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	MAT 3501	Metric Spaces	3	48
	MAT 3502	Real Analysis I	3	48
	MAT 3503	Group Theory	3	48
	MAT 3504	Ordinary Differential Equation	3	48
	MAT 3505	Operation Research	3	48
	MAT 3506	Number Theory	3	48
	MAT 3507	Practical based on MAT 3501 and MAT 3502	2	48
	MAT 3508	Practical based on MAT 3503 and MAT 3504	2	48
	MAT 3509	Practical based on MAT 3505 and MAT 3506	2	48
VI	MAT 3601	Complex Analysis	3	48
	MAT 3602	Real Analysis II	3	48
	MAT 3603	Ring Theory	3	48
	MAT 3604	Partial Differential Equation	3	48
	MAT 3605	Optimization Techniques	3	48
	MAT 3606	Lebesgue Integration	3	48
	MAT 3607	Practical based on MAT 3601, MAT 3602, and MAT 3603	2	48
	MAT 3608	Practical based on MAT 3604, MAT 3605, and MAT 3606	2	48
	MAT 3609	Mathematics Project	2	48

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3601
Course: 1 **Title of the Course:** Complex Analysis
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To understand the algebraic properties, operations, and geometric interpretations of complex numbers, including sums, products, and roots.
2. To learn the concepts of limits, continuity, and differentiability in the context of complex functions, with an emphasis on Cauchy-Riemann equations and harmonic functions.
3. To analyze the properties and applications of exponential, logarithmic, trigonometric, and hyperbolic functions in the complex domain.
4. To gain proficiency in computing contour integrals, understanding the implications of Cauchy-Goursat's Theorem, and applying the Cauchy integral formula in different contexts.
5. To study the convergence of sequences and series, and apply Taylor and Laurent series to represent complex functions.
6. To learn to identify isolated singular points and calculate residues, and use these concepts to evaluate complex integrals via the residue theorem.
7. To develop the ability to apply complex analysis concepts to solve problems in physics, engineering, and applied mathematics.

B) Course Outcomes:

1. Students will be able to perform algebraic operations with complex numbers and represent them geometrically in the complex plane.
2. Students will demonstrate the ability to analyze limits, continuity, and differentiate functions of a complex variable using Cauchy-Riemann equations.
3. Students will be able to manipulate and apply exponential, logarithmic, and trigonometric functions in complex scenarios.
4. Students will be skilled in evaluating contour integrals, understanding the significance of Cauchy's theorems, and applying these to complex problems.
5. Students will be able to determine the convergence of series and represent functions using Taylor and Laurent series.
6. Students will be able to identify singular points, compute residues, and apply the residue theorem to solve complex integrals.
7. Students will apply their knowledge of complex analysis to solve practical problems in various fields such as physics and engineering.

TOPICS/CONTENTS:

Unit 01: Complex Numbers [*6 Lectures*]

- Sums and products, Basic algebraic properties GCD, LCM,
- Vectors and Moduli, Complex Conjugates
- Exponential Form, Products and powers in exponential form
- Arguments of products and quotients, Roots of complex numbers
- Regions in the complex plane

Unit 02: Analytic functions [*12 Lectures*]

- Functions of Complex Variables, Limits, Theorems on limits
- Limits involving the point at infinity
- Continuity, Derivatives, Differentiation formulas, Cauchy- Riemann Equations
- Sufficient Conditions for differentiability
- Polar coordinates, Analytic functions, Harmonic functions.

Unit 03: Elementary Functions [*7 Lectures*]

- The Exponential functions, The Logarithmic function
- Branches and derivatives of logarithms
- Complex exponents
- Trigonometric functions, Hyperbolic functions.

Unit 04: Integrals [*12 Lectures*]

- Derivatives of functions, Definite integrals of functions
- Contours, Contour integral, Examples, Upper bounds for Moduli of contour integrals,
- Anti-derivatives, Examples, Cauchy-Groursat's Theorem (without proof)
- Simply and multiply connected domains. Cauchy integral formula
- Derivatives of analytic functions
- Liouville's Theorem and Fundamental Theorem of Algebra.

Unit 05: Series [*5 Lectures*]

- Convergence of sequences and series
- Taylor's series, Laurent series (without proof), examples

Unit 06: Residues and Poles [*6 Lectures*]

- Isolated singular points, Residues, Cauchy residue theorem
- residue at infinity, types of isolated singular points, residues at poles
- zeros of analytic functions, zeros and poles.

