

FACULTY OF SCIENCES
SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

Programme Code: MMAH

Programme Name: M.Sc. Mathematics (Under the Honours Scheme)
(Semester I-IV)

Examinations: 2023-2025



Department of Mathematics
Khalsa College, Amritsar

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(b) Subject to change in the syllabi at any time.
(c) Please visit the College website time to time.

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

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S.No.	PROGRAMME OBJECTIVES
1.	To enhance problem solving skills and develop logical thinking.
2.	To exhibit proficiency in application of mathematics to solve daily life problems

S.No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	Understand the nature of abstract mathematics and explore the concepts in various fields.
PSO-2	Comprehend and write effective reports and design documentation related to mathematical research and literature, make effective presentations.
PSO-3	To make them expertise in using ICT tools in solving problems in mathematics.
PSO-4	Inculcate mathematical reasoning and assimilate complex mathematical ideas and arguments.
PSO-5	Communicate mathematical ideas with clarity and coherence, both written and verbally.

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COURSE SCHEME											
SEMESTER - I											
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.
			L	T	P		Th	P	IA	Total	
Major Courses											
MHMH-411	Real Analysis-I	6	5	1	0	6	75	-	25	100	5-6
MHMH-412	Modern Algebra	6	5	1	0	6	75	-	25	100	7-8
MHMH-413	Classical Mechanics and Calculus of variations	6	5	1	0	6	75	-	25	100	9-10
MHMH-414	Complex Analysis	6	5	1	0	6	75	-	25	100	11-12
MHMH-415	Differential Equations	6	5	1	0	6	75	-	25	100	13-14
*MHMH-416	Latex Lab-I	4	2	0	2	4	-	37	13	50	15-16
Total		30	25	5	0	30	-	-	-	500	

SEMESTER - II											
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.
			L	T	P		Th	P	IA	Total	
Major Courses											
MHMH-421	Real Analysis-II	6	5	1	0	6	75	-	25	100	17-18
MHMH-422	Advanced Algebra	6	5	1	0	6	75	-	25	100	19-20
MHMH-423	Number Theory	6	5	1	0	6	75	-	25	100	21-22
MHMH-424	Differential Geometry	6	5	1	0	6	75	-	25	100	23-24
MHMH-425	Partial Differential Equations and Integral Equations	6	5	1	0	6	75	-	25	100	25-26
*MHMH-426	Latex Lab-II	4	2	0	2	4	-	37	13	50	27-28
Total		30	25	5	0	30	-	-	-	500	

*Pass Course

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SCHEME											
SEMESTER - III											
Course Code	Course Name	Hours/Week	Credits			Total Credits	Max Marks				Page No.
			L	T	P		Th	P	IA	Total	
Major Courses											
MHMH-531	Functional Analysis-I	6	5	1	0	6	75	-	25	100	29-30
MHMH-532	Topology-I	6	5	1	0	6	75	-	25	100	31-32
MHMH-533	Advanced Linear Algebra	6	5	1	0	6	75	-	25	100	33-34
MHMH-534	Statistics-I	6	5	1	0	6	75	-	25	100	35-36
Choose any one of the following subjects											
MHMH-535A	Applied Statistics	6	5	1	0	6	75	-	25	100	37-38
MHMH-535B	Project	6	-	2	4	6	-	75	25	100	39
Total		30	25	5	0	30	-	-	-	500	

SEMESTER - IV												
Course Code	Course Name	Hours/Week	Credits			Total Credits	Max Marks				Page No.	
			L	T	P		Th	P	IA	Total		
Major Courses												
MHMH-541	Functional Analysis-II	6	5	1	0	6	75	-	25	100	40-41	
MHMH-542	Topology-II	6	5	1	0	6	75	-	25	100	42-43	
MHMH-543	Discrete Mathematics	6	5	1	0	6	75	-	25	100	44-45	
MHMH-544	Statistics-II	6	5	0	1	6	60	15	T 20	P 5	100	46-47
MHMH-545	Operations Research	6	5	1	0	6	75	-	25	100	48-49	
Total		30	25	4	1	30	-	-	-	500		

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Syllabus for

PROGRAMME: M.Sc.-Mathematics (UHS) (Semester-I)**COURSE CODE-MHMH- 411****COURSE TITLE: REAL ANALYSIS-I**

L	T	P	Credits
5	1	0	6

COURSE CREDIT(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory Marks: 75****Internal Assessment: 25)****Medium: English****Time: 3Hrs.****INSTRUCTIONS FOR PAPER SETTERS:**

1. The question paper will consists of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- This course introduce students to the fundamentals of mathematical analysis
- The objective of this course is to enable students to understand the concept of cardinality of a set, open sets, closed sets, compact sets and connected sets.
- Students will realize how these notions are generalized from real line to metric spaces.

COURSE CONTENT:**Unit-I**

Set Theory: Finite, countable and uncountable sets. Metric spaces: Definition and examples, open sets, closed sets, compact sets, elementary properties of compact sets, k- cells, compactness of k- cells, Compact subsets of Euclidean space \mathbb{R}^k , Perfect sets, The Cantor set.

Unit-II

Separated sets, connected sets in a metric space, Connected subsets of real line, Components, Functions of Bounded Variation, Sequences in Metric Spaces: Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Complete metric spaces, Cantor's Intersection Theorem

Unit-III

Baire's theorem, Banach contraction principle, Continuity: Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform Continuity.

Unit-IV

The Riemann Stieltje's Integral: Definition and existence of Riemann Stieltje's integral, Properties of integral. Integration and Differentiation. Fundamental Theorem of Calculus, 1st and 2nd Mean Value Theorems of Riemann Stieltje's integral.

Books Recommended:

1. Walter Rudin : Principles of Mathematical Analysis (3rd Edition) McGraw-Hill Ltd Ch.2, Ch.3, (3.1-3.12), Ch.4, Ch.6, (6.1-6.22)
2. Simmons, G.F. : Introduction to Topology and Modern Analysis, McGraw- Hill Ltd(App.1) pp337-338, Ch.2(9-13)
3. Shanti Narayan : A course of Mathematical Analysis.
4. Apostol, T.M. : Mathematical Analysis 2nd Edition 7.18(Th.7.30&7.31)
5. Malik, S.C and Savita Arora. : Mathematical Analysis, Wiley Eastern Ltd.

COURSE OUTCOMES : On completing the course, the students will be able to:

- introduces students to the fundamentals of mathematical analysis and reading and writing mathematical proofs.
- correlate Calculus with real analysis by finding infinite sums and evaluating limits to understanding the concept of continuity and uniform continuity one is doing real analysis.
- understand the abstract language of Mathematics.
- generalize mathematical concepts to higher dimensions.

