unit III	Separation axioms (To, T1. T2, T3. T4). Compact and locally compact spaces. Continuity and Compactness.	15
Unit IV	Product and Quotient spaces. One point compactification theorem. Connected and Locally connected spaces, Continuity and Connectedness.	15

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 Modem Analysis, McGraw-Hill, 1963.

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Functional Analysis-I

Course Objectives:

The objective of this course is to provide students a solid foundation in the theory of metric spaces and normed linear spaces. Students will explore key concepts such as convergence, completeness, compactness, and continuity, as well as the applications of various theorems in functional analysis. By the end of the course, students will be equipped to analyze and apply these concepts in advanced mathematical contexts.

Course outcomes:

Upon successful completion of this course, students will be able to analyze Metric Spaces, Understand Completeness, Explore Compactness and Connectedness

Course Title:	**Functional Analysis -I**	**Course Code: 24MMS9301T**
Total Lecture hour: 60		**Hours**
Unit I	Metric Space, Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergent Sequence, Cauchy sequence. Complete metric space.	**15**
Unit II	Banach contraction theorem, Baire's category theorem, compact sets, compact spaces, Separable metric space and connected metric spaces.	**15**
Unit 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.	**15**
Unit IV	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.	**15**
Reference and Reading 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. 5. J.N.Sharma, Functional Analysis, Krishna Prakashan, Meerut **Note:** Work with Normed Linear Spaces, Employ Advanced Theorems.		

Viscous Fluid Dynamics

Course Objectives:

The objective of this course is to provide students a comprehensive understanding of fluid mechanics, focusing on the principles of viscosity, stress, and strain, as well as the mathematical formulation of fluid motion. Students will explore the Navier-Stokes equations, dimensional analysis, and the significance of various non-dimensional parameters. The course aims to equip students with both theoretical knowledge and practical skills to analyze and solve problems related to fluid flow in various contexts.

Course outcomes:

Upon successful completion of this course, students will be able to:

Understand Fluid Properties, Apply Navier-Stokes Equations, Conduct Dimensional Analysis, Solve Fluid Flow Problems and Examine Complex Flows.

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Course Title:	Viscous Fluid Dynamics	Course Code: 24MMS9302T
Total Lecture hour: 60		**Hours**
Unit 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 equations of motion.	15
Unit 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.	15
Unit III	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.	15
Unit IV	Flow between two concentric rotating cylinders. Stagnation point flows: Hiemenz flow, Homann flow. Flow due to a rotating disc.	15

Reference and Reading 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., Ing., Princeton, New Jersey, N.Y., Landon, Toronto, 1956.
6. F. M. White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

Continuum Mechanics

Course Objectives:
The objective of this course is to provide students a thorough understanding of tensor analysis and its applications in continuum mechanics. Students will explore Cartesian tensors, their transformation laws, and the mathematical tools necessary for analyzing stress, strain, and fluid motion. By the end of the course, students will be equipped to apply these concepts to complex problems in solid and fluid mechanics.

Course outcomes:
Upon successful completion of this course, students will be able to:
Understand Tensor Notation, Apply Vector Calculus Theorems, Analyze Stress and Equilibrium, Describe Deformation and Flow, Interpret Strain and Rotation

Course Title:	Continuum Mechanics	Course Code: 24MMS9303T
Total Lecture hour: 60		**Hours**
Unit I	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.	15
Unit II	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.	15
Unit III	Lagrangian and Eulerian description of deformation of flow. Comoving derivative, Velocity	15

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	and Acceleration. Continuity equation. Strain tensors. Linear rotation tensor and rotation vector, Analysis of relative displacements.	
Unit IV	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.	**15**
Reference and Reading Books:		

1. W. Prager, Introduction to Mechanics of Contirua, Lexinton Mass, Ginn, 1961.
2. A.C. Eringen, Mechanics of Continua, Wiley, 1967.
3. T.J. Chung, Continuum Mechanics, Prentice-Hall
4. K.D.Sharma, Continuum Mechanics, Navkar Prakashan,Ajmer

Advanced Numerical Analysis

Course Objectives:

The objective of this course is to provide a comprehensive understanding of numerical methods for solving algebraic and differential equations. The course covers iterative methods, polynomial equations, systems of simultaneous linear equations, and eigenvalue problems. Students will explore various techniques for accelerating convergence, solving polynomial equations, and handling systems of linear equations using direct and iterative methods. Additionally, the course will delve into eigenvalue problems, including methods for finding eigenvalues and eigenvectors. By the end of the course, students will have acquired the skills necessary to apply these numerical techniques effectively in practical and theoretical problems.