Text Book:

J.W. Brown and R.V. Churchill, Complex Variables and Applications, International Student Edition, 2009. (Eighth Edition).
Chapter1 : §1 to §11. Chapter 2: §12,§15 to §26. Chapter 3 : §29 to §35. Chapter4 : §37 to §46 and §48 to §53. Chapter:5 §55 to §60 and §62.Chapter 6: §68 to §76.

Reference Books:

1. S. Ponnusamy, Complex Analysis, Second Edition (Narosa).
2. S. Lang, Complex Analysis, (Springer Verlag).
3. A.R. Shastri, An Introduction to Complex Analysis, (MacMillan)

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Complex Analysis **Course Code:** MAT 3601
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	3	3	3	3	3	3
PO3	1	1	1	1	1	1	2
PO4	2	3	3	3	3	3	3
PO5	1	2	2	2	2	2	3
PO6	2	2	2	2	2	2	2
PO7	1	1	1	1	1	1	1
PO8	1	1	1	1	1	1	2
PO9	2	3	3	3	3	3	3

Justification for the mapping

PO1: ***Disciplinary Knowledge*** - All COs directly relate to disciplinary knowledge as they involve understanding and applying advanced calculus concepts, integral to the mathematical analysis discipline (Rating: 3).

PO2: ***Critical Thinking and Problem Solving*** - High relevance in applying complex analysis techniques for solving mathematical and real-world problems.

PO3: ***Social Competence*** - Minimal direct social interaction, but CO7 involves applications in fields affecting society.

PO4: ***Research-related Skills and Scientific Temper*** - Involves analytical thinking and exploring advanced concepts relevant for research in complex analysis.

PO5: ***Trans-disciplinary Knowledge*** - Cross-disciplinary applications become more apparent in CO7 for physics and engineering.

PO6: ***Personal and Professional Competence*** - Competence in complex analysis enhances both personal mathematical understanding and professional application.

PO7: ***Effective Citizenship and Ethics*** - Little direct connection to citizenship and ethics within this specific mathematical framework.

PO8: ***Environment and Sustainability*** - Indirect relevance, with potential applications in modeling systems affecting the environment.

PO9: ***Self-directed and Life-long Learning*** - High correlation with independent learning in advanced topics and continual mathematical skill improvement.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3602
Course: 2
Title of the Course: Real Analysis II
Credit: 3
No. of Lectures: 48

A) Course Objectives:

1. To comprehend the fundamental principles and theoretical underpinnings of Riemann integrals, including the definition, properties, and significance in mathematical analysis.
2. Develop proficiency in solving a variety of problems related to Riemann integrals, ranging from basic calculations to more complex applications involving functions with discontinuities or irregular domains.
3. Apply Riemann integrals to practical scenarios across various disciplines, demonstrating the ability to model and solve real-world problems using integration techniques.
4. To provide students with a comprehensive understanding of the concept of improper integrals, including their definition, properties, and conditions for convergence or divergence.
5. To apply various methods such as limit comparison, comparison, and integration by parts to evaluate and determine convergence/divergence of improper integrals involving infinite limits or unbounded functions.
6. Foster the development of analytical skills in students to solve real-world problems and apply improper integrals in areas such as physics, engineering, economics, and other disciplines.
7. To develop a deep comprehension of sequences of functions, including convergence, divergence, and their behavior within various domains.
8. To enable students to analyze and evaluate series of functions, exploring convergence criteria, power series, and applications in real-world problems.

B) Course Outcomes:

1. Students will demonstrate a thorough understanding of the definition of Riemann integrals, their properties (such as linearity, additivity, and boundedness), and the relationships between integrability and continuity.
2. Students will exhibit the ability to solve a wide range of problems involving Riemann integrals, including the computation of integrals for different types of functions, understanding partitions, and applying Riemann sums.
3. Students will be able to apply Riemann integrals to various fields such as physics, economics, and engineering, effectively translating real-world problems into mathematical expressions and solving them using integral calculus techniques.
4. Students will be able to proficiently evaluate improper integrals by employing appropriate techniques and demonstrate the ability to distinguish between convergent and divergent integrals.
5. Students will demonstrate the ability to apply improper integrals in diverse practical scenarios, providing solutions to real-world problems where these integrals are crucial, thus showcasing the utility of the concept in various fields of study and applications.
6. Students will demonstrate the ability to analyze the convergence or divergence of sequences and series of function.

7. Students will be capable of applying function series in diverse contexts, such as engineering, physics, or economics, solving problems related to approximation, differential equations, and Fourier series.