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Syllabus for
PROGRAMME: M.Sc.-Mathematics (UHS) (Semester-I)
COURSE CODE-MHMH- 412

COURSE TITLE: MODERN ALGEBRA

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK):6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs

Medium: English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- To understand Groups, Rings, Ring homomorphisms, Direct product of the rings and Euclidean Rings.
- To study the Composition series, Groups of automorphisms, Symmetric groups and Alternating groups.

COURSE CONTENT:

Unit-I

Composition series, the Jordan Holder theorem, Groups of automorphisms, Inner automorphisms, Symmetric groups, Alternating groups, Sylow's theorems, p-groups.

Unit-II

Nilpotent groups, Simplicity of A_n ; $n \geq 5$, Cayley's theorem, the imbedding theorem, Commutator subgroup, Characteristic Subgroup, Solvable groups, Sequences of subgroups.

Unit-III

Direct product and semi direct product of groups, Fundamental theorem of finitely generated abelian groups, groups of symmetries.

Unit IV

Rings, Subrings, Ideals, Factor rings, Homomorphisms, Integral domains, Maximal and prime ideals.

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BOOKS PRESCRIBED:

1. Artin, M : Algebra, Prentice-Hall, 1991
2. I.N. Herstein, : Topics in Algebra, 2nd edition, Wiley I
3. Dummit, D.S.: Abstract-Algebra, John-Wiley & Sons, Students Edition-1999 & Foote
4. Fraleigh, J. B.: An Introduction to Abstract Algebra.
5. J Gallian : Contemporary Abstract Algebra, CENGAGE.
6. Surjit Singh & Qazi zamerrudin. Modern Algebra, Vikas Pub. House.

COURSE OUTCOMES: On completing the course, the students will be able to:

- recognize the foundation required for more advanced studies in Algebra.
- Investigate symmetry using group theory.
- Understand the concept of various algebraic structures.
- Understand the importance of algebraic properties relative to working within various number systems.

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Syllabus for
PROGRAMME: M.Sc.-Mathematics (UHS) (Semester-I)
COURSE CODE-MMH- 413

COURSE TITLE: CLASSICAL MECHANICS AND CALCULUS OF VARIATIONS

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)**

Time: 3Hrs
Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The course will introduce the concepts of Lagrange's equation for holonomic and non holonomic constraints.
- The course is designed to introduce the applications of Lagrange's formulation and generalized coordinates.
- The course gives introduction of fundamental problems of calculus of variations and variational problems with moving boundaries.
- The course explains the concepts of variation of a functional and its properties.

COURSE CONTENT:**Unit-I**

Generalized co-ordinates and generalized velocities, virtual work, generalized forces, Lagrange's equations for a holonomic dynamical system, conservative system, holonomic dynamical system for impulsive forces and their applications.

Unit-II

Kinetic energy as a quadratic function of velocities, theory of small oscillations, Functional, variation of functional and its properties, fundamental lemma of calculus of variation, Euler's equations, necessary and sufficient conditions for extremum, The Brachistochrone problem, Functionals dependent on higher order derivatives and several dependent variables.

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Unit-III

Variational problems with fixed boundaries, Transversality conditions, Orthogonality conditions, Sturm-Liouville's theorem on extremals, one sided variations, Hamilton's principle, The principle of least action, Lagrange's equations from Hamilton's principle.

Unit-IV

Variational Methods: The Ritz method, Kantorovich Method for Boundary value problems in ODE's & PDE's, Isoperimetric Problems.

BOOKS PRESCRIBED:

1. Chorlton, F.: Text Book of Dynamics.
2. Elsgolts, L: Differential Equations and the Calculus of Variations.
3. Gelfand, I.M. and Fomin, S.V.: Calculus of Variations.

COURSE OUTCOMES: On completing the course, the students will be able to:

- apply the classical mechanics approach to solve a mechanical problem.
- understand the concept of functional and determine stationary paths of a functional to deduce the differential equation for stationary paths.
- describe and understand the motion of a mechanical system using Lagrange Hamilton formalism.
- recognize the degrees of freedom and understand the concept of generalized coordinates.

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Syllabus for**PROGRAMME: M.Sc.-Mathematics (UHS) (Semester-I)****COURSE CODE: MHMH- 414****COURSE TITLE: COMPLEX ANALYSIS**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs**

Medium: English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- To provide an introduction to the theories for functions of a complex variable.
- The content of this course is designed to make the students understand the properties of analytic functions.
- To present complex integration and complex power series.
- To understand concept of poles, singularities, residues, contour integration and conformal mappings and their applications.

COURSE CONTENT:**Unit-I**

Functions of complex variables, continuity and differentiability. Analytic functions, Conjugate function, Harmonic function. Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions, Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form.

Unit-II

Cauchy's inequality. Poisson's integral formula, Morera's theorem. Liouville's theorem, Power Series, Taylor's theorem, Laurent's theorem. Maximum Modulus Principle. Schwarz's lemma. Theorem on poles and zeros of meromorphic functions.

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Unit–III

Zeros, Singularities, Residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma. Integration round Unit circle. Evaluation of integrals of the type of $\int_{-\infty}^{\infty} f(x)dx$ and integration involving many valued functions.

Unit–IV

Fundamental theorem of Algebra and Rouché's theorem. Argument principle. Conformal transformations. Bilinear transformations. Critical points, fixed points, cross-ratio. Problems on cross-ratio and bilinear transformation.

BOOKS RECOMMENDED:

1. Copson, E.T.: Theory of functions of complex variables.
2. Ahlfors, D. V.: Complex analysis.
3. Kasana, H.S. : Complex variables theory and applications.
4. Conway, J.B.: Functions of one complex variable
5. Shanti Narayan : Functions of Complex Variables.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Demonstrate to accurate and efficient use of complex analysis technique.
- Apply problem solving using evaluation of improper integral by Cauchy residue theorem.
- understand the properties of analytic functions.
- to understand the concept of poles, singularities, residues, contour integration and conformal mappings and their applications.

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Syllabus for

PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-I)**COURSE CODE-MHMH- 415****COURSE TITLE: DIFFERENTIAL EQUATIONS**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- Studentms will be able to know how to model the world in terms of differential equations, and how to solve those equations and interpret the solutions.
- Students will understand properties of solutions of differential equations is fundamental to much of contemporary science and engineering.
- Ordinary differential equations (ODE's) will help the students to deal with functions of one variable, which can often be thought of as time.