Course outcomes:

Upon successful completion of this course, students will be able to:

Apply Iterative Methods, Utilize Polynomial Equation Techniques:, Solve Systems of Simultaneous Linear Equations, Analyze Eigenvalue Problems.

Course Title:	**Advanced Numerical Analysis**	**Course Code: 24MMS9304T**
Total Lecture hour: 60		**Hours**
Unit I	Iterative methods, Theory of iterative methods, Acceleration of the convergence, Chebyshev method, Muler's method, Methods for multiple and complex roots.	**15**
Unit II	Newton-Raphson method for simultaneous equations, Convergence of iteration process in the case of several unknowns. Polynomial equation, Solution of polynomial equations, Real and complex roots, Synthetic division, the Birge-Vieta, Bairstow and Graeffe's root squaring method.	**15**
Unit 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.	**15**
Unit IV	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.	**15**
Reference and Reading 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. C.E. Froberg, Introduction to Numerical Analysis, (Second Edition), Addition-Wesley, 1979.

Magnetohydrodynamics

Course Objectives:
The objective of this course is to provide an in-depth understanding of magnetohydrodynamics (MHD) and its applications in fluid mechanics and electromagnetic theory. Students will explore Maxwell's equations in the context of fluid motion, the fundamental principles of MHD, and various MHD approximations and boundary conditions. The course also emphasizes the use of dimensional analysis to interpret key dimensionless numbers in fluid dynamics and MHD. Practical applications of MHD will be studied through analysis of different flow scenarios, including those in channels, pipes, and rotating systems. By the end of the course, students will be equipped with both theoretical knowledge and practical skills to analyze and solve complex MHD problems.
Course outcomes:
Upon successful completion of this course, students will be able to:
Understand Maxwell's Equations and MHD Fundamentals, Apply MHD Approximations and Boundary Conditions, Utilize Dimensional Analysis in MHD, Analyze MHD Flow Scenarios.

Course Title:	**Magnetohydrodynamics**	**Course Code: 24MMS9305T**
Total Lecture hour: 60		**Hours**
Unit I	Maxwell electromagnetic field equations. Constitutive equations of fluid motion, Stokes hypothesis. Maxwell stress tensor. Fundamental equations of Magnetofluid-dynamics.	15
Unit II	Magnetofluiddynamic approximations. Magnetic field equation, Frozen in fluid, Alfven transverse waves. MHD boundary conditions.	15
Unit III	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.	15
Unit IV	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.	15

Reference and Reading 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, 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.

Combinatorics and Graph Theory

Course Objectives:
The objective of this course is to develop a foundational understanding of combinatorial mathematics, discrete numeric functions, and graph theory. Students will explore various combinatorial techniques, including counting principles and generating functions, and will delve into the fundamentals of graph theory, including the study of different types of graphs, paths, and circuits. The course also covers advanced topics such as the Traveling Salesman Problem and operations on trees. By the end of the course, students will be equipped with the theoretical knowledge and practical skills necessary for solving complex combinatorial and graph based problems.
Course outcomes:
Upon successful completion of this course, students will be able to:
Apply Combinatorial Techniques, Utilize Discrete Numeric Functions, Analyze Graphs and Graph Properties, Solve Graph-Based Problems

Course Title:	**Combinatorics and Graph Theory**	**Course Code: 24MMS9306T**
Total Lecture hour: 60		**Hours**
Unit I	Introduction to diagraph, Orientation of a graph, Underlying graph, Parallel edges, Source and Sink, Types of digraphs, Accessibility, Arborescence, Spanning arborescence, Euler digraphs, Handshaking dilemma, Incidence matrix of a digraph, Circuit matrix of a digraph.	15
Unit II	Degree sequences, Graphic sequence, Havel Hakimi Theorem. Matrix representation of graphs except adjacency and incidence matrix.	15
Unit III	Planar graphs Kurotowski's graphs, Maximal planar graphs, Outer planar graphs, Maximal outer planar graph, Minimally non-outer planar graph, Thikness and Crossing number of bipartite and complete bipartite graph, Euler's formula, Kuratowski's theorem.	15
Unit IV	Isomorphism, Homomorphism. Graph theory in Network analysis Network flows, Transport networks, Max-flow min-cut-theorem.	15
Reference and Reading Books:		
1. K.H. Rosen, Discrete Mathematics and it's Applications, McGraw Hill, 1999. 2. C. Vasudev, Graph theory and it application, New Age International Pvt., 2006. 3. N.L. Biggs, Discrete Mathematics, Oxford Science Publication, 1985. 4. T. Koshy, Discrete Mathematics with Applications, Academic Press, 2005. 5. N. Deo, Graph Theory, Prentice Hall of India		

