S.S. JAIN SUBODH P.G. AUTONOMOUS COLLEGE

RAM BAGH CIRCLE, JAIPUR-302004

DETAILED COURSE STRUCTURE & SCHEME OF EXAMINATION

AS PER

UGC CURRICULUM AND CREDIT FRAMEWORK FOR POST UNDERGRADUATE PROGRAMMES UNDER NEP 2020

FOR

MASTER OF SCIENCE/ARTS (M.SC. / M.A.)

SUBJECT–MATHEMATICS

(2023-2024 & ONWARDS)

MEDIUM OF INSTRUCTION: ENGLISH

M.Sc. Mathematics Programme Details

Programme Objectives (POs):

The M.Sc. Mathematics programme's main objectives are-

- To inculcate and develop mathematical aptitude and the ability to think abstractly in the student.
- To develop computational abilities and programming skills.
- To develop in the student the ability to read, follow and appreciate mathematical text.
- Train students to communicate mathematical ideas in a lucid and effective manner.
- To train students to apply their theoretical knowledge to solve problems.
- To encourage the use of relevant software such as MATLAB and MATHEMATICA.

Programme Specific Outcomes (PSOs):

On successful completion of the M.Sc. Mathematics programme a student will

- Have a strong foundation in core areas of Mathematics, both pure and applied.
- Be able to apply mathematical skills and logical reasoning for problem solving.
- Communicate mathematical ideas effectively, in writing as well as orally.
- Have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.

The Credit Courses have been classified as:

a) Discipline Specific Core (DSC)

b) Discipline Specific Elective (DSE)

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

Semester - I

S. No.	Paper Code	Nomenclature of paper	Course Category	Credit	Contact hour per week	EoSE Duration (Hrs.)
1.	MAT 101	Algebra -I	DSC	4	4	3
2.	MAT 102	Real Analysis	DSC	4	4	3
3.	MAT 103	Differential Equations-I	DSC	4	4	3
4.	MAT 104	Differential Geometry	DSC	4	4	3
5.	MAT 105	Dynamics of Rigid Bodies	DSC	4	4	3
6.	MAT 106	Calculus of Variation and Special Function-I	DSC	4	4	3
		Total Credit in the Semester		**24**		

Semester - II

S. No.	Paper Code	Nomenclature of paper	Course Category	Credit	Contact hour per week	EoSE Duration (Hrs.)
1.	MAT 201	Algebra -II	DSC	4	4	3
2.	MAT 202	Topology	DSC	4	4	3
3.	MAT 203	Differential Equations-II	DSC	4	4	3
4.	MAT 204	Riemannian Geometry and Tensor Analysis	DSC	4	4	3
5.	MAT 205	Hydrodynamics	DSC	4	4	3

6.	MAT 206	Special Function-II	DSC	4	4	3
		Total Credit in the Semester		**24**		

EoSE: End of Semester Examination

Elective Core Courses

Specialization Clusters

A. CM Continuum Mechanics

B. MP Mathematical Programming

C. RC Relativity and Cosmology

D. NA Numerical Analysis

E. CA Computer Applications

F. CC Certificate Course on Swayam/ MOOCs/ Coursera of three month

Elective Course	Specialization	Paper	Prerequisite	Credit
MAT A01	CM	Continuum Mechanics-I	-	4
MAT A02	CM	Continuum Mechanics-II	MAT A01	4
MAT B01	MP	Mathematical Programming-I	-	4
MAT B02	MP	Mathematical Programming-II	MAT B01	4
MAT C01	RC	Relativistic Mechanics	-	4
MAT C02	RC	General Relativity and Cosmology	MAT C01	4
MAT D01	NA	Numerical Analysis -I	-	4
MAT D02	NA	Numerical Analysis -II	MAT D01	4
MAT E01	CA	Computer Applications-Theory	MAT E01	4
MAT E02	CA	Computer Applications-Practical	MAT E02	4
MAT CC	CC	Certificate Course on Swayam/ MOOCs/ Coursera portal.	MAT CC	4

Semester - III						
S. No.	Paper Code	Nomenclature of paper	Course Category	Credit	Contact hour per week	EoSE Duration (Hrs.)
1.	MAT 301	Functional Analysis-I	DSC	4	4	3
2.	MAT 302	Viscous Fluid Dynamics-I	DSC	4	4	3
3.	MAT 303	Integral Transforms	DSC	4	4	3

In addition **Candidates are required to opt any three elective core courses (4 credits each) from MAT A01, MAT B01, MAT C01, MAT D01, MAT E01, MAT CC.** Student has to take Prior permission by the Head of the Department for the online Certificate Course on Swayam/ MOOCs/ Coursera portal.

