Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Department of Mathematics

2019 Pattern

T. Y. B. Sc. (Mathematics)

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
V	USMT351	Metric Spaces	3	48
	USMT352	Real Analysis I	3	48
	USMT353	Group Theory	3	48
	USMT354	Ordinary Differential Equation	3	48
	USMT355	Number Theory	3	48
	USMT356(A)	Operation Research	3	48
	USMT356(B)	C Programming	3	48
	USMT357	Practical based on USMT351 and USMT352	2	48
	USMT358	Practical based on USMT353 and USMT354	2	48
	USMT359	Practical based on USMT355 and USMT356	2	48
VI	USMT361	Complex Analysis	3	48
	USMT362	Real Analysis II	3	48
	USMT363	Ring Theory	3	48
	USMT364	Partial Differential Equation	3	48
	USMT365	Lebesgue Integration	3	48
	USMT366(A)	Optimization Techniques	3	48
	USMT366(B)	Python Programming	3	48
	USMT367	Practical based on USMT361, USMT362, and USMT363	2	48

	USMT368	Practical based on USMT364, USMT365, and USMT366	2	48
	USMT369	Mathematics Project	2	48

Equivalence of the old syllabus with the new syllabus

Old Course		New Course	
MAT 3501	Metric Spaces	USMT351	Metric Spaces
MAT 3502	Real Analysis I	USMT352	Real Analysis I
MAT 3503	Group Theory	USMT353	Group Theory
MAT 3504	Ordinary Differential Equation	USMT354	Ordinary Differential Equation
MAT 3505	Operation Research	USMT356(A)	Operation Research
MAT 3506	Number Theory	USMT355	Number Theory
MAT 3507	Practical based on MAT 3501 and MAT 3502	USMT357	Practical based on USMT351 and USMT352
MAT 3508	Practical based on MAT 3503 and MAT 3504	USMT358	Practical based on USMT353 and USMT354
MAT 3509	Practical based on MAT 3505 and MAT 3506	USMT359	Practical based on USMT355 and USMT356
MAT 3601	Complex Analysis	USMT361	Complex Analysis
MAT 3602	Real Analysis II	USMT362	Real Analysis II
MAT 3603	Ring Theory	USMT363	Ring Theory
MAT 3604	Partial Differential Equation	USMT364	Partial Differential Equation
MAT 3605	Optimization Techniques	USMT366(A)	Optimization Techniques
MAT 3606	Lebesgue Integration	USMT365	Lebesgue Integration
MAT 3607	Practical based on MAT 3601, MAT 3602, and MAT 3603	USMT367	Practical based on USMT361, USMT362, and USMT363
MAT 3608	Practical based on MAT 3604, MAT 3605, and MAT 3606	USMT368	Practical based on USMT364, USMT365, and USMT366
MAT 3609	Mathematics Project	USMT369	Mathematics Project

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT351
Course: 1 **Title of the Course:** Metric Spaces
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. Develop a rigorous understanding of metric spaces as a foundation for advanced analysis.
2. Learn to define and manipulate distances in metric spaces.
3. Grasp the concepts of convergence and completeness in metric spaces.
4. Explore the topological properties of metric spaces, including open and closed sets, subspaces, and separation axioms.
5. Analyze continuity and its variations (uniform continuity, homeomorphism) in the context of metric spaces.
6. Investigate connectedness and its different forms (connected, locally connected, arcwise connected) in metric spaces.
7. Introduce the concept of compactness in metric spaces and its applications**.**

B) Course Outcomes:

1. Students will be able to define a metric space and provide examples of common metric spaces.
2. Students will be able to prove statements about distances in metric spaces and use them to solve problems.
3. Students will be able to determine the convergence of sequences in a metric space and identify Cauchy sequences.
4. Students will be able to explain the concept of completeness and demonstrate its importance in metric spaces.
5. Students will be able to define open and closed sets in a metric space and prove basic theorems related to them.
6. Students will be able to analyze the continuity of functions between metric spaces and apply extension theorems.
7. Students will be able to identify connected and compact sets in metric spaces and prove their key properties.

TOPICS	**No. of Lectures**
Unit 01: Basic Concepts	**8**
• Inequalities	
• Metric Spaces	
• Sequences in Metric Spaces	
• Cauchy Sequences	
• Completion of a Metric Space	
Unit 02: Topology of a Metric Space	**8**
• Open and Closed Sets	
• Relativisation and Subspaces	
• Countability Axioms and Separability	
• Baire's Category Theorem	

Unit 03: Continuity **10**

- Continuous Mappings
- Extension Theorems
- Real and Complex-valued Continuous Functions
- Uniform Continuity
- Homeomorphism, Equivalent Metrics and Isometry

Unit 04: Connected Spaces **8**

- Connectedness
- Local Connectedness
- Arcwise Connectedness

Unit 05: Compact Spaces **10**

- Bounded sets and Compactness
- Other Characterisations of Compactness
- Continuous Functions on Compact Spaces
- Locally Compact Spaces
- Compact Sets in Special Metric Spaces

Unit 05: Product Spaces **4**

- Finite and Infinite Products of Sets
- Finite Metric Products
- Infinite Metric Products
- Cantor Set

Textbook: Satish Shirali and Harkrishan L. Vasudeva, Metric Spaces, Springer

Reference Books:

1) O'Searcoid, Metric Spaces, Springer
2) James R. Munkres, Topology, Pearson
3) Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co Pvt.Ltd

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Metric Spaces **Course Code:** USMT351
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2				2			2
CO 2	3	3		1		2			3
CO 3	3	3		1		2			3
CO 4	3	3		1		2			3
CO 5	3	3		1	1	2			3
CO 6	3	3		1	1	2			3
CO 7	3	3		1	1	2			3

Justification for the mapping

PO 1: Disciplinary Knowledge:
Strong understanding of metric spaces forms a core component of advanced mathematics.
PO2: Critical Thinking and Problem Solving:
Solving problems and proving theorems in metric spaces enhances critical thinking.
PO4: Research-related skills and Scientific temper:
Metric space theory provides a basis for research in analysis but requires further development in advanced studies.
PO5: Trans-disciplinary Knowledge:
Applications of metric spaces can relate to other fields, especially in higher mathematical contexts.
PO6: Personal and professional competence:
Competence in the subject improves analytical thinking and professionalism.
PO9: Self-directed and Life-long learning:
The rigorous nature of metric spaces encourages independent learning and continued study in mathematics.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT352
Course: 2 **Title of the Course:** Real Analysis I
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. Understand the fundamental concepts of sets and operations on sets.
2. Define and analyze various types of functions, including real-valued functions.
3. Explore the properties of real numbers and their significance in mathematical analysis.
4. Investigate the concepts of equivalence and countability in relation to sets.
5. Grasp the concept of least upper bound and its role in real analysis.
6. Analyze sequences of real numbers, including subsequence, convergence, and monotonicity.
7. Examine the properties of bounded sequences and their relevance in mathematical analysis.
8. Understand operations on sequences and their implications in the context of real analysis.
9. Investigate the notions of limit superior and limit inferior in the study of sequences.
10. Study the concept of Cauchy sequences and their significance in real analysis.