TOPICS/CONTENTS:

Unit 01: Riemann Integral [*16 Lectures*]

- Sets of measure zero
- Definition of the Riemann integral
- Existence of the Riemann integral
- Properties of the Riemann integral
- Fundamental theorem of integral calculus
- Mean value theorems of integral calculus

Unit 02: Improper Integrals [*16 Lectures*]

- Definition of improper integral of first kind
- Comparison test
- Absolute and conditional convergence
- Integral test for convergence of series
- Definition of improper integral of second kind
- Cauchy principal value

Unit 03: Sequences and series of functions [*16 Lectures*]

- Point wise convergence of sequences of functions
- Uniform convergence of sequences of functions
- Consequences of uniform convergence
- Convergence and uniform convergence of series of functions
- Integration and differentiation of series of functions

Text Books:

1. R. R. Goldberg, *Methods of Real Analysis*, Oxford & I. B. H. Publications, 1970.
   Ch. 7, Art. 7.1 to 7.4 and 7.8 Ch. 9, Art 9.1 to 9.5
2. D. Somasundaram and B. Choudhary, *A first course in Mathematical Analysis*, Narosa Publishing House, 1997.
   Ch. 8, Art 8.5

Reference Books:

1. Ajit Kumar and S.Kumaresan, *A Basic Course in Real Analysis*, CRC Press, Second Indian Reprint 2015.
2. Robert, G. Bartle, Donald Sherbert, *Introduction to Real Analysis*, Third edition, John Wiley and Sons.

3. Shantinarayan and Mittal, *A course of Mathematical Analysis*, Revised edition, S. Chand and Co. (2002).
4. S.C. Malik and Savita Arora, *Mathematical Analysis*, New Age International Publications, third Edition, (2008).

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Real Analysis II **Course Code:** MAT 3602
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							
CO 2	2	3							
CO 3	3	3		1	1				1
CO 4	2	2							
CO 5	3	3				1		1	1
CO 6	2	2							
CO 7	3	3		1	1	1		1	1

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Students need to comprehend Riemann integrals, their properties, and the correlation between integrability and continuity to grasp foundational concepts essential for advanced mathematical applications.
CO2: Students will develop critical problem-solving skills by mastering Riemann integrals, enabling them to compute diverse integrals, comprehend partitions, and effectively apply Riemann sums across various functions.
CO3: Riemann integrals enable students to mathematically model and solve real-world problems in diverse fields like physics, economics, and engineering, fostering a profound understanding and application of integral calculus techniques across disciplines.
CO4: Students will master evaluating improper integrals to discern convergence/divergence, vital for a comprehensive understanding of mathematical analysis and applications in various fields.
CO5: Improper integrals offer essential solutions in engineering, physics, and economics, showcasing their indispensability in addressing real-world problems across diverse disciplines.
CO6: Understanding convergence or divergence of sequences and series of functions is crucial for evaluating the behavior and limits of mathematical functions, enabling precise predictions and modeling in various disciplines.
CO7: Understanding function series enables students to model and solve complex real-world problems across various disciplines by utilizing powerful mathematical tools like approximation, differential equations, and Fourier series.

PO2: Critical Thinking and Problem Solving

CO1: Understanding Riemann integrals and their properties cultivates a foundational grasp of calculus, fostering critical thinking by linking the concepts of integration, mathematical properties, and the fundamental connection between integrability and continuity.
CO2: Mastering Riemann integrals equips students with analytical skills to tackle diverse real-world problems through advanced computation techniques and a deep understanding of partitions and Riemann sums.
CO3: Understanding Riemann integrals equips students to seamlessly model and solve diverse real-world challenges across physics, economics, and engineering by adeptly employing integral calculus methods.
CO4: Students will effectively assess improper integrals through varied methods, distinguishing between convergent and divergent integrals, showcasing advanced critical thinking skills in problem-solving.
CO5: Improper integrals equip students with problem-solving skills essential across disciplines by solving real-world problems, showcasing the pervasive utility of this concept in diverse fields.
CO6: Analyzing convergence or divergence of sequences and series of functions sharpens logical reasoning and problem-solving skills essential in critical thinking.
CO7: Mastering function series enables students to tackle real-world problems across multiple fields by employing diverse mathematical tools like approximation, differential equations, and Fourier series, fostering critical thinking and problem-solving skills.

