

BHAKTA KAVI NARSINH MEHTA UNIVERSITY

Major, Minor and Skill Courses

Syllabus of B.Sc. (Honours & Honours with Research) Mathematics as per NEP-2020

Faculty of Science

Effective from June 2026

Subject: Mathematics

SEMESTER- VII

SUMMARY OF THE SYLLABUS for B.Sc. (Honors & Honours with Research)

Sem No.	Sr. No.	Category of Course	Course Title	Course Level	Credit	Teaching Hours / Week	SEE Marks	CCE Marks	Total Marks	Exam Duration
Sem - 7	1	Major-17	Abstract Algebra-III	6.0	4	4 Hours / Week	50	50	100	2 Hours
	2	Major-18	Topology-1	6.0	4	4 Hours / Week	50	50	100	2 Hours
	3	Major-19	Elementary Number Theory	6.0	4	4 Hours / Week	50	50	100	2 Hours
	4	Major (Instead of OJT for B.Sc. Mathematics(Honours) students)	Functional Analysis-I	6.0	4	4 Hours / Week	50	50	100	2 Hours
	5	Minor-8 (For B.Sc. Mathematics(Honours & Honours with Research Students))	Financial Mathematics	6.0	4	4 Hours / Week	50	50	100	2 Hours
	6	Minor-8 (For non-Major Mathematics Students)	Mechanics	6.0	4	4 Hours / Week	50	50	100	2 Hours
	7	SEC (Instead of OJT for B.Sc. Mathematics (Honours) students)	Introduction to LaTeX (Practical Based Course)	6.0	2	4 Hours / Week / batch	25	25	50	2 Hours
		Research Methodology (Instead of OJT for B.Sc. Mathematics (Honours) students)	Research Methodology - 1	6.0	2	2 Hours / Week	25	25	50	1 Hours

- Note:** (1). **Sr. No. 7 is elective (either SEC or Research Methodology – 1).**
 (2). **Research Project of 6 credits is compulsory for B.Sc. Mathematics (Honours with Research Students) instead of OJT.**

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INTERNAL EVALUATION SCHEME		
Sr. No.	Particulars	Marks
1	Mid Semester Exam (Mandatory)	25
2	Class Test	05
3	Open book exam/test	05
4	Open note exam/test	05
5	Self-test/ Online test	05
6	Essay/Article writing	05
7	Quizzes/Objective test	05
8	Class assignment	05
9	Home assignment	05
10	Reports Writing	05
11	Research/Dissertation	05
12	Case Studies	05
13	Viva/Oral exam	05
14	Group Discussion	05
15	Role Play	05
16	Paper presentation/Seminar	05
17	Language Lab work	05
18	Interview	05
19	Craft work	05
20	Co-curricular work	05
21	Field Assignment	05
22	Poster Presentation	05
23	Attendance	05
24	Project Work	05
	Total	50

Note: Sr. No. 1 is mandatory. Select any five from Sr. No. 2 to 24. Each contains five marks. Student should secure 18 marks for passing in internal exam.

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Paper Style

Paper Style for SEE of

Major courses – 17, 18, 19, Major course (instead of OJT) and Minor course – 8:

Que. No.	Particulars	From which Unit	Marks
1	Answer any TWO out of THREE	1	10
2	Answer any TWO out of THREE	2	10
3	Answer any TWO out of THREE	3	10
4	Answer any TWO out of THREE	4	10
5	Answer any TWO out of THREE	From all units	10
		Total Marks	50

Paper Style for SEE of SEC

(Practical based course of 2 credits)

Que. No.	Particulars	Marks
1	Answer any THREE out of FIVE (6 Marks each)	18
2	VIVA	04
3	JOURNAL	03
	Total Marks	25

Paper Style for SEE of Research Methodology

(Course of 2 credits)

Que. No.	Particulars	From which Unit	Marks
1	Answer any TWO out of THREE	1	10
2	Answer any TWO out of THREE	2	10
3	Answer any ONE out of TWO	From all units	5
		Total Marks	25

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SEMESTER- VII

B.Sc. Semester – VII

Major Course– 17 (Abstract Algebra - III)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. Mathematics (Honours) & B.Sc. Mathematics (Honours With Research)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Major Course – 17	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Abstract Algebra – III		

Course Objectives:

The course is an advanced group theory course aimed and designed with the following list of objectives:

- ❖ To develop a comprehensive understanding of the fundamental concepts and structures of group theory, including subgroups, quotient groups, homomorphisms and automorphisms.
- ❖ To study the role of normal subgroups, factor groups, commutator subgroups and related algebraic constructions in analyzing group structures.
- ❖ To introduce group actions and their applications in counting problems and the study of finite groups.
- ❖ To familiarize students with isomorphism theorems.
- ❖ To familiarize students with composition series, solvable groups and the structural classification of groups.
- ❖ To understand Sylow theorems and their applications in determining the existence and properties of subgroups of finite groups.
- ❖ To introduce free abelian groups and free groups as fundamental algebraic structures and explore their basic properties and applications.

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Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Demonstrate a thorough understanding of fundamental concepts of group theory, including subgroups, permutation groups, homomorphisms, normal subgroups and quotient groups.
- Apply homomorphism theorems and quotient group constructions to analyze and establish relationships between algebraic structures.
- Determine and investigate group properties using concepts such as automorphisms, conjugate subgroups, centers, normalizers, maximal subgroups and commutator subgroups.
- Apply the theory of group actions, orbits and stabilizers to study symmetries and solve counting problems involving finite groups.
- Use Burnside's Formula to enumerate distinct configurations arising from group actions.
- Analyze the structure of groups through isomorphism theorems, normal and subnormal series and the Jordan–Hölder theorem.
- Characterize and examine solvable groups and establish their properties using appropriate algebraic techniques.
- Apply Cauchy's theorem and Sylow's theorems to determine the existence of subgroups of finite groups, number of subgroups of finite groups and structure of subgroups of finite groups.
- Utilize class equation and Sylow's theory to investigate finite groups and solve related structural problems.
- Explain the concepts of free abelian groups, rank of free abelian groups.
- Demonstrate competence in abstract reasoning, mathematical proof writing and the rigorous analysis of algebraic structures.

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SEMESTER- VII

Course contents of Abstract Algebra - III (Major – 17)

UNIT 1: Review of Group Essentials (Approx. 15 Hours)

Definition, examples, essential introductory results on groups and subgroups, permutation groups, Lagrange's theorem, Euler's theorem, Fermat's little theorem, Homomorphism, examples and properties; normal subgroup, factor group, examples and properties, fundamental theorem of homomorphism.

UNIT 2: Factor Group and Commutator Group (Approx. 15 Hours)

Inner automorphism, conjugate subgroup, factor group computation, simple group, maximal subgroup, centre of a group, normalizer of an element of a group, commutator subgroup, examples and properties.

UNIT 3: Group Action (Approx. 15 Hours)

Group action on a set: definition and its examples, G-set; Orbits: definition and its examples; Application of G-sets to counting, Burnside's formula. Isomorphism theorems, series of groups: subnormal and normal series, Jordan Holder theorem, solvable groups and its examples, characteristic property of solvable groups.

