FACULTY OF SCIENCES

SYLLABUS FOR SESSION: 2023-2024

Programme Code: MMAH

Programme Name:M.Sc. Mathematics (Under the Honours Scheme)

(Semester I-II)

Examinations: 2023-2024

Department of Mathematics

Khalsa College, Amritsar

Note: (a) Copy rights are reserved. Nobody is allowed to print it in any form.
(b)) Subject to change in the syllabi at any time.
(c) Please visit the College website time to time.

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.

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**	**4-5**
MHMH-412	Modern Algebra	6	5	1	0	6	**75**	**-**	**25**	**100**	**6-7**
MHMH-413	Classical Mechanics and Calculus of variations	6	5	1	0	6	**75**	**-**	**25**	**100**	**8-9**
MHMH-414	Complex Analysis	6	5	1	0	6	**75**	**-**	**25**	**100**	**10-11**
MHMH-415	Differential Equations	6	5	1	0	6	**75**	**-**	**25**	**100**	**12-13**
*MHMH-416	Latex Lab-I	4	2	0	2	4	**50**	**-**	**-**	**50**	**14-15**
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**	**16-17**
MHMH-422	Advanced Algebra	6	5	1	0	6	**75**	**-**	**25**	**100**	**18-19**
MHMH-423	Number Theory	6	5	1	0	6	**75**	**-**	**25**	**100**	**20-21**
MHMH-424	Differential Geometry	6	5	1	0	6	**75**	**-**	**25**	**100**	**22-23**
MHMH-425	Partial Differential Equations and Integral Equations	6	5	1	0	6	**75**	**-**	**25**	**100**	**24-25**
*MHMH-426	Latex Lab-II	4	2	0	2	4	**50**	**-**	**-**	**50**	**26-27**
Total		30	25	5	0	30	-	-	-	**500**	

*Pass Course

Chairperson, BoS in Mathematics

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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 sudivided 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:

- 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 wil 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 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, Ist 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.

Time: 3Hrs **MAXIMUM MARKS: 100**

Medium: English **(Theory : 75**

Internal Assessment: 25)

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 sudivided 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 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, Homomorpghisms, Integral domains, Maximal and prime ideals.

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 & Quazi 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.
- use group theory in modern physics which is based on symmetry principles.
- apply group theory such that the existence of several particles can be predicted before they are experimentally observed.
- apply ring theory in chemistry such as the symmetry of a molecule provides students with the information of energy levels of the orbital , the orbital symmetries,bond order.

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Syllabus for

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

COURSE CODE-MHMH- 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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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 will introduce the concepts of Lagrange's equation for holomonic and non holomonic 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.

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, Langrange's equations from Hamilton's principle.

Unit-IV

Variational Methods: Direct Methods, Euler's finite difference method, 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.
- apply the concepts of classical mechanics in Geology, engineering, and many other inter-disciplinary areas.

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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.

Time: 3Hrs **MAXIMUM MARKS: 100**
Medium: English **(Theory : 75**
Internal Assessment: 25)

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 sudivided 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 properties of analytic functions, 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.

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 Rouche'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:

- 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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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:

- Studemts 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 othogonality 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.

learn to 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

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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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 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 Fitzpatrik, 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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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.

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.

Time: 3Hrs
Medium: English

MAXIMUM MARKS: 100
(Theory : 75
Internal Assessment: 25)

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 sudivided 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.

Khalsa College, Amritsar

(An Autonomous College)

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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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, the relation of tangent planes, principle normals and binormals, the intrinsic and non-intrinsic properties of surfaces and geodesics, tensors analysis and its applications.

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.

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, principle normals and binormals.
- know the intrinsic and non-intrinsic properties of surfaces and geodesics, tensors analysis and its applications.

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Khalsa College, Amritsar

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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

Time: 3Hrs **(Theory : 75**

Medium -English **Internal Assessment: 25)**

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 sudivided 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 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

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.

Time: 3Hrs

MAXIMUM MARKS: 50

Medium -English

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.

- **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 Pr\imer" by Indian TEX Users Group.