B) Course Outcomes:

1. Demonstrate proficiency in performing operations on sets and understanding their properties.
2. Apply knowledge of functions to solve problems involving real-valued functions.
3. Analyze real numbers and their properties in the context of mathematical analysis.
4. Determine the equivalence and countability of sets and their relevance in mathematical analysis.
5. Utilize the concept of least upper bound to analyze real numbers and sequences.
6. Evaluate the convergence and monotonicity of sequences and their implications.
7. Demonstrate proficiency in applying various tests for convergence and absolute convergence of series, including the class l^2.

Topics and Learning Points

Teaching Hours

Unit 1: Sets and functions **12**

1.1 Sets and operations on sets
1.2 Functions
1.3 Real valued functions
1.4 Equivalence and countability
1.5 Real numbers
1.6 Least upper bound

Unit 2: Sequence of real numbers **18**

2.1 Sequence and subsequence
2.2 Convergence of sequence
2.3 Bounded and monotone sequences

2.4 Operations on sequences
2.5 Limit superior and limit inferior
2.6 Cauchy sequences

Unit 3: Series of real numbers **18**

3.1 Convergence of series
3.2 Series with nonnegative terms
3.3 Alternating series
3.4 Conditional and absolute convergence
3.5 Tests for absolute convergence of series
3.6 The class l^2

Text Book:

Richard R. Goldberg, *Methods of Real Analysis*, Oxford & IBH Publishing Co. Pvt. Ltd., Indian Edition.
Unit 1 – Sections 1.1 to 1.7, **Unit 2** – Sections 2.1 to 2.10,
Unit 3 – Sections 3.1 to 3.4, 3.6, 3.7 & 3.10

Reference Books:

1. Ajit Kumar and S. Kumaresan, *A Basic Course in Real Analysis*, CRC Press, Second Indian Reprint 2015.
2. D. Somasundaram and B. Choudhary, *A first course in Mathematical Analysis*, Narosa Publishing House, 1997.
3. Robert G. Bartle and Donald Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 3rd Edition.
4. Shantinarayan and Mittal, *A course of Mathematical Analysis*, S. Chand and Co., Revised Edition (2002).
5. S. C. Malik and Savita Arora, *Mathematical Analysis*, New Age International Publications, 3rd Edition (2008).

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Real Analysis I **Course Code:** USMT352
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2			1				1
CO 2	3	3		2	1	1			1
CO 3	3	3			1				1
CO 4	3	2			1				1
CO 5	3	2		2	2				1
CO 6	2	3		2	1	1			1
CO 7	2	3		2	1	1			1

Justification for the mapping

PO1: Disciplinary Knowledge
All course outcomes are directly related to disciplinary knowledge as they involve understanding and applying mathematical concepts fundamental to the discipline.
PO2: Critical Thinking and Problem Solving
CO2, CO3, CO6, and CO7 involve problem-solving skills and critical thinking in analyzing functions, sequences, and series, respectively.
PO4: Research-related skills and Scientific Temper
CO4, CO5, CO6, and CO7 involve analytical skills and a scientific temper in analyzing mathematical concepts and applying tests for convergence.
PO5: Trans-disciplinary Knowledge
Although primarily focused on mathematics, the skills developed through the course can be applied across various disciplines, indicating a partial relation.
PO6: Personal and Professional Competence
CO2, CO6, and CO7 enhance problem-solving skills and analytical abilities, contributing to personal and professional competence.
PO9: Self-directed and Life-long Learning
All course outcomes contribute to building a foundation for self-directed learning, especially in the field of mathematics, which often requires continuous learning and exploration.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT353
Course: 3 **Title of the Course:** Group Theory
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To Introduce students to the fundamental concept of abstract algebra and the notion of mathematical structures called groups.
2. To develop problem-solving skills through the exploration of group theory concepts and the solution of theoretical and practical problems.
3. To study various operations on groups, including multiplication, addition, and composition, and understanding how these operations interact with group properties.
4. To understand the notion of group isomorphisms, Caley's theorem and their role in establishing equivalences between different groups.
5. To explore the concepts of subgroups and cosets within groups, and understanding their significance in group theory.
6. To enhance students' ability to formulate rigorous mathematical arguments and proofs related to group theory concepts and theorems.
7. Demonstrating the applications of group theory in various areas of mathematics, such as number theory, geometry, cryptography, and particle physics.

B) Course Outcomes:

1. Understand the abstract algebra, particularly in relation to and be able to articulate the key concepts and properties associated with groups.
2. Explain the significance of the notions of cosets, normal subgroups and factor groups.
3. Analyse consequences of Lagrange's theorem.
4. Recognize group structures in various mathematical contexts and understand how different mathematical objects can be analyzed using group theory.
5. Describe about structure preserving maps between groups and their consequences.
6. Construct clear and rigorous mathematical proofs related to group theory concepts and theorems, demonstrating logical reasoning and mathematical maturity.
7. Apply group theory concepts and techniques to solve problems in mathematics and related fields, such as cryptography, particle physics, and chemistry.

