MAHARAJA SURAJMAL BRIJ UNIVERSITY
BHARATPUR

SYLLABUS

(As Per NEP 2020)

M.Sc. (MATHEMATICS)

(*SEMESTER SCHEME*)

I & II SEMESTER EXAMINATION 2024-2025 & ONWARDS

Dr. Farbat Singh
Asstt. Registrar
Acad.I

Dr. Mahendra Devanda

(Dr. Mahesh Kumar Jayswal)
Assistant professor

(Mr. Munesh Kumar)
(Assistant Professor)

Final Credit Summary

Year	Semester	Credits							Total
		DSC	DSE	GEC	AEC	SEC	VAC	Seminar/Internship/Dissertation	
I	I	20	4	---	---	---	2	----	26
	II	20	4	---	---	---	2	-----	26

Proposed Distribution of Credits for PG Programme		
Course	Semester-I	Semester-II
DSC	DSC1(4)	DSC6(4)
	DSC2(4)	DSC7(4)
	DSC3(4)	DSC8(4)
	DSC4(4)	DSC9(4)
	DSC5(4)	DSC10(4)
DSE	DSE1(4)	DSE2(4)
GEC	---	---
AEC	---	---
SEC	---	---
VAC	VAC1(2)	VAC2(2)
Seminar/Internship/Dissertation	---	---
SemesterTotal	26	26
Year Total	52	

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Curriculum Structure First Semester

S. No.	Paper Code	Paper Name	Paper Category	Credit	Teaching hrs/Week			Weightage(%)		
					L	T	P	Internal	External	M. M
Discipline Specific Core (DSC):										
1.	MAT701	Algebra-I	DSC	4	4	0	0	30	70	100
2.	MAT702	Real Analysis	DSC	4	4	0	0	30	70	100
3.	MAT703	Differential Equations-I	DSC	4	4	0	0	30	70	100
4.	MAT704	Differential Geometry	DSC	4	4	0	0	30	70	100
5.	MAT705	Dynamics of Rigid Bodies	DSC	4	4	0	0	30	70	100
Discipline Specific Elective (DSE):										
1.	MAT706	Calculus of Variation and Special Functions-I	DSE	4	4	0	0	30	70	100
OR										
2.	MAT707	Complex Analysis	DSE	4	4	0	0	30	70	100
Value Added Course (VAC):										
1.				2	2	0	0	15	35	50
Seminar/Internship/Dissertation										
1.	----	------	------	----	----			-----	-----	-----
Total Credit in the Semester				26						

Summary: I Semester		
S.No.	Particulars	Credits
1.	**Discipline Specific Core (DSC):**	**20**
2.	**Discipline Specific Elective (DSE):**	**04**
3.	Value Added Course (VAC):	**02**
4.	Seminar/Internship/Dissertation	--
	Total	**26**

Note: Semester end examination of theory papers shall carry 70 marks. The semester end examination will be of 3 hours duration. The question paper is divided into two parts: Part 'A' and Part'B'.Part 'A' will be 10 marks and Part'B' will be 60 marks.

1. **Part A** of the theory paper shall contain 10 short answer type questions based on knowledge, understanding, and applications of the topic/texts covered in the syllabus. Each question will carry 01 marks for the correct answer.

2. **Part B**of the question paper shall contain 04 descriptive type questions, one from each unit with internal choice. Each question carry 15 marks.

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Curriculum Structure Second Semester

S.No.	Paper Code	Paper Name	Paper Category	Credit	Teaching hrs/Week			Weightage(%)		
					L	T	P	Internal	External	M.M.
Discipline Specific Core (DSC):										
1.	MAT801	Research Methodology	DSC	4	4	0	0	30	70	100
2.	MAT802	Algebra-II	DSC	4	4	0	0	30	70	100
3.	MAT803	Topology	DSC	4	4	0	0	30	70	100
4.	MAT804	Differential Equations-II	DSC	4	4	0	0	30	70	100
5.	MAT805	Riemannian Geometry and Tensor Analysis	DSC	4	4	0	0	30	70	100
Discipline Specific Elective (DSE):										
1.	MAT806	Operation Research	DSE	4	4	0	0	30	70	100
			OR							
2.	MAT807	Special Functions-II	DSE	4	4	0	0	30	70	100
			OR							
3.	MAT808	Hydrodynamics	DSE	4	4	0	0	30	70	100
Value Added Course (VAC):										
1.				2	2	0	0	15	35	50
Seminar/Internship/Dissertation										
1.	----	------	------	----	----			------	-----	-----
Total Credit in the Semester				26						

