M.A./M.Sc. in Mathematics

(W.E.F. Academic Session 2024-2025 onwards)

Ordinance & Syllabus

(As per NEP 2020)

Department of Mathematics

Pandit Deendayal Upadhyaya Shekhawati University

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Final Credit Summary

M.A./M.Sc. in Mathematics

Yr	Sem	Credits							Total
		DSC	**DSE/ P/D**	**GEC**	**AEC**	**SEC**	**VAC**	Seminar / Internship / Dissertation	
First	Pawas	16	4	---	---	---	**2**	---	**22**
	Vasant	16	4	---	---	---	**2**	---	**22**
Second	Pawas	8	16	---	---	---	**2**	---	**26**
	Vasant	**4**	**8**	---	---	---	---	**8**	**20**
		44	**32**	---	---	---	**6**	**8**	**90**

Proposed Distribution of Credits for PG Programme				
Courses	SEM I	SEM II	SEM III	SEM IV
Major DSC	DSC1(4) DSC2(4) DSC3(4) DSC4(4)	DSC5(4) DSC6(4) DSC7(4) DSC8(4)	DSC9(4) DSC10(4)	DSC11(4)
DSE	DSE1(4)	DSE2(4)	DSE3(4) DSE4(4) DSE5(4) DSE6(4)	DSE7(4) DSE8(4)
GEC	---	---	---	---
AEC	---	---	---	---
SEC	---	---	---	---
VAC	VAC1(2)	VAC2(2)	VAC3(2)	---
Seminar / Internship / Dissertation	---	---	---	Dissertation(8)
Total	22	22	26	20
	44		**46**	
	90			

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Curriculum Structure										
Session 2024-2025 onwards										
Name of the Programme: M.A./M.Sc. in 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):								
	24MMS9T1 01	Algebra-I	4	0	0	4	10	20	70
	24MMS9T1 02	Real Analysis	4	0	0	4	10	20	70
	24MMS9T1 03	Differential Equations-I	4	0	0	4	10	20	70
	24MMS9T1 04	Tensor Analysis & Riemannian Geometry	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE):								
	24MMS9T1 05	Dynamics of Rigid Bodies	4	0	0	4	10	20	70
	OR								
	24MMS9T1 06	Calculus of Variation and Special Function-I	4	0	0	4	10	20	70
	Value Added Course (VAC): * from central Pool								
			2	0	0	2	10	20	70
	Seminar/Internship/Dissertation (S/I/D):								
	--	--	--	--	--	--	--	--	--
		Total				22			

Summary: I Semester		
S.N.	Particulars	Credits
1.	Discipline Specific Core(DSC):	16
2.	Discipline Specific Elective(DSE):	04
3.	Value Added Course(VAC):	02
4.	Seminar/Intership/Dissertation(S/I/D):	--
	Total	22
$CW (Classwork): It would include attendance, assignments, class test/ quiz test/assignments, ppt, play, learn by fun activities, etc.		

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Curriculum Structure										
Session 2024-2025 onwards										
Name of the Programme: M.A./M.Sc. in Mathematics										
Year: First							**Semester: II (Vasant)**			
Vasant Semester II	**Course Code**	**Course Title**	**Contact Hrs per Week**			**Credits**	**Weightage (%)**			
			L	T	P		CW$	MTE	ETE
	Discipline Specific Core(DSC):									
	24MMS9T201	Research Methodology	4	0	0	4	10	20	70
	24MMS9T202	Algebra-II	4	0	0	4	10	20	70
	24MMS9T203	Differential Equations-II	4	0	0	4	10	20	70
	24MMS9T204	Differential Geometry	4	0	0	4	10	20	70
	Discipline Specific Elective(DSE):									
	24MMS9T205	Hydrodynamics	4	0	0	4	10	20	70
		OR								
	24MMS9T206	Special Functions-II	4	0	0	4	10	20	70
		OR								
	24MMS9T207	Topology	4	0	0	4	10	20	70
	Value Added Course (VAC): * from central Pool									
	--	--	--	--	--	--	--	--	--
		Total				**22**			

Summary: II Semester		
S.N.	**Particulars**	**Credits**
1.	Discipline Specific Core(DSC):	**16**
2.	Discipline Specific Elective(DSE):	**04**
3.	Value Added Course(VAC):	**02**
4.	Seminar/Intership/Dissertation(S/I/D):	**--**
	Total	**22**
$CW (Class work): It would include attendance, assignments, class test/ quiz test/ assignements, ppt, play, learn by fun activities etc.		