Total Credit in the Semester **24**

Semester – IV						
S. No.	Paper Code	Nomenclature of paper	Course Category	Credit	Contact hour per week	EoSE Duration (Hrs.)
1.	MAT 401	Functional Analysis-II	DSC	4	4	3
2.	MAT 402	Viscous Fluid Dynamics-II	DSC	4	4	3
3.	MAT 403	Integral Equations	DSC	4	4	3
4.	MAT DE	Project/ Dissertation	DSC	4	-	-

In addition **Candidates are required to opt the corresponding three elective core courses of same specialization cluster obtained in Semester Third (4 credits each) from MAT A02, MAT B02, MAT C02, MAT D02, MAT E02, MAT CC.** Student has to take Prior permission by the Head of the Department for the online Certificate Course on Swayam/ MOOCs/ Coursera portal. A Project/ Dissertation work is a compulsory course to be taken up in the Fourth Semester. This work will be of 4 Credits. The Project work will be of 100 Marks.

Total Credit in the Semester **28**

Examination Scheme for Each Paper

Duration: 3 hrs. Max. Marks: 70

Note: There will be two parts in end semester theory paper.

Part A- comprises of eight very short answer questions from all units. It's a compulsory question and attempt any seven (Science/Arts) 7 × 2 mark each =14 Marks

Part B- 4 questions (one question from each unit with internal choice) and all questions are compulsory. Each Question Carries 14 Marks. (Science/Arts)

4 × 14 mark each = 56 Marks

Total of End semester exam (duration of exam 3 hours) =70

Marks Internal assessment = 30Marks

Evaluation Scheme of Project/ Dissertation

Total Marks 100

Internal Marks: 30

Viva-Voice: 20 Marks

Presentation: 20 Marks

Dissertation/ Project: 30 Marks

S. S. Jain Subodh P.G. College, Jaipur (Autonomous)
CBCS Scheme for M.Sc.

SEM.	CORE COURSE	ELECTIVE COURSE	Credits
	DSC (76)	DSE (24)	
1	Algebra -I (4 Real Analysis (4) Differential Equations-I (4) Differential Geometry (4) Dynamics of Rigid Bodies (4) Calculus of Variation and Special Function-I (4)		24
2	Algebra -II (4) Topology (4) Differential Equations-II (4) Riemannian Geometry and Tensor Analysis (4) Hydrodynamics (4) Special Function-II (4)		24
3	Functional Analysis-I (4) Viscous Fluid Dynamics-I(4) Integral Transforms(4)	Elective Group A (Choose Any Three from the following group) Continuum Mechanics-I (4) Mathematical Programming-I (4) Relativistic Mechanics (4) Numerical Analysis -I (4) Computer Applications- Theory (4) Certificate Course on Swayam/ MOOCs/ Coursera portal. (4)	24
4	Functional Analysis-II (4) Viscous Fluid Dynamics-II (4) Integral Equations (4) Project/ Dissertation (4)	Elective Group B A (Choose Any Three from the following group) Continuum Mechanics-II (4) Mathematical Programming-II (4) General Relativity and Cosmology (4) Numerical Analysis -II (4) Computer Applications- Practical (4) Certificate Course on Swayam/ MOOCs/ Coursera portal. (4)	28
		TOTAL CREDITS	100

SEMESTER – I

MAT 101: Algebra-I

Course Objectives:

Students will have the knowledge and skills to apply the concepts of the course in pattern recognition in the field of computer science and also for diverse situations in physics, chemistry and other streams. This course is a foundation for next course in Algebra. Fields form one of the important and fundamental algebraic structures and has an extensive theory dealing mainly with field extensions which arise in the study of roots of polynomials. In this course we study fields in detail with a focus on Galois theory which provides a link between group theory and roots of polynomials.

Course Learning Outcomes:

After studying this course, the student will be able to

CO1. understand, explain in depth, and apply the fundamental concepts of Groups, Structure of Groups, isometries, Rings and integral domains.

