Programme Project Report (PPR)

MA (MATHEMATICS)

1. Overview

The MA (Mathematics) programme is conducted under the department of Mathematics, School of Sciences, Uttarakhand Open University. The Department of Mathematics shares the vision of achieving excellence in distance education and research.

Uttarakhand Open University Haldwani was established in the year 2005 by Act No 23 of Uttarakhand Government. The University is fully equipped with Information and Communication Technology. Our University have the Learners support system. The current information is given on University Website (https://www.uou.ac.in/) and other electronic medium (SMS, whatapps group, department blog, telephonic conversation, mail etc). All learners can take admission through our university website and in some cases offline admission is also available. The learners need not to come in the university for taking the Self Learning Materials (SLM) and Examination etc. All of these facilities are provided to the learners through respective study center.

2. Contents of Programme Project Report (PPR):

The MA (Mathematics) Programme was started in 2019 in Uttarakhand Open University Haldwani. It is the two year Programme (Semester Mode). In the first semester four papers are compulsory and in second semester five papers are to be studied then in third semester four papers are compulsory and in forth Semester two paper are to be selected out of seven optional papers and dissertation is compulsory. In dissertation there is a compulsory provision of viva-voce.

(I) Programme Mission and Objectives: The mission of the MA (Mathematics) Programme is Providing access to high quality Mathematics education to learners doorsteps.

The MA (Mathematics) Programme objectives are as mentioned below:

- To cultivate a mathematical aptitude and nurture the interests of the learners towards problem solving aptitude.

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- Motivating the young minds for research in mathematical sciences.
- To inculcate Entrepreneurial skills among learners.
- To develop learners to become globally competent.

(II) Relevance of the Programme with HEI's Mission and Goals: - The MA (Mathematics) program is designed to provide learners with a strong foundation in mathematics that can be applied to a wide range of fields, including engineering, computer science, finance, and the natural sciences. The MA (Mathematics) programme given to those learners who want to work in science, engineering, or computing a solid core education. Most degree programs also require a research component, so learners can get a feel for how to use their new skills in the real world. This Programme is giving the opportunity to those persons, who cannot take the face to face higher education for any some personal reason as for his/her job, age, economic problems, marriage, distance of higher institute or college. The MA (Mathematics) programme is giving help to all of those persons who want to come into the profession of teaching at higher education level.

(III) Nature of Prospective Target group of Learners:- The target group of learners is all Arts graduate of the society, the teacher of the different schools, those want to enhance their education and workers of different corporate society, those could not complete their education and want to get higher education. The Master of Arts in Mathematics program is designed to meet the needs of a wide range of individuals who are interested in pursuing careers or further Education in Mathematics. The program can be beneficial for individuals who want to

- Enhance their knowledge and skills in mathematics and related fields.
- Pursue careers in research, academia, or industry.
- Prepare for further studies in mathematics or related fields.
- Improve their chances of promotion or career advancement in their current field.
- Develop a deeper understanding of mathematical concepts and their applications in various fields.

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(IV) Appropriateness of the Programme to be conducted in Open and Distance Learning and/or Online mode to acquire specific skills and competence:-

The MA (Mathematics) can be offered in Open and Distance Learning system. By using modern technology, the learners can get all the quality materials. A lot of study material and online lectures are available in the online medium. Many international scientific institutions are providing their lectures and other subject material to the society. Learners can avail this facility. But they cannot appropriate for all types of learners. Our self-learning materials fulfill the almost requirement of learners. Our model study centers always organize the counseling lectures and the learners shall be trained and skilled through the year .

(V) Instructional Design: - MA (Mathematics) programme Curriculum has been designed by the Board of Studies committee of the Department of Mathematics. We have completed the syllabus of First, Second, Third and Fourth Semester. The self-learning materials are prepared by the approved experts by Board of Studies committee. Our experts are belongs to distinguish institution of all over India. The MA Mathematics programme self-learning materials is Online available in our website. The materials are updated from time to time. The final Version of SLM will be updated after June 2023.If a learners downloads SLM online, then he is given discount 25 percent in fees. Our self-learning materials are self-directed and in the form of easy explanations, sequential development, illustrations, learning activities, etc. The course structure and syllabus are in Annexure - A and Annexure - B.

(VI) Procedure of Admission curriculum transaction and evolution:- The admission process in the programme of MA (Mathematics) is available on-line. The learners may apply in the course run by the University by getting themselves enrolled in the various study centers run by the university. The criteria to be met by the learner intending to take admission in MA (Mathematics) courses run by the University are as follows:

For MA (Mathematics): BA with mathematics as one of the major subject.

Examination is conducted in the various examination centers decided by the University. Further, the examination copy is to be evaluated by various evaluators of the concern subject approved by Hon'ble Vice–Chancellor.

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(VII) Requirement of Library Support: -.The Department of Mathematics teachers always give the guidance to books selection in the library, The departmental information, assignment, examination is also uploaded on the website and also send regular essential information via WhatsApp group. Eight regional centres and study centres also give the library facility to learners.A comprehensive soft copy of the study material is provided to the learners through the online library in the University website and the learners can also avail the facility of the books available in the University Library and different e-books are provided by central library of the Uttarakhand open university.

(VIII) Cost Estimate of the Programme and Provision:-

The approximate cost of development of study material

14 units x 19 courses = 266 units

Cost of development of 1 unit = Rs 6000

Cost of development of 266 units = Rs 15,96,000/-

Number of learners getting admission each year= nearly 300 (approximated)

Annual Fee deposited by each MA learner = 11650

Total fee deposited by all learners (300) = Rs. 3,495,000

Total expenditure for Editing =798000/-

The SLM is published by the MPDD department of uttarakhand open university.

(IX) Quality assurance mechanism and expected programme outcomes: The MA (Mathematics) Programme is of 68 credits. The expert and department teaching staff updated the Self Learning Material (SLM) from time to time. The Self Learning Material (SLM) prepared in such a manner in which the learner feels as if the learner is being taught by a teacher in the class room. We focused in our programme in following strategies :

- Be simple
- Be flexible
- Be authentic
- Be familiar with new digital technique
- Be organized
- Be concise.

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Prof. Manoj Kumar

Prof. Sanjay Kumar

(Dr. Jyoti Rani)

(Dr. Kamlesh Bisht)

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Expected Programme Outcomes: After completion of post graduate in Mathematics learner will be able

- Explain the advanced concept of Pure and Applied Mathematics.
- Analyze the application of Mathematics in different subjects.
- Describe the different theorems and proofs.
- Solve the different Mathematical problems.