PO4: Research-related skills and Scientific temper
CO3: Mastering Riemann integrals equips students with a powerful toolset to mathematically model and solve complex real-world phenomena across disciplines like physics, economics, and engineering, fostering invaluable research skills and a robust scientific mindset.
CO7: Mastering function series enables students to solve complex problems in diverse fields like engineering, physics, and economics, fostering research skills through approximation, differential equations, and Fourier series applications while nurturing a scientific mindset.

PO5: Trans-disciplinary Knowledge
CO3: Riemann integrals enable students to mathematically model and solve diverse real-world problems in fields like physics, economics, and engineering, fostering a trans-disciplinary approach to applying integral calculus techniques.
CO7: Function series equip students with versatile problem-solving skills applicable across disciplines like engineering, physics, and economics, enabling solutions in approximation, differential equations, and Fourier series within trans-disciplinary contexts.

PO6: Personal and Professional Competence
CO5: Proficiency in improper integrals equips students to solve real-world problems across disciplines, showcasing their adaptability and essential role in diverse professional and personal contexts.
CO7: Mastering function series equips students with versatile problem-solving skills essential across engineering, physics, and economics, enabling proficiency in approximation, differential equations, and Fourier series applications, enhancing personal and professional competence.

PO8: Environment and Sustainability
CO5: Improper integrals enable students to solve real-world problems involving infinite or unbounded quantities, crucial in environmental studies for modeling continuous processes such as population growth or resource distribution, highlighting their relevance in diverse fields of sustainability.
CO7: Understanding function series is pivotal for students as it equips them to solve complex problems in diverse fields like engineering, physics, and economics, crucial in addressing

environmental and sustainability challenges through approximation, differential equations, and Fourier series applications.

PO9: Self-directed and Life-long Learning
CO3: Understanding Riemann integrals enables students to translate diverse real-world problems in physics, economics, and engineering into mathematical forms, empowering them to solve these problems using integral calculus techniques, fostering self-directed and lifelong learning.
CO5: Proficiency in improper integrals enables students to solve real-world problems across disciplines, fostering self-directed learning by showcasing its vital role in diverse fields and encouraging a lifelong pursuit of interdisciplinary knowledge.
CO7: Mastering function series equips students to solve intricate problems across engineering, physics, and economics, enabling a self-directed and lifelong learning approach for tackling approximation, differential equations, and Fourier series in diverse real-world scenarios.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3603
Course: 3 **Title of the Course:** Ring Theory
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To develop a grasp of the basic concepts in ring theory such as rings and will be able to give examples and non-examples of such concepts.
2. To understand theorems arising from the concepts covered in this course.
3. To use Isomorphism theorems of Rings.
4. To apply techniques covered in this course to solve problems pertaining to ring theory.
5. To construct polynomial ring over a field and factorization in polynomial ring.
6. To construct Principal ideal domain (PID), Unique factorization domain (UFD), Euclidean domain (ED).
7. To acquire proficiency in this course for further study.

B) Course Outcomes:

1. Students will able to develop a grasp of the basic concepts in ring theory such as rings and will be able to give examples and non-examples of such concepts.
2. Students will able to understand theorems arising from the concepts covered in this course.
3. Students will able to use Isomorphism theorems of Rings.
4. Students will develop skills to apply techniques covered in this course to solve problems pertaining to ring theory.
5. Students will able to construct polynomial ring over a field and factorization in polynomial ring.
6. Students will able to construct Principal ideal domain (PID), Unique factorization domain (UFD), Euclidean domain (ED).
7. Students will acquire proficiency in this course for further study.

TOPICS/CONTENTS:

Unit 01: Ring [5 Lectures]

- Definition and properties of Ring,
- Subring.

Unit 02: Integral Domains [*5 Lectures*]

- Zero divisors,
- Cancellation Law,
- Field,
- Characteristics of Ring.

.

Unit 03: Ideals and Factor Rings [*6 Lectures*]

- Existence of Factor Ring,
- Prime Ideals,

- Maximal Ideals.

Unit 04: Homomorphism of Rings [*8Lectures*]

- Properties of Ring Homomorphism,
- Kernel, First isomorphism Theorem for Ring,
- Prime Fields,
- The field of Quotients..

Unit 05: Polynomial Ring[*6 Lectures*]

- Definition,
- The division Algorithm,
- Principle Ideal Domain.

Unit 06: Factorization of Polynomial[*8Lectures*]

- Reducibility and Irreducibility Tests,
- Eisenstein criterion. Ideals in F[x],
- Unique Factorization in Z[x]

Unit 07: Divisibility in Integral Domain[*10Lectures*]

- Associates, Irreducible and Primes,
- Unique Factorization Domains,
- Ascending chain Condition for PID,
- PID implies UFD, Euclidean Domains.
- ED Implies PID, D is UFD implies D[x] is UFD.