TOPICS/CONTENTS: **Teaching Hours**

Unit 01: Introduction to Groups [8]

1. 1 Symmetries of square
1. 2 The Dihedral groups
1. 3 Definition and examples of groups
1. 4 Elementary properties of groups

Unit 02: Finite Groups and Subgroups [*8*]

2. 1 Order of group, order of elements.
2. 2 Subgroup Tests and examples.
2. 3 Center of a group
2. 4 Centralizer of element.
2. 5 Cosets: definition and properties
2. 6 Lagrange's theorem and corollary

Unit 03: Cyclic Groups [10]

3. 1 Properties of cyclic groups and examples
3. 2 Order of finite cyclic groups
3. 3 Generators of finite cyclic groups
3. 4 Generators of Zn
3. 5 Fundamental theorem of Cyclic Groups

Unit 04: Permutation Groups [*8*]

4. 1 Definition and examples
4. 2 Permutation on S_n, detail discussion of S_3
4. 3 Cycle notation
4. 4 Properties and theorems on permutation.
4. 5 Even odd permutation

Unit 05: Normal Subgroup [*4*]

5. 1 Definition
5. 2 If G is abelian then every subgroup of G is normal subgroup
5. 3 Theorems on Normal subgroup.

Unit 06: Homomorphism and Isomorphism's [*10*]

6. 1 Homomorphism and fundamental theorem of homomorphism
6. 2 Group isomorphism's
6. 3 Cayley's Theorem
6. 4 Properties of isomorphism
6. 5 Automorphisms

Textbook:
1. Contemporary Abstract Algebra, Joseph Gallian. (Ch. 1 to 6 and ch .9 to 10)
Unit 01: Chapter1&Chapter2
Unit 02:Chapter3
Unit 03:Chapter4
Unit 04:Chapter5
Unit 05:Chapter9
Unit 06:Cahpter6 &Chapter10

Reference Books:

1. I.N. Herstein, Topics in Algebra, Wiley.(Normal subgroup chapter)
2. .P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic abstract Algebra, Second Ed.
3. J. B. Fraleigh, A. First Course in Abstract Algebra, Third Edition, Narosa publication.
4. M. Artin, Algebra, Prentice Hall of India, New Delhi.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Group Theory **Course Code:** USMT353
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2		2	1	1			2
CO 2	3	2		2	1	1			2
CO 3	3	3		3	2	2			3
CO 4	3	2		3	3	2			2
CO 5	3	2		3	2	1			2
CO 6	3	3		3	2	2			3
CO 7	3	3		3	3	2			3

Justification for the mapping

PO 1: Disciplinary Knowledge:
Strong relation as the course builds foundational knowledge of group theory and its structures.
PO2: Critical Thinking and Problem Solving:
Moderate to strong relation, especially in applying group theory concepts to solve complex problems.
PO4: Research-related skills and Scientific temper:
Theorems and proofs in group theory require rigorous logical reasoning, essential for research skills.
PO5: Trans-disciplinary Knowledge:
Group theory has applications in diverse fields such as cryptography, making it trans-disciplinary.
PO6: Personal and professional competence:
Limited connection, but problem-solving skills developed are beneficial for professional competence.
PO9: Self-directed and Life-long learning:
Strong emphasis on independent learning, especially in proofs and solving advanced group theory problems.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT354
Course: 4 **Title of the Course:** Ordinary Differential Equations
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To introduce student ordinary differential equations, their definitions, classifications, and basic properties.
2. To teach students techniques to solve various types of ordinary differential equations, including first-order, second-order, linear, and nonlinear equations.
3. To explain the existence and uniqueness theorems for solutions of initial value problems, and their implications in understanding the behaviour of solutions to ODEs.
4. To familiarizing students with analytical methods such as separation of variables, integrating factors, variation of parameters, and power series solutions for solving ODEs.
5. To develop students' critical thinking skills by presenting them with challenging problems involving ordinary differential equations.
6. To apply ordinary differential equations in various scientific and engineering fields, such as physics, chemistry, biology, economics, and engineering, including modeling physical systems, population dynamics, chemical reactions, and electrical circuits.
7. To prepare student for further study in advanced topics related to ordinary differential equations, such as partial differential equations, dynamical systems, control theory, and mathematical modeling.

B) Course Outcomes:

1. Understand basic concept of differential equations.
2. Solve first order differential equations.
3. Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
4. Solve differential equations using variation of parameter method, undetermined coefficient and by numerical methods.
5. Solve constant-coefficient linear second-order differential equations.
6. Demonstrate ability to think critically by determining and using appropriate techniques for solving a variety of differential equations.
7. Demonstrate the ability to integrate knowledge and ideas of differential equations in a coherent and meaningful manner for solving real world problems.

TOPICS/CONTENTS: **Teaching Hours**

Unit 01: Differential Equations [*12*]

1.1 Introduction
1.2 Nature of solution
1.3 Separable Equations
1.4 First order linear equations
1.5 Exact Equations
1.6 Orthogonal Trajectories and Families of Curves

1.7 Homogeneous Equations
1.8 Integrating Factor

Unit 02: Second Order Differential Equations [*14*]

2.1 Method of undetermined coefficients.
2.2 Method of variation of parameters.
2.3 Method of reduction of order.
2.4The use of a known solution to find another.

Unit 03: Power series solutions [*12*]

3. 1 Introduction and review of power series.
3. 2 Linear equations and power series.
3. 3 Convergence of power series.
3. 4 Ordinary points and regular singular points.

Unit 04: **System of First-Order Equations** [*10*]

4. 1 Introductory remarks
4. 2 Linear systems
4. 3 Homogeneous linear systems with constant Coefficients
4. 4 Distinct roots, repeated roots, Complex roots

Textbook:

1. Differential Equations by George F. Simmons, Steven G. Krantz, Tata McGrawHill.

Unit 01: Chapter 1; Section 1.1 to 1.9
Unit 02: Chapter2; Section 2.1 to 2.4
Unit 03: Chapter 3; Section 3.1 to 3.3
Unit 04: Chapter 8: Secton 8.1 to 8.2

Reference Books:

1. Ordinary and Partial Differential Equation, by M.D. Raisinghania, S.Chand and Company LTD, 2009.
2. Daniel Murray, Introductory Course in Differential Equations, Orient Longman.
3. Elementary Differential Equations, Rainville and Bedient, Macmillan Publication.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Ordinary Differential Equations **Course Code:** USMT354
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2		2	1	1			2
CO 2	3	2		2	1	1			2
CO 3	3	3		3	2	2			2
CO 4	3	3		3	2	2			2
CO 5	3	3		3	2	2			2
CO 6	3	3		3	2	2			3
CO 7	3	3		3	3	3			3

Justification for the mapping

PO 1: Disciplinary Knowledge:
Strong understanding of core concepts in differential equations is required.
PO2: Critical Thinking and Problem Solving:
Solving various types of differential equations fosters critical thinking.
PO4: Research-related skills and Scientific temper:
Research is essential for finding appropriate solution techniques and methods.
PO5: Trans-disciplinary Knowledge:
Differential equations are applicable across disciplines like physics and engineering.
PO6: Personal and professional competence:
Problem-solving in this course builds personal and professional confidence.
PO9: Self-directed and Life-long learning:
The course promotes continuous learning and problem-solving skills.