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Annexure - A

PROGRAMME STRUCTURE FOR MA (MATHEMATICS)

Subject: Mathematics **Course Code: MAMT**

First Semester

Sr. No.	Course Name	Course Code	Marks			Credits	Minimum counselling hours
			Th.	Ass.	Total		
1.	Advanced Abstact Algebra	MAT501	70	30	100	04	12
2.	Real Analysis	MAT502	70	30	100	04	12
3.	Advanced Statistics	MAT503	70	30	100	04	12
4.	Advanced Differential Equation- I	MAT504	70	30	100	04	12
		Total Credit				16	

Second Semester

Sr. No.	Course Name	Course Code	Marks			Credits	Minimum counselling hours
			Th.	Ass.	Total		
1.	Advanced Linear Algebra	MAT505	70	30	100	04	12
2.	Topology	MAT506	70	30	100	04	12
3.	Measure Theory	MAT507	70	30	100	04	12
4.	Advanced Differential Equation-II	MAT508	70	30	100	04	12
5.	Mathematical Methods	MAT509	70	30	100	04	12
		Total Credit				20	

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Third Semester

Sr. No.	Course Name	Course Code	Marks			Credits	Minimum counselling hours
			Th.	Ass.	Total		
1.	Advanced Complex Analysis	MAT601	70	30	100	04	12
2.	Functional Analysis	MAT602	70	30	100	04	12
3	Operations Research	MAT603	70	30	100	04	12
4	Fluid Mechanics	MAT604	70	30	100	04	12
Total Credit						16	

Fourth Semester

Learners can take any two courses from Course code MAT605 to MAT611. Course code MAT612 is compulsory for all learners in Fourth Semester.

Sr. No.	Course Name	Course Code	Marks			Credits	Minimum counselling hours
			Th.	Ass.	Total		
1.	Operator Theory	MAT 605	70	30	100	04	12
2.	Number Theory	MAT 606	70	30	100	04	12
3	Combinatorics and Graph Theory	MAT 607	70	30	100	04	12
4.	Classical Mechanics	MAT 608	70	30	100	04	12
5.	Theory of Relativity	MAT 609	70	30	100	04	12
6.	Mathematical Modeling	MAT 610	70	30	100	04	12
7.	Geometry	MAT 611	70	30	100	04	12
8	Dissertation	MAT 612			100	08	
Total Credit						16	

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Annexure - B

FIRST SEMESTER

Course Name: Advanced Abstract Algebra
Course Code: MAT501
Credit: 4

SYLLABUS

Normal subgroups and Homomorphism

Introduction, Normal subgroups, Quotient groups, Conjugate element, Center of group, Normalizer of an element, Homomorphism and Isomorphism theorems of groups.

Class Equation and Sylow's theorem

Cayley's theorem, Class equations, Direct product of groups (External and Internal), Cauchy's Theorem for finite abelian groups, *p*-Sylow Subgroups, Sylow's Theorem, Applications of *p*- Sylow subgroups.

Composition Series, Jordan Holder Theorem and Solvable group

Normal and subnormal series, composition series, Jordan Holder Theorem, Solvable Groups, Simplicity of An($n \geq 5$), Nilpotent Groups.

Rings, Fields and Galois Extension

Quotient Ring, Ring over Rational Field, Homomorphism and Embedding of Rings, Ideals, Prime and Maximal Ideals, Divisibility in an Integral Domain, Units, Associates, Prime Elements. Unique Factorization Domain, Principal Ideal Domain, Euclidean Domain, Polynomial Rings and Irreducibility Criteria, Eisenstein's Criterion of Irreducibility, Extension Fields, Finite, Algebraic and Transcendental Extensions, Simple and Algebraic Field Extensions, Splitting Fields and Normal Extensions, Algebraically Closed Fields, Galois Groups, Galois Extension, Galois Correspondence.

UNIT SCHEDULE

BLOCK I: NORMAL SUBGROUPS AND HOMOMORPHISM

Unit 1 Normal Subgroups and Quotient Groups

Unit 2 Conjugate element, Normalizer and Center of group

Unit 3 Homomorphism and Isomorphism

BLOCK II: CLASS EQUATION AND SYLOW'S THEOREM

Unit 4 Cayley's Theorem and Class Equation

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Unit 5 Direct product of Groups and Cauchy's Theorem for Finite Abelian Groups
Unit 6 Sylow Subgroups, Sylow's Theorem and their applications

BLOCK III: COMPOSITION SERIES, JORDAN HOLDER THEOREM AND SOLVABLE GROUP

Unit 7 Normal and Subnormal Series, Composition Series
Unit 8 Jordan Holder Theorem
Unit 9 Solvable Groups, Simplicity of An($n \geq 5$), Nilpotent Groups

BLOCK IV: RINGS, FIELDS AND GALOIS EXTENSION

Unit 10 Rings and Ideals
Unit 11 Integral Domain and Fields
Unit 12 Unique Factorization Domain, Principal Ideal Domain, Euclidean Domain
Unit 13 Polynomial Rings and Irreducibility Criteria, Eisenstein's Criterion of a Irreducibility
Unit 14 Field extension, Galois Groups and Galois Extension

Course Name: Advanced Real Analysis
Course Code: MAT502
Credit-04

SYLLABUS

Real number System

Finite and infinite sets, Natural numbers and Induction Principle, Countable and Uncountable sets, Cardinality, Integers, Rational Numbers, Ordered Field, Complete Ordered Field, Real Numbers, Dedekind Cuts. Sequences, limit point of sequences, limit-inferior and superior, convergent sequences, Cauchy's General principle of convergence, positive term series, Cauchy's root test, D'Alembert Ratio test, Raabe's test, series with arbitrary terms Rearrangements of Terms of a Series, limit, Continuity, Uniform Continuity, Derivative, Darbaux;'s theorem, Rolle's theorem, Lagrange's mean Value Theorem, Cauchy's mean Value Theorem.

Riemann Integral

Refinement of partitions, Conditions of Integrability, Riemann Sums and Riemann Integral, Fundamental theorem, Improper Integrals. Monotonic Functions, Definition and Existence of Riemann-Stieltjes Integral, Improper Integral.

Uniform Convergence and Lebegue Integral

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Pointwise Convergence, Uniform Convergence on Interval, Cauchy's Criterion for Uniform Convergence, Test for Uniform Convergence, Test for Uniform Convergence of Series, Weierstrass M-test, Abel's and Dirichlet's test, Properties of Uniform Convergence, Uniform convergence and integrity. Measurable sets, Borel sets, Lebegue Integral, Comparison with Riemann Integral for unbounded sets.

Metric Spaces

Definition and Examples of Metric Spaces, Definition and Examples of Metric Spaces, open sphere and closed sphere, Neighbourhoods, open sets and closed sets, limit points and Boundary points, subspace of metric sp[ace and Product of Metric space Bases, Convergent sequence, Cauchy sequence, Complete spaces, Dense sets and seperable spaces, Baire's Category theorem, Continuity, Uniform continuity, Homeomorphism, Compact spaces and sets, sequential compactness, Finite Intersection Property, Seperated Sets, Disconnected and Connected sets, Fixed point theorem, Contraction, Lipschitzian Map, Non-expansive Maps, Contractive Maps, Continuation Methods for Contractive and Non-expansive Mappings, Banach Contraction Principle.