Relativistic Mechanics

Course Objectives:
The objective of this course is to provide a thorough understanding of the principles and mathematical framework of special relativity. Students will explore the foundational concepts such as the relativity of space and time, Lorentz transformations, and relativistic effects. The course covers the theoretical underpinnings of relativistic mechanics, including time dilation, Lorentz contraction, and the relationship between mass and energy. Additionally, students will delve into the geometrical interpretation of relativity through Minkowski space and understand the principles of equivalence and general covariance. By the end of the course, students will gain a solid grasp of both the conceptual and mathematical aspects of special relativity and their implications for modern physics.

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Course outcomes:
Upon successful completion of this course, students will be able to: Understand and Apply Relativity Principles, Analyze Relativistic Effects, Utilize Relativistic Mechanics, Interpret Minkowski Space and Relativistic Geometry.

Course Title:	**Relativistic Mechanics**	**Course Code: 24MMS9307T**
Total Lecture hour: 60		**Hours**
Unit 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. Simultaneity, Relativistic transformation formulae for velocity, Lorentz contraction factor, Particle acceleration.	15
Unit II	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.	15
Unit III	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. 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.	15
Unit IV	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. Three crucial tests in General Relativity and their detailed descriptions.	15
Reference and Reading 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.		

Integral Transforms

Course Objectives:
The objective of this course is to provide a comprehensive understanding of advanced integral transforms and their applications in solving differential equations and analyzing functions. The course covers Fourier, Mellin, Laplace, and Hankel transforms, focusing on their definitions, properties, and theorems. Students will learn how to apply these transforms to solve problems involving derivatives, integrals, and convolutions, and gain insight into their practical uses in various fields of mathematics and engineering. By the end of the course, students will have developed the skills needed to utilize these integral transforms for both theoretical analysis and practical problem-solving.
Course outcomes:
Upon successful completion of this course, students will be able to:
Work with Laplace Transforms, Apply Fourier Transforms, Utilize Mellin Transforms, Implement Hankel Transforms

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Course Title:	Integral Transforms	Course Code: 24MMS9308T
Total Lecture hour: 60		**Hours**
Unit I	Laplace transform- Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Properties of inverse Laplace transform. Convolution theorem. Complex inversion formula.	15
Unit II	Fourier transform Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.	15
Unit III	Mellin transform Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem. Infinite Hankel transform-Definition and elementary properties. Hankel transform of derivatives. Inversion theorem. Parseval Theorem	15
Unit IV	Solution of ordinary differential equations with constant and variable coefficients by Laplace transform. Application to the solution of Simple boundary value problems by Laplace, Fourier and infinite Hankel transforms.	15
Reference and Reading Books:		
1. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and their Applications, Taylor and Francis Group, 2014. 2. Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill, 1965. 3. Integral Transform by Goyal & Goyal, J. P. H., Jaipur		

Computer Applications

Course Objectives:

The objective of this course is to provide a foundational understanding of computer systems, including hardware, software, and operating systems, and to develop practical skills in programming and problem-solving using popular computational tools. Students will learn about computer organization, input-output devices, and memory systems, as well as gain proficiency in using system and application software, including MS Word and MS Excel. The course emphasizes hands-on experience with programming languages and computational tools such as MATLAB, Mathematica, or Maple, focusing on variables, matrix operations, and algorithmic problem-solving. By the end of the course, students will be equipped to use computational tools effectively for a variety of tasks and problems.

Course outcomes:

Upon successful completion of this course, students will be able to:

Understand Computer Systems, Use System and Application Software, Perform Computational Programming, Implement Advanced Programming Techniques.