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT355
Course: 5 **Title of the Course:** Number Theory
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. Develop a solid understanding of divisibility properties of integers, including the Division Algorithm and the Fundamental Theorem of Arithmetic.
2. Introduce the concept of congruences and explore their properties, including residue classes and theorems like Fermat's, Euler's, and Wilson's.
3. Investigate the greatest integer function and related arithmetic functions like Euler's function, divisor function, sum of divisors function, and number of prime divisors function.
4. Introduce the concept of multiplicative functions and explore the Mobius function and its inversion formula.
5. Develop an understanding of quadratic residues, Legendre's symbol, and the Law of Quadratic Reciprocity.
6. Introduce Jacobi symbol as an extension of Legendre's symbol.
7. Expose students to Diophantine equations, focusing on linear equations (ax + by = c) and explore Pythagorean triplets as an example.

B) Course Outcomes:

1. Students will be able to apply divisibility properties and the Division Algorithm to solve problems involving integers.
2. Students will be able to perform operations on congruence classes and utilize theorems like Fermat's, Euler's, and Wilson's to solve problems.
3. Students will be able to calculate the greatest integer function and related arithmetic functions for various integers.
4. Students will be able to identify and utilize multiplicative functions, particularly the Mobius function and its inversion formula.
5. Students will be able to determine quadratic residues and apply Legendre's symbol to solve problems related to quadratic reciprocity.
6. Students will be able to understand the concept of Jacobi symbol and its connection to Legendre's symbol.
7. Students will be able to solve linear Diophantine equations and identify Pythagorean triplets using number theory concepts.

TOPICS/CONTENT

Unit 01: Divisibility **8**

- Divisibility in integers, Division Algorithm
- GCD, LCM,
- Fundamental theorem of Arithmetic
- Infinitude of primes

Unit 02: Congruences **12**

- Properties of Congruences
- Residue classes, complete and reduced residue system, their properties
- Fermat's theorem. Euler's theorem, Wilson's theorem
- Linear Congruences of degree 1
- Chinese remainder theorem

Unit 03: Greatest integer function **10**

- Arithmetic functions Euler's function
- the number of divisors d(n)
- $\sigma(n)$, $\omega(n)$ and $\Omega(n)$
- Multiplicative functions, Mobius function, Mobius inversion formula.

Unit 04: Quadratic Reciprocity **10**

- Quadratic residues
- Legendre's symbol and its properties
- Law of quadratic reciprocity
- Jacobi symbol

Unit 05: Diophantine Equations **8**

- Diophantine Equations ax + by = c
- Pythagorean triplets

Text Book:

I. Niven, H. Zuckerman and H.L. Montgomery, An Introduction to Theory of Numbers, 5th Edition, John Wiley and Sons.
(§1.1- §1.3, §2.1- §2.3, §3.1- §3.3, §4.1 -§4.3, §5.1 and §5.3.)

Reference Book:

David M. Burton, Elementary Number Theory (Second Ed.)

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Number Theory **Course Code:** USMT355
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3		2	2	2			2
CO 2	3	3		2	2	2			2
CO 3	2	2		2	1	2			2
CO 4	2	3		2	1	2			2
CO 5	2	3		2	1	2			2
CO 6	2	2		2	1	2			2
CO 7	3	3		3	2	3			3

Justification for the mapping

PO 1: Disciplinary Knowledge:
Mastery of divisibility and congruence is essential for understanding number theory concepts.
PO2: Critical Thinking and Problem Solving:
All COs require analytical skills to apply theorems and solve complex problems.
PO4: Research-related skills and Scientific temper:
The concepts explored can form the basis for research in number theory and its applications.
PO5: Trans-disciplinary Knowledge:
Understanding number theory is relevant in various fields, such as cryptography and computer science.
PO6: Personal and professional competence:
Mastering these concepts aids in professional applications and enhances personal competency in mathematics.
PO9: Self-directed and Life-long learning:
Engaging with number theory fosters independent study habits and lifelong learning in mathematics.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT356(A)
Course: 6 **Title of the Course:** Operations Research
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To familiarize students with the basic concepts, terminologies, and constraints involved in linear programming problems, enabling them to articulate problem formulations effectively.
2. Develop students' proficiency in graphically representing and solving linear programming problems using the graphical method, including identifying feasible regions, optimal solutions, and sensitivity analysis.
3. Enable students to apply the simplex method algorithmically to solve complex linear programming problems, emphasizing the understanding of pivot operations and iterations.
4. Equip students with the skills to handle linear programming problems with constraints that require artificial variables using the Big-M method, focusing on conversion and manipulation techniques.
5. Introduce students to graphical sensitivity analysis methods to assess the impact of changes in objective function coefficients, resource availability, and constraint boundaries on optimal solutions.
6. To enable students to understand and apply the concept of duality in Linear Programming (LP) problems, exploring its significance, properties, and practical implications.
7. To familiarize students with the core concepts, algorithms, and mathematical techniques used in transportation modeling, enabling them to comprehend the underlying principles of optimization in transportation systems.
8. To equip students with the ability to identify, formulate, and solve transportation problems using appropriate mathematical models and optimization techniques. This includes practical applications in logistics, supply chain management, and urban transportation planning.
9. To familiarize students with the fundamental principles and concepts underlying assignment models in Operations Research, including the Hungarian method, transportation problems, and linear programming techniques used in solving assignment problems.