BLOCK I: REAL NUMBER SYSTEM

UNIT 1 Introduction of Real Number System and Countable Set
UNIT 2 Sequences, Series and properties
UNIT 3 Limit and Continuity
UNIT 4 Derivative and Mean Value Theorem

BLOCK II: RIEMANN INTEGRAL

UNIT 5 Riemann Integral
UNIT 6 Riemann-Stieltjes Integral
UNIT 7 Improper Integral

BLOCK III: UNIFORM CONVERGENCE AND LEBEGUE INTEGRAL

UNIT 8 Pointwise Convergence
UNIT 9 Uniform Convergence
UNIT 10 Lebesgue Integral

BLOCK IV: METRIC SPACE

UNIT 11 Metric Spaces
UNIT 12 Completeness
UNIT 13 Continuous function and Compactness
UNIT 14 Fixed Point Theorems

Course Name: Advanced Statistics

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Course Code: MAT503
Credit: 4

SYLLABUS

Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Univariate Discrete, Continuous Distributions and Bivariate Distribution

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Correlation, Regression, Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Markov's inequality, Chebyshev's inequality, Convergence in Probability, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Concept of Statistical Hypothesis and Analysis of Variance

Population, Sample, Parameters, Sample size problem, Theory of Estimators, Elementary theory of testing of Hypothesis, Concept of Statistical Hypothesis, Types of hypothesis, Procedure of testing the hypothesis, Types of Errors, Level of Significance, Degree of freedom. Analysis of Variance: Completely randomized design and randomized block design.

UNIT SCHEDULE

BLOCK I: PROBABILITY FUNCTIONS AND MOMENT GENERATING FUNCTION

Unit 1 Basics of Probability

Unit 2 Conditional Probability

Unit 3 Random Variable, Distribution functions, Probability mass/density functions

Unit 4 Transformations and moment generating function

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BLOCK II: UNIVARIATE DISCRETE AND CONTINUOUS DISTRIBUTIONS AND BIVARIATE DISTRIBUTION

Unit 5 Discrete distributions

Unit 6 Continuous distributions

Unit 7 Bivariate Distribution

BLOCK III: CORRELATION, REGRESSION, CENTRAL LIMIT THEOREM

Unit 8 Correlation

Unit 9 Regression

Unit 10 Central limit theorem

BLOCK IV: CONCEPT OF STATISTICAL HYPOTHESIS AND ANALYSIS OF VARIANCE

Unit 11 Basics of Sampling

Unit 12 Theory of Estimators

Unit 13 Test in Sampling

Unit 14 Analysis of variance

Course Name: Advanced Differential Equation I

Course Code: MAT504

Credit: 04

SYLLABUS

Existence and nature of solutions

Introduction, order, degree and Exactness of differential Equation, Principle of Duality, Picard's theorem.

General theory of Linear Differential Equation

Basic Concept, Linear Differential Equation and its Properties, Existence and Uniqueness theorem, Variation of Parameters, Ordinary Points, Regular and Singular points, Two Space System, Autonomous System, Critical points, Limit Cycles.Uniqueness Theorem, Characteristic Equation and Characteristic Values, Boundary Condition and Fourier's Convergence Theorem.

Integral curves and Damped Linear Oscillator

Path of a System, Integral Curves, Singular points, Critical Point, Node, Saddle Point, Damped Linear Oscillator, Fundamental Existence Theorem, Stability, Lyapunov Function, Differential Equations with Periodic Solution, Method of Bogoliubov and Krylov.

Special functions

Chebyshev Polynomials and Legendre Polynomials, Bessel Functions and Hermite Polynomials, Leguerre Polynomials.

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UNIT SCHEDULE

BLOCK I: EXISTENCE AND NATURE OF SOLUTIONS

UNIT 1 Existence & Nature of Solution.

UNIT 2 Degree & Exactness of Differential Equation and Principle of Duality

BLOCK II: GENERAL THEORY OF LINEAR DIFFERENTIAL EQUATIONS

UNIT 3 Linear Differential Equation.

UNIT 4 Variation of Parameters.

UNIT 5 Ordinary, Regular & Singular Points.

UNIT 6 Second Order Differential Equation

BLOCK III: INTEGRAL CURVES AND DAMPED LINEAR OSCILLATOR

UNIT 7 Path of a System.

UNIT 8 Integral Curves and Damped Linear Oscillator.

UNIT 9 Fundamental Existence Theorem.

UNIT 10 Differential Equations with Periodic Solution.

UNIT 11 Method of Bogoliubov and Krylov

BLOCK IV: SPECIAL FUNCTIONS

UNIT 12 Chebyshev Polynomials and Legendre Polynomials.

UNIT 13 Bessel Functions and Hermite Polynomials

UNIT 14 Leguerre Polynomials

SECOND SEMESTER

Course Name: Advanced Linear Algebra
Course Code: MAT505
Credit : 04

SYLLABUS

Vector Spaces and Linear Transformation

Vector Spaces: Subspaces, Direct Sums, Spanning Sets and Linear Independence, The Dimension of a Vector Space, Ordered Bases and Coordinate Matrices, The Row and Column Spaces of a Matrix.

Linear Transformations: Isomorphisms, The Kernel and Image of a Linear Transformation, Rank-Nullity Theorem, The Matrix of a Linear Transformation, Change of Bases for Linear Transformations, Equivalence of Matrices, Similarity of Matrices, Similarity of Operators, Invariant Subspaces and Reducing Pairs.

Isomorphism Theorems

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The Isomorphism Theorems: Quotient Spaces, The Universal Property of Quotients and the First Isomorphism Theorem, Quotient Spaces, Complements and Codimension, Additional Isomorphism Theorems, Linear Functionals, Dual Bases, Reflexivity, Annihilators, Operator Adjoints.

Linear Operator, Eigenvalues and Eigenvectors

Linear Operator , Orders , Characteristic Polynomial and Minimal Polynomial of an Operator, Eigenvalues and Eigenvectors, Geometric and Algebraic Multiplicities, The Jordan Canonical Form, Triangularizability Diagonalizable Operators, Projections, Algebra of Projections, Resolutions of the Identity, Spectral Resolutions, Projections and Invariance.

Inner Product Spaces and Bilinear Form

Real and Complex Inner Product Spaces, Norm and Distance, Isometries, Orthogonality, Orthogonal and Orthonormal Sets, The Projection Theorem and Best Approximations, Orthogonal Direct Sums, The Riesz Representation Theorem.

The Adjoint of a Linear Operator, Normal Operators, The Matrix of a Bilinear Form, Quadratic Forms, Orthogonality.

UNIT SCHEDULE

BLOCK I: VECTOR SPACES AND LINEAR TRANSFORMATION

UNIT 1 Vector Spaces and Subspace..