CO2. To introduce the concepts and to develop working knowledge on fundamentals of algebra. identify and construct examples of fields, distinguish between algebraic and transcendental extensions, characterize normal extensions in terms of splitting fields and prove the existence of algebraic closure of a field.

CO3. characterize perfect fields using separable extensions, construct examples of automorphism group of a field and Galois extensions as well as prove the fundamental theorem of Galois theory.

CO4. classify finite fields using roots of unity and Galois theory and prove that every finite separable extension is simple.

CO5. Use Galois Theory of equations to prove that a polynomial equation over a field of characteristic is solvable by radicals iff its group (Galois) is a solvable group and hence deduce that a general quintic equation is not solvable by radicals.

Contents:

Unit-1

Direct product of groups (External and Internal). Isomorphism theorems – Diamond isomorphism Theorem, Butterfly Lemma, Conjugate classes (Excluding p-groups). Sylow's Theorem (Without Proof). Cauchy's theorem for finite abelian groups.

Unit - 2

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

Unit - 3

Polynomial Ring and irreducibility Criteria, Field theory – Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, Normal extensions. Splitting fields.

Unit -4

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

Reference Books:

1. Deepak Chatterjee, Abstract Algebra, Prentice Hall of India (PHI), New Delhi, 2004
2. N. S. Gopalkrishnan, University Algebra, New Age International, 1986.
3. 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.

MAT 102: Real Analysis

Course Objectives:

The main objective is to familiarize yourself with the Measurable sets, Measurable functions, Integration, Convergence of sequences of functions and their integrals, Functions of bounded variation, L_p -spaces.

Course Learning Outcomes: After studying this course the student will be able to

CO1. verify whether a given subset of a real valued function is measurable.

CO2. understand the requirement and the concept of the Lebesgue integral (a generalization of the Reimann integration) along its properties.

CO3. demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems and their applications.

CO4. know about the concepts of functions of bounded variations and the absolute continuity of functions with their relations.

CO5. extend the concept of outer measure in an abstract space and integration with respect to a measure.

CO6. learn and apply Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem. in Lp -spaces and understand completeness of Lp -spaces and convergence in measures.

Contents:

Unit – 1

Algebra and algebras of sets, Algebras generated by a class of subsets, Borel sets, Lebesgue measure of sets of real numbers, Measurability and Measure of a set, Existence of Non-measurable sets.

Unit – 2

Measurable functions, Realization of non-negative measurable function as limit of an increasing sequence of simple functions, Structure of measurable functions, Convergence in measure, Egoroff's theorem.

Unit - 3

Weierstrass's theorem on the approximation of continuous function by polynomials, Lebesgue integral of bounded measurable functions, Lebesgue theorem on the passage to the limit under the integral sign for bounded measurable functions.

Unit - 4

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

Reference Books:

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

MAT 103: Differential Equations- I

Course Objectives:

The objective of this course is to study the solutions of various types of nonlinear differential equations, total differential equations of the three and four variables and total differential equations of second degree. Also using series solution method solutions of differential equations will be obtained. By applying Monge's method partial differential equations will be solved.

Course Learning Outcomes:

After studying this course the student will be able to

CO1. Students will have the knowledge and skills to solve various types of non-linear differential equations.

CO2. Can solve total differential equation of the three and four variables and total differential equations of second degree.

CO3. Describe solutions of differential equations using series solution method.

CO4. Have skills to solve partial differential equations using Monge's method.

Contents:

Unit - 1

Non-linear ordinary differential equations of particular forms. Riccati's equation – General solution and the solution when one, two or three particular solutions are known.

Unit - 2

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

Unit - 3

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

Unit - 4

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

Reference Books:

1. J. L. Bansal and H. S. Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.

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

MAT 104: Differential Geometry

Course Objectives:

The primary objective of this course is to understand the notion of space curves, Tangent, Osculating plane, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Metric of a surface, First, Second and Third fundamental forms, Orthogonal trajectories, Gauss's characteristic equation, Fundamental existence theorem for surfaces, Gaussian and mean curvature for a parallel surface.

Course Learning Outcomes:

After studying this course the student will be able to

CO1. understand the space curves, their curvature and torsion, Serret-Frenet's formulae and its applications

CO2. learn about envelops and ruled surfaces with emphasis on the properties of developable and skew surfaces.