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M.A./M.Sc.-Mathematics
Semester-I

Algebra - I
24MMS9T101
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

Learning Objectives

The course aims to study the fundamental idea of Abstract Algebra and apply the concepts and principles 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 abelian group.
- Apply Linear transformation and diagonalization.

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.

Unit-II

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

Unit-III

Polynomial rings and irreducibility criteria. Field theory — Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, and Normal extensions. Splitting fields.

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.

Reference Books:

Deepak Chatterjee, Abstract Algebra, Prentice — Hall of India (PHI), New Delhi, 2004.

N.S. Gopalkrishnan, University Algebra, New Age International, 1986.

Qazi Zameeruddin and Surjeet Singh, Modern Algebra, Vikas Publishing,2006

G.C. Sharma, Modern Algebra, Shivlal Agrawal & Co., Agra,1998.

Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), Narosa Publishing House, 1999.

David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.

Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

I.N. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006.

Michael Artin, Algebra (2nd edition), Pearson Prentice Hall, 2011

M.A./M.Sc.-Mathematics
Semester-I

Real Analysis
24MMS9T102
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

Learning Objectives

The objective of the course is to introduce Lebesgue's theory of Measure and develop a Fundamental tool 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.

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.

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.

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.

Unit-IV

Summable functions, Space of square summable functions. Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem.

Reference Books:

Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., N.D., 1995.
S.C. Malik and Savita Arora, Mathematical Analysis, New Age International, 1992.
T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi,1985.
R.R. Goldberg, Real Analysis, Oxford & IBH Publishing Co., New Delhi,1970.
S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
Walter Rudin, Real and Complex Analysis, Tata McGraw-Hill Pub. Co. Ltd., 1986.
I.N. Natansen, Theory of Functions of a Real Variable, Fredrik Pub. Co., 1964.

M.A./M.Sc.-Mathematics
Semester-I

Differential Equations- I
24MMS9T103
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

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.

Unit-II

Total Differential equations. Forms and solutions, necessary and sufficient condition, Geometrical MeaningEquation containing three and four variables, total differential equations of second degree.

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.

Unit-IV

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

Reference Books:

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

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M.A./M.Sc.-Mathematics
Semester-I

Tensor Analysis & Riemannian Geomatery
24MMS9T104
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpartwill carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

Learning Objectives

- The objective of the course is to give an introduction to the basic concept and terminology of 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.

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.

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.

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.

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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.

Reference Books:

R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions,Macmillan India Ltd., 1994.
Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.
Barry Spain, Tensor Calculus, Radha Publ. House Ca1cutta, l988.
J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog, 2013.
T.J. Willmore - An Introduction to Differential Geometry. Oxford UniversityPress.1972.
Weatherbum, Riemannian Geometry, and Tensor Calculus, Cambridge Univ. Press, 2008.
Thorpe, Elementary Topics in Differential Geometry, Springer Verlag, N.Y.(1985).
US. Milkman and G.D. Parker, Elements of Differential Geometry, PrenticeHall, 1977.

M.A./M.Sc.-Mathematics
Semester-I

Dynamics of Rigid Bodies
24MMS9T105
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L	T	P
4	0	0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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, moment of 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.

Unit I

D'Alembert's principle. The general equations of motion of a rigid body. The motion of the center of inertia and motion relative to the center of inertia. Motion about a fixed axis.