COURSE CONTENT:**Unit-I**

Existence and uniqueness theorem for solution of the equation $dy/dx = f(x,y)$, The method of successive approximation, general properties of solution of linear differential equation of order n, adjoint and self-adjoint equations, Total differential equations. Simultaneous differential equations, orthogonal trajectories, Sturm Liouville's boundary value problems. Sturm comparison and Separation theorems, Orthogonality solution.

Unit-II

Laplace Transform: Definition, existence, and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace transform solution of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit-III

Fourier Transform: Definition, existence, and basic properties, Convolution theorem, Fourier transform of derivatives and Integrals, Inverse Fourier transform, solution of linear ordinary differential equations, Complex Inversion formula.

Unit-IV

Special Functions: Solution, Generating function, recurrence relations and orthogonality of Legendre polynomial, Bessel functions, Hermite and Laguerre polynomials.

BOOKS RECOMMENDED:

1. Piaggio, H.T.H.: Differential equations.
2. Ross, S.L.: Differential equations.
3. Sneddon, I. N. : Elements of partial differential equations.

COURSE OUTCOMES: On completing the course, the students will be able to:

- learn to express laws of nature with the help of differential equations.
- know how to model the world in terms of differential equations, and how to solve those equations and interpret the solutions.
- to focus on the equations and techniques most useful in science and engineering.
- understand properties of solutions of differential equations is fundamental to much of contemporary science and engineering.
- formulate, classify and transform first order partial differential equation into canonical forms

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Syllabus for

PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-I)

Course Title: Latex Lab-I

Semester-I

Course Code: MHMH-416

L	T	P	Credits
2	0	2	4

TOTAL HOURS: 60 hrs.

MAXIMUM MARKS: 50

PRACTICAL :37

INTERNAL ASSESSMENT:13

Time: 3Hrs

Medium -English

Course Objectives:

By the end of the course, students should be able to:

- TO know about history and installation of latex software
- Create documents with mathematical equations, tables, and figures using LaTeX.
- Apply different symbols , operators and matrices and citations
- To get knowledge about cross-referencing

Course CONTENT:

Introduction to LaTeX:

- History, features, and advantages of using LaTeX.
- Installing LaTeX Distribution: Downloading and setting up a LaTeX distribution on different platforms (Windows, macOS, Linux), Installation of Kile and MikeTeX.
- First Document: Preamble preparation, Class and packages (.cls and .sty files),
Introduction to Math Mode: Typesetting mathematical expressions and equations.

Advanced Math Mode:

- Working with mathematical symbols, operators, and matrices, Creating a basic LaTeX document with sections, text, and simple formatting. Error messages: Some sample errors, list of LaTeX error messages
- Cross-referencing and Citations: Creating labels, references, and bibliographies in LaTeX.
- Lists and Tables: Creating bulleted lists, numbered lists, and tables in LaTeX.

Course outcome :

Students will be able

- to install latex software & MikeTex software
- to learn the working with mathematical symbols , operators and matrices in Latex
- to write up cross references and Citations, list of tables in Latex Documents

Reference books:

"The LaTeX Companion" by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, Chris Rowley.

"Getting to Grips with LaTeX" by Andrew Roberts.

"LaTeX: A Document Preparation System" by Leslie Lamport.

"Math into LaTeX: An Introduction to LaTeX and AMS-LaTeX" by George Grätzer.

"LaTeX for Beginners" by David R. Wilkins.

"LaTeX in 24 Hours: A Practical Guide for Scientific Writing" by Dilip Datta.

"LaTeX Tutorials - A Primer" by Indian TEX Users Group.

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Syllabus for

PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-II)**COURSE CODE-MHMH- 421****COURSE TITLE:REAL ANALYSIS –II**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The course objective is to enable students to understand Riemann Stieltjes integrability of a bounded function and prove a selection of theorems concerning integration.
- Students will recognize the difference between pointwise and uniform convergence of sequence and series of functions.
- Students will be familiar with the Riemann Stieltje's integral which is generalization of the Riemann integral.
- Students will analyze the applications of Power series in the field of engineering i.e in spectrum analysis, radio, audio, and light applications.

COURSE CONTENT:**Unit-I**

Sequence and Series of functions: Discussion of main problem, Uniform Convergence, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem.

Unit-II

Outer Measure, Lebesgue Measure, Properties of Measurable Sets, Non Measurable Sets, Measurable Functions: Definition & Properties of Measurable functions.

Unit-III

Characteristic functions, Step Functions and Simple Functions, Littlewood's three Principles, Lebesgue Integral: Lebesgue Integral of bounded function, Comparison of Riemann and

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Lebesgue Integral, Integral of a non negative function, General Lebesgue Integral, Convergence in measure.

Unit-IV

Differentiation and Integration: Differentiation of monotone functions, Differentiation of an integral, Absolute Continuity.

Books Recommended:

1. Walter Rudin :Principles of Mathematical Analysis (3rd edition) McGraw Hill Ltd. Ch. 7 (7.1-7.27)
2. Royden, H.L. and Fitzpatrick, P.M. :Real Analysis, Macmillan Co. (Ch. 3, 4, 5 excluding section 2, 5)

COURSE OUTCOMES: On completing the course, the students will be able to:

- study the behavior of sequences and series of functions.
- get familiar with the Riemann Stieltje's integral which is generalization of the Riemann integral.
- analyze the applications of Power series in the field of engineering i.e in spectrum analysis, radio, audio, and light applications.
- understand Riemann Stieltjesintegrability of a bounded function and prove a selection of theorems concerning integration.
- recognize the difference between pointwise and uniform convergence of sequence and series of functions, Equicontinuous families of functions, Arzela Ascoli's theorem and Weierstrass Approximation Theorem .

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Syllabus for**PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-II)****COURSE CODE-MHMH- 422****COURSE TITLE: ADVANCED ALGEBRA**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- To understand Principal Ideal domains, Euclidean Rings and Unique factorization domains.
- To study the Modules and Structure theorem of modules over PID's.
- To study the theory of fields.

COURSE CONTENT:**Unit-I**

The field of quotients of an integral domain, Principal Ideal domains, Euclidean Rings. The ring of Gaussian Integers, Unique factorization domains, Polynomial rings, Gauss Theorem and irreducibility of a polynomial.

Unit-II

Extension Fields: Finite and Infinite, Simple and Algebraic Extensions, Splitting fields: Existence and uniqueness theorem. Separable and inseparable extensions, perfect fields, finite fields.

Unit-III

Existence of $GF(p^n)$, construction with straight edge ruler and compass, Galois Theory: Group of automorphisms of a field. Normal extensions and Fundamental Theorem of Galois theory. Symmetric rational functions, Solvability by radicals.