UNIT 4: Sylow theory and Free Abelian Groups (Approx. 15 Hours)

Sylow theorems: p-group and its examples, Cauchy theorem for a finite abelian group, Cauchy theorem for a finite group, Sylow's first theorem, Sylow's second theorem, Sylow's third theorem. Application of Sylow's theorems: Application to p-groups and class equation, related examples. Free abelian group, rank of free abelian group, free groups and related examples.

Suggested References:

1. **A First Course in Abstract Algebra** by J. B. Fraleigh, Pearson Education (main book for above syllabus).
2. **Abstract Algebra** by David S. Dummit and Richard M. Foote, Wiley.
3. **Contemporary Abstract Algebra** by Joseph A. Gallian, 9th edition, 2019, Cengage Learning.
4. **Topics in Algebra** by I. N. Herstein, Wiley.
5. **A Course in Abstract Algebra** by Vijay K. Khanna and S. K. Bhambri, S. Chand & Co.
6. **Basic Abstract Algebra** by P. B. Bhattacharya and S. K. Nagpaul, Cambridge University Press.
7. **Algebra** by S. Lang, Pearson Education.

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B.Sc. Semester – VII

Major Course – 18 (Topology - I)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. Mathematics (Honours) & B.Sc. Mathematics (Honours With Research)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Major Course – 18	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Topology – I		

Course Objectives:

The course curriculum aims to:

- ❖ Introduce students to the fundamental concepts of topological spaces and their role in modern mathematics.
- ❖ Provide a clear understanding of open sets, closed sets and the topological structure of the real line.
- ❖ Develop the ability to identify, construct and analyze various topologies, such as discrete, indiscrete and product topologies.
- ❖ Enable students to master the definitions and implications of separation axioms (T_0 , T_1 & T_2).
- ❖ Equip students with the skills to analyze functions for continuity in a topological context.
- ❖ Facilitate a deep understanding of core topological invariants, specifically connectedness and compactness.
- ❖ Foster the ability to perform rigorous mathematical proofs using limit points, interiors, and closures.
- ❖ Demonstrate the use of basis and sub-basis to generate topologies effectively.

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- ❖ Cultivate geometric intuition regarding topological spaces through visual reasoning and example-driven learning.
- ❖ Prepare students for advanced studies in differential geometry, algebraic topology and analysis.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Define a topological space and construct examples using basis and sub-basis elements.
- Compare and contrast different topologies on the same set, including product and subspace topologies.
- Determine whether a given set is open, closed, dense or compact based on topological definitions.
- Distinguish between various separation axioms and determine if a space is Hausdorff.
- Formulate proofs for the continuity of functions between topological spaces.
- Explain the significance of topological invariants such as connectedness and path-connectedness.
- Apply the property of compactness to demonstrate convergence and related theorems.
- Identify and construct homeomorphisms to establish topological equivalence between spaces.
- Construct quotient topologies and visualize geometric structures like circles and tori.
- Effectively read, construct and communicate complex mathematical arguments and proofs.

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Course contents of Topology – I (Major – 18)

UNIT 1: Foundations of Topological Spaces (Approx. 15 Hours)

General set concepts, operations, Cartesian products, functions, relations. Definition and examples of topological spaces (discrete, indiscrete, cofinite, usual). Lower-limit topology on $\mathbb{R}$. Open sets, closed sets, neighborhood, interior, closure, boundary, limit point, dense sets, separable spaces, accumulation points.

UNIT 2: Bases, Subspaces and Basic Separation (Approx. 15 Hours)

Base and sub-base for a topology, characterization of a topology, alternative criteria. Subspace (induced) topology, open and closed sets in a subspace. Finite product topology and projection maps. T_0 , T_1 & T_2 (Hausdorff) spaces (definitions, examples, hereditary/productive properties, uniqueness of limits).

UNIT 3: Continuity, Homeomorphisms and Quotient Spaces (Approx. 15 Hours)

Continuous functions (via open sets, closed sets, closure criteria, at a point). Open maps, closed maps and homeomorphisms, topological invariants. Quotient map, quotient topology and geometric constructions (circle, cylinder, torus from a square).

UNIT 4: Topological Invariants: Connectedness and Compactness (Approx. 15 Hours)

Connected spaces, connected subsets of $\mathbb{R}$, components, local connectedness, path-connectedness and path-components. Compact spaces, compact subsets of $\mathbb{R}$, extreme value theorem, tube lemma, finite intersection property, local compactness. Interaction of compactness with Hausdorff (T_2) spaces.

Suggested References:

1. **Topology** by James R. Munkres, 2nd edition, Pearson Education, ISBN 978-0131816299.
2. **General Topology** by John L. Kelley, Springer Verlage (GTM), ISBN 978-0387901251.
3. **Introduction to Topology and Modern Analysis** by George F. Simmons, McGraw Hill Education, ISBN 978-0070575905.
4. **General Topology for Beginners** by Jay Mehta, Cambridge Univ. Press, ISBN 978-1009505888.
5. **Topology** by Klaus Janich, 1984, Springer, ISBN 978-0387908922.
6. **Basic Topology** by M. A. Armstrong, Springer(UTM), ISBN 978-0387908397.
7. **Topology of Metric Spaces** by S. Kumaresan, Narosa Publishing House, ISBN 978-8184870589.
8. **Introduction to General Topology** by K. D. Joshi, New Age International Publishers, ISBN 978-0852264447.

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B.Sc. Semester – VII

Major Course – 19 (Elementary Number Theory)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. Mathematics (Honours) & B.Sc. Mathematics (Honours With Research)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Major Course – 19	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Elementary Number Theory		

Course Objectives:

The course aims to develop a fundamental understanding of elementary number theory by introducing concepts of divisibility, prime numbers, congruences and arithmetic functions. It has the following list of objectives:

- ❖ To introduce the fundamental concepts and principles of Number Theory, including divisibility, prime numbers and congruence.
- ❖ To develop the ability to solve linear diophantine equations and problems, involving divisibility and greatest common divisors.
- ❖ To understand the properties of prime numbers and their significance in arithmetic.
- ❖ To apply modular arithmetic and the Chinese Remainder Theorem (CRT) in problem-solving.
- ❖ To study Fermat's and Euler's theorems, Euler's phi function and arithmetic functions, and apply them to analyze and solve number-theoretic problems.
- ❖ To enhance logical reasoning, mathematical rigor and problem-solving skills through the study of elementary number theory.