Unit II

The compound pendulum the center of percussion. Conservation of momentum (linear and angular) and energyfor finite as well as impulsive forces.

Unit III

Motion in three dimensions with reference to Euler's dynamical and geometrical equations. A motion under n forces, Motion under impulsive forces, Motion of a top,

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.

Reference Books:

N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.

M. Ray and H.S. Sharma, A Text Book of Dynamics of a Rigid Body,Students' Friends & Co., Agra, 1984.

H. Goldstein, Classical Mechanics, Narosa, 1990.

J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill,1991.

L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge UniversityPress, 1999

M.A./M.Sc.-Mathematics
Semester-I

Calculus of Variation and Special Function – I
24MMS9T106
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

T	L	P
4	0	0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

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.

Unit II

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

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 seriessolution of Legendre's equation.

Unit IV

Legendre polynomials and functions Pn (x) and Qn (x).

Reference Books:

J.L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.

M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.

J.N. Sharma and R.K. Gupta, Differential Equations with Special Functions,Krishna Prakashan, 1991.

Earl D. Rainville, Special Functions, Macmillan Company, New York, 1960.

L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics,Vol. 19, AMS, 1999.

I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

M.A./M.Sc.-Mathematics
Semester-II

Research Methodology
24MMS9T201
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpartwill carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

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.

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.

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.

Unit IV

Methods and Techniques of Data collection:-Distinction between Primary and Secondary Data, Data Collection for Primary data. Processing of data.

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Reference Books:

Srivastava, S. C.: Foundation of Social Research and Economics Techniques, Himalaya Publishing House, 1990.

Sharma H.D. and Mukherji S. P.: Research Methods in Economics and Business, New York: The Macmillan Company, 1992.

Gerber R. and Verdoom, P.J.: Research Methods in Economicsand Business, New York, The Macmillan Company, 1992.

Krishnaswami O.R.: Methodology of Research in SocialSciences, Himalaya Publishing House, 1993.

Courtis J.K. (ed.) Research and Methodology in Accounting &Financial Management, 1980.

Menden HYall and Varacity: Reinmuth J.E.: Statistics forManagement and Economics (2nd Edition), 1982.

M.A./M.Sc.-Mathematics
Semester-II

Algebra-II
24MMS9T202
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

T L P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

Learning Objectives

The objective of the course 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.

- 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.

Unit I

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

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

Unit III

Determinants of matrices and their computations. Characteristic polynomial, minimal polynomial, and eigenvalues. Real inner product space, Schwartz's inequality.

Unit IV

Orthogonality, Bessel's inequality, Adjoint, Self-adjoint linear transformations and matrices, Orthogonal lineartransformation and matrices, Principal Axis Theorem.

Reference Books:

Deepak Chatter j e e , Abstract Algebra, Prentice — Hall of India (PHI), New Delhi, 2004.

N.S. Gopalakrishnan, University Algebra, New Age International, 1986.

Qazi Zameeruddin and Surjeet Singh, Modern Algebra, Vikas Publishing, 2006.

G.C. Sharma, Modem Algebra, Shivlal Agrawal & Co., Agra,1998.

Joseph A. Gallian, Contemporary Abstract Algebra (4th Ed.), NarosaPublishing House, 1999.

David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), JohnWiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.

Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra(4th Edition), Prentice-Hallof India Pvt. Ltd., New Delhi, 2004.

I.N. Herstein, Topics in Algebra (2nd edition), John Wiley & Sons, 2006.

Michael Artin, Algebra (2nd edition), Pearson Prentice Hall, 2011.

M.A./M.Sc.-Mathematics
Semester-II

Differential Equations- II
24MMS9T203
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

T L P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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 growthand apply calculus of variations in biological and medical fields.

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

Unit II
Linear homogeneous boundary value problems, Eigenvalues, and eigenfunctions, Sturm-Liouville boundary value problems, orthogonality of eigenfunctions, Lagrange's identity, properties of eigenfunctions, importanttheorems of Sturm Liouville system, Periodic 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.