Unit-IV

Modules, Submodules, free modules, quotient modules, Homomorphism theorems, Direct sums, Finitely generated modules, Simple modules, Cyclic modules.

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BOOKS PRESCRIBED:

1. Fraleigh, J. B.: A first course in Abstract Algebra 7th edition, Narosa Publishing House, New Delhi.
2. Singh ,S. and Zameeruddin ,Q.: Modern Algebra, Vikas Publishing House, New Delhi.
3. Dummit, D.S. & Foote, R.M. : Abstract-Algebra, John-Wiley & Sons, Students Edition-1999
4. Bhattacharya, P.B.,Jain, S.K., Nagpal, S.R. : Basic Abstract Algebra, Cambridge University Press, 1997.
5. Musili, C.: Rings and Modules, Narosa Publishing House, New Delhi, 1994.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Use ring theory in wide areas of current research in mathematics, computer science and mathematical/theoretical physics.
- introduce themselves with the concepts and develop working knowledge on simple ring and ring homomorphism.
- know the structure of rings, their representations, modules, special classes of rings (group rings, division rings, and universal enveloping algebras).
- Deal with developments of commutative ring theory and field theory, which is a major area of modern mathematics.
- appreciate the significance of unique factorization in rings and integral domains.

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Syllabus for**PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-II)****COURSE CODE-MHMH- 423****COURSE TITLE:NUMBER THEORY**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs**

Medium: English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consists of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The content of this course is designed to make the students understand the various types of numbers and their properties.
- It will help the students to use various arithmetic functions and the concept of congruences to solve various arithmetic problems.
- Students will analyze the concept of continued fractions and Pythagorean triplets and insolvability of Diophantine equations.

COURSE CONTENT:**Unit-I**

Simultaneous Linear Congruences, Chinese Remainder theorem with applications, Wolsten-Holme's theorem, Lagrange's proof of Wilson theorem, Fermat numbers, The order of an integer modulo n . Primitive roots, Existence and number of primitive roots.

Unit-II

Indices and their applications, Quadratic residues, Euler's criterion, Product of quadratic residues and quadratic non-residues, The Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties..

Unit-III

Arithmetic functions $\tau(n)$, $\sigma(n)$, $\sigma_k(n)$, $\mu(n)$, Perfect numbers, Mobius inversion formula, Diophantine equation $x^2 + y^2 = z^2$ and its applications to $x^n + y^n = z^n$ when $n = 4$., Criterion for an integer to be expressible as sum of two squares and sum of four squares

Unit-IV

Farey series, Farey dissection of a circle and its applications to approximations of irrationals by rationals, Finite and Infinite simple continued fractions, periodic and purely periodic continued fractions, Lagrange's Theorem on periodic continued fractions. Applications to Pell's equation. The fundamental solution of Pell's equation.

BOOKS RECOMMENDED:

1. Hardy, G.H. and Wright, Herbert, S. : Theory of Numbers.
2. Niven, Ivan and Zuckerman, E.M. : An introduction to number theory.
3. Burton, David M. : Elementary Number Theory, McGraw Hill 2002.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Form the bridge between pure mathematics and applied mathematics.
- Apply Number Theory in mathematics as well in practical applications such as security system like in banking securities, coding theory, barcodes and memory management systems.
- understand the various types of numbers and their properties.
- use various arithmetic functions and the concept of congruences to solve various arithmetic problems.
- Analyze the study of integers and integer-valued functions.

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Syllabus for**PROGRAMME:M.Sc.-Mathematics (UHS) (Semester-II)****COURSE CODE-MHMH- 424****COURSE TITLE: DIFFERENTIAL GEOMETRY**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The aim of this course is to get the students familiar with curvature and torsion of space curves.
- To understand the relation of tangent planes, principal normals and binormals, the intrinsic and non-intrinsic properties of surfaces.
- To understand concept of geodesics,its curvature and torsion.
- To make students familiar with concept of tensors analysis, their addition, subtraction, multiplication and inner multiplication.

COURSE CONTENT:**Unit-I**

Notation and summation convention, transformation law for vectors, Kronecker delta, Cartesian tensors, addition, multiplication, contraction and quotient law of tensors. Differentiation of Cartesians tensors, metric tensor, contra-variant, covariant and mixed tensors, Christoffel symbols. Transformation of christoffel symbols and covariant differentiations of a tensor.

Unit-II

Theory of Space Curves: Tangent, principal normal, bi-normal, curvature and torsion. Serret-Frenet formulae. Contact between curves and surfaces. Locus of centre of curvature, spherical curvature, Helices. Spherical indicatrix, Bertrand curves.

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Unit-III

Surfaces, envelopes, edge of regression, developable surfaces, two fundamental forms. Curves on a surface, Principle Directions, Lines of Curvature, Principal Curvatures, Mainardi-Codazzi equations.

Unit-IV

Geodesics, Differential Equation of Geodesic, torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem.

Books Recommended:

1. Lass, H.: Vector and Tensor Analysis
2. Shanti Narayan: Tensor Analysis
3. Weather burn, C.E.: Differential Geometry
4. Willmore, T.J.: Introduction to Differential Geometry
5. Bansi Lal : Differential Geometry

COURSE OUTCOMES: On completing the course, the students will be able to:

- familiar with curvature and torsion of space curves, the relation of tangent planes, principal normals and binormals.
- know the intrinsic and non-intrinsic properties of surfaces and geodesics,
- understand the order of different types of tensors.

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Syllabus for
PROGRAMME: M.Sc. Mathematics (UHS) (Semester-II)
COURSE CODE-MHMH- 425

**COURSE TITLE: PARTIAL DIFFERENTIAL EQUATIONS
AND INTEGRAL EQUATIONS**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs
Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A, which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The objective of this course is to provide students an understanding of Laplace and Fourier Transforms and enable them to apply these for solving simultaneous, linear and partial differential equations.
- The concept of Volterra and Fredholm integral equations and solutions of these equations using various methods.

COURSE CONTENT:

Unit-I

Partial Differential Equations of First Order: origin of first order partial differential equations. Cauchy problem of first order equations. Integral surface through a given curve. Surface orthogonal to given system of surfaces. Non linear p.d.e of first order, Charpit's method and Jacobi's method. Partial differential equations of the 2nd order. Origin of 2nd order equations. Linear p.d.e. with constant coefficients and their complete solutions.

Unit-II

Second order equation with variable coefficient and their classification and reduction to standard form. Solution of linear hyperbolic equation. Non-linear equations of second order, Monge's Method. Solution of Laplace, wave and diffusion equations by method of separation of variables and Fourier transforms. Green function for Laplace, waves and diffusion equation.