Summary: II Semester		
S.No.	Particulars	Credits
1.	Discipline Specific Core (DSC):	20
2.	Discipline Specific Elective (DSE):	04
3.	Value Added Course (VAC):	02
4.	Seminar/ Internship/ Dissertation	---
	Total	26

Note: Semester end examination of theory papers shall carry 70 marks. The semester end examination will be of 3 hours duration. The question paper is divided into two parts: Part 'A' and Part 'B'. Part 'A' will be 10 marks and Part 'B' will be 60 marks.

1. **Part A** of the theory paper shall contain 10 short answer type questions based on knowledge, understanding, and applications of the topic/texts covered in the syllabus. Each question will carry 01 marks for the correct answer.

2. **Part B** of the question paper shall contain 04 descriptive type questions, one from each unit with internal choice. Each question carry 15 marks.

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M.Sc. Mathematics Syllabus
Semester I and II
Semester–I

Paper-1: MAT701: Algebra-I

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.

Leaning Outcomes

After completion of this course, students will be able to

- Understand the direct product of subgroups Cauchy's theorem.
- Apply Sylow's and Jordan Holder's theorem.
- Understand solvable group and their properties, fundamental theorem of finite abelian groups.
- Apply linear transformation and diagonalization.

Unit-I

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, Normal extensions. Splitting fields.

Unit -IV

Galois theory – the elements of Galois theory, Automorphisms of extensions,Fundamental theorem of Galois theory, Solutions of polynomial equations by radicalsAnd Insolvability of general equation of degree five by radicals.

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice Hall of India (PHI), New Delhi, 2004
2. N.S. Gopal krishnan, 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.), NarosaPublishing House, 1999.
6. David S. Dummit and Richard M. Foote, Abstract Algebra (3rd Edition), JohnWiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.

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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.

Paper -2: MAT702: Real Analysis

Learning Objectives

The objective of the course is to introduce Lebesgue' theory of Measure and develop a Fundamental tool for carrying out the behaves well within limits

Leaning 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 theorem 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 limit of anIncreasing 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, 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:

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.

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3. T. M. Apostol, Mathematical Anslysis, Narosa Publishing House, New Delhi,1985.
4. R.R. Goldberg, Real Analysis, Oxford & IBH Publishing Co., New Delhi,1970.
5. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
6. Walter Rudin, Real and Complex Analysis, Tata McGraw-Hill Pub. Co. Ltd.,1986.
7. I.N. Natansen, Theory of Functions of a Real Variable, Fredrik Pub. Co., 1964.

Paper-3: MAT 703: Differential Equations-I

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

1. Understand the concept of partial differential equations, and solution of second-Order PDEusing Monge's method.
2. Classify partial differential equations and transform them into canonical form.
3. Use the information about the eigenvalue and the corresponding eigenfunctions for aBoundary value problem.
4. Extract information from partial derivative models to interpret reality andunderstand the concept of BVPs.
5. Develop the knowledge in the path of the rocket trajectory, and optimal economicgrowthand 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 the solution when one, two or three particular solutions areKnown.

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.

Unit – III

Series Solution: Radius of convergence, method of differentiation, Cauchy-EulerEquation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity.

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Unit – IV

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

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, PrenticeHall 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.

Paper- 4: MAT704: Differential Geometry

Learning Objectives.

The objective of the course is to give an introduction to the basic concept anderminology of Differential Geometry. Students will study plane sections, confocal conicoids, conoids, andCurves 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

Space curves, Tangent, Contact of curve and surface, Osculating plane, Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Existence and Uniqueness theorems, Bertrand curves, Involute and Evolutes.

Unit – II

Conoids, Inflexional tangents, Singular points, Indicatrix. Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and sufficient condition that a surface

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= f(n) should represent a developable surface. Metric of a surface, First, Second and Third fundamental forms. Fundamental magnitudes of some important surfaces, Orthogonal trajectories.