B) Course Outcomes:

1. Students will demonstrate the ability to formulate real-world problems into mathematical linear programming models, identifying decision variables, constraints, and the objective function accurately.
2. Students will be able to graphically solve and interpret linear programming problems, accurately identifying feasible regions, optimal solutions, and performing sensitivity analysis on graphical representations.
3. Students will apply the simplex method proficiently to solve multi-variable linear programming problems, showcasing competence in formulating initial tables, conducting iterations, and identifying optimal solutions.

4. Students will exhibit proficiency in applying the Big-M method to solve problems with artificial variables, manipulating constraints effectively, and transitioning between phases while solving LP problems.
5. Students will be able to explain the concept of duality in Linear Programming, outlining its mathematical basis and relevance in optimization problems.
6. Students will be able to develop and implement transportation models to optimize logistical operations, effectively analyze transportation networks, and propose strategic solutions for minimizing transportation costs, maximizing efficiency, and addressing complex real-world transportation challenges.
7. Students will be proficient in formulating assignment problems in different contexts (such as workforce allocation, resource assignment, task optimization) as mathematical models. They will demonstrate the capability to apply appropriate algorithms and techniques, like the Hungarian algorithm or linear programming, to solve these assignment problems efficiently and effectively.

Topics and Learning Points

	Teaching Hours
Unit 1: Modeling with Linear Programming	**8**
1.1 Two variable LP Model 1.2 Graphical LP solution 1.3 Selected LP Applications 1.4 Graphical Sensitivity analysis	
Unit 2: The Simplex Method	**14**
2.1 LP Model in equation form 2.2 Transition from graphical to algebraic solutions 2.3 The simplex method 2.4 Artificial starting solutions.	
Unit 3: Duality	**6**
3.1 Definition of the dual problem 3.2 Primal dual relationship	
Unit 4: Transportation Model	**12**
4.1 Definition of the Transportation model 4.2 The Transportation algorithm	
Unit 5: Assignment Model	**8**
5.1 The Hungarian method 5.2 Simplex explanation of the Hungarian method.	

Text Book:

Hamdy A. Taha, *Operation Research*, Prentice Hall of India Pvt. Ltd, 8th Edition 2009.
Ch.2: 2.1,2.2,2.3(2.3.4, 2.3.5, 2.3.6). Ch.3: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 (3.6.1).
Ch.4: 4.1, 4.2. Ch.5: 5.1,5.3 (5.3.1, 5.3.2, 5.3.3), 5.4(5.4.1, 5.4.2).

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, *Introduction to Operation Research* (8th Edition) Tata McGraw Hill.
2. J. K. Sharma, *Operations Research: Theory and Applications*, (2nd Edition, 2006), Macmilan India Ltd.
3. Hira and Gupta, *Operation Research*.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Operations Research **Course Code:** USMT356(A)
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	2				1			
CO 2	3	2			1				
CO 3	2	2							
CO 4	3	3		1	1			1	1
CO 5	2	1							
CO 6	3	2		1	1	1		1	1
CO 7	2	2			1				1

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Students will apply linear programming to convert real-world problems into mathematical models, showcasing adeptness in defining decision variables, constraints, and objective functions, vital in problem-solving within the discipline.
CO2: Students will acquire vital analytical skills by graphically solving linear programming problems, enabling them to identify feasible regions, optimal solutions, and conduct sensitivity analysis, fostering a deeper understanding of quantitative decision-making.
CO3: Students will master the simplex method to efficiently tackle multi-variable linear programming problems, demonstrating expertise in constructing tables, performing iterations, and recognizing optimal solutions within Disciplinary Knowledge.
CO4: Students demonstrate mastery in utilizing the Big-M method by efficiently employing artificial variables, effectively manipulating constraints, and smoothly transitioning between phases when solving Linear Programming (LP) problems.
CO5: Duality in Linear Programming provides a complementary perspective by establishing relationships between primal and dual problems, enabling students to comprehend optimization trade-offs and derive optimal solutions efficiently in various disciplinary applications.

CO6: Students will gain expertise in transportation modeling to optimize logistics, analyze networks, and propose cost-effective strategic solutions, addressing real-world transportation challenges comprehensively.
CO7: Equips students with the expertise to translate real-world scenarios into mathematical models and adeptly utilize algorithms such as the Hungarian algorithm or linear programming for optimal problem-solving in diverse contexts.

PO2: Critical Thinking and Problem Solving
CO1: Developing linear programming models sharpens analytical skills by translating real-world problems into mathematical formulations, clarifying decision variables, constraints, and the objective function with precision.
CO2: Graphical linear programming enables students to visually analyze constraints, pinpoint feasible regions, optimize solutions, and conduct sensitivity analysis, fostering critical thinking in problem-solving.
CO3: Students will demonstrate critical thinking and problem-solving skills by efficiently utilizing the simplex method to navigate complex multi-variable linear programming problems, displaying adeptness in constructing initial tables, performing iterative calculations, and discerning optimal solutions.
CO4: Students will develop problem-solving skills by mastering the Big-M method, efficiently handling artificial variables, constraints, and seamlessly transitioning between phases in Linear Programming problem-solving.
CO5: Understanding duality in Linear Programming offers a dual perspective to optimization, presenting a mathematical basis for exploring alternative solutions and providing valuable insights into the primal problem, fostering critical thinking and problem-solving skills in tackling complex optimization challenges.
CO6: Empowering students with transportation modeling skills fosters the ability to strategically tackle real-world logistical challenges by optimizing networks, minimizing costs, and maximizing operational efficiency.
CO7: Students will enhance critical thinking by mastering diverse mathematical modeling techniques, like the Hungarian algorithm or linear programming, to proficiently solve assignment problems across various real-world scenarios, fostering effective problem-solving skills.

PO4: Research-related skills and Scientific temper
CO4: Mastering the Big-M method fosters adeptness in handling artificial variables, efficiently manipulating constraints, and seamlessly transitioning between phases, essential for resolving LP problems in research settings.
CO6: Students will acquire the expertise to devise and apply transportation models, enabling them to optimize logistics, analyze networks effectively, and propose strategic solutions, fostering a robust approach towards minimizing costs, maximizing efficiency, and addressing multifaceted real-world transportation challenges.