Unit-III

Volterra Equations : Integral equations and algebraic system of linear equations. Volterra equation L2 Kernels and functions. Volterra equations of first & second kind. Volterra integral equations and linear differential equations.

Unit-IV

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Fredholm equations, solutions by the method of successive approximations. Neumann's series, Fredholm's equations with Pincherte-Goursat Kernel's, The Fredholm theorem (Scope same in chapters I and II excluding 1.10 to 1.13 and 2.7 of integral equations by F.G. Tricomi's).

BOOKS PRESCRIBED:

1. Tricomi, F.G. : Integral Equation (Ch. I and II)
2. Kanwal R, P : Linear Integralequations
3. S.G. Mikhlin : Integral Equations
4. Pinckus, A. and Zafrany, S.: Fourier Series and Integral Transforms

COURSE OUTCOMES: On completing the course, the students will be able to:

- prepare themselves with mathematical tools and techniques that are required in advanced courses offered in the applied mathematics and engineering problems.
- apply concept of mathematical methods in diverse areas of science and technology such as electric analysis, communication engineering, solution of partial differential operation.
- learn to solve the Integral equations which are encountered in various problems including radiative transfer, and the oscillation of a string, membrane, or axle.
- understand the concept of Laplace and Fourier Transforms and enable them to apply these for solving simultaneous, linear and partial differential equations.
- interpret the concept of Volterra and Fredholm integral equations and find solutions of these equations using various methods

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Syllabus for
PROGRAMME:M.Sc. Mathematics (UHS) (Semester-II)

Course Title: Latex Lab -II

Course Code:MHMH-426

L	T	P	Credits
2	0	2	4

TOTAL HOURS: 60 hrs.

MAXIMUM MARKS: 50

PRACTICAL :37

INTERNAL ASSESSMENT:13

Course Objectives:

By the end of the course, students should be able to:

- Understand the basic syntax and structure of LaTeX documents.
- Create documents with mathematical equations, tables, and figures using LaTeX.
- Apply formatting styles and packages to enhance the appearance of documents.
- Troubleshoot common issues and errors in LaTeX documents.
- Gain proficiency in creating academic papers, reports, and presentations using LaTeX.

Course Outline:

- Graphics and Figures: Including images and figures in LaTeX documents.

Customizing Document Layout: Adjust margins, page layout, and headers/footers.

- Document Classes: Exploring different document classes for specific purposes (article, report, book, etc.).
- Packages and Environments: Using LaTeX packages to enhance document features.

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- **Lab Practical Work:** Practical exercises to apply LaTeX concepts covered in lectures.
- **Troubleshooting LaTeX:** Common errors and solutions in LaTeX document compilation.
- **Final Project:** Students will work on a final project to create a well-structured document showcasing the skills they've acquired throughout the course.

Course outcome :

Students will be able

- to install latex software & MikeTex software
- to learn the working with mathematical symbols , operators and matrices in Latex
- to write up cross references and Citations, list of tables in Latex Documents

Reference books:

"The LaTeX Companion" by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, Chris Rowley.

"Getting to Grips with LaTeX" by Andrew Roberts.

"LaTeX: A Document Preparation System" by Leslie Lamport.

"Math into LaTeX: An Introduction to LaTeX and AMS-LaTeX" by George Grätzer.

"LaTeX for Beginners" by David R. Wilkins.

"LaTeX in 24 Hours: A Practical Guide for Scientific Writing" by Dilip Datta.

"LaTeX Tutorials - A Primer" by Indian TEX Users Group.

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Syllabus for**PROGRAMME:M.Sc. Mathematics(UHS) (Semester-III)****COURSE CODE-MMH- 531****COURSE TITLE: FUNCTIONAL ANALYSIS-I**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
 3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
 4. Question paper should cover at least 40% article work from the recommended books.
 5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The objective of this course is to provide the main concepts and fundamental methods of functional analysis to enable a student to treat various concrete problems based on Hilbert spaces.
- Students will study the conjugate spaces and their properties.
- Students will learn about compact linear operators and spectral theory.

Unit-I

Normed linear spaces, Banach spaces, subspaces, quotient spaces. Continuous linear transformations.

Unit-II

Equivalent norms, Finite dimensional normed linear spaces and compactness, Riesz Lemma, The conjugate space N^* .

Unit-III

The Hahn-Banach theorem and its consequences. The natural imbedding of N into N^{**} , reflexivity of normed spaces. Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle.

Unit-IV

Conjugate operators. L_p -spaces: Holder's and Minkowski,s inequalities, completeness of L_p -spaces.

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BOOKS PRESCRIBED:

- 1 .G.F. Simmons: Introduction to Topology and Modern Analysis, Ch. 9, Ch.10 (Sections 46 - 51), Mc.Graw-Hill International Book Company, 1963.
2. Royden, H. L. & P.M. Fitzpatrik: Real Analysis, Ch 6 (Sections 6.1 -6.3), Macmillan Co. 1988.
3. Erwin Kreyszig : Introduction. to Functional Analysis with Applications John Wiley & Sons,1978.
4. Balmohan V. Limaye: Functional Analysis, New Age International Limited.
- 5 .P.K.Jain and O.P Ahuja : Functional Analysis, New Age International (P) Ltd Publishers, 2010
6. K. Chanrashekhra Rao : Functional Analysis, Narosa, 2002
7. D. Somasundram: A First Course in Functional Analysis, Narosa, 2006

COURSE OUTCOMES: On completing the course, the students will be able to:

- Learn the main concepts and fundamental methods of functional analysis to treat various concrete problems based on Banach spaces.
- study the certain classes of functions defined in functional spaces.
- learn the various examples of banach spaces.
- verify the requirements of a norm and completeness with respect to a norm.
- compute the spectrum of operators and classify the set into sub-classes.

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Syllabus for**PROGRAMME:M.Sc. Mathematics(UHS) (Semester-III)****COURSE CODE-MHMH- 532****COURSE TITLE: TOPOLOGY-I**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

Course Objective:

- To prove basic results about completeness, compactness, connectedness and convergence within these structures.
- To demonstrate an understanding the concepts of topological sciences and their role in mathematics.

Unit-I

Topological Spaces, Basic concepts, closure, interior, exterior and boundary of a set. Dense sets, Closure operator [Kuratowski function] and Interior operator. Neighbourhoods and neighbourhood system, Coarser and finer topologies. Local bases, bases and sub – bases for a topological space. Convergence of a sequence. First and second countable spaces. Lindeloff spaces, Separable spaces. Sub-spaces, Hereditary properties.