Unit-III

Normal curvature. Pricipal directions and Principal curvatures, First curvature, Mean curvature, Gaussion curvature, Radius of curvature of a given section through any point on $z = f(x,y)$. Lines of curvature, Principal radii, Relation between fundamental forms.

Unit – IV

Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asymptotic line. Gauss's formulae, Gauss's characteristic equation, Weingarten equations, Mainardi-Codazzi equations. Fundamental existence theorem for surfaces, Parallel surfaces, Gaussian and mean curvature for a parallel surface.

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.
2. Barry Spain, Tensor Calculus, Radha Publ. House Calcutta, 1988.
3. J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog, 2013.
4. T.J. Willmore An Introduction to Differential Geometry. Oxford UniversityPress. 1972.
5. Weatherbum, Reimanian Geometry and Tensor Calculus, Cambridge Univ. Press, 2008.
6. Thorpe, Elementary Topics in Differential Geometry, Springer Verlag, N.Y.(1985).
7. R.S. Millman and G.D. Parker, Elements of Differential Geometry, PrenticeHall, 1977.

Paper- 5: MAT705: Dynamics of Rigid Bodies

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.

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- 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. Motion of centre of inertia and motion relative to centre of inertia. Motion about a fixed axis.

Unit –II

The compound pendulum, Centre of percussion. Conservation of momentum (linear and angular) and energy for finite as well as impulsive forces.

Unit – III

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

Unit – IV

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

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.
4. 5. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998.

Paper -6: MAT706: Calculus of Variation and Special Functions-I

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.

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- 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 their first order derivatives.

Unit-II

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

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.

Unit – IV

Legendre polynomials and functions $P_n(x)$ and $Q_n(x)$.

Reference Books:

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

Paper -7: MAT707: Complex Analysis

Learning Objectives:

The course aims to familiarize the learner with complex function theory, analytic functions theory, the concept of index and Cauchy's theorems, integral formulas, singularities and contour integrations and finally provide a glimpse of maximum principle and Schwarz lemma.

Learning Outcomes:

After studying this course the student will be able to

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- Understand analytic function as a mapping on the plane, Mobius transformation and branch of logarithm.
- Understand Cauchy's theorems and integral formulas on open subsets of the plane.
- Understand the concept of homotopy and homotopic version of Cauchy's theorem and simply connectivity.
- Understand how to count the number of zeros of analytic function giving rise to open mapping theorem and Goursat theorem as a converse of Cauchy's theorem.
- Know about the kind of singularities of meromorphic functions which helps in residue theory and contour integrations.
- Handle integration of meromorphic function with zeros and poles leading to the argument principle and Rouche's theorem.
- Know different versions of the maximum principle as well as the Schwarz's lemma representing analytic function on a disk as fractional mappings.

Unit -I:
Analytic functions as mappings, conformal mapping, Mobius transformations, Branch of logarithm.

Unit -II:
Power series representation of analytic functions, Maximum modulus theorem, Index of a closed curve, Cauchy's theorem and integral formula on open subset of.

Unit- III:
Homotopy, Homotopic version of Cauchy's theorem, Simple connectedness, Counting zeros and open mapping theorem, Goursat's theorem, Classification of singularities, Laurent series.

Unit -IV:
Residue, Contour integration, Argument principle, Rouche's theorem, Maximum principles, Schwarz' lemma.

Reference Books:

1. L.V. Ahlfors, Complex Analysis, Mc Graw Hill Co., Indian Edition, 2017.
2. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa, New Delhi, 1996.
3. T.W. Gamelin, Complex Analysis, Springer, 2001.
4. L. Hahn, B. Epstein, Classical Complex Analysis, Jones and Bartlett, 1996.
5. D.C. Ullrich, Complex Made Simple, American Mathematical Society, 2008.

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Semester – II

Paper-1: MAT801: Research Methodology

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 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.

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Unit IV

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

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: ReinmuthJ.E.: Statistics forManagement and Economics (2nd Edition), 1982.

Paper-2: MAT802: Algebra- II

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 map, Eigen values, Eigen vectors, Rank and Nullity of linear maps and matrices, Invertible matrices, Similar matrices.

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Unit – III

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

Unit – IV

Orthogonality, Bessel's inequality, Adjoint, Self adjoint linear transformations and matrices, orthogonal linear transformation and matrices, Principal Axis Theorem.