PO5: Trans-disciplinary Knowledge
CO2: Graphical solutions in linear programming facilitate comprehension of feasible regions, optimal solutions, and sensitivity analysis, aiding students' trans-disciplinary understanding of complex problem-solving and decision-making processes.
CO4: Mastering the Big-M method allows students to adeptly navigate artificial variables, manipulate constraints, and seamlessly transition phases, enabling effective problem-solving in Trans-disciplinary Knowledge.
CO6: Students will acquire essential skills to enhance logistical efficiency and tackle real-world transportation complexities by mastering transportation modeling and strategic optimization techniques within a trans-disciplinary framework.

CO7: Equipping students with diverse mathematical modeling skills and algorithmic techniques ensures adeptness in solving assignment problems across varied contexts, fostering trans-disciplinary problem-solving expertise.

PO6: Personal and Professional Competence

CO1: Enables strategic problem-solving by converting real-world scenarios into precise mathematical representations, optimizing decision-making through linear programming techniques.

CO6: Enables students to apply transportation models for cost-effective logistics, network analysis, and strategic problem-solving in real-world transportation scenarios, enhancing their personal and professional competence.

PO8: Environment and Sustainability

CO4: Mastering the Big-M method empowers students to navigate and solve complex environmental and sustainability problems by adeptly manipulating constraints and seamlessly transitioning between phases in linear programming.

CO6: Students will acquire expertise in transportation modeling to optimize logistics, analyze networks, and propose cost-effective, efficient solutions for real-world sustainability challenges in transportation.

PO9: Self-directed and Life-long Learning

CO4: Mastering the Big-M method enables seamless problem-solving by adeptly handling artificial variables, constraints manipulation, and phase transitions in Linear Programming, fostering self-directed and lifelong learning.

CO6: Empowering students with transportation modeling skills fosters lifelong learning by enabling them to strategically optimize logistics, analyze networks, and innovate solutions for cost reduction and efficiency enhancement in real-world transportation complexities.

CO7: Equipping students to translate real-world scenarios into mathematical models and apply relevant algorithms fosters adaptable problem-solving skills crucial for continual learning and self-directed problem resolution.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT356(B)
Course: 6 **Title of the Course:** C Programming
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To introduce the basic concepts of C programming language and its syntax.
2. To develop problem-solving skills through control structures, loops, and conditionals in C.
3. To familiarize students with the use of arrays, strings, and functions in modular programming.
4. To enable students to understand and use pointers effectively for memory management.
5. To introduce structures, unions, and their applications in data organization.
6. To provide hands-on experience with file handling for data storage and retrieval.
7. To build a strong foundation in C programming, enabling students to apply these skills in mathematics and real-world scenarios.

B) Course Outcomes:

1. Students will be able to write, compile, and execute basic C programs, understanding the structure and components of a C program.
2. Students will demonstrate the ability to implement control structures and loops to solve mathematical and logical problems.
3. Students will be able to apply functions and arrays to develop modular programs for solving mathematical problems.
4. Students will be able to use pointers for memory management and efficient program execution.
5. Students will understand and implement structures and unions for organizing and managing complex data.
6. Students will gain practical knowledge in file handling, creating programs that read and write data to files.
7. Students will be able to apply C programming skills to develop solutions for real-world mathematical problems and further their learning in more advanced programming courses.

Topics and Learning Points

Teaching Hours

Unit 1: Basics of C Programming **10**

1.1 Introduction to programming languages, history of C
1.2 Structure of a C program, compiling, and running a C program
1.3 Data types, variables, constants, keywords
1.4 Input/output functions: `scanf()`, `printf()`
1.5 Operators: Arithmetic, relational, logical, bitwise, assignment, and other operators
1.6 Type conversion and type casting
1.7 Decision control structures: `if`, `if-else`, `switch` statement

Unit 2: Looping and Control Statements **10**

2.1 Looping structures: `for`, `while`, `do-while`
2.2 Break, continue, and goto statements
2.3 Nested loops, use of loops in problem solving
2.4 Introduction to arrays: One-dimensional arrays, two-dimensional arrays
2.5 Examples of array manipulation: Sorting and searching algorithms

Unit 3: Functions and Storage Classes **10**

3.1 Defining and declaring functions, return types, and function arguments
3.2 Function prototypes, recursion
3.3 Storage classes: `auto`, `static`, `extern`, `register`
3.4 Scope and lifetime of variables
3.5 Passing arrays and functions to functions
3.6 Inline functions and recursion

Unit 4: Pointers and Dynamic Memory Allocation **08**

4.1 Introduction to pointers, pointer variables
4.2 Pointer arithmetic, pointers and arrays
4.3 Pointers to functions, dynamic memory allocation: `malloc()`, `calloc()`, `free()`, `realloc()`
4.4 Concept of pointers to structures and unions
4.5 Memory management techniques

Unit 5: Structures, Unions, and File Handling **10**

5.1 Definition and use of structures, array of structures
5.2 Union: Definition and differences between structures and unions
5.3 File handling in C: Opening, reading, writing, and closing files
5.4 File modes: Text vs binary files
5.5 Command-line arguments
5.6 Working with files using standard library functions: `fopen()`, `fclose()`, `fread()`, `fwrite()`, `fprintf()`, `fscanf()`

Text Book:

Yashavant Kanetkar, *Let Us C*, BPB Publications, 8th Edition.

Reference Books:

1. Brain W. Kernighan and Dennis M. Ritchie, *The C Programming Language* (2nd Edition), Pearson.
2. E. Balagurusamy, *Programming in ANSI C*, (9th Edition), McGraw Hill.
3. Peter van der Linden, *Expert C Programming: Deep C Secrets*.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: C Programming **Course Code:** USMT356(B)
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3		2	2	2			2
CO 2	3	3		2	2	2			2
CO 3	2	2		2	1	2			2
CO 4	2	3		2	1	2			2
CO 5	2	3		2	1	2			2
CO 6	2	2		2	1	2			2
CO 7	3	3		3	2	3			3

Justification for the mapping

PO 1: Disciplinary Knowledge:
Mastery of divisibility and congruence is essential for understanding number theory concepts.
PO2: Critical Thinking and Problem Solving:
All COs require analytical skills to apply theorems and solve complex problems.
PO4: Research-related skills and Scientific temper:
The concepts explored can form the basis for research in number theory and its applications.
PO5: Trans-disciplinary Knowledge:
Understanding number theory is relevant in various fields, such as cryptography and computer science.
PO6: Personal and professional competence:
Mastering these concepts aids in professional applications and enhances personal competency in mathematics.
PO9: Self-directed and Life-long learning:
Engaging with number theory fosters independent study habits and lifelong learning in mathematics.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT357
Course: 7 **Title of the Course:** Practical based on USMT351 and USMT352
Credit: 2 **No. of Lectures:** 48