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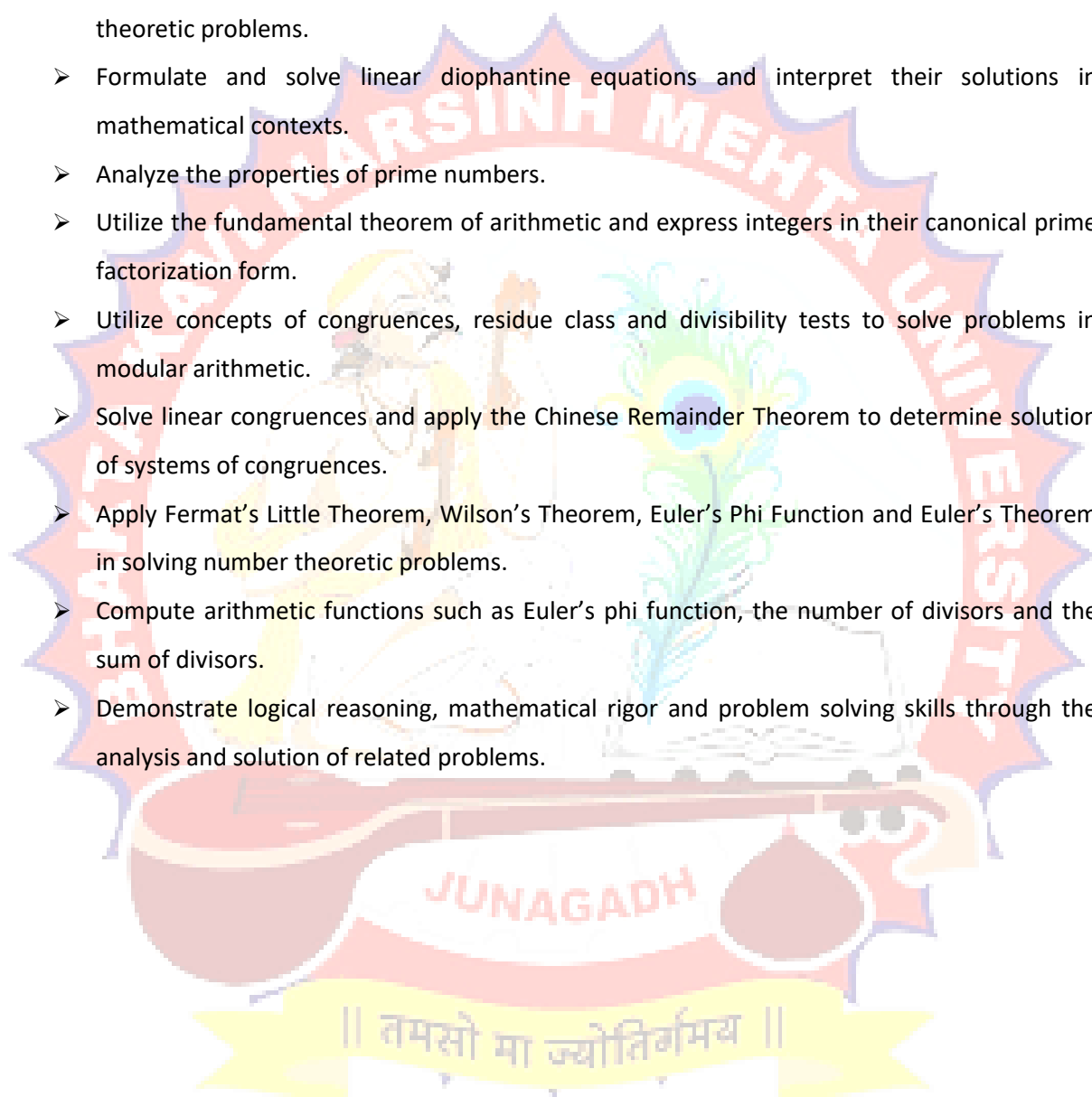
Subject: Mathematics

SEMESTER- VII

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Apply principles of divisibility, the Euclidean algorithm and GCD to solve elementary number theoretic problems.
- Formulate and solve linear diophantine equations and interpret their solutions in mathematical contexts.
- Analyze the properties of prime numbers.
- Utilize the fundamental theorem of arithmetic and express integers in their canonical prime factorization form.
- Utilize concepts of congruences, residue class and divisibility tests to solve problems in modular arithmetic.
- Solve linear congruences and apply the Chinese Remainder Theorem to determine solution of systems of congruences.
- Apply Fermat's Little Theorem, Wilson's Theorem, Euler's Phi Function and Euler's Theorem in solving number theoretic problems.
- Compute arithmetic functions such as Euler's phi function, the number of divisors and the sum of divisors.
- Demonstrate logical reasoning, mathematical rigor and problem solving skills through the analysis and solution of related problems.



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Course contents of Elementary Number Theory (Major – 19)

UNIT 1: Divisibility Theory and Linear Diophantine Equation (Approx. 15 Hours)

Some preliminary consideration: Well ordering principle, Principle of Mathematical induction, the binomial theorem & binomial coefficients.

Divisibility theory: The division algorithm, divisor, remainder, prime number, relatively prime numbers, GCD, the Euclidean algorithm (Without proof), LCM.

Diophantine equation: the Linear Diophantine Equation (LDE), problems based on LDE.

UNIT 2: Primes and its properties (Approx. 15 Hours)

Prime and composite numbers, the fundamental theorem of arithmetic, canonical form of a number, the Sieve of Eratosthenes, [OMIT:- Goldbach Conjecture], Euclid's theorem on infinitely many primes.

UNIT 3: Congruences (Approx. 15 Hours)

Definition and basic properties of congruence, residue class, complete system of residues.

Special divisibility tests, linear congruence, Chinese Remainder Theorem (CRT) and problems based on CRT.

UNIT 4: Fermat's Theorem and Euler's ϕ function (Approx. 15 Hours)

Fermat's little theorem, Fermat's factorization method, Wilson's theorem, Euler's Phi-function $\phi(n)$ and its properties, Euler's theorem and related examples, sum of divisors, number of divisors, multiplicative function, [OMIT:- Application to Calendar].

Suggested References:

1. **Elementary Number Theory** by David M. Burton, Tata McGraw Hill Publishing Co. Ltd.
2. **A Concise Introduction to the Theory of Numbers** by Alan Baker, Cambridge University Press.
3. **An Introduction to the Theory of Numbers** by Ivan Niven, H. S. Zuckerman, H. L. Montgomery, John Wiley and Sons Inc.
4. **Number Theory** by S. G. Telang, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. **Number Theory** by George E. Andrews, Hindustan Publishing Corporation, Delhi.
6. **A first course in Theory of Numbers** by K. C. Chowdhary, Asian Books Pvt. Ltd., New Delhi.
7. **Introduction to Number Theory** by Trygve Nagell, Wiley.