CO3. know about Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asymptotic line.

CO4. deal with Gauss's formulae, Gauss's characteristic equation, Weingarten equations, Mainardi-Codazzi equations.

Contents:

Unit - 1

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

Unit-2 (12)

Conoids, Inflexional tangents, Singular points, Indicatrix. Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and sufficient condition that a surface $\zeta = f(\xi, \eta)$ should represent a developable surface. Metric of a surface, First, Second and Third fundamental forms. Fundamental magnitudes of some important surfaces, Orthogonal trajectories.

Unit - 3

Normal curvature, 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.

Unit - 4

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

Reference Books:

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

MAT 105: Dynamics of Rigid Bodies

Course Objectives:

This course will enable the students to -

1. Acquaint the students with mechanical systems under generalized coordinate systems, virtual work, energy and momentum.
2. Aware about the mechanics developed by Lagrange's, Hamilton.

Course Learning Outcomes:

After studying this course the student will be able to

CO1. Understand D'Alembert's Principle and its simple applications. Able to construct General equation of motion of a rigid body under fixed force, no force and impulsive force.

CO2. Describe the concept of Motion of a rigid body in two dimensions, Rolling and sliding friction, rolling and sliding of uniform rod and uniform sphere.

CO3. Able to Describe Motion in three dimensions with reference to Euler's dynamical and geometrical equations, Motion under no forces, Motion under impulsive forces.

CO4. Analyse the Derivation of Lagrange's Equations to holonomic Systems. Understand the motion of top.

CO5. Distinguish the concept of the Hamilton Equations of Motion and the Principle of Least Action.

Contents:

Unit - 1

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

Unit - 2

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

Unit - 3

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

Unit - 4

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

Reference Books:

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

MAT 106: Calculus of Variation and Special Function-I

Course Objectives:

This course will enable the students to

1. Learn about functional, variational problems.
2. Solve brachistochrone, problem of geodesics, isoperimetric problem.
3. Understand the properties of special functions like Gauss hypergeometric, Legendre functions with their integral representations.
4. Understand how special function is useful in differential equations.

Course Learning Outcomes:

At the end of the course Students will have the knowledge and skills to understand, explain in depth and apply in various situations the techniques to-

CO1. Solving the problem of brachistochrone, problem of geodesics, isoperimetric problem, Variation and its properties, functions and functionals,

CO2. Solving Variational problems with the fixed boundaries.

CO3. Variational problems involving higher order derivatives, constraints involving several variables and their derivatives.

CO4. Explain the applications and the usefulness of these special functions.

CO5. To analyse properties of special functions by their integral representations and symmetries.

CO6. Identified the application of some basic mathematical methods via all these special functions.

Contents:

Unit - 1

Calculus of variation – Functional, 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. (Variational Problems with fixed boundaries)

Unit - 2

Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form. (Variational Problems with fixed boundaries)

Unit-3

(15)

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.

Unit - 4

Legendre polynomials and Series Solution of Legendre's equation and functions $P_n(x)$ and $Q_n(x)$.

Reference Books:

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

SEMESTER - II

MAT 201: Algebra II

Course Objectives:

The primary objective of this course is to provide knowledge and skills to demonstrate a competence in formulating, analysing and solving problems in several core areas of higher level of Linear Algebra concepts- linear form, dual spaces, orthogonal basis.

Course Learning Outcomes:

After studying this course, the student will be able to

CO1. To explain demonstrate accurate and efficient use of Eigen values and eigen vectors.

CO2. To understand application of Orthogonal Projection.

CO3. To learn the concept of dual spaces and dual basis, maps and annhilator.

CO4. To understand the Real inner product space and Schwartzs inequality.

CO5. To explain invertible matrices and similar matrices.

Contents:

Unit - 1

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

Unit - 2

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

Unit - 3

Determinants of matrices and its computations, Characteristic polynomial, minimal polynomial and Eigen values. Real inner product space, Schwartzs inequality.

Unit - 4

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), 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.

MAT 202: Topology

Course Objectives: To introduce basic concepts of point set topology, basis and sub-basis for a topology and order topology. Further, to study continuity, homeomorphisms, open and closed maps, product and introduce notions of connectedness, path connectedness, local connectedness, local path connectedness, convergence, nets, Filters, and compactness of spaces.