Course Title:	Computer Applications	Course Code: 24MMS9309T
Total Lecture hour: 45		**Hours**
Unit I	Computer languages, System software and application software. Windows: Graphical user interface, control panel and all features there in files and folders management. Using Accessories, Getting help, copying, moving and sharing information between programs. Setting up printer and fonts. Configuring modem.	12
Unit II	Introduction to MS Word and Ms-Excel. Algorithms and flow charts. Programming languages and problem solving on computers.	12
Unit III	Arithmetic expressions, Input-output, Conditional statements, Implementing loops in	11

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	programs. Defining and manipulating arrays,	
Unit IV	Programming using Matlab/Mathematica/Maple Variables, Vector and Matrix Computation, Built-in-functions, Plotting, output, M-files.	**10**

Reference and Reading Books:

1. Y. Kanetkar, Let Us C, BPB Publications, 2008.
2. C. Ghezzi and M. Jazayeri, Programming Languages Concepts, John Wiley, 1977.
3. M. Marcotty & H.F. Ledgard, Programming Language Landscape, Galgotia Publication, 1981.
4. R.C. Hutchinson and S.B. Just, Programming using the C Language, McGraw-Hill.
5. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, PHI, N.Delhi, 1999.
6. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB, Cambidge Univ. Press, 2001.
7. Duane hanselman and Bruce Littlefield, Mastering Matlab-7, Pearson Education 2005.
8. William J. Palm III, Introduction to Matlab-7 for Engineers, McGraw Hill, 2005.

Computer Application-Practical

Course Title:	**Computer Application-Practical**

Solution of system of linear equations Gauss elimination, Gauss-Seidel, Eigenvalues and Eigenvectors - Power method and inverse power method. Least Squares Approximation Fitting of straight line parabola and cubic equation. Numerical integration Trapezoidal and Simpson's methods, Differential equations and graphics: Double integration, Roots of polynomial, two and three dimensional plots, Numerical solution of Initial value problems - Euler's method, Fourth order Runge - Kutta method, solution of Boundary value problems by using inbuilt functions of MATLAB/Mathematica/Maple/Scilab.

Distribution of Marks:

Two Practical-10 Marks each	= 20 Marks
Practical Record	= 05 Marks
Viva-Voce	= 05 Marks
Total Marks	= 30 Marks

Note:

1. Problems will be solved by using MATLAB/Mathematica/Maple/Scilab

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PG-Semester-IV
Functional Analysis-II

Course Objectives:

The objective of this course is to provide a comprehensive understanding of functional analysis, focusing on linear functionals, normed spaces, and inner product spaces, with particular emphasis on Hilbert spaces. The course covers fundamental theorems such as Hahn-Banach and Riesz Representation Theorem, explores the properties and structures of Hilbert spaces, and examines various operators and their spectral properties. By the end of the course, students will develop a deep understanding of functional analysis concepts and their applications in advanced mathematical contexts.

Course outcomes:

Upon successful completion of this course, students will be able to:
Understand and Apply Functional Analysis Theorems, Analyze Hilbert Spaces, Utilize Orthonormal Sets and Bases, Analyze Operators on Hilbert Spaces.

Course Title:	**Functional Analysis -II**	**Course Code: 24MMS9401T**
Total Lecture hour: 60		**Hours**
Unit I	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples. Inner product spaces.	15
Unit II	Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Phythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples.	15
Unit 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.	15
Unit 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.	15
Reference and Reading 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.		

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PG-Semester-IV

BOUNDARY LAYER THEORY

Course Objectives :
This course aims to provide a comprehensive understanding of boundary layer theory and its applications in fluid mechanics. Students will learn the derivation of boundary layer equations for two-dimensional and three-dimensional flows, analyze characteristic parameters, and explore various exact and approximate solutions. Emphasis will be placed on practical applications such as flow past different geometries and boundary layer behaviour in complex scenarios, including jets and rotating systems. By the end of the course, students will develop the ability to model and analyze boundary layer phenomena in both academic and industrial contexts.

Course outcomes:

Upon successful completion of this course, students will be able to:
Derive and Apply Boundary Layer Equations, Analyze Boundary Layer Solutions, Model Complex Flows, Employ Transformations and Techniques.

Course Title:	BOUNDARY LAYER THEORY	Course Code: 24MMS9402T
		Hours
Total Lecture hour: 60		
Unit I	Derivation of boundary layer equations for two-dimensional flow. Boundary layer along a flat plate (Blasius-Topfer solution). Characteristic boundary layer parameters. Similar solutions.	15
Unit II	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.	15
Unit III	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.	15
Unit IV	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.	15

Reference and Reading 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., Ing., Princeton, New Jer N.Y., Landon, Toronto, 1956.
6. F. M. White, Viscous Fluid Flow, McGraw-Hill, N.Y., 1974.