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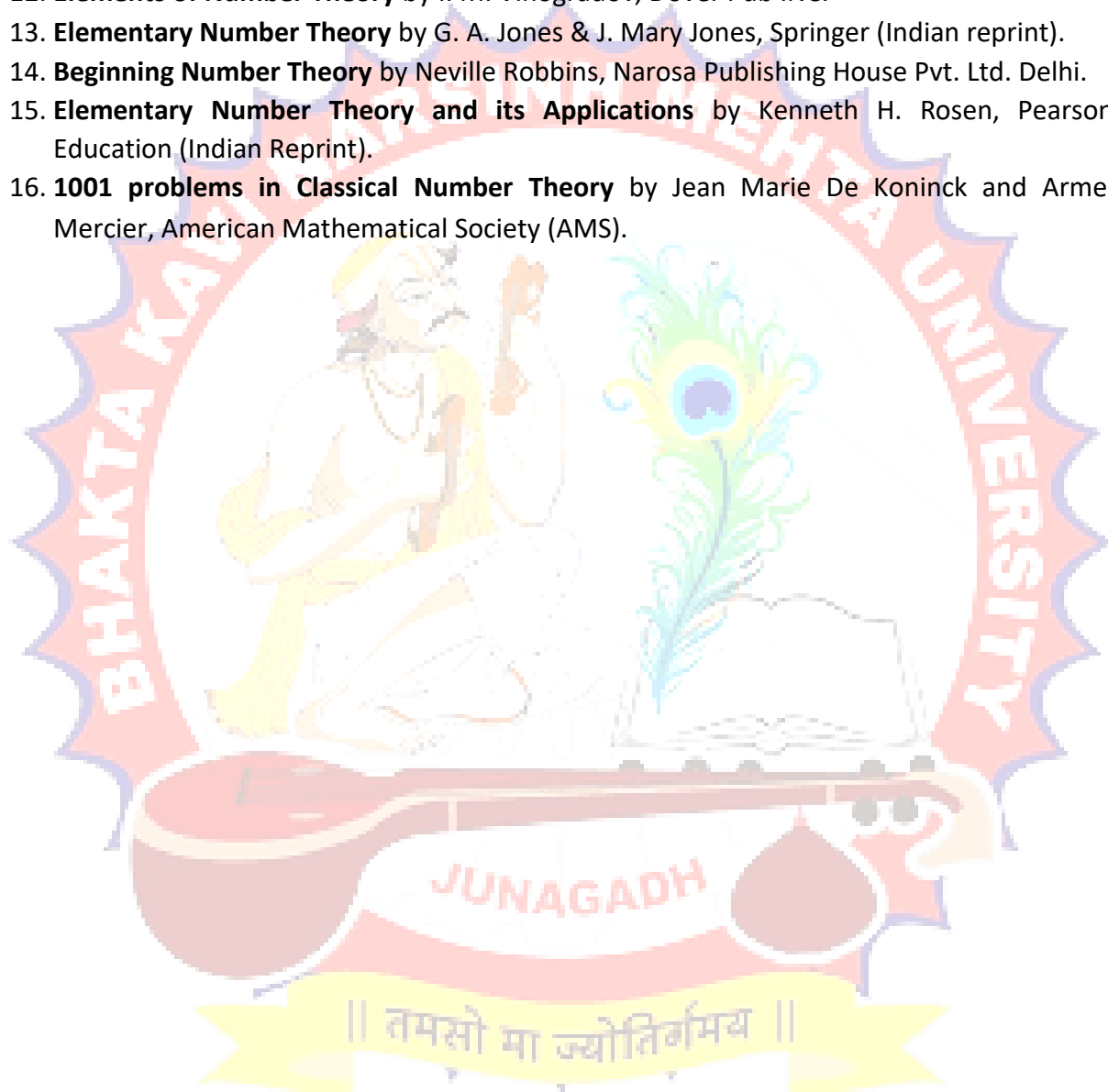
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8. **Elementary Number Theory** by J. V. Uspensky and M. A. Heaslet, Tata McGraw Hill.
9. **Inequalities** by G. H. Hardy, J. E. Littlewood, G. Polya, Cambridge University Press.
10. **An Introduction to the Theory of Numbers** by G. H. Hardy and E. M. Wright, Oxford Press, 1954.
11. **Theory of Numbers** by B. M. Stewart, The Macmillan Company, New York.
12. **Elements of Number Theory** by I. M. Vinogradov, Dover Pub INC.
13. **Elementary Number Theory** by G. A. Jones & J. Mary Jones, Springer (Indian reprint).
14. **Beginning Number Theory** by Neville Robbins, Narosa Publishing House Pvt. Ltd. Delhi.
15. **Elementary Number Theory and its Applications** by Kenneth H. Rosen, Pearson Education (Indian Reprint).
16. **1001 problems in Classical Number Theory** by Jean Marie De Koninck and Armel Mercier, American Mathematical Society (AMS).



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B.Sc. Semester – VII

Major Course (Functional Analysis – I)

(For B.Sc. Mathematics (Honours) students instead of OJT)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. Mathematics (Honours)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Major Course (For B.Sc. Mathematics (Honours) students instead of OJT)	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Functional Analysis – I		

Course Objectives:

The primary objective of the course is to transition students from classical calculus and linear algebra to the abstract framework of functional analysis. The specific objectives are to:

- ❖ Establish foundations of normed spaces: Introduce the algebraic, topological and geometric structures of Normed Linear Spaces and Banach Spaces.
- ❖ Explore linear transformations and dual spaces: Investigate the properties of linear operators and functionals, establish the crucial equivalence between boundedness and continuity and construct dual spaces.
- ❖ Master fundamental principles: Analyze and understand the four pillars of modern functional analysis: the Hahn-Banach Theorem, the Uniform Boundedness Principle, the Open Mapping Theorem and the Closed Graph Theorem.
- ❖ Extend geometry to abstract Hilbert spaces: Introduce inner product spaces to generalize geometric concepts like orthogonality, orthonormal expansions, Riesz representation and specific operator classes.

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Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Evaluate the completeness of various finite and infinite-dimensional vector spaces.
- Apply Hölder's and Minkowski's inequalities to validate standard sequence spaces and metrics.
- Understand the foundational bridge between point set topology and linear algebra.
- Formally prove the equivalence between the continuity and boundedness of a linear operator.
- Map algebraic relations between the null space (kernel) and the range of linear transformations.
- Construct dual spaces and determine the behavior of operator sequences under weak and weak* convergence modes.
- Apply the Hahn-Banach extension theorem to guarantee the existence of non-trivial bounded linear functionals.
- Utilize the Uniform Boundedness Principle, Open Mapping Theorem, Closed Graph Theorem, and Bounded Inverse Theorem to resolve complex problems regarding operator mappings and invertibility.
- Demonstrate a strong geometric intuition regarding orthogonality, orthonormal sets and Parseval's identity.
- Employ the Riesz Representation Theorem to characterize the conjugate space of a Hilbert space.
- Classify and analyze bounded operators, including self-adjoint, normal and unitary operator classes.

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Course contents of **Functional Analysis – I**

(For B.Sc. Mathematics (Honours) students instead of OJT)

UNIT 1: Basics of Normed Spaces and Banach Spaces (Approx. 15 Hours)

Normed linear space (NLS), examples (finite and infinite-dimensional) and properties of an NLS. Young's inequality, Hölder's and Minkowski's inequalities for finite and infinite sequences with related examples, continuity and boundedness of a function between NLS. Cauchy sequences in an NLS, completeness and Banach Spaces. Finite-dimensional subspaces of an NLS and their geometric properties. Equivalent norms.

UNIT 2: Bounded Linear Operators and Dual Spaces (Approx. 15 Hours)

Linear operators: relation between the null space (kernel) and the range of an operator. Equivalence of boundedness and continuity of a linear operator. Linear functionals, spaces of bounded linear functionals and dual spaces. Weak and weak* convergence, relations between norm convergence, weak convergence and weak* convergence. The Banach-Alaoglu Theorem (statement and applications).