Unit-II

Separated sets, Connected sets, Connected and disconnected spaces, Connectedness on real line. Components, Locally connected space. Totally disconnected space, Continuous functions, Restriction and extension of a mapping. Sequential continuity at a point. Invariants under a continuous mapping. Open and closed mappings. Homeomorphism and embedding. Topological properties.

Unit-III

Product of two spaces, The product of n spaces. Base for a finite product topology. General product spaces. Sub-base and base for product topology. Productive properties. Quotient spaces.

Unit-IV

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Separation Axioms: T_0 , T_1 , T_2 – spaces. Regular spaces, T_3 – spaces, Normal spaces, T_4 – space. Tychonoff lemma, Urysohn lemma, Tietze extension theorem.

BOOKS RECOMMENDED:

1. T.O. Moore : Elementary general topology (Chapter 2 to 8).
2. J.L. Kelley : General Topology (Chapter 1 to 5).
3. J.R. Munkres : Topology.
4. G.F. Simmons: Introduction to Topology and Modern Analysis.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Understand the mathematical tools that are useful to applied mathematicians and to theoretical physicists.
- understand the various topological spaces and their properties, separation axioms, Tietz extension theorem and Tychonoff theorem.

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Syllabus for
PROGRAMME: M.Sc. Mathematics (UHS) (Semester-III)
COURSE CODE-MHMH- 533

COURSE TITLE: ADVANCED LINEAR ALGEBRA

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs
Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
 3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
 4. Question paper should cover at least 40% article work from the recommended books.
 5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The course will introduce the basic concepts of dual spaces and its general proofs.
- The course is designed to introduce the relationship of matrices and linear transformations and different classes of linear operators on inner product spaces and their structures.
- The course gives introduction of inner product spaces, orthogonal vectors, orthogonal sets and Gram Schmidt orthogonalization process.
- The course explains the concepts of bilinear and quadratic forms on vector spaces.

Unit-I

Linear Functionals, Dual spaces and Dual basis, The double dual, Subspaces invariant under linear operators, Characteristic and minimal polynomials, Eigen values and Eigen Vectors of Linear Operators.

Unit-II

Triangulation, Diagonalization, Jordan canonical form, Generalized eigen vectors, canonical basis, rational canonical form.

Unit-III

Bilinear forms, Self-Adjoint Operators, Sylvester's theorem, quadratic forms, Hermitian forms.

Unit-IV

Inner Product Spaces, The Gram-Schmidt Orthogonalization, orthogonal complements. The Adjoint of a Linear operator on an inner product space, Normal and Unitary Operators, Spectral Theorem.

BOOKS PRESCRIBED:

1. Hoffman, K. and Kunze, R.: Linear Algebra, Second Edition, Prentice Hall, 1971
2. Axler, S.: Linear Algebra Done Right, Second Edition, Springer-Verlag, 1997
3. Friedberg, S.H., Insel, A.J., Spence, L.E. : Linear Algebra, Fourth Edition Prentice Hall, 2003
4. Lang, S.: Linear Algebra, Third edition Springer-Verlag, 1987.
5. Sahai, Vivek and Bist, Vikas: Linear Algebra, Narosa Publishing House, 2008

COURSE OUTCOMES: On completing the course, the students will be able to:

- become familiar with the concepts of linear independence, basis, span, linear maps, the properties of linear transformations and orthogonal decomposition of inner product spaces.
- have a good knowledge of inner product spaces, and will be able to define and use the adjoint of a linear map on a finite-dimensional inner product space.
- construct the matrix of a bilinear form and to find index, rank and signature of a bilinear form.
- determine a linear operator is normal, unitary and orthogonal projection and to construct the spectral decomposition of normal and self-adjoint operators.

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Syllabus for**PROGRAMME:M.Sc. Mathematics(UHS) (Semester-III)****COURSE CODE-MHMH- 534****COURSE TITLE: STATISTICS-I**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.
6. Use of non-programable scientific calculator is allowed.

COURSE OBJECTIVES:

- The main objective of this course is to provide students with the foundation of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction networks etc.
- With this course learner will have good understanding of exploratory data analysis.
- Students will learn the differences between discrete distributions and continuous distribution.

Unit-I

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem, Random variable, probability mass function, probability density function, cumulative distribution function.

Unit-II

Two and higher dimensional random variables, joint distribution, marginal and conditional distributions, Stochastic independence, function of random variables and their probability density functions, Mathematical expectations and moments, moment generating function and its properties.

Unit-III

Chebyshev's inequality and its application, Stochastic convergence, central limit (Laplace Theorem, Linderberg-Levy's Theorem), Discrete Probability Distributions: Uniform hyper geometric, Binomial, Poisson, Geometric, Hyper geometric, Multinomial.

Unit-IV

Continuous probability distributions: Uniform, Exponential, Gamma, Beta, Normal distributions. Least square principle, correlation and linear regression analysis for bi-variate data, partial and multiple correlation coefficients, correlation ratio, association of attributes.

Books Recommended:

1. Hogg, R.V., Mckean, J.W. and Craig, A.T.: Introduction to Mathematical Statistics.
2. Mukhopadhyay, P : Mathematical Statistics.
3. Goon,A.M.,Gupta, M.K. &Dasgupta B. : An Outline of Statistical Theory Vol.-I.

COURSE OUTCOMES:

On completing the course, the students will be able to:

- acquaint with the foundation of probabilistic and statistical analysis, mostly used in engineering and science like disease modeling, climate prediction networks etc.
- have good understanding of exploratory data analysis. Learner will be able to write a short-report describing a simple statistical data set.
- become informed consumer of statistical information provided in newspaper, magazine and journals.

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Syllabus for**PROGRAMME: M.Sc.-Mathematics** (under the Hons. Scheme)**(Semester-III)****COURSE CODE- MHMH-535(A)****COURSE TITLE- Applied Statistics**

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6**TOTAL HOURS: 90 hrs.****MAXIMUM MARKS: 100****(Theory : 75****Internal Assessment: 25)****Time: 3Hrs****Medium -English****INSTRUCTIONS FOR PAPER SETTERS**

1. The question paper will consist of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- To enhance skills to solve the problems based on birth rate, death rate, index numbers and time series.
- To exhibit proficiency in application of statistics to solve daily life problems.

COURSE CONTENT:**UNIT-I****Time series Analysis:** Definition, utility, measurement of trend: Graphic Method, method of curve fitting by principle of least squares(excluding logistic curve).

Measurement of seasonal variations (only method of simple averages).