MATHEMATICAL PROGRAMMING

Course Objectives :

The objective of this course is to provide a thorough understanding of various advanced optimization techniques and their applications in solving complex decision-making problems. The course covers foundational topics in linear programming, integer programming, goal programming, separable programming, and dynamic programming. Students will learn both theoretical concepts and practical algorithms for solving optimization problems, including methods for handling bounded and integer variables, achieving multiple goals, and solving problems with non-linear and fractional components. The course aims to equip students with the skills necessary to apply these methods to real-world scenarios and advanced problem-solving situations.

Course outcomes:

Upon successful completion of this course, students will be able to:

Apply Advanced Linear Programming Techniques, Solve Integer Programming Problems, Employ Goal Programming Methods, Address Non-Linear and Separable Programming, Implement Dynamic Programming technique.

Course Title:	MATHEMATICAL PROGRAMMING	Course Code: 24MMS9404T
Total Lecture hour: 60		**Hours**
Unit I	Separating and Supporting hyperplane and their theorems. Revised simplex method to solve Linear Programming Problems, Bounded variable problems.	15
Unit 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.	15
Unit III	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.	15
Unit IV	Dynamic programming: Introduction, Bellman principle of optimality, solution of problems with finite number stages, solution of L.P.P. by dynamic programming.	15
Reference and Reading Books:		
1. Kanti Swaroop, P.K.Gupta and Manmohan, Operation Research, Sultan Chand & Sons., N. Delh 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 (9 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.		

Dy. Registrar
Pandit Deendayal Upadhyaya
Shekhawati University
Sikar(Rajasthan)

MATHEMATICAL THEORY OF STATISTICS

Course Objectives :

The objective of the course is to study probability theory, discrete and continuous distribution with applications which will be foundation for further study in statistics.

Course outcomes:

Upon successful completion of this course, students will be able to:

- Understand concepts of probability, Baye's theorem and its applications.
- Finding mathematical expectations, moments generating function.
- Apply Binomial, Poisson distribution.
- Study Normal, Gamma and Beta distributions and apply real life problem.

Course Title:	**MATHEMATICAL THEORY OF STATISTICS**	**Course Code: 24MMS9406T**
Total Lecture hour: 60		**Hours**
Unit I	Elements of theory of probability: Sample space, Various definitions of probability, Addition and multiplication laws of probability, Conditional probability and statistical independence of events, Baye's theorem and its applications.	15
Unit II	Mathematical expectations, conditional expectations, Moments and cumulates, Moments generating and characteristic functions, Inversion theorem, Chebychev's inequality, Central limit theorem for i.i.d. random variables.	15
Unit III	Binomial, Negative-binomial, Geometric distribution, Poisson and Hyper Geometric distributions.	15
Unit IV	Rectangular, Normal, Cauchy, Gamma and Beta Distributions, Elementary idea of Exponential and Laplace distributions.	15
Reference and Reading Books:		
1. Gupta and Kapoor : Fundamentals of Mathematical Statistics 2. Kapur and Sexena : Mathematical Statistics 3. Goon and Others : Outline of Statistical Theory		

Course Title: Seminar

Course Code: 24MMS9401S

Max. Marks: 100

Guideline for Seminar

- Select a latest topic relevant to stream of study.
- Topic of presentation should be approved by head of the department/seminar coordinator well in advance.
- Know the topic very well and message of presentation should be clear.
- Presentation (PPT) should consist of minimum 15 slides and maximum of 25 slides.
- In slides mention key point only and fonts should be readable
- For presentation select simple themes and avoid unnecessary animations.
- Give title for each slide and slide number.
- Seminar should be 20 to 25 minutes duration and another 5 minutes for question answers.
- Organization of slides should be as follows
  1. First slide will be title page showing title of seminar, name of student, roll number and class of student.
  2. Second page will contain overview of seminar
  3. Body of seminar includes principle, methodology, graph, charts, block diagram, application, case study, advantages and disadvantages arranged in logical sequence depending on the topic.
  4. Conclusion
  5. Last slide should contain references and bibliography.
- Seminar must be evaluated by at least two faculty members of Mathematics stream.
- Submit handout of presentation to Coordinator of seminar.

Distribution of marks

Relevance of title	Content of seminar	Presentation in slides	Knowledge of topic	Message of presentation	Maximum marks
12	12	13	50	13	100

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