UNIT 3: Fundamental Theorems of Functional Analysis (Approx. 15 Hours)

Zorn's Lemma. The Hahn-Banach Theorem (extension forms for real and complex vector spaces) and its core applications to dual spaces. The Uniform Boundedness Principle (consequences and examples). The Open Mapping Theorem, the Closed Graph Theorem and the Bounded Inverse Theorem.

UNIT 4: Inner Product Spaces and Hilbert Spaces (Approx. 15 Hours)

Inner product spaces and Hilbert spaces: definitions, properties and concrete examples. Geometry of Hilbert spaces: orthogonality, orthogonal complements and orthonormal sets. Projection theorem and the Riesz Representation Theorem. The conjugate (dual) space of a Hilbert space. Adjoint operators, self-adjoint, normal and unitary operators: definitions, examples, characterizations and fundamental results.

Suggested References:

1. **Introductory Functional Analysis with Applications** by E. Kreyszig, John Wiley and Sons, ISBN 978-0471504597.
2. **Functional Analysis** by B. V. Limaye, New Age International Pvt. Ltd., ISBN 978-9386286093.
3. **Functional Analysis** by Walter Rudin, McGraw-Hill Publishing Co., ISBN 978-0070619883.
4. **A Friendly Approach to Functional Analysis** by Amol Sasane, World Scientific Pub. Co., ISBN 978-1786343345.

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SEMESTER- VII

B.Sc. Semester – VII

Minor Course – 7 (Financial Mathematics) (For Major Mathematics students)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. Mathematics (Honours) & B.Sc. Mathematics (Honours With Research)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Minor Course – 7 (For Major Mathematics students)	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Financial Mathematics		

Course Objectives:

The course aims to introduce students to basics of financial mathematics. It has the following list of objectives:

- ❖ To familiarize students with the basic terminology, concepts and financial instruments used in modern financial markets.
- ❖ To develop mathematical skills for analyzing interest rates, time value of money, inflation, bonds, annuities and other deterministic cash-flow models.
- ❖ To introduce quantitative methods for portfolio analysis, risk-return assessment and asset pricing using portfolio theory and the Capital Asset Pricing Model (CAPM).
- ❖ To provide an understanding of forward and future contracts and their applications in hedging and risk management.
- ❖ To introduce derivative securities, option pricing concepts and mathematical models used in financial decision-making.
- ❖ To develop analytical and problem-solving skills required for applications in financial mathematics, investment analysis, actuarial science and quantitative finance.

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Course Learning Outcomes:

Upon successful completion of the course, student will be able to:

- Explain the fundamental concepts, terminology and financial instruments used in financial markets, including bonds, shares, mutual funds, portfolios and derivatives.
- Apply the principles of simple and compound interest, nominal and effective interest rates and the time value of money to determine present and future values of cash flows.
- Analyze deterministic cash flows using techniques such as Net Present Value (NPV), Internal Rate of Return (IRR), bond valuation, annuities, perpetuities and mortgage calculations.
- Evaluate fixed-income securities using concepts of yield, duration, convexity, term structure of interest rates, forward rates and immunization strategies.
- Apply probability-based concepts and portfolio theory to assess risk-return characteristics of investments and construct efficient portfolios using the Markowitz model.
- Analyze asset pricing and market equilibrium using the Capital Asset Pricing Model (CAPM) and related financial models.
- Explain the structure, valuation and applications of forward and future contracts and use them for hedging and risk management.
- Apply option pricing concepts, including put-call parity, binomial option pricing models, risk-neutral valuation and dynamic hedging, to evaluate derivative securities.
- Demonstrate quantitative reasoning and problem-solving skills in analyzing financial decisions, investment opportunities and risk management strategies.

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SEMESTER- VII

Course contents of Financial Mathematics (Minor – 7)

(Minor Course for Major Mathematics students of Honours & Honours with Research)

UNIT 1: Basic Terminology and Concepts (Approx. 15 Hours)

Bond, share, mutual fund, risk, asset, portfolio, hedging, arbitrage, simple interest, compound interest, nominal rate of interest, effective rate of interest.

Present and future value, inflation, deflation, rate of inflation, dividend, total market capitalization, stock index.

UNIT 2: Deterministic Cash Flows (Approx. 15 Hours)

Net Present Value (NPV), Internal Rate of Return (IRR), Comparison of IRR and NPV, Bond price and yield, annuities, perpetuities, mortgages, clean and dirty price, price – yield curves, duration, term structure of interest rates, forward rates, immunization, convexity.

UNIT 3: Random Cash Flows and Forwards and Futures (Approx. 15 Hours)

Random Cash Flows: Random variable, random returns, portfolio diagrams and efficiency, feasible set, Markowitz model, market equilibrium, CAPM as pricing model.

Forwards and futures, value of a futures contract, hedging with futures, currency futures, stock index futures, use of stock index futures to adjust beta.

UNIT 4: Stock Price Models and Derivatives (Approx. 15 Hours)

Call options, put options, put-call parity, binomial options pricing model, factors influencing option premiums, options on assets with dividends, dynamic hedging, risk-neutral valuation.

Suggested References:

1. **The Calculus of Finance** by Amber Habib, University Press.
2. **Investment Science** by David G. Leunberger, Oxford University Press, Delhi.
3. **Options, Futures and Other Derivatives** by John C. Hull & S. Basu, Pearson Education.
4. **Investment Analysis and Portfolio Management** by Prasanna Chandra, TMH.
5. **An Introduction to Actuarial Mathematics** by A. K. Gupta & T. Varga, Kluwer Academic.
6. **An elementary Introduction to Mathematical Finance** by Sheldon M. Ross, Cambridge.
7. **Financial Modeling** by S. Benninga & T. Mofkadi, MIT Press, Cambridge.
8. **Mastering Financial Mathematics in Microsoft Excel: A Practical Guide for Business Calculations** by A. L. Day, Pearson Education Ltd.

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SEMESTER- VII

B.Sc. Semester – VII

Minor Course – 7 (Mechanics) (For non-major Mathematics students)

Course Level	6.0	Internal Marks	50
Programme	B.Sc. (Honours) & B.Sc. (Honours With Research)	External Marks	50
Semester	VII	Practical Internal	---
Category of Course	Minor Course – 7 (For non-major Mathematics students)	Practical External	---
Course Credit	4	Prac. External Exam Duration	---
Teaching Hours	4 hours/week	Total (SEE+CCE)	100
Course Code		Exam Duration	2 Hours
Course Title	Mechanics		

Course Objectives:

The course curriculum aims to:

- ❖ Explain the vector addition of forces and the mathematical criteria needed to preserve the static equilibrium of a single particle.
- ❖ Analyze complex force-couple systems to evaluate the structural equilibrium of multi-particle configurations.
- ❖ Apply the principle of virtual work and potential energy gradients to determine whether a system is in a stable or unstable state.
- ❖ Formulate integrals and discrete summation methods to calculate the exact location of the mass centre and centre of gravity.
- ❖ Examine the boundary conditions of dry static and kinetic friction for objects resting on or moving across rough planes.
- ❖ Develop the governing differential equations that model the tension and geometric profile of loaded flexible cables.
- ❖ Formulate expressions for position, velocity and acceleration vectors in cartesian and polar coordinates for plane particle kinematics.
- ❖ Map the rotational and translational velocity profiles of a rigid body operating parallel to a fixed reference plane.