UNIT 2 Basis and Dimension.

UNIT 3 Linear Transformation.

UNIT 4 Rank Nullity Theorem.

UNIT 5 Change of Bases

BLOCK II: THE ISOMORPHISM THEOREMS

UNIT 6 Quotient Spaces and Isomorphism Theorem.

UNIT 7 Linear Function

BLOCK III: LINEAR OPERATOR, EIGENVALUES AND EIGENVECTORS

UNIT 8 Linear Operator and Orders.

UNIT 9 Characteristic and Minimal Polynomial of an Operator.

UNIT 10 Eigenvalues and Eigenvectors.

UNIT 11 The Jordan Canonical Form.

UNIT 12 Triangularizability Diagonalizable Operators, Projections, The Algebra of Projections, Resolutions of the Identity, Spectral Resolutions, Projections and Invariance

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BLOCK IV: INNER PRODUCT SPACES

UNIT 13 Inner product Space and projection Theorem.

UNIT 14 Linear Operators.

Course Name: Topology

Course Code: MAT506

Credit: 04

SYLLABUS

Topological Spaces and Continuous Functions

Topological Spaces and Continuous Functions: Basics, Topological Spaces, Basis for a Topology, The Order Topology, The Product Topology on $X \times Y$ The Subspace Topology, Closed Sets and Limit Points, Continuous Functions, The Product Topology, The Metric Topology, The Quotient Topology.

Connectedness and Compactness

Connectedness and Compactness: Connected Spaces, Connected Sets in the Real Line.Components and Path Components, Local Connectedness, Compact Spaces, Compact set in the Real line, Limit Point Compactness, Local Compactness.

Countability and Separation Axioms

Countability and Separation Axioms: The Countablity Axioms, The Sepration Axioms, The Urysohn Lemma, The Urysohn Metrization Theorem, Partitions of Unity.

Tychonoff Theorem

Tychonoff Theorem, Completely Regular Spaces.

UNIT SCHEDULE

BLOCK I: TOPOLOGICAL SPACES AND CONTINUOUS FUNCTIONS

UNIT 1 Basics, Topological Spaces and Basis for a Topology.

UNIT 2 Order Topology, Product Topology and Subspace Topology.

UNIT 3 Closed Sets and Limit Points, Continuous Functions.

UNIT 4 Product Topology, Metric Topology and Quotient Topology.

BLOCK II: CONNECTEDNESS AND COMPACTNESS

UNIT 5 Connected Spaces, Connected Sets in the Real Line.

UNIT 6 Components and Path Components, Local Connectedness.

UNIT 7 Compact Spaces, Compact set in the Real line.

UNIT 8 Limit Point Compactness and Local Compactness.

BLOCK III: COUNTABILITY AND SEPARATION AXIOMS

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UNIT 9 Countablity Axioms.
UNIT 10 Axioms.
UNIT 11 The Urysohn Lemma and The Urysohn Metrization Theorem.
UNIT 12 Partitions of Unity.

BLOCK IV: TYCHONOFF THEOREM

UNIT 13 Tychonoff Theorem.
UNIT 14 Completely Regular Spaces

Course Name: Measure Theory
Course Code: MAT507
Credit:04

SYLLABUS

Sets and Lebesgue measure

Countable sets, uncountable sets, relation between the cardinality of a nonempty set and the cardinality of its power set, ring of set, Boolean ring, σ-ring, Boolean algebra and σ-algebra of sets, Set function. Outer measure, Measurable sets, Non measurable sets and Lebesgue measure, Example of non-measurable sets.

Measurable functions and Convergence theorem

Measurable functions, Simple function, Step function, The Lebesgue integral of a bounded function over a set of finite measure, The integral of nonnegative measurable functions. The general Lebesgue integral, Fatou's lemma, Monotone convergence, , dominated Convergence theorem, Dini's theorem, Convergence in measure. Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, Convex functions.Measure spaces, Measurable functions, Integration, General convergence theorems.

L_p Space and Weierstrass approximation theorem

The L_p space, Holder's inequality, Schwarz inequality, Reisz Fisher theorem, Theorem on Lebesgue integration, Weierstrass approximation theorem .

Signed measure and Product measure

Signed measures, Hahn decomposition theorem, Jordan decomposition theorem, Lebesgue decomposition theorem, The Radon-Nikodym Theorem., Product measures, Fubini's theorem, Relation between Riemann and Lebesgue.

UNIT SCHEDULE

BLOCK I: SETS AND LEBESGUE MEASURE

UNIT 1 Sets and Cardinality
UNIT 2 Boolean Algebra

UNIT 3 Measure Space

UNIT 4 Lebesgue Measure

BLOCK II: MEASURABLE FUNCTIONS AND CONVERGENCE THEOREM

UNIT 5 Measurable Functions

UNIT 6 Lebesgue Integral of a Function

UNIT 7 General Convergence Theorem

UNIT 8 Differentiation of an integral

BLOCK III: L_p SPACE AND WEIERSTRASS APPROXIMATION THEOREM

UNIT 9 L_p space

UNIT 10 Theorem in Lebesgue integration

UNIT 11 Weierstrass approximation Theorem

BLOCK IV: SIGNED MEASURE AND PRODUCT MEASURE

UNIT 12 Signed measure

UNIT 13 Product measure

UNIT 14 Relation between Riemann and Lebesgue

Course Name: Advanced Differential Equation-II

Course code: MAT508

Credit:04

SYLLABUS

Partial Differential Equations-I

Formation and Solutions of PDE, Integral Surface, Cauchy Problem Order of an equation, Orthogonal Surfaces, First Order Non-Linear Characteristics, Compatible System, Charpit Method.

Fundamentals: Classification and Canonical Forms of PDE. Monge's Method.

Partial Differential Equation-II

Derivation of Laplace and Poisson Equation, BVP-Separation of Variables, Dirichlet's Problem and Newmann Problem for a Rectangle, Interior and Exterior Dirichlet's Problem for a circle, Interior Newmann problem for a circle, Solution of Laplace equation in Cylindrical and spherical coordinates, Examples. Formation and Solution of diffusion Equation.

Dirac-Delta Function, Wave Equation and Green's Function

Dirac-Delta function, Separation of Variables Method, Solution of Diffusion Equation in Cylindrical and Spherical Coordinates, Examples.Formation and Solution of One-Dimensional wave equation, Canonical Reduction, IVP-d ' Alembert's Solution, Vibrating String, Forced Vibration, IVP and BVP for Two-

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Dimensional Wave Equation, Periodic Solution of One- Dimensional Wave Equation in Cylindrical and Spherical Coordinate Systems, Vibration of Circular Membrane, Uniqueness of the Solution for the Wave Equation, Duhamel's Principle, Examples. Green's function for Laplace equation, Methods of Images, Eigen Function Method, Green's Function for the Wave and Diffusion Equations.Laplace Transform method: Solution of Diffusion and Wave equation by Laplace Transform. Hyper Geometric and Confluence, Hyper geometric Functions.