A) Course Objectives:

1. Understand the fundamental concepts of metric spaces, including distance, open and closed sets, and convergence.
2. Explore the topology of metric spaces, including the concepts of open and closed balls, neighborhoods, and limit points.
3. Investigate the properties of continuous functions between metric spaces and their implications.
4. Analyze the notions of connectedness and path-connectedness in metric spaces and their applications.
5. Examine the concept of compactness in metric spaces and its relationship with continuity and convergence.
6. Study the construction and properties of product spaces and their relevance in various contexts.
7. Develop proficiency in formal mathematical reasoning and proof techniques applicable to metric spaces.
8. Gain familiarity with sets, functions, and basic operations in the context of real analysis.
9. Explore the properties of real numbers, including their construction and classification.
10. Investigate sequences and series of real numbers, including convergence criteria and their applications.

B) Course Outcomes:

1. Demonstrate proficiency in defining and manipulating basic concepts in metric spaces, such as open sets, closed sets, and metric functions.
2. Apply topological notions to analyze the structure and properties of metric spaces, including compactness and connectedness.
3. Evaluate the continuity of functions between metric spaces and understand its implications for various mathematical contexts.
4. Identify and classify different types of sequences of real numbers, including Cauchy sequences, and analyze their convergence behavior.
5. Analyze the convergence of series of real numbers using various tests and criteria, including absolute convergence.
6. Construct and analyze product spaces, understanding their properties and relationships with component spaces.
7. Demonstrate proficiency in constructing rigorous mathematical proofs to justify statements and conclusions related to metric spaces and real analysis.

List of Practical:

Teaching Hours

Practical based on Metric Spaces (USMT351): **24**

1. Practical 1: Basic Concepts in Metric Spaces
2. Practical 2: Topology of a Metric Space
3. Practical 3: Continuity
4. Practical 4: Connected Spaces
5. Practical 5: Compact Spaces
6. Practical 6: Product Spaces

Practical based on Real Analysis 1 (USMT352): **24**

1. Practical 1: Sets and Functions
2. Practical 2: Real numbers and Countability
3. Practical 3: Sequences of real numbers
4. Practical 4: Operations on sequences and Cauchy sequences
5. Practical 5: Series of real numbers
6. Practical 6: Tests for absolute convergence and the class l^2

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Practical based on USMT351 and USMT352 **Course Code:** USMT357
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3		1	1	1			1
CO 2	3	3		1	2	1			1
CO 3	3	3		1	1	1			1
CO 4	3	2		1	1				1
CO 5	3	2		1	2				1
CO 6	3	2		1	1				1
CO 7	3	3		2	2	1			1

Justification for the mapping

PO1: Disciplinary Knowledge
All course outcomes (COs) are strongly related to disciplinary knowledge as they directly address the understanding and proficiency in specific mathematical concepts and techniques relevant to the course.

PO2: Critical Thinking and Problem solving
COs 1-3, and CO7 involve critical thinking and problem-solving skills as they require students to analyze, manipulate, and apply abstract mathematical concepts and properties to solve problems and construct proofs.

PO4: Research-related Skills and Scientific Temper
CO7 involves constructing rigorous mathematical proofs, which aligns with research-related skills and fostering a scientific temper.

PO5: Trans-disciplinary Knowledge

While the course outcomes focus on specific mathematical topics, they provide a foundation that can be applied across various disciplines, indicating a moderate relation to trans-disciplinary knowledge.

PO6: Personal and Professional Competence

COs 1-3, and CO7 contribute to personal and professional competence by developing students' analytical skills, logical reasoning, and ability to communicate mathematical ideas effectively.

PO9: Self-directed and Life-long Learning

All COs indirectly contribute to self-directed and life-long learning by fostering critical thinking skills, problem-solving abilities, and a deep understanding of fundamental mathematical concepts that are applicable beyond the classroom setting.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT358
Course: 8 **Title of the Course:** Practical based on USMT353 and USMT354
Credit: 2 **No. of Lectures:** 48

A) Course Objectives:

1. To solve real-world problems using both ODE and Group Theory methodologies, emphasizing practical applications over theoretical abstraction
2. Ensure students are proficient in implementing numerical methods for ODEs, understanding the algorithms' strengths, limitations, and appropriateness for different scenarios.
3. To introduce students to computational techniques for group analysis, including subgroup identification, coset enumeration, and exploring group.
4. To Illustrate how ODEs and Group Theory can be applied across various disciplines such as physics, chemistry, biology, economics, and engineering through practical examples and case studies.
5. To provide opportunities for students to tackle challenging problems that require the integration of ODE and Group Theory concepts, fostering critical thinking and creativity.
6. To guide students in formulating mathematical models of physical, biological, or economic systems using ODEs and understanding how group theory can enhance these models.
7. To equip students with practical skills and theoretical understanding that can serve as a solid foundation for pursuing research or advanced study in mathematical modeling, computational mathematics, or related fields.

B) Course Outcomes:

1. Demonstrate when a binary algebraic structure is a group.
2. Determine possible subgroup of a group.
3. Understand the isomorphism between two groups.
4. Understand the symmetry of regular n-gon.
5. Understand the genesis of ordinary differential equations.
6. Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
7. Understand the formation of modelling problems in ordinary differential equations and apply some standard methods to obtain its solutions.

Title of experiments:

Group Theory:

1. □ Elementary properties of groups
2. □ Finite Groups and Subgroups
3. □ Cyclic Groups
4. □ Permutation Groups
5. □ Normal Subgroup
6. □ Homomorphism and Isomorphism’s

Ordinary Differential Equations:

7. • Linear Differential Equations with constant coefficients
8. • Non-Homogeneous Differential Equations
9. • Power series solutions
10. • System of First-Order Equations

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Practical based on USMT353 and USMT354 **Course Code:** USMT358
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2							
CO 2	3	2		2	2				
CO 3	3	2		2					
CO 4	3	2							
CO 5	3			2					
CO 6	3	2		2					
CO 7	3			2	2				2

Justification for the mapping

PO 1: Disciplinary Knowledge:
All of these COs contribute to development of student's disciplinary knowledge. For example, CO1, CO2, CO3 requires to think students critically to apply differentiation, behaviour of functions in various fields. CO5, CO6 and CO7 requires to develop deep understanding of continuity, limits of a function, differentiation and use it to solve real world problems.