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- ❖ Solve the second-order differential equations of motion arising from fundamental plane dynamics of a particle.
- ❖ Model the ballistic trajectory parameters of parabolic projectiles operating without atmospheric resistance.

Course Learning Outcomes:

Upon successful completion of the course, student will be able to:

- Compute unknown tension and reaction forces for a particle subjected to concurrent coplanar forces.
- Reduce complex corporate systems of forces acting on multi-particle arrays into simpler equivalent resultant forces.
- Evaluate the static stability of mechanical structures by applying work functions and potential energy mathematical models.
- Pinpoint the geometric centroids and center of mass for uniform, non-uniform and composite rigid bodies.
- Predict the onset of sliding, tipping or slipping of blocks on inclined surfaces by applying coefficients of friction.
- Determine the structural equations of a catenary or parabolic arc for suspension lines and flexible cable assemblies.
- Calculate tangential, normal, radial and transverse components of velocity and acceleration for arbitrary planar motion.
- Analyze the instantaneous center of zero velocity for rigid links translating or rotating parallel to a fixed plane.
- Apply Newton's second law of motion to predict the position and velocity of particles under varying planar force fields.
- Calculate the flight path angle, maximum height, total range and flight duration for unresisted projectiles.

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Course contents of Mechanics (Minor – 7)

(Minor Course for non-major Mathematics students)

UNIT 1: Foundations of Plane Statics

(Approx. 15 Hours)

Particle Equilibrium: Definitions of force, the criteria for equilibrium of a single particle.
System Equilibrium: System reduction, force composition and the equilibrium of a system of particles.

UNIT 2: Work, Energy and Mass Distribution

(Approx. 15 Hours)

Energy Principles: Principle of virtual work, conservative forces, and potential energy functions.
Centroids: Geometric and physical tracking to determine the Mass Centre and Centre of Gravity.

UNIT 3: Structural Constraints (Friction and Cables)

(Approx. 15 Hours)

Friction: The mathematical laws governing static and kinetic friction on rough planes.
Flexible Elements: Static equilibrium, tension distribution, and mathematical profiles of Flexible Cables.

UNIT 4: Plane Kinematics and Particle Dynamics

(Approx. 15 Hours)

Kinematics: Planetary tracking and plane kinematics of a particle along with the motion of a rigid body parallel to a fixed plane.
Dynamics: Fundamental methods of plane dynamics, rectilinear motion, and the trajectories of Projectiles without resistance.

Suggested References:

1. **Principles of Mechanics** by John L. Synge & Byron A. Griffith, McGraw-Hill Book Company, ISBN 978-0070627253.
2. **સ્થિતશાસ્ત્ર (Statics)** by Prof. Dave & Prof. Shukla, University Granth Nirman Board, Gujarat, Reprint edition, ISBN 978-9381234567.
3. **સ્થિતશાસ્ત્ર (Statics)** by Acharya Shri K. M. Shah & Patel, Akhil Hind Prakashan, Ahmedabad, Classical edition, ISBN 978-8190453218.
4. **Classical Mechanics** by Herbert Goldstein, Charles P. Poole & John L. Safko, Pearson Education, 3rd edition, ISBN 978-0201657029.
5. **Vector Mechanics for Engineers: Statics and Dynamics** by Ferdinand P. Beer, E. Russell Johnston Jr. & Phillip J. Cornwell, McGraw-Hill Education, ISBN 978-1259638091.

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SEMESTER- VII

B.Sc. Semester – VII

Introduction to LaTeX

(For B.Sc. Mathematics honours students instead of OJT)

Course Level	6.0	Internal Marks	---
Programme	B.Sc. Mathematics (Honours)	External Marks	---
Semester	VII	Practical Internal	25
Category of Course	Skill Enhancement Course (Instead of OJT)	Practical External	25
Course Credit	2	Prac. External Exam Duration	2 hour
Teaching Hours	4 hours/week/batch	Total (SEE+CCE)	50
Course Code		Exam Duration	2 hour
Course Title	Introduction to LaTeX (Practical Based Course)		

Course Objectives:

The course curriculum aims to make you familiar with LaTeX so that you are able :

- ❖ To download and install comprehensive LaTeX distribution and take necessary updates as and when required.
- ❖ To typeset complicated mathematics with a lot of ease.
- ❖ To create basic LaTeX documents of article type.
- ❖ To typeset tables, insert/import figures, graphics and nicely manage them alongside text.

Course Learning Outcomes:

Upon successful completion of the course, student will be able to:

- Install and configure the LaTeX environment on Windows systems using MikTeX and compatible IDEs like TeXnicCenter or WinEdt.
- Execute basic file operations including creating, opening, saving and compiling TeX documents while identifying different LaTeX file extensions.

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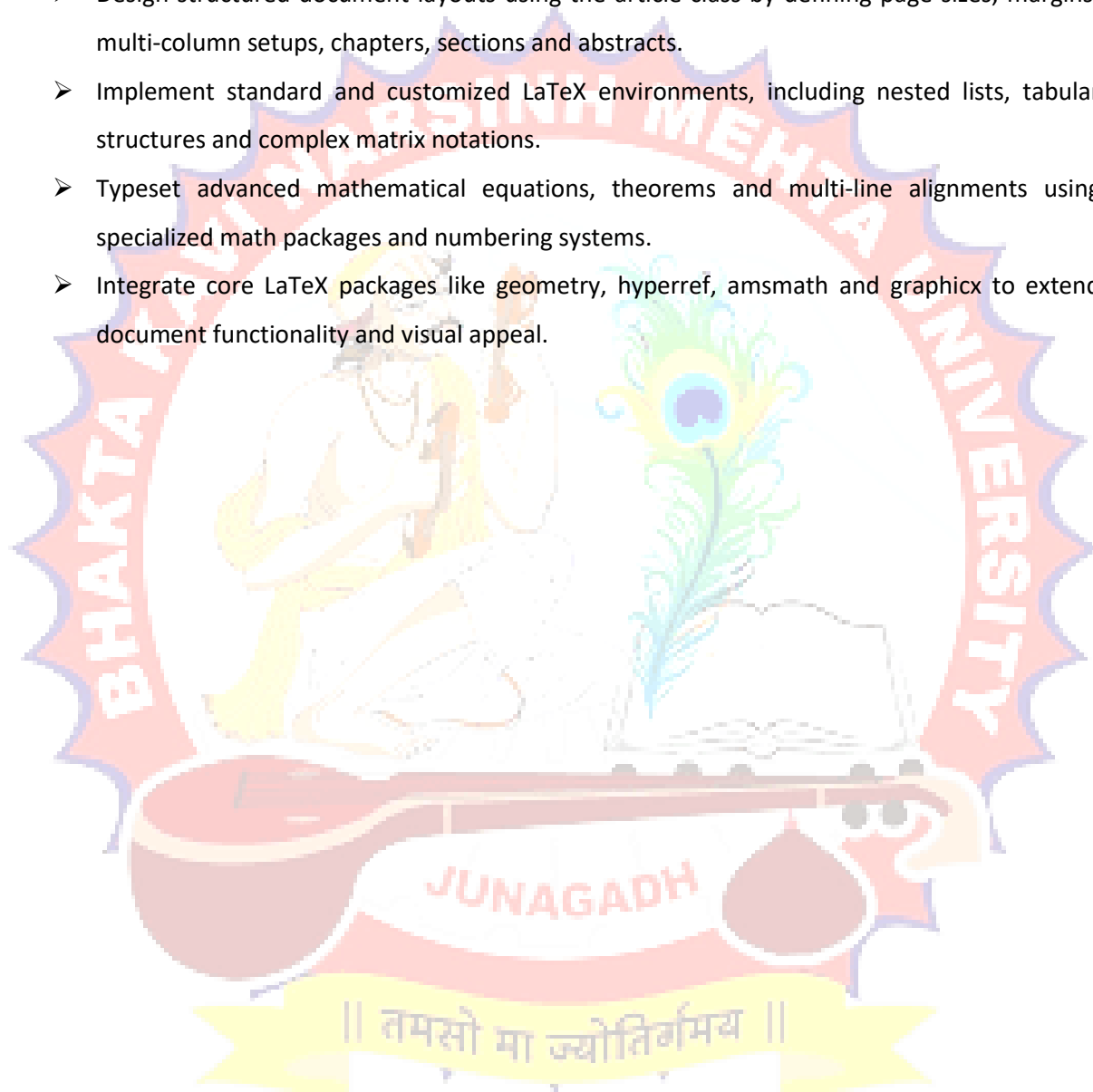
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SEMESTER- VII