Numerical Solutions of Partial Differential Equations

Numerical Solutions of Partial Differential Equations: Finite differences, Finite Element Method, Orthogonal Collocation technique, Numerical solution of partial differential equations - elliptic, parabolic and hyperbolic equations.

UNIT SCHEDULE

BLOCK I: PARTIAL DIFFERENTIAL EQUATION-I

UNIT 1 Formation and Solution of PDE. First Order Non-Linear Characteristics

UNIT 2 Compatible System

UNIT 3 Fundamentals: Classification and Canonical Forms of PDE

UNIT 4 Monge's Method

BLOCK II: PARTIAL DIFFERENTIAL EQUATION-II

UNIT 5 Derivation of Laplace and Poisson Equation.

UNIT 6 Dirichlet's Problem and Newmann Problem for a Rectangle.

UNIT 7 Interior and Exterior Dirichlet's Problems for a circle. Laplace equation in Cylindrical and Spherical Coordinates.

UNIT 8 Formation and Solution of Diffusion Equation.

BLOCK III: PARTIAL DIFFERENTIAL EQUATION-III

UNIT 9 Dirac-Delta function. Separation of Variables Method.

UNIT 10 One- Dimensional Wave Equation

UNIT 11 Wave Equation. Green's Function.

BLOCK IV: NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS

UNIT 12 Finite differences, Orthogonal Collocation technique.

UNIT 13 Finite Element Method

UNIT 14 Numerical solution of elliptic, parabolic and hyperbolicequations

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Course Name: Mathematical Methods

Course Code: MAT 509

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Credit: 4

SYLLABUS

Green's function

Concept and calculation of Green's function, Approximate Green's function, Green's function method for differential equations

Fourier Series, Laplace transform and Fourier transform:

Fourier series, Generalized Fourier series, Fourier Cosine series, Fourier Sine series, Fourier integral, Fourier transform and inverse Fourier Transform, Laplace transform, convolution theorem and inverse Laplace transform and application in solving differential equation. Definition, example and elementary properties of Wavelet Transforms

Calculus of Variation

Calculus of Variation: Introduction, problem of brachistochrone, isoperimetric problem, concept of extrema of a functional, variation and its properties. Variational problems with fixed boundaries, The Euler equation, The fundamental lemma of calculus of variations. Variational problems with moving boundaries, Reflection and refraction extremals. Transversality conditions, Sufficient conditions for an extremum, Field of extremals, Jacobi conditions, Legendre Condition, Second variations, Canonical equations and variational principles, Introduction to direct method for variational principle.

Integral Equations and Numerical Method:

Integral Equations: Regular Integral equations: Volterra integral equations, Fredholm integral equations, Volterra and Fredholm equations of first and second kind, Volterra and Fredholm equations with regular kernels. Degenerate kernel, Fredholm Theorem, Method of Successive approximation, Bernstein polynomials and its properties.Weierstrass approximation theorem, Solving integral equations by using Bernstein polynomials and general polynomial. Quadrature method for Integral equations, Green's function in integral equations.

UNIT SCHEDULE

BLOCK I: GREEN'S FUNCTION

Unit 1 Basic Concepts of Green's function

Unit 2 Calculation of Green's function

Unit 3 Green's function method for differential equations.

BLOCK-II FOURIER SERIES, LAPLACE TRANSFORM AND FOURIER TRANSFORM

Unit 4 Basic Concepts.

Unit 5 Fourier Series and Generalisation.

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Unit 6 Fourier transform
Unit 7 Laplace transform

BLOCK III: CALCULUS OF VARIATION

Unit 8 Introduction of calculus of variation
Unit 9 Variation problem with the fixed boundaries
Unit 10 Variation problem with the fixed boundaries
Unit 11 Sufficiency condition

BLOCK IV: INTEGRAL EQUATIONS AND NUMERICAL METHOD

Unit 12 Basic Concepts, Volterra and Fredholm integral equations.
Unit 13 Solving integral equations by using different polynomials.
Unit 14 Numerical method and Green's Method concept for Integral equations

THIRD SEMESTER

Course Name: Advanced Complex Analysis
Couse code: MAT601
Credit: 4

SYLLABUS

Algebra and Topology of the complex plane. Geometry of the complex plane, Complex differentiation. :Power series and its convergence, Cauchy-Riemann equations, Harmonic functions, Conformal Mapping: Circle and line revisited, Conformal Mapping, Möbius transformations, Other Mapping, Integration along a contour, The fundamental theorem of calculus, Homotopy, Cauchy's theorem, Cauchy integral formula, Cauchy's inequalities and other consequences, Winding number, Open mapping theorem, Schwarz reflection Principle, Singularities of a holomorphic function, Laurent series, The residue theorem, Argument principle, Rouche's theorem, Branch of the Complex logarithm, Automorphisms of the Unit disk Week, : Covering spaces., Picard's theorem.

UNIT SCHEDULE

BLOCK I: ANALYTIC FUNCTIONS

Unit 1 Algebra and Topology of the complex plane.
Unit 2 Geometry of the complex plane, Complex differentiation.
Unit 3 Power series and its convergence, Cauchy-Riemann equations.
Unit 4 Harmonic functions.

BLOCK II: CONFORMAL MAPPING

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Unit 5 Circle and line revisited and Conformal Mapping.
Unit 6 Möbius transformations and Other Mapping

BLOCK III :COMPLEX INTEGRATION

Unit 7 Integration along a contour, The fundamental theorem of calculus.
Unit 8 Homotopy, Cauchy's theorem.
Unit 9 Cauchy integral formula, Cauchy's inequalities and other consequences.
Unit 10 Winding number, Open mapping theorem, Schwarz reflection Principle.

BLOCK III : SINGULARITIES AND RESIDUE

Unit 11 Singularities of a holomorphic function, Laurent series
Unit 12 The residue theorem, Argument principle, Rouche's theorem.
Unit 13 Branch of the Complex logarithm. Automorphisms of the Unit disk.
Unit 14 Covering spaces, Picard's theorem.

Course Name: Functional Analysis
Course Code: MAT602
Credit: 4

SYLLABUS

Normed and Banach spaces and Fundamental theorems for Normed and Banach spaces

Normed linear space, Banach space, Properties of Banach Spaces, subspaces and its example, Finite dimension of normed spaces and subspaces, Compactness and finite dimension, Linear operator, bounded and continuous linear operator, linear functional, linear functional of finite dimensional spaces, Normed space of operators and dual space.

Zorn's lemma, Hahn-Banach theorem and its applications, Adjoint operator, dual space of $L_p[a,b]$ and $C[a,b]$, reflexivity, Uniform boundedness principle, Strong and Weak Convergence, convergence of operators and functional, open mapping theorem, closed linear operator, projection on Banach Spaces, closed graph theorem, Banach fixed point theorem, Approximation theory.