UNIT-II**Index numbers:** Definition, uses, construction of index numbers, simple (unweighted) aggregate method, weighted aggregate method (Laspeyre's method, Paasche's method, Bowley's method, Fisher's method).**Quantity Index Numbers:** Time reversal test, Factor(Volume) reversal test, base shifting.**UNIT-III****Vital Statistics:** Uses, methods of obtaining vital statistics.**Measurement of Fertility:** Crude Birth Rate(C.B.R.), General Fertility Rate(G.F.R.), Specific Fertility Rate (S.F.R.), Total Fertility Rate(T.F.R.).

UNIT-IV

Measurement of mortality: Crude Death Rate (C.D.R), Specific Death Rate (S.D.R.), Infant Mortality Rate (I.M.R.), Standardized Death Rate (S.D.R.) .

BOOKS PRESCRIBED:

1. S.C. Gupta and V.K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand and Sons.
2. S. P. Gupta: Statistical Methods, Sultan Chand & Sons.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Analyze the trends using various methods such as graphic method and method of curve fitting.
- Construct index numbers with the help of Laspeyre's method, Paasche's method, Bowley's method, Fisher's method.
- Learn the methods of obtaining vital Statistics.
- Apply the knowledge of applied statistics to measure the mortality rate
- Calculate the total fertility rate and general fertility rate with the help of applied statistics.

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Syllabus for

PROGRAMME:M.Sc.-Mathematics (under the Hons. Scheme)

(Semester-III)

COURSE CODE: MHMH-535(B)

COURSE TITLE: Project

L	T	P	Credits
-	2	4	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS:90 hrs.

MAXIMUM MARKS: 100

(Project Work: 75

Internal Assessment: 25)

Time: 3Hrs

Medium -English

COURSE OBJECTIVES:

- To get admission in Ph.D programmes and other higher studies in national and international universities.
- To acquaint the students with research oriented work.
- It will help the students to enhance the knowledge of pure and applied mathematics.
- To work on various mathematical topics beyond the syllabus.
 - To inculcate discussion abilities, flexibility of thought and effective time management in students.

Note: In this paper, the students will be allotted a topic and they have to prepare a Dissertation under the supervision of assigned teacher. An external examiner will be appointed to evaluate the performance of the students during final examination.

The division of marks out of a total of 75 is as under:

Dissertation:50

Presentation:25

COURSE OUTCOMES: after the completion of the course, students will be able to:

- develop presentation skills in the students.
- inculcate discussion abilities, flexibility of thought and effective time management in students.
- acquaint themselves with research oriented work.
- enhance the knowledge of pure mathematics.
- experience to face a panel in logical way.

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Syllabus for
PROGRAMME:M.Sc. Mathematics(UHS) (Semester-IV)
COURSE CODE-MHMH- 541

COURSE TITLE: FUNCTIONAL ANALYSIS-II

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs

Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section–B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section–A will consists of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections–B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- The objective of this course is to provide the main concepts and fundamental methods of functional analysis to enable a student to treat various concrete problems based on Hilbert spaces.
- Students will study the conjugate spaces and their properties.
- Students will learn about compact linear operators and spectral theory.

Unit-I

Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets,

Unit-II

The conjugate space H^* , Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, weakly compact set in Hilbert spaces.

Unit-III

The adjoint of an operator, self adjoint operators, positive operators, normal operators, Unitary

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operators. Projections on a Hilbert space.

Unit-IV

Spectral Theorem for normal operators, Compact linear operators on normed spaces, properties of Compact linear operators.

BOOKS PRESCRIBED:

1. Simmon G.F.: Introduction to topology and Modern Analysis Ch.X (sections 52-59) Ch. XI (Sections 61-62) Mc Graw- Hill (1963) International Book Company.
2. Erwin Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons (1978).
3. Limaye, Balmohan V.: Functional Analysis, New Age International Limited, 1996.
4. Jain, P.K. & Ahuja, O.P.: Functional Analysis, New Age International (P) Ltd. Publishers, 2010
5. Chandrasekhra Rao, K.: Functional Analysis, Narosa, 2002.
6. Somasundram, D.: A First Course in Functional Analysis, Narosa, 2006

COURSE OUTCOMES: On completing the course, the students will be able to:

- Learn the main concepts and fundamental methods of functional analysis to enable a student to treat various concrete problems based on Hilbert spaces .
- Study functional spaces which play vital role in study of existence and uniqueness of solutions of differential equations, boundary value problems, optimization techniques etc.
- distinguish between Banach spaces and Hilbert spaces.
- classify operators into self-adjoint, unitary and normal operators.
- represent a bounded linear functional in terms of inner product.

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Syllabus for
PROGRAMME: M.Sc. Mathematics (UHS) (Semester-IV)
COURSE CODE- MHM- 542

COURSE TITLE: TOPOLOGY-II

L	T	P	Credits
5	1	0	6

CREDIT HOURS (PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs

Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.

Unit-I

Higher Separation Axioms: Completely regular spaces. Tychonoff spaces, Completely normal space, T_5 – spaces. Metric spaces as Hausdorff regular, normal and completely normal space. Product of metric spaces.

Unit-II

Compact spaces, Compact sets, Subsets of compact space. Finite intersection property. Compactness of subsets of real line. Relation of compact spaces with Hausdorff spaces, Regular spaces and normal spaces, Sequentially compact spaces, Bolzano Weierstrass property. Countably compact spaces. Locally compact spaces. Compactness in terms of base element and sub – base elements. Tychonoff theorem. One point compactification.

Unit-III

The Stone-Čech compactification, Evaluation mappings, Separate point family, Separate point and closed set family. Embedding lemma, Tychonoff cube, Embedding theorem, Metrization. Urysohn metrization theorem.

Unit-IV

Directed sets and nets. Convergence of a net in a space, Clustering of a net, nets and continuity, Nets in product spaces, Ultra nets. Compactness in term of nets, Topologies determined by nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultrafilters and compactness.

BOOKS RECOMMENDED:

1. T.O. Moore : Elementary general topology (Chapter 2 to 8).
2. J.L. Kelley : General Topology (Chapter 1to 5).
3. J.R. Munkres : Topology.
4. G.F. Simmons: Introduction to Topology and Modern Analysis.

COURSE OUTCOMES: On completing the course, the students will be able to:

- Learn the properties of a geometric object that are preserved under continuous deformations, such as stretching, twisting, crumpling and bending.
- discuss the shape of molecules in chemistry by analysis of the topology of a related graph.
- Understand the mathematical tools that are useful to applied mathematicians and to theoretical physicists.
- Apply the knowledge of topology in computers specially in network science.
- understand the various topological spaces and their properties, separation axioms, Tietz extension theorem and Tychnoff theorem

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Syllabus for

PROGRAMME: M.Sc. Mathematics(UHS) (Semester-III)

COURSE CODE-MHMH- 543

COURSE TITLE: DISCRETE MATHEMATICS

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 75

Internal Assessment: 25)

Time: 3Hrs

Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consist of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consist of eight short answer type questions, each of 2.5 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each (**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 15 marks.
4. Question paper should cover at least 40% article work from the recommended books.