PO2: Critical Thinking and Problem Solving:
CO1, CO2 and CO4 requires to development of student's knowledge of derivative, Mean Value theorems, integration to find critical points of a function, to solve problems related to accuracy etc. CO3, CO6 contribute to development of students understanding to solve real world problems in different fields by using behaviour of functions.

PO4: Research-related skills and Scientific temper:
CO2, CO3, CO5, CO6, CO7 requires to develop students research related skills. Student's will able to apply the tools of calculus to various real-world problems in different areas.

PO5: Trans-disciplinary Knowledge:
CO7: Students will apply mathematical concept such as Continuity, limits and differentiation. These concepts are useful in many different fields such as Physics, engineering, chemistry and economics.

PO9: Self-directed and Life-long learning:
CO7: Students will demonstrate the ability to apply the concept of calculus and differential equations in practical context. This ability will enable them to continue learning and developing skills throughout life.

Choice Based Credit System Syllabus (2022 Pattern)

Class: T.Y.B.Sc. (Semester – V)
Course Code: USMT359
Course: 9 **Title of the Course:** Practical based on USMT355 and USMT356
Credit: 2 **No. of Lectures:** 48

A) Course Objectives:

1. Understand the fundamental concepts of Operations Research (OR) and its applications in decision-making processes.
2. Develop proficiency in formulating Linear Programming Problems (LPP) and solving them using graphical methods.
3. Master the graphical and simplex methods for solving LPPs efficiently.
4. Explore and analyze special cases that arise in the solution of LPPs, enhancing problem-solving skills.
5. Comprehend the concepts of duality and graphical sensitivity in LPPs, enabling a deeper understanding of optimization techniques.
6. Gain proficiency in solving transportation models and understanding their relevance in real-world logistics and distribution problems.
7. Acquire the necessary skills to solve assignment models and analyze transportation problems effectively.
8. Develop a strong foundation in Number Theory, focusing on divisibility properties and their applications.
9. Explore advanced concepts such as congruences, quadratic reciprocity, and Diophantine equations in Number Theory.
10. Apply Number Theory principles to solve real-world problems and develop analytical thinking skills.

B) Course Outcomes:

1. Students will be able to formulate and solve Linear Programming Problems using graphical and simplex methods, demonstrating proficiency in optimization techniques.
2. Students will analyze and interpret special cases in the solution of Linear Programming Problems, showcasing critical thinking and problem-solving abilities.
3. Upon completion of the course, students will demonstrate a clear understanding of duality and graphical sensitivity in Linear Programming Problems, enabling them to analyze optimization models effectively.
4. Students will be proficient in solving transportation models and assignment models, applying OR techniques to solve real-world logistics and distribution challenges.
5. Through the study of Number Theory, students will develop a deep understanding of divisibility properties and their applications in mathematical problem-solving.
6. Students will be able to apply congruence principles to solve mathematical problems and analyze their relevance in cryptography and computer science.
7. By exploring advanced topics such as quadratic reciprocity and Diophantine equations, students will enhance their problem-solving skills and develop a deeper appreciation for the theoretical aspects of Number Theory.

List of Practical:

Teaching Hours

Practical based on Number Theory (USMT355): **24**

1. Practical 1: Divisibility
2. Practical 2: Congruences 1
3. Practical 3: Congruences 2
4. Practical 4: Greatest Integer Function
5. Practical 5: Quadratic Reciprocity
6. Practical 6: Diophantine Equations

Practical based on Operations Research (USMT356(A)): **24**

1. Practical 1: Formulation of LPP and Graphical method
2. Practical 2: Graphical and Simplex methods for LPP
3. Practical 3: Special cases in solution of LPP
4. Practical 4: Duality and Graphical Sensitivity in LPP
5. Practical 5: Transportation Model
6. Practical 6: Assignment Model and Transportation Model

OR

Practical based on C Programming (USMT356(B)): **24**

1. Practical 1: Print 'Hello, World!'
2. Practical 2: Simple Calculator
3. Practical 3: Check even or odd
4. Practical 4: Find the largest of three numbers
5. Practical 5: Sum of natural numbers
6. Practical 6: Factorial of a number

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem V) **Subject:** Mathematics
Course: Practical based on USMT355 and USMT356 **Course Code:** USMT359
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3	1	3	1	1			2
CO 2	2	3		2	1	1			1
CO 3	3	3	1	3	1	1			2
CO 4	3	3	1	3	1	1			2
CO 5	2	3		1	3	1			1
CO 6	2	3		1	3	1			1
CO 7	2	3		1	3	1			1

Justification for the mapping

PO1: Disciplinary Knowledge
CO1, CO3, CO4 have a strong relation as they directly involve the application and understanding of Operations Research concepts. CO5, CO6, and CO7 have a moderate relation as they involve understanding and applying advanced mathematical concepts related to Number Theory.

PO2: Critical Thinking and Problem solving
All course outcomes have a strong relation as they involve problem-solving skills, critical analysis, and logical reasoning, which are essential for both operations research and number theory.

PO3: Social competence
CO1, CO3, and CO4 have a weak relation as they indirectly relate to social competence through their applications in real-world logistics and distribution challenges.

PO4: Research-related skills and Scientific temper
CO1, CO3, and CO4 have a strong relation as they involve understanding and analyzing optimization models, which requires research-related skills and a scientific temper.

PO5: Trans-disciplinary Knowledge
CO5, CO6, and CO7 have a strong relation as they involve concepts that have applications beyond mathematics, such as cryptography and computer science.

PO6: Personal and professional competence
All course outcomes have a moderate to strong relation as they contribute to the development of analytical skills, problem-solving abilities, and professional competence.

PO9: Self-directed and life-long learning
All course outcomes have a partial relation as they contribute to the development of skills necessary for self-directed learning and lifelong learning in the fields of operations research and number theory.