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.

Reference Books:

J. L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.

M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.

L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.

I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.

Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.

D.A. Murray, Introductory Course on Differential Equations, Orient Longman,1902.

A.R. Forsyth, A Treatise on Differential Equations, Macmîllan & Co. Ltd., London, 1956.

M.A./M.Sc.-Mathematics
Semester-II

Differential Geometry

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24MMS9T204
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts to the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

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.

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.

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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 existencetheorem for surfaces, Parallel surfaces, Gaussian, and mean curvature for a parallel surface.

Unit IV

Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surfaceof revolution, Geodesic curvature and torsion, Gauss-Bonnet Theorem

Reference Books:

R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.

Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.

Barry Spain, Tensor Calculus, Radha Publ. House Calcutta, l988.

J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog, 2013.

T.J. Willmore - An Introduction to Differential Geometry. Oxford UniversityPress.1972.

Weatherbum, Riemannian Geometry, and Tensor Calculus, Cambridge Univ. Press, 2008.

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

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

M.A./M.Sc.-Mathematics
Semester-II

Hydrodynamics
24MMS9T205
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

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.

Unit II

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

Unit III

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

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 ofvortex situated at the origin and streamlines.

Reference Books:

M.D. Raisinghania, Hydrodynamics, S. Chand & Co. Ltd., N.D. 1995.

M. Ray and G.C. Chadda, A Text Book on Hydrodynamics, Students'Friends & Co., Agra, 1985.

N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.

H. Goldstein, Classical Mechanics, Narosa, 1990.

J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill,1991.

L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge UniversityPress, 1998.

M.A./M.Sc.-Mathematics
Semester-II

Special Function-II
24MMS9T206
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs

L T P
4 0 0

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

Unit I
Bessel functions Jn (X)

Unit II
Hermite polynomials Hn(X), Laguerre and Associated Laguerre polynomials.

Unit III
Jacobi Polynomial: Definition and its special cases, Bateman's generating function, Rodrigue's formula, orthogonality, recurrence relations, expansion in series of polynomials.

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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.

Reference Books:

J.L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.

M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand &Co., 2003.

J.N. Sharma and R.K. Gupta, Differential Equations with Special Functions,Krishna Prakashan, 1991.

Earl D. Rainville, Special Functions, Macmillan Company, New York, 1960.

L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics,Vol. 19, AMS, 1999.

I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

M.A./M.Sc.-Mathematics
Semester-II

L T P
4 0 0

Topology
24MMS9T207
Maximum Mark-100
External Examination-70
Internal Assessment-30
Max. Time- 3hrs.

Note: There shall be five questions in all. Candidates are required to attempt all five questions. This paper is divided into four units. There shall be two parts in the question paper. Part 'A' of the question paper shall contain the first question with 7 subparts consisting of very short answer-type questions based on knowledge, understanding, and applications of the topics covering the syllabus (all four units). Each question of the subpart will carry 2 marks. Part 'B' of the paper shall contain four questions. One question will be set from each unit. Each question will have three parts. Candidates are required to attempt all four units by taking any two parts from each question of the unit. All questions carry equal marks.

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.

Unit I

Topological spaces, Subspaces, Open sets, Closed sets, Neighbourhood system, Bases and sub-bases.

Unit II

Continuous mapping and Homeomorphism, Nets, Filters.

Unit III

Separation axioms (To, T1. T2, T3. T4). Compact and locally compact spaces. Continuity and Compactness.

Unit IV

Product and Quotient spaces. One point compactification theorem. Connected and Locally connected spaces, Continuity and Connectedness.

Reference Books:

Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., N.D.,1995.

S.C. Malik and Savita Arora, Mathematical Analysis, New Age International,1992.

James R. Munkres, Topology, 2nd Edition, Pearson International, 2000.

J. Dugundji, Topology, Prentice-Hall of India, 1975.

George F. Simmons, Introduction to Topology and Modem Analysis, McGraw-Hill, 1963.