Inner product space and Hilbert space

Inner product spaces, Hilbert spaces and its example, Orthogonality, Orthonormal sets, Reisz Representation theorem, Legendre and Leguerre polynomial, Parsevals's theorem, the conjugate space of Hilbert space. Hilbert-Adjoint Operator, Self Adjoint, normal and unitary Operator, projection Operator.

Spectral theory of linear operator

Spectral theory of linear operator in normed space and self-adjoint linear operator,

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Spectral theorem for bounded self-adjoint operator, Unbounded linear operator on Hilbert space.

UNIT SCHEDULE

BLOCK I: NORMED, BANACH SPACES

UNIT 1 Basics.

UNIT 2 Normed Linear Space.

UNIT 3 Banach Spaces

BLOCK II: FUNDAMENTAL THEOREMS FOR NORMED AND BANACH SPACES

UNIT 4 Hahn-Banach theorem and convergence of operators

UNIT 5 Open mapping theorem and projection on Banach Spaces

UNIT 6 Banach Theorem

UNIT 7 Approximation theory

BLOCK III: INNER PRODUCT SPACE AND HILBERT SPACE

UNIT 8 Inner Product space

UNIT 9 Hilbert Space

UNIT 10 Hilbert-Adjoint Operator and unitary Operator

BLOCK IV: SPECTRAL THEORY OF LINEAR OPERATOR

UNIT 11 Spectral theory of linear operator in normed space

UNIT 12 Compact linear operator in Normed space

UNIT 13 Spectral theory of Bounded Self-Adjoint linear operators

UNIT 14 Unbounded Linear Operators in Hilbert Space

Course Name: Operations Research

Course Code: MAT603

Credit: 4

SYLLABUS

Linear Programming

Introduction to Linear Programming, Linear Programming Problems and Mathematical Formulation, Graphical Solution, Lines and Hyper Plane, Convex Set, Extreme Points of convex set, Convex Combination of vector Convex Hull. Basic solution and basic feasible solution. Fundamental Theorem of Linear Programming, Simplex Method, Big-M Method, Two Phase Method, Degeneracy, Concept of Duality, Dual Simplex Method, Revised Simplex Method.

Real life problem

Sensitivity Analysis, Integer Linear Programming, Branch and Bound Method, Travelling Salesman Method, Transportation, Test of Optimality, Degeneracy in

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Transportation Problem, Balanced and Unbalanced Transportation Problem, North West Corner method, Vogel's approximation method, Transhipment Problem.

Dynamical Programming

Dynamical Programming, Decision Tree and Bellman's Principle of Optimality, Decomposition, Non Linear Programming, Quadratic Programming, Kuhn-Tucker Condition, Dynamic Programming. Quadratic Programming, Bell's Method. Goal Programming, Assignment Problem.

UNIT SCHEDULE

BLOCK I: LINEAR PROGRAMMING

Unit 1 Introduction to Linear Programming & Operation Research.
Unit 2 Simplex method.
Unit 3 Big-M method
Unit 4 Two phase method and Degeneracy.
Unit 5 Duality

BLOCK II: REAL LIFE PROBLEM

Unit 6 Sensitivity Analysis.
Unit 7 Integral Programming.
Unit 8 Transportation.

BLOCK III: NON LINEAR PROGRAMMING

Unit 9 Non-Linear Programming.
Unit 10 Quadratic Programming.

BLOCK IV: DYNAMICAL PROGRAMMING

Unit 11 Integer Linear Programming Problems.
Unit 12 Dynamic Programming.
Unit 13 Wolfe's modified Simplex Methods, Bell's Method.
Unit 14 Goal Programming

Course Name: Fluid Mechanics
Course Code: MAT604
Credit:04

Kinematics of fluids in motion

Real fluids and Ideal fluids, Velocity of a Fluid at a point, Stream lines, Path lines, steady and Unsteady Flows, Velocity Potential, the Vorticity Vector, Local and Particle Rates of Changes, Equations of Continuity, worked Examples, Acceleration of a fluid, conditions at Rigid Boundary.

Equations of Motion of a Fluid

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Pressure at a Point in a fluid at Rest, Pressure at a point in moving Fluid, Conditions at the Boundary of two In viscous Immiscible Fluids, Euler's Equation of motion, Discussion of the case of steady Motion under Conservative Body Forces.

Two dimensional flow

Meaning of Two Dimensional Flow, Use of Cylindrical Polar Coordinates, The Stream Function, The Complex Potential for two Dimensional,

Irrotational, Incompressible flow, Complex velocity potentials for standard two dimensional flows, some worked Examples, Two-dimensional Image Systems, The Milne Thompson Circle Theorem.

Sources, Sinks and Doublets and Stokes function

Introduction of Sources, Sinks and Doublets, Images in Rigid infinite plane, Axis Symmetric Flows Stokes Stream Function. Relation between Cartesian Components of Stress Translational Motion of Fluid Elements, The rate of Strain Quadric and principal Stresses, Some further properties of the rate of strain Quadric, stress Analysis in fluid motion, Relation between stress and rate of strain, the coefficient of viscosity and Laminar flow, The Navier-Stokes Equations of Motion of a viscous Fluid. Stokes function, Property of Stokes function, Image of source relative to sphere, Image of doublet relative to sphere.

UNIT SCHEDULE

BLOCK I: KINEMATICS OF FLUIDS IN MOTION

UNIT 1 Real fluids and Ideal fluids.

UNIT 2 Velocity of a fluid.

UNIT 3 Equation of Continuity

BLOCK II: EQUATIONS OF MOTION OF A FLUID

UNIT 4 Pressure at a Point in a Fluid at Rest or in a Motion

UNIT 5 BoundaryConditions

UNIT 6 Motion under Conservative Body Forces

BLOCK III: TWO DIMENSIONAL FLOW

UNIT 7 Two dimensional flows

UNIT 8 Complex Velocity Potentials for Standard two Dimensional flows

UNIT 9 Two Dimensional Image System

BLOCK IV: SOURCES, SINKS AND DOUBLETS AND STOKES FUNCTION

UNIT 10 Sources, Sinks and Doublets.

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UNIT 11	Images in Rigid infinite plane.
UNIT 12	Relations between Cartesian Components of Stress- Translational Motion of fluid Elements
UNIT 13	The Rate of strain Quadric and Principal Stresses & its Property
UNIT 14	Stoke's Stream Function

FOURTH SEMESTER

Course Name: Operator Theory
Course Code: MAT605
Credit:04

SYLLABUS

Spectral properties

Spectral Theory of Linear Operators in Normed Spaces, Spectral Theory in Finite Dimensional Normed Spaces, Basic Concepts, Spectral properties of Bounded Linear Operators, Further Properties of Resolvant and Spectrum.