- Apply correct LaTeX syntax to typeset mathematical fractions, standard algebraic functions, reserved characters and currency/temperature symbols.
- Format document text and paragraphs efficiently by manipulating fonts, sizes, weights, alignments, spacing, colors, subscripts and superscripts.
- Design structured document layouts using the article class by defining page sizes, margins, multi-column setups, chapters, sections and abstracts.
- Implement standard and customized LaTeX environments, including nested lists, tabular structures and complex matrix notations.
- Typeset advanced mathematical equations, theorems and multi-line alignments using specialized math packages and numbering systems.
- Integrate core LaTeX packages like geometry, hyperref, amsmath and graphicx to extend document functionality and visual appeal.



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Course contents of **Introduction to LaTeX (Practical Based Course)**

(Instead of OJT for B.Sc. Mathematics (Honours) students)

UNIT 1: Introduction and Installation

(Approx. 10 Hours)

Brief history, Installing MikTeX and TeXnic center/Winedt on Windows systems (Linux and MacOS version softwares are also available), LaTeX syntax, TeX / LaTeX file types.

Getting started with LaTeX:

Creating, opening, saving and compiling documents; Typesetting fractions, well known functions etc., some Ready-made strings, Typesetting specially reserved LaTeX symbols, Understanding GUI and using its toolbar;

Text and paragraph formatting:

Boldface, underline, italics, spacing, font type and size alteration, text colouring, text alignment, subscript, superscript etc., typesetting symbols such as Euro, rupee, degree symbol for temperature etc.

UNIT 2: Page Layouts, Environments and Mathematical Packages (Approx. 20 Hours)

Page layout and style:

Page size, two-sided documents, margins, orientation, multi-column style, numbering, making title of a document, writing abstract of a document. Dividing a document into chapters, sections, subsections, paragraphs, subparagraphs.

LaTeX Environment:

Concept of environment in LaTeX and maths environments such as enumerate, itemize, tabular, equation, align and so on; Nested listing, inline lists, customizing lists.

Typesetting Mathematics:

More on typesetting equations: single equations, group of equations, long equations, equation numbering; Matrices: keywords like pmatrix, bmatrix, vmatrix, matrix, Vmatrix, Bmatrix etc. and dots, ldots, cdots, vdots, binom, dfrac, dbinom, typesetting theorem etc., other math stuff; creating tables.

Packages and document class:

Packages: Geometry, hyperref, amsmath, amssymb, amsfons, tfrupee, color, graphicx, enumerate, fullpage, array, multirow etc.

Classes: article class only

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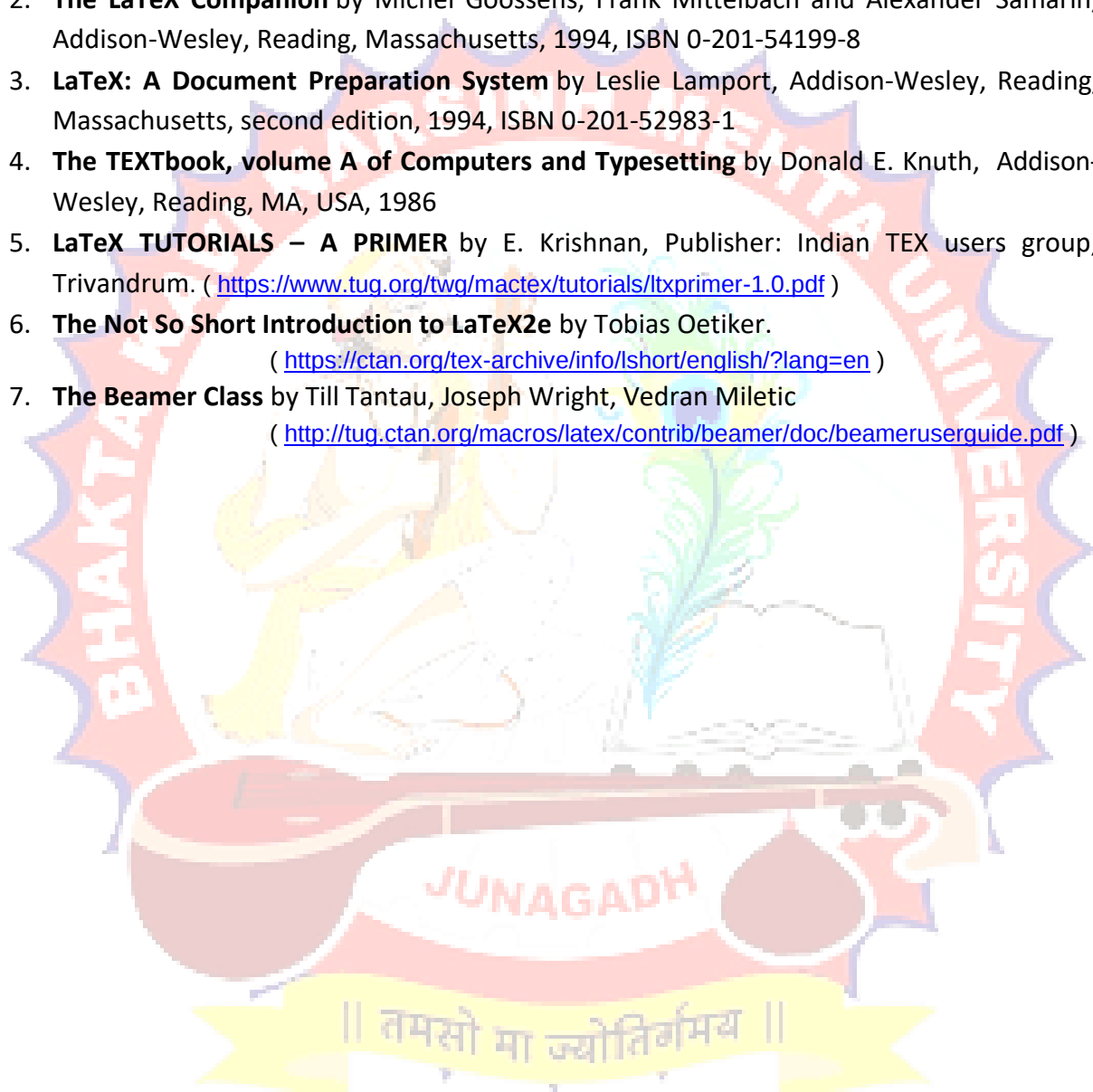
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Suggested References:

1. **A Guide to LaTeX2e** by Helmut Kopka and Patrick Daly, Addison-Wesley, Reading, Massachusetts, 1995, ISBN 0-201-42777-X
2. **The LaTeX Companion** by Michel Goossens, Frank Mittelbach and Alexander Samarin, Addison-Wesley, Reading, Massachusetts, 1994, ISBN 0-201-54199-8
3. **LaTeX: A Document Preparation System** by Leslie Lamport, Addison-Wesley, Reading, Massachusetts, second edition, 1994, ISBN 0-201-52983-1
4. **The TEXTbook, volume A of Computers and Typesetting** by Donald E. Knuth, Addison-Wesley, Reading, MA, USA, 1986
5. **LaTeX TUTORIALS – A PRIMER** by E. Krishnan, Publisher: Indian TEX users group, Trivandrum. (<https://www.tug.org/twg/mactex/tutorials/txprimer-1.0.pdf>)
6. **The Not So Short Introduction to LaTeX2e** by Tobias Oetiker.
(<https://ctan.org/tex-archive/info/lshort/english/?lang=en>)
7. **The Beamer Class** by Till Tantau, Joseph Wright, Vedran Miletic
(<http://tug.ctan.org/macros/latex/contrib/beamer/doc/beameruserguide.pdf>)



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SEMESTER- VII

B.Sc. Semester – VII

Research Methodology – 1

(Instead of OJT for B.Sc. Mathematics (Honours) students)

Course Level	6.0	Internal Marks	25
Programme	B.Sc. Mathematics (Honours)	External Marks	25
Semester	VII	Practical Internal	---
Category of Course	Research Methodology (Instead of OJT)	Practical External	---
Course Credit	2	Prac. External Exam Duration	---
Teaching Hours	2 hours/week	Total (SEE+CCE)	50
Course Code		Exam Duration	1 Hour
Course Title	Research Methodology – 1 (Instead of OJT for B.Sc. Mathematics (Honours) students)		

Course Objectives:

The course curriculum aims to:

- ❖ **Distinguish Research Paradigms:** To differentiate between the fundamental nature, methodologies and objectives of pure vs. applied mathematical research.
- ❖ **Develop Logical Reasoning:** To impart a deep understanding of mathematical formalisms, propositional logic and deductive reasoning techniques.
- ❖ **Master Proof Techniques:** To introduce various mathematical proof strategies (e.g. direct proof, contradiction, induction, counter examples) for constructing rigorous mathematical arguments.
- ❖ **Formulate Research Questions:** To train students in identifying gaps in existing mathematical literature and formulating well-defined research problems.
- ❖ **Delineate Scope & Constraints:** To guide students in defining boundary conditions, scope and feasibility parameters for targeted mathematical projects.
- ❖ **Navigate Scientific Databases:** To familiarize students with digital indexing databases and preprint servers such as Scopus, Web of Science, MathSciNet and arXiv.org.

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- ❖ Optimize Literature Search: To teach effective literature search methodologies using advanced Boolean operators and keyword optimization strategies.
- ❖ Analyze Bibliometric Metrics: To provide comprehensive insights into researcher and publication performance metrics including the h-index, i10-index, Journal Impact Factor (JIF).
- ❖ Evaluate Journal Credibility: To equip students with critical evaluation criteria for identifying predatory open-access journals and bogus metrics.
- ❖ Promote Academic Integrity: To instill ethical standards in mathematical research, literature documentation, citation practices and publishing.

Course Learning Outcomes:

Upon successful completion of the course, student will be able to:

- Classify Mathematical Domains: Critically analyze and classify research problems into pure or applied mathematical domains based on underlying theoretical and real-world implications.
- Apply Deductive Proofs: Apply appropriate proof strategies (e.g. contraposition, structural induction) to construct rigorous proofs for mathematical claims.
- Formulate Novel Problems: Synthesize existing mathematical knowledge to formulate well-posed research problems with defined scope and objectives.
- Execute Target Queries: Perform literature searches using optimized keyword sequences and Boolean operators across platforms like Scopus and MathSciNet.
- Retrieve Open-Access Preprints: Effectively navigate preprint repositories like arXiv.org to track cutting-edge, pre-publication research in specialized fields.
- Evaluate Researcher Impact: Calculate, interpret and compare bibliometric indices (h-index, i10-index) to evaluate the scholarly contribution of researchers.
- Interpret Journal Quality: Assess the prestige and quality of mathematical journals using metrics such as Journal Impact Factor (JIF), SJR and CiteScore.
- Detect Predatory Outlets: Detect predatory open-access journals by analyzing peer-review transparency, editorial boards and indexing authenticity.
- Draft Literature Surveys: Synthesize academic literature to prepare structured, well-referenced literature reviews with proper citations.
- Uphold Publication Ethics: Demonstrate academic integrity by strictly avoiding plagiarism, citation manipulation and predatory publishing practices.

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Course contents of Research Methodology – 1

(Instead of OJT for B.Sc. Mathematics (Honours) students)

UNIT 1: Fundamentals of Research and Logic in Mathematics (Approx. 15 Hours)

Nature and scope of pure vs. applied mathematical research; deductive logic, proof strategies, formulation of research problems and defining research scope.

UNIT 2: Literature Survey and Research Metrics (Approx. 15 Hours)

Accessing digital libraries: Scopus, Web of Science, MathSciNet, arXiv.org; search techniques, keyword optimization, h-index, i10-index, Journal Impact Factor, identifying predatory open-access journals.

Suggested References:

1. **Research Methodology in Mathematics** by Dr. Dnyaneshwar D. Pawar & Dr. Ganesh D. Kedar, Himalaya Publishing House, ISBN 978-9365577365.
2. **Research Methodology: Methods and Techniques** by C. R. Kothari & Gaurav Garg, New Age International Publishers, ISBN 978-9386649225.
3. **Research Methodology and Quantitative Techniques** by K. A. Varghese, B. R. Ranwah, Nisha Varghese & Nikhil Varghese, Routledge India / Taylor & Francis, ISBN 978-1032840338.
4. **Research Methodology and Quantitative Methods** by G. Nageswara Rao, BS Publications, ISBN 978-9381075562.