Text Book:
Joseph, A. Gallian, Contemporary Abstract Algebra,(4th Edition), Narosa Publishing House. Chapter Numbers : 12,13,14,15,16,17 and 18.

Reference Books:
1.J.B. Fraleigh, First course in Abstract Algebra (4rd Edition). Narosa Publishing House.

2. I.N. Herstein, Abstract Algebra, (3rd Edition), Prentitice Hall of India, 1996.

3. N.S. Gopalkrishnan, University of Algebra, Wiley Eastern 1986. 4. C. Musili, Rings and Modules, NarosaPublishing House, 1992.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Ring Theory **Course Code:** MAT 3603
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
CO 2	3	3		2	3	2			2
CO 3	3	3				2			2
CO 4	3	3				2			2
CO 5	3	3		2	2	2			2
CO 6	3	3				2			2
CO 7	3	3		2	2	2			2

Justification for the mapping

PO 1: Disciplinary Knowledge:

All of these course outcomes (COs) contribute to the student's development of abstract reasoning skills by working with the abstract algebraic structures inherent in group theory. For example, CO1, CO2, CO3, CO5, CO6 requires student to develop deep learning of rings, ideals, factor ring, PID, UFD etc. CO4 and CO7 requires students to apply the concepts of Ring Theory in many fields like Cryptography, coding theory and quantum mechanics.

PO2: Critical Thinking and Problem Solving:

All of these course outcomes (COs) contribute to the development of students critical thinking and problem solving. For example, CO1, CO2 CO3, CO5 requires students to think critically and apply these to solve complex problems in various filed like engineering and physics. CO4, CO6 and CO7 requires to apply and construct logical proofs to solve real world problems.

PO4: Research-related skills and Scientific temper:

CO2, CO5, CO7 contribute to the development of student's research related skills and scientific temper. For example, CO2 and CO7 requires students to develop their ability to think critically and apply knowledge to various field. CO5 requires students to apply knowledge of homomorphism to solve real life problems

PO5: Trans-disciplinary Knowledge:

CO2, CO5, CO7 requires students to apply ring theory concepts in various fields like cryptography and codding theory.

PO6: Personal and professional competence:

All COs contribute to development of personal and professional competences. For example, all COs requires students to approach and solve complex problem systematically.

PO9: Self-directed and Life-long learning:

All these course outcomes contribute to development of student's ability to engage in self-directed and life-long learning. For example, all COs requires students to develop their ability to learn new concepts, form a simple proof and apply them to new problem.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3604
Course: 4 **Title of the Course:** Partial Differential Equations
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To understand the formation and solution of PDEs of first, second and higher order.
2. To classify partial differential equations and transform into canonical form.
3. To solve first-order linear and nonlinear PDEs using the method of characteristics.
4. To apply various analytic methods to obtain solutions to PDEs of first and second order, which occur in science and engineering.
5. To use appropriate numerical methods to study phenomena modeled as PDEs.
6. To analyze the method of characteristics to understand the concepts related to shocks.
7. To point out real phenomena as models of partial differential equations.

B) Course Outcomes:

1. Students will able to understand the formation and solution of PDEs of first, second and higher order.
2. Students will able to classify partial differential equations and transform into canonical form.
3. Students will able to solve first-order linear and nonlinear PDEs using the method of characteristics.
4. Students will able to apply various analytic methods to obtain solutions to PDEs of first and second order, which occur in science and engineering.
5. Students will able to use appropriate numerical methods to study phenomena modeled as PDEs.
6. Students will able to analyze the method of characteristics to understand the concepts related to shocks.
7. Students will able to point out real phenomena as models of partial differential equations.

TOPICS/CONTENTS:

Unit 01: Ordinary Differential Equations in More Than Two Variables[*22 Lectures*]

- Surface and Curves in Three Dimensions
- Simultaneous Differential Equations of the First Order and First Degree in 3 Variables.
- Methods of solution of $dx/P = dy/Q = dz/R$
- Orthogonal Trajectories of a System of curves on a Surface.
- Pfaffian Differential Forms and Equations.
- Solution of Pfaffian Differential Equations in Three Variables.

Unit 02: First Order Partial Differential Equations [*26 Lectures*]

- Genesis of First Order Partial Differential Equations

- Classification of Integrals
- Linear Equations of the First Order
- Pfaffian Differential Equations
- Compatible Systems
- Charpit's Method
- Jacobi's Method
- Integral Surfaces through a given curve
- Quasi-Linear Equation.