Teaching time for this paper would be eight periods per week.

COURSE OBJECTIVES:

- To gain knowledge about computing and mathematics appropriate to the discipline.
- To visualize the given problem as graphical representation.
- To get familiar with the concept of recurrence relation.

UNIT-I

Combinatorics: Permutations, combinations, and their results, Basics of counting, Principle of inclusion-exclusion, Pigeonhole principle

UNIT-II

Recurrence relation : Order and degree of recurrence relation, telescoping form, solution of linear recurrence relation, homogeneous solution, closed form expression

UNIT-III

Generating functions : , Discrete Numeric Function, Generating function, Generating Functions of some standard sequences, solution of recurrence relations using generating functions.

UNIT-IV

Euler's theorem on the existence of Eulerian paths and circuits, Trees: Rooted tree, search tree, tree traversals, spanning trees, minimal spanning trees, Kruskal's algorithm, colouring of the graph, four-colour problem, chromatic polynomials.

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SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

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BOOKS RECOMMENDED:

1. Gass, S. L. : Linear Programming
2. Hadley, G. : Mathematical Programming
3. Kambo, N. S. : Mathematical Programming
4. Panneerselvam, R. : Operations Research

COURSE OUCOMES: On completing the course, the students will be able to:

- understand special situations such as redundancy, infeasibility, unboundedness and alternate optimal solutions in linear programming problems.
- acquire quantitative, analytical tools to support decision making in the optimization of economic processes.
- develop the functional mathematical relationship that describe decision variables, objective function, constraints of the problem and non-negativity conditions.
- decide optimum allocation of various limited resources to arrive at the optimum decision by using various techniques like assignment, transportation problems etc.
- extend their knowledge of basic optimization techniques to do interesting research work on these types of optimization techniques.

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

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Syllabus for
PROGRAMME:M.Sc. Mathematics (UHS) (Semester-IV)
COURSE CODE-MHMH-544
COURSE TITLE: STATISTICS-II

L	T	P	Credits
5	0	1	6

CREDIT HOURS(PER WEEK): 6

TOTAL HOURS: 90 hrs.

MAXIMUM MARKS: 100

(Theory : 60

Internal Assessment Theory: 20

Practical Marks:15

Practical Internal Assessment marks:05)

Time: 3Hrs
Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
2. Section-A will consists of eight short answer type questions, each of 2 marks. Students are to attempt any six.
3. Sections-B, C, D & E will consist of two questions each(**each question should be subdivided into two parts**). Students are to attempt any four questions in total by selecting one question from each section. Each question carries 12marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper would be eight periods per week.
6. Use of non-programable scientific calculator is allowed.

COURSE OBJECTIVES:

- To understand the concept of estimation of parameters.
- To get familiar with testing of hypothesis.
- To learn the use of various statistical tests to solve practical problems.

UNIT-I

Sampling Distributions: Chi-square, t and F-distributions with their properties, distribution of sample mean and variance, distribution of order statistics and sample range from continuous populations.

UNIT-II

Point Estimation: Estimators, Properties of unbiasedness, consistency, sufficiency, efficiency, completeness, uniqueness, methods of estimation, Testing of Hypothesis: Null hypothesis and its test of significance, p-value simple and composite hypothesis, M.P. test, UMP test

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UNIT-III

Likelihood tests (excluding properties of Likelihood Ratio Tests), Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t-test, F-test.

UNIT-IV

Linear Estimation: Gauss Markoff linear models, BLUE, Gauss Markoff Theorem, estimation with linear restrictions on parameters, residual sum of squares, analysis of variance, analysis of variance for one way and two way classified data with one observation per cell.

BOOKS RECOMMENDED:

1. Hogg R.V., Mckean, J.W. and Craig A.T. : Introduction to Mathematical Statistics
2. Hoel P.G. : Introduction to Mathematical Statistics
3. Mukhopadhyay, P : Mathematical statistics
4. Goon, A.M., Gupta M.K. & Das Gupta B. : Fundamental of statistic, Vol. I
5. Goon, A.M., Gupta M.K. & Das Gupta B. : An outline of statistical theory, Vol. I

COURSE OUTCOMES: On successful completion of this course, students will be able to:

- Solve the problems based on estimation and to test the efficiency of various estimators.
- Handle the practical problems using hypothesis testing.
- Solve the practical problems using t-test, F-test, Z-test, chi-square test for various types of data.

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Syllabus for
PROGRAMME:M.Sc. Mathematics(UHS) (Semester-IV)
COURSE CODE-MHM- 545

COURSE TITLE:OPERATIONS RESEARCH

L	T	P	Credits
5	1	0	6

CREDIT HOURS(PER WEEK): 6
TOTAL HOURS: 90 hrs.
MAXIMUM MARKS: 100
(Theory : 75
Internal Assessment: 25)

Time: 3Hrs
Medium -English

INSTRUCTIONS FOR PAPER SETTERS

1. The question paper will consists of five sections namely Section-A which will be from entire syllabus (equally distributed from each unit), Section-B, C, D and E from Unit-I, II, III and IV, respectively.
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Unit-I

The linear programming problem, properties of a solution to the linear programming problem, generating extreme point solution, simplex computational procedure, development of minimum feasible solution, the artificial basis techniques, a first feasible solution using slack variables, two phase and Big-M method with artificial variables.

Unit-II

General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of duality, dual simplex method.General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, LP formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm (MODI method), time- minimization transportation problem.

Unit-III

Mathematical formulation of assignment problem, assignment method, typical assignment problem, the traveling salesman problem. Game Theory: Two-person zero-sum games, maximin- minimax principle, games without saddle points(Mixed strategies), graphical solution of $2 \times n$ and $m \times 2$ games, dominance property, arithmetic method of $n \times n$ games, general solution of $m \times n$ rectangular games.

Unit-IV

Queueing Theory: Introduction, Queueing System, elements of queueing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queueing models, single service queueing model with infinite capacity (M/M/1): (∞ /FIFO), Queueing Models:(M/M/1): (N/FIFO), Generalized Model: Birth-Death Process.

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- develop the functional mathematical relationship that describe decision variables, objective function, constraints of the problem and non-negativity conditions.
- decide optimum allocation of various limited resources to arrive at the optimum decision by using various techniques like assignment, transportation problems etc.
- extend their knowledge of basic optimization techniques to do interesting research work on these types of optimization techniques.