Complex analysis in Spectral theory

Use of Complex analysis in Spectral Theory

Banach Algebra and C*-Algebra

Banach Algebras, Further properties of Banach Algebra. Gelfand - Naimark theorem. C*-algebras , Non-commutative C*-algebras and Gelfand-Naimark-Segal construction.

UNIT SCHEDULE

BLOCK I: INTRODUCTION

UNIT 1	Basic Definition
UNIT 2	Basic Results

BLOCK II: SPECTRAL PROPERTIES

UNIT 3	Spectral Theory in Finite Dimensional Normed Spaces
UNIT 4	Spectral Theory in Infinite Finite Dimensional Normed Spaces
UNIT 5	Spectral properties of Bounded Linear Operators
UNIT 6	Resolvent and Spectrum

BLOCK III: COMPLEX ANALYSIS IN SPECTRAL THEORY

UNIT 7	Basic Concepts.

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UNIT 8 Use of Complex Analysis in Spectral Theory.

BLOCK IV: BANACH ALGEBRA AND C*-ALGEBRA

UNIT 9 Banach Algebras.

UNIT 10 Properties of Banach Algebra.

UNIT 11 Gelfand- Naimark theorem.

UNIT 12 C*-algebras.

UNIT 13 Properties of C*-algebras .

UNIT 14 Gelfand-Naimark-Segal construction.

Course Name: Number Theory
Course Code: MAT606
Course Credit: 4

SYLLABUS

Distribution of Primes and Theory of Congruencies

Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Twin-prime conjecture, Odd perfect numbers conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Number Theoretic Functions

Number theoretic functions for sum and number of divisors, Multiplicative function, The Möbius inversion formula, Greatest integer function, Euler's phi-function and properties, Euler's theorem.

Primitive Roots

Order of an integer modulo *n*, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, Euler's criterion.

Quadratic Reciprocity Law

The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli.

Applications

Public key encryption, RSA encryption and decryption with applications in security systems.

UNIT SCHEDULE

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BLOCK I: DISTRIBUTION OF PRIMES AND THEORY OF CONGRUENCIES

UNIT 1 Linear Diophantine equation, Prime counting function, Prime number theorem.

UNIT 2 Goldbach conjecture, Twin-prime conjecture, Odd perfect numbers conjecture.

UNIT 3 Fermat and Mersenne primes, Congruence relation and its properties.

UNIT 4 Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

BLOCK II: NUMBER THEORETIC FUNCTIONS

UNIT 5 Number theoretic functions for sum and number of divisors, Multiplicative function.

UNIT 6 The Möbius inversion formula, Greatest integer function.

UNIT 7 Euler's phi-function and properties, Euler's theorem.

BLOCK III: PRIMITIVE ROOTS

UNIT 8 Order of an integer modulo *n*, Primitive roots for primes.

UNIT 9 Composite numbers having primitive roots; Definition of quadratic

UNIT 10 Residue of an odd prime.

UNIT 11 Euler's criterion.

BLOCK IV: QUADRATIC RECIPROCITY LAW ANDAPPLICATIONS

UNIT 12 The Legendre symbol and its properties.

UNIT 13 Quadratic reciprocity, Quadratic congruencies with composite moduli

UNIT 14 Public key encryption.

UNIT 15 RSA encryption and decryption with applications in security systems.

Course Name: Combinatorics and Graph Theory
Course Code: MAT 607
Credit: 04

SYLLABUS

Partially ordered Set

Introduction of sets, Venn diagram, Partially ordered sets, lattices, complete lattices, Distributive lattices, complement Boolean algebra, Boolean expression, permutation and combinations, Pigeon-Hole principle, principle of inclusion and exclusion.

Graphs, Subgraphs and Trees

Graphs and Simple Graphs, Graph Isomorphism, the Incidence and Adjacency

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Matrices, Subgraphs, Vertex, Degrees, Paths and Connects, Cycles, Trees, Cut Edges and Bonds, Cut Vertices.

Connectivity, Euler Tour and Hamilton Cycles

Connectivity, Blocks, Euler Tours, Hamilton cycles, matching, matchings and Covering of Bipartite Graphs, Edge Chromatic Number, Vizing's Theorem.

Independent Sets and Cliques, Vertex colorings

Independent Sets, Ramsey's Theorem, Chromatic Number, Brooks 'Theorem, Chromatic Polynomials. Plane and planar Graphs, dual Graphs, Euler's Formula, Four-color Conjecture and five color theorem.

UNIT SCHEDULE

BLOCK I: PARTIALLY ORDERED SET

Unit 1 Introduction
Unit 2 Partially ordered Set
Unit 3 Lattices
Unit 4 Permutation & Combination

BLOCK II: GRAPHS, SUBGRAPHS AND TREES

Unit 5 Graphs & Simple Graphs.
Unit 6 Path & connection.
Unit 7 Trees

BLOCK III: CONNECTIVITY, EULER TOUR AND HAMILTON CYCLES

Unit 8 Connectivity.
Unit 9 Euler Tours.
Unit 10 Hamilton Cycles.
Unit 11 Matching & Edge Colouring

BLOCK IV: INDEPENDENT SETS AND CLIQUES, VERTEX COLOURINGS

Unit 12 Independent Sets.
Unit 13 Chromatic Number & Polynomial.
Unit 14 Plane and Planar Graphs.

Course Name: Classical Mechanics
Course Code: MAT608
Credit: 04

SYLLABUS

Mechanical Systems

The Mechanical System, Generalized Coordinates, Constraints, Virtual Work,

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Energy and Momentum. Derivation of Lagrange's Equations, Examples, Integrals of Motion, Lagrangian formulation for continuous System.

Hamilton's equations

Hamilton's Principle, Hamilton's Equation, The principle of least Action, Derivation of Hamilton's Equations from a Variational Principle and Cyclic Coordinates. Hamilton-Jacobi Equation for Hamilton Principle function.

Motion of rigid body

Motion of rigid body, Theory of small oscillations, Problems on Hamilton-Jacobi Method, Separability.

Canonical form

Differential Forms and Generating Functions, Special Transformations, Lagrange and Poisson Brackets.

UNIT SCHEDULE

BLOCK I: MECHANICAL SYSTEMS

UNIT 1 Mechanical Systems
UNIT 2 Generalized Coordinates
UNIT 3 Energy and Momentum
UNIT 4 Lagrange's Equations

BLOCK II: HAMILTON'S EQUATIONS

UNIT 5 Hamilton's Principle & Equation
UNIT 6 The principle of least Action
UNIT 7 Hamilton –Jacobi Equation for Hamilton Principle function
UNIT 8 Separability

BLOCK III: MOTION OF RIGID BODY

UNIT 9 Motion of Rigid Body
UNIT 10 Theory of Small Oscillation

BLOCK IV: CANONICAL TRANSFORMATION

UNIT 11 Differential Forms and Generating Functions
UNIT 12 Special Transformations
UNIT 13 Lagrange and Poisson Brackets
UNIT 14 Differential Forms and Generating Functions

Course Name: Theory of Relativity
Course Code: MAT609
Credit:04

SYLLABUS

Special Relativity

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Special Relativity: The relativity of simultaneity, the relativistic concept of space and time, Postulates of Special theory of Relativity. Lorentz Transformations Equations, Consequences of Lorentz Transformations, Time Dilation, Lorentz Transformation form a Group, Variation of mass with Velocity, Equivalence of Mass and Energy, Transformation Formula for Momentum and Energy.