Text Book:

1. Ian Sneddon, Element of Partial Differential Equations, McGraw-Hill Book Company, McGraw-Hill Book Company. Chapter 1: §1 to §6.
2. T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Publishing, House 2nd Edition, 2003 (Reprint, 2006). Chapter 1: §1 to §10.

Reference Books:

1. W.E. Williams, Partial Differential Equations, Clarendon Press, Oxford.
2. Frank Ayres Jr., Differential Equations, McGraw-Hill Book Company, SI Edition (International Edition, 1972).
3. K. SankaraRao, Introduction to Partial Differential Equations, Third Edition,PHI.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Ring Theory **Course Code:** MAT 3604
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				
CO 2	3	3			3				
CO 3	3	3			2				
CO 4	3	3		2	2				
CO 5	3	3		2	2				
CO 6	3	3			2				
CO 7	3	3			2				

Justification for the mapping

PO 1: Disciplinary Knowledge:

All of these course outcomes (COs) contribute to the development of student's All of these course outcomes (COs) contribute to the development of student's ability to formation of solution of partial differential equations. For example, CO1, CO2, CO3, CO5 requires student to develop deep learning of solution of linear and non-linear partial differential equation. CO4, CO6 and CO7 requires students to apply the concepts of partial differential equations in many fields like engineering, chemistry and physics.

PO2: Critical Thinking and Problem Solving:

All of these course outcomes (COs) contribute to the development of students critical thinking and problem solving. For example, CO1, CO2 CO3, CO5 requires students to think critically and apply these to solve complex problems in various filed like engineering and physics. CO4, CO6 and CO7 requires to solve real world problems.

PO4: Research-related skills and Scientific temper:

CO1, CO4, CO5 contribute to the development of student's research related skills and scientific temper. For example, CO1 and CO4 requires students to develop their ability to think critically and apply knowledge to various field. CO5 requires students to apply knowledge of to solve real life problems using formation of mathematical model of PDE.

PO5: Trans-disciplinary Knowledge:

All of these COs requires students to apply partial differential concepts in various fields like Chemistry, Engineering and Physics.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3605
Course: 5
Title of the Course: Optimization Techniques
Credit: 3
No. of Lectures: 48

A) Course Objectives:

1. To comprehend the foundational principles of Critical Path Analysis in Operations Research, including the identification of critical paths, slack time, and the application of network diagrams to solve real-world project management problems.
2. To equip students with the skills necessary to analyze complex project networks, identify critical activities, and optimize project schedules by employing techniques such as forward and backward pass calculations, resource leveling, and crashing of activities.
3. To understand and apply the principles of PERT methodology in project management, enabling them to effectively plan, analyze, and control complex projects.
4. To comprehend the foundational principles and theories of Game Theory, including equilibrium, strategic interactions, and decision-making under various scenarios.
5. To apply theoretical knowledge to real-world scenarios, fostering the ability to model and analyze strategic interactions in economics, social sciences, biology, and other relevant fields.
6. To comprehend the fundamentals of sequencing problems by analyzing different problem structures, such as job sequencing, task scheduling, and assembly line sequencing.
7. To comprehend and apply the principles of replacement and maintenance models in optimizing the lifecycle of assets or systems.

B) Course Outcomes:

1. Students will be able to construct network diagrams to represent project activities, identify critical paths, and compute project duration, slack times, and float for each activity, demonstrating proficiency in applying Critical Path Analysis techniques.
2. Students will demonstrate the ability to make informed decisions in project planning and management by utilizing Critical Path Analysis, effectively identifying bottlenecks, allocating resources optimally, and devising strategies to shorten project duration while considering project constraints.
3. Students will be proficient in developing PERT networks, estimating project duration, identifying critical paths, and employing variance analysis techniques to manage uncertainties in project schedules, resulting in enhanced project planning and execution skills in real-world scenarios.
4. Students will be able to analyze and interpret complex strategic situations using appropriate game models and methodologies.
5. Students will enhance their critical thinking abilities and problem-solving skills in analyzing decision-making processes and strategizing in competitive environments.
6. Students will be able to apply various optimization techniques, including dynamic programming, heuristic algorithms, and mathematical modeling, to solve sequencing problems effectively, demonstrating the ability to select appropriate methodologies based on problem constraints and complexities.

7. Students will be able to analyze and recommend appropriate replacement strategies for assets/systems based on factors such as economic life, technological advancements, and maintenance costs, thereby optimizing the overall efficiency and effectiveness of the system's lifecycle.