Course Learning Outcomes:

After studying this course the student will be able to

CO1. Determine interior, closure, boundary, limit points of subsets and basis and sub-basis of topological spaces.

CO2. check whether a collection of subsets is a basis for a given topological spaces or not, and determine the topology generated by a given basis.

CO3. Identify the continuous maps between two spaces and maps from a space into product space and determine common topological property of given two spaces.

CO4. Determine the connectedness and path connectedness of the product of an arbitrary family of spaces.

CO5. find Hausdorff spaces using the concept of Net and Filter in topological spaces and learn about 1st and 2nd countable spaces, separable, Lindelöf spaces and Tychonoff's theorem.

Contents:

Unit - 1

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

Unit – 2

Continuous mapping and Homeomorphism, Nets, Filters.

Unit – 3

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

Unit - 4

Product and Quotient spaces. Tychonoff's one point compactification. 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.

MAT 203: Differential Equation-II

Course Objectives:

The objective of this course is to study the Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem, boundary value problems, eigen values and eigen functions of Sturm Liouville systems, Green's function.

Course Learning Outcomes:

After studying this course, the student will be able to

CO1. Students will have the knowledge and skills to classify and reduce various types of linear partial differential equation of second order into Canonical forms.

CO2. understand with eigen values and eigen functions of Sturm□Liouville systems and the solutions of initial and boundary value problems.

Contents:

Unit - 1

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

Unit - 2

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

Unit-3 (19)

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

Unit - 4

Green's Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green's function), Procedure of constructing the Green's function and solution of boundary value problem, properties of Green's function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green's function, Modified Green's function.

Reference Books:

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

MAT 204: Riemannian geometry and Tensor Analysis

Course Objectives:

The objective of this course is to study the geodesic, differential equation of geodesic and various types of tensors.

CO1: Study the most fundamental knowledge for understanding tensors were taught in the traditional way.

CO2: Prior to our applying tensor analysis to our research area of modern continuum mechanics.

CO3: Tensor analysis provides a kind of bridge between elementary aspects of linear algebra, geometry and analysis.

Contents:

Unit - 1

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

Unit - 2

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

Unit - 3

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

Unit - 4

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

Reference Books:

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

MAT 205: Hydrodynamics

Course objective:

This course will enable the students to -

Understand the motion of fluid and develop the concept of models and give the techniques which enable us to solve the problems of fluid flow.

Course Learning Outcomes:

After the completion of the course the students will be able to:

CO1- Understand the basic principles of ideal fluid, such as Lagrangian and Eulerian approach, conservation of mass etc.

CO2- Use Euler and Bernoulli's equations and the conservation of mass to determine velocity and acceleration for incompressible and non-viscous fluid.

CO3-Understand the concept of rotational and irrotational flow, stream functions, velocity potential, complex potential due to sink, source and doublets.

CO4-Understand the motion of a fluid element, Vorticity, Body forces, Surface forces, Stress & Strain analysis, Flow and circulation, Connectivity, Irrotational motion in multiple connected space,

CO5-Distinguish the concept of Irrotational motion of a cylinder in two dimensions, Motion of a circular cylinder in a uniform stream and two co-axial cylinders, Streaming and circulation for a fixed circular cylinder.

Contents:

Unit - 1

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

Unit - 2

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

Unit - 3

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

Unit - 4

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

Reference Books:

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

MAT 206: Special Functions- II

Course Objectives: This course will enable the students to

1. Understand the concept of Bessel's function, Hermite function, Laguerre and Associated Laguerre polynomials. Jacobi Polynomial, Chebyshev polynomials with its properties like recurrence relations, orthogonal properties, generating functions etc.
2. Understand how special function is useful in differential equations.

Course Learning Outcomes:

After the completion of the course the students will be able to:

CO1: Explain the applications and the usefulness of these special functions.

CO2: Classify and explain the functions of different types of differential equations.

CO3: To analyse properties of special functions by their integral representations and symmetries.

CO5: Identified the application of some basic mathematical methods via all these special functions.

CO6: Apply these techniques to solve and analyse various mathematical problems.

Contents:

Unit - 1

Bessel functions Jn(x).

Unit - 2

Hermite polynomials Hn(x), Laguerre and Associated Laguerre polynomials.

Unit - 3

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

Unit - 4

Chebyshev polynomials Tn(x) and Un(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.