Minkowski's Space and Energy Momentum

Minkowski's Space, Space and Time Like Intervals, World Point and World Lines, Energy Momentum Four Vector, Minkowski's Equation of Motion.

General Relativity

General Relativity: Principal of covariance, Non-inertial frames of reference, Principal of equivalence, Equality of Inertial and Gravitational Masses,

Geodesic and Covariant Curvature Tensor

Differential Equation of Geodesic, Geodesic Equations from Lagrangian Equation, Geodesic Co-ordinates, Transformation Law for Christoffel Symbols, Covariant Derivative of a Covariant Vector. Riemannian Christoffel's Curvature Tensor, Covariant Curvature Tensor, Properties of Covariant Curvature Tensor, Bianchi Identity, Uniform Vector Field, Flat Space Time.

Newtonian Equation of Motion and Einstein's Law of Gravitation

Energy Momentum Tensor, Einstein Field Equation, Newtonian Equation of Motion as an Approximation of Geodesic Equations, Field Equation, Poisson's Equations as an Approximation of field Equations. Einstein's Law of Gravitation in Empty Space, Exterior Solution, Birkhoff's Theorem, Isotropic Coordinates, Planetary Orbits. Crucial Tests in Relativity, Gravitational Deflection of Light rays Schwarzschild Interior Solution.

UNIT SCHEDULE

BLOCK I: SPECIAL RELATIVITY

UNIT 1 Special Relativity
UNIT 2 Lorentz Transformations Equations
UNIT 3 Transformation Formula for Momentum and Energy
UNIT 4 Minkowski Space
UNIT 5 Some applications of special theory of Relativity

BLOCK II: GENERAL RELATIVITY

UNIT 6 General Relativity
UNIT 7 Differential Equation of a Geodesic
UNIT 8 Curvature Tensor
UNIT 9 Flat Space Time

BLOCK III: RELATIVISTIC FIELD EQUATIONS

UNIT 10	Energy Momentum Tensor
UNIT 11	Newtonian Equation of Motion
UNIT 12	Schwarzschild Interior Solution
UNIT 13	Schwarzschild Exterior Solution
UNIT 14	Crucial Test in Relativity

Course Name: Mathematical Modelling
Course Code:MAT 610
Credit:04

SYLLABUS

Introduction of Mathematical modelling

Simple situations requiring mathematical modelling, techniques of mathematical modelling, Classifications.

Mathematical modelling through differential equation

Characteristics and limitations of mathematical models, Some simple illustrations. Mathematical modelling through differential equations, linear growth and decay models, Non-linear growth and decay models, Mathematical modelling in dynamics through ordinary differential equations of first order.

Mathematical Modelling through Difference Equations

Mathematical models through difference equations, some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modelling through difference equations in economic and
finance, Mathematical modelling through difference equations in population dynamic.

Mathematical modelling through linear programming

Mathematical modelling through linear programming, Linear programming models in Transportation and assignment.

UNIT SCHEDULE

BLOCK I: INTRODUCTION OF MATHEMATICAL MODELLING

UNIT 1	Some fundamental concepts, mathematical modelling
UNIT 2	Simple situations requiring mathematical modelling
UNIT 3	Techniques of mathematical modelling
UNIT 4	Classifications, Characteristics and limitations of mathematical models

BLOCK II: MATHEMATICAL MODELLING THROUGH DIFFERENTIAL EQUATION

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UNIT 5 Characteristics and limitations of mathematical models

UNIT 6 Mathematical modelling through differential equations

UNIT 7 linear growth and decay models

UNIT 8 Nonlinear growth and decay models

BLOCK III: MATHEMATICAL MODELLING DIFFERENCE EQUATIONS

UNIT 9 Basic theory of difference equations

UNIT 10 Mathematical modelling through difference equations in economic

UNIT 11 Mathematical modelling through difference equations in finance and some Simple models

BLOCK IV: MATHEMATICAL MODELLING THROUGH LINEAR PROGRAMMING

UNIT 12 Mathematical modelling through linear programming.

UNIT 13 Linear programming models in Transportation

UNIT 14 Linear programming models in assignment.

Course Name: Geometry
Course Code: MAT 611
Credit-04

SYLLABUS

Space Curves. Normal and Binormal. Curvature and Torsion. Fundamental Existence Theorem for space curves. Intrinsic Properties of a Surface. Surface of Revolution and Geodesics.

Fundamental Forms, Angle between Parametric Curves, Orthogonal Trajectories. n- Dimensional Space. Dummy Suffix Real Suffix, Transformation of Coordinate and Contravariant, Covariant, Addition, Subtraction & Multiplication of Tensor. Inner Product.

Metric and angle between two vector & Coordinate Curve. Gradient of a Scalar Function, Christoffel Symbols or Christoffel Brackets. Tensor Laws of Transformation of Christoffel Symbols. Divergence and Curl of a Vector.

UNIT SCHEDULE

BLOCK I: SPACE CURVES AND GENERAL THEORY OF LINEAR DIFFERENTIAL EQUATION

UNIT 1 Space Curves. Normal and Binormal

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UNIT 2	Curvature and Torsion and Fundamental Existence Theorem fo space curves
UNIT 3	Intrinsic Properties of a Surface
UNIT 4	Surface of Revolution and Geodesics

BLOCK II: RIEMANNIAN METRIC

UNIT 5	Fundamental Forms
UNIT 6	Angle between Parametric Curves
UNIT 7	Orthogonal Trajectories

BLOCK III: TENSOR ALGEBRA

UNIT 8	n- Dimensional Space
UNIT 9	Dummy Suffix Real Suffix
UNIT 10	Transformation of Coordinate and Contravariant, Covariant
UNIT 11	Addition, Subtraction & Multiplication of Tensor Inner Product

BLOCK IV: RIEMANNIAN METRIC AND SEQUENCES OF FUNCTIONS

UNIT 12	Metric and angle between two vector & Coordinate Curve
UNIT 13	Gradient of a Scalar Function
UNIT 14	Christoffel Symbols or Christoffel Brackets
UNIT 15	Tensor Laws of Transformation of Christoffel Symbols
UNIT 16	Divergence and Curl of a Vector

Course Code: Dissertation

Course Code: MAT612

This Course will be of 08 Credit including 2 credit viva voce. Dissertation and Viva-Voce examination are compulsory for Post Graduate programmes.

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