TOPICS/CONTENTS:

Unit 01: Network Models [*12 Lectures*]

- CPM and PERT
- Network representation
- Critical Path Computations
- Construction of the time schedule
- Linear programming formulation of CPM, PERT calculations.

Unit 02: Decision Analysis and Games [*12 Lectures*]

- Decision under uncertainty
- Game theory: Some basic terminologies
- Optimal solution of two person zero sum game
- Solution of mixed strategy games
- Graphical solution of games
- Linear programming solution of games.

Unit 03: Replacement and Maintenance Models [*08 Lectures*]

- Introduction
- Types of failure
- Replacement of items whose efficiency deteriorates with time

Unit 04: Sequencing Problems [*06 Lectures*]

- Introduction
- Notation, terminology and assumptions
- Processing n jobs through two machines
- Processing n jobs through three machines

Unit 05: Classical Optimization Theory [*10 Lectures*]

- Unconstrained problems
- Necessary and sufficient conditions
- Newton Raphson method
- Constrained problems
- Equality constraints (Lagrangian Method Only)

Text Book:

1. Hamdy A. Taha, *Operation Research* (8^{th} Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
   Ch.6: 6.5 (6.5.1 to 6.5.5), Ch.13: 13.3, 13.4(13.4.1, 13.4.2, 13.4.3). Ch.18: 18.1(18.1.1, 18.1.2), 18.2 (18.2.1).
2. J. K. Sharma, *Operations Research: Theory and Applications*, (2^{nd} Edition, 2006), Macmilan India Ltd.
   Ch.17: 17.1, 17.2, 17.3, Ch.20: 20.1, 20.2, 20.3, 20.4.

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, *Introduction to Operation Research* (8^{th} Edition) Tata McGraw Hill.
2. Hira and Gupta, *Operation Research*.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Optimization Techniques **Course Code:** MAT 3605
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							
CO 2	3	3		1	2	2		1	1
CO 3	3	3		1	1	1		1	1
CO 4	2	2							
CO 5	3	3		2	2	2		1	1
CO 6	2	3		1					
CO 7	2	2			1	1		1	1

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Enables students to proficiently apply Critical Path Analysis techniques, constructing network diagrams to identify project activities, critical paths, and compute durations, slack times, and float for each activity within their disciplinary knowledge.
CO2: Students will apply Critical Path Analysis to make informed decisions, efficiently identifying bottlenecks, optimizing resource allocation, and strategizing to minimize project duration within constraints.
CO3: Proficiency in PERT networks, critical path identification, variance analysis, and project duration estimation enhances students' project planning and execution skills for managing uncertainties effectively in real-world scenarios.
CO4: Enables students to dissect intricate strategic scenarios through suitable game models and methodologies within their field of expertise.

CO5: Studying disciplinary knowledge fosters critical thinking and problem-solving by dissecting decision-making and strategizing in competitive contexts.
CO6: Students can effectively solve sequencing problems by applying diverse optimization techniques, such as dynamic programming, heuristic algorithms, and mathematical modeling, showcasing adept methodology selection aligned with problem constraints and complexities in their disciplinary knowledge.
CO7: Students will enhance systems by identifying optimal replacement strategies aligning economic viability, technological advancements, and maintenance costs, elevating overall lifecycle efficiency.

PO2: Critical Thinking and Problem Solving
CO1: Students will develop expertise in Critical Path Analysis, enabling them to visualize project activities, determine critical paths, and calculate durations, slack times, and float, fostering adeptness in problem-solving through network diagrams.
CO2: Mastering Critical Path Analysis enables students to strategically identify bottlenecks, optimize resource allocation, and devise solutions for shortening project duration within defined constraints, showcasing adept decision-making in project planning and management.
CO3: Students will excel in project planning and execution by mastering PERT networks, project duration estimation, critical path identification, and variance analysis, enhancing their problem-solving abilities for real-world scenarios.
CO4: Empowers students to decipher intricate strategic scenarios by applying relevant game models and methodologies, fostering critical thinking and problem-solving skills.
CO5: Critical Thinking and Problem Solving fosters students' analytical prowess to evaluate decision-making and develop strategic approaches for competitive settings.
CO6: Students will proficiently apply diverse optimization techniques, such as dynamic programming and heuristic algorithms, exhibiting adeptness in method selection tailored to problem constraints and complexities, showcasing critical thinking and problem-solving skills.
CO7: Enhances critical thinking by evaluating asset/system viability and recommending optimal replacement strategies, considering economic, technological, and maintenance aspects for lifecycle efficiency.