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice Hall of India (PHI), NewDelhi, 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), 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.

Paper-3: MAT803: Topology

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, Neighborhood system, Bases and sub-bases.

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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:

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

Paper 4: MAT804: Differential Equations-II

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 first order partial differential equation.

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Unit – II

Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange's identity, properties of eigen functions, important theorems of sturm Liouville system, Periodic functions.

Unit – III

Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of Eigen function expansion). Method of separation of variables, Laplace, wave and diffusion equations.

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:

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, PrenticeHall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, OrientLongman, 1902.
8. A.R. Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

Paper-5: MAT805: Riemannian Geometry and Tensor Analysis

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.

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- Understand the basic concepts of covariant differentiation of tensors.

Unit – I

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

Unit –II

Tensor Analysis- Kronecker delta. Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, Relative tensor. Riemannian space. Metric tensor, Indicator, Permutation symbols and Permutation tensors.

Unit -III

Christoffel symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Field of parallel vectors.

Unit – IV

Reimann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.

Reference Books:

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

Paper-6: MAT806: Operations Research

Note:-Scientific calculator is to be permitted for mathematical calculations.

Learning Objectives:

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The objective of the course is to enable the student to understand and analyse managerial and engineering problems to equip him to use the resources such as capitals, materials, productions, controlling, directing, staffing and machines more effectively.

Learning Outcomes

After completion of this course, students will be able to

- Formulate and obtain the optimal solution for Linear Programming problems.
- Determine the optimal solution for Transportation problems.
- Determine the optimal solution for Assignment problems.
- Determine the best strategy and value of the given game model.
- Plan, Schedule and Control the given project.
- Decide an optimal replacement period/policy for a given item/equipment/machine.
- Understand the need of inventory management
- Choose the appropriate queuing model for a given practical application.

Unit-I:

Problems of Replacement- Introduction, concept of present value, replacement models and their solutions, mortality tables, group replacement method, staffing problems.

Unit-II:

Inventory Control- Introduction, Classification of inventory models, Deterministic models, Economic lot-size models, production lot-size models, quantity discount, deterministic models with shortages, fixed time model, lost sales shortages.

Unit-III:

Queueing Theory- Introduction, Components of queueing system, Classification of queues and their problems, Steady, transient and explosive states, distribution of arrivals and service times, queue models, M/M/1:(infinite/ FIFO), M/M/1(N/FIFO), M/M/c :(infinity/FIFO), M/M/c :(N/FIFO).

Unit-IV:

Game Theory- Introduction, Description of games, Maximin and minimax principles, Saddle point, Dominance in games, Solution of rectangular games, Solution of 2x2 game without saddle point, Solution of two person zero sum 2xn game, graphical method, algebraic method, Solution of two person zero-sum game by transforming into l. p. p. using Simplex method.

References Books:

1. Vohra N. D., "Quantitative Techniques in Management", 4th ed., Tata McGraw Hill
2. Sharma J. K., "Operations Research: Theory and Applications", Macmillan India Ltd.
3. Taha H. A., "Operations Research - An Introduction", 9th ed., Prentice Hall India

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4. Wagner H. M., "Principles of Operations Research", Prentice Hall India
5. Gupta P. K., Hira D.S., "Operations Research", S Chand Publishers

Paper-7:MAT807: Special Functions- II

Learning Objectives

The objective of the course is to analyze the 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 $J_n(x)$.

Unit -II

Hermite polynomials $H_n(x)$, 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.

Unit – IV

Chebyshev polynomials T,(x) and U(x): Definition, Solutions of Chebyshev's equation, expansions, Generating functions, Recurrence relations, Orthogonality.

Reference Books:

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

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Paper-8: MAT808: Hydrodynamics

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- continuous matter, 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 ideal fluid. Lagrange's and Euler's methods. Equation of continuity in Cartesian, cylindrical and spherical polar coordinates. Boundary surface. Stream-lines, path-lines and streak lines, velocity potential, irrotational motion.

Unit – 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, Images in two-dimensions.

Unit – IV

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

Reference Books:

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

Dr. Mahendra Devanda

Dr. Farbat Singh

(Dr. Manish Kumar Jaiswal, A.P.)

(Mr. Munesh Kumar, Assistant Professor)