PO4: Research-related skills and Scientific temper
CO2: Students will exhibit proficient decision-making in project planning through Critical Path Analysis, optimizing resource allocation, bottleneck identification, and strategic planning to enhance project efficiency within constraints, showcasing advanced research skills and scientific acumen.
CO3: Students will gain advanced project management expertise through PERT networks, critical path analysis, and variance analysis, ensuring adeptness in handling uncertainties for superior project planning and execution in research-driven scenarios, fostering scientific acumen.
CO5: Engaging in research cultivates critical thinking and problem-solving by analyzing decision-making and strategizing within competitive settings, nurturing scientific temper and research-related skills.
CO3: Students will master diverse optimization methods—dynamic programming, heuristics, and mathematical models—tailoring their use according to problem intricacies, showcasing adeptness in problem-solving and method selection in research and scientific reasoning.

PO5: Trans-disciplinary Knowledge
CO2: Students will exhibit proficient decision-making in project planning and management through Critical Path Analysis, efficiently identifying bottlenecks, optimizing resource allocation, and devising strategies to reduce project duration within set constraints in Trans-disciplinary Knowledge.

CO3: Proficiency in PERT networks, critical path identification, variance analysis, and project duration estimation enhances project planning skills across diverse fields, ensuring effective execution in real-world scenarios.
CO5: Trans-disciplinary knowledge fosters critical thinking by examining decision-making in diverse fields, cultivating strategic problem-solving in competitive settings.
CO7: Enabling students to optimize system lifecycle by evaluating economic, technological, and maintenance factors for recommending efficient asset replacement strategies in a trans-disciplinary context.

PO6: Personal and Professional Competence
CO2: Students will showcase adeptness in informed decision-making through Critical Path Analysis, enabling efficient bottleneck identification, optimal resource allocation, and strategic planning for shortened project durations within defined constraints.
CO3: Proficiency in PERT networks, critical path identification, variance analysis, and project duration estimation enhances students' real-world project planning and execution skills, managing uncertainties effectively.
CO5: Studying decision-making processes in competitive environments cultivates critical thinking and sharpens problem-solving skills crucial for personal and professional competence.
CO7: Enhancing students' ability to optimize asset/system lifecycle by analyzing economic viability, technological advancements, and maintenance costs for efficient replacement strategies, fostering personal and professional competence.

PO8: Environment and Sustainability
CO2: Critical Path Analysis enables students to strategically allocate resources, identify bottlenecks, and optimize project duration within environmental constraints, fostering informed decision-making in project planning for sustainability.
CO3: Students proficient in PERT networks, critical path identification, variance analysis will excel in project planning for Environment and Sustainability by managing uncertainties effectively, enhancing real-world execution skills.
CO5: Studying environment and sustainability enhances critical thinking and problem-solving by analyzing decision-making processes crucial for strategizing in competitive settings for a sustainable future.
CO7: Empowering students to optimize system lifecycles by analyzing economic viability, technological advancements, and maintenance costs for recommending efficient asset replacement strategies, fostering environmental sustainability.

PO9: Self-directed and Life-long Learning
CO2: Students will showcase informed decision-making in project planning via Critical Path Analysis, optimizing resource allocation, identifying bottlenecks, and strategizing to reduce project duration within constraints, fostering self-directed and lifelong learning.
CO3: Mastering PERT networks, critical path identification, variance analysis cultivates robust project planning for real-world scenarios, fostering self-directed learning and lifelong proficiency.
CO5: Engaging in self-directed and lifelong learning cultivates students' critical thinking and problem-solving skills, essential for analyzing decisions and strategizing effectively in competitive environments.
CO7: Students gain expertise in optimizing system lifecycles by analyzing economic, technological, and maintenance factors to recommend efficient asset replacement strategies, fostering self-directed learning and lifelong skills.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3606
Course: 6
Title of the Course: Lebesgue Integration
Credit: 3
No. of Lectures: 48

A) Course Objectives:

1. To provide a foundational understanding of measure theory, focusing on measurable sets and functions, which are crucial for advanced mathematical analysis.
2. To study the length, inner and outer measure, and properties of open and closed sets, developing a clear understanding of measurable sets.
3. To define measurable functions, analyze their properties, and explore sequences of measurable functions, laying the groundwork for advanced integration theory.
4. To introduce the concept of the Lebesgue integral, including its definition for both bounded and unbounded functions, and examine its fundamental properties.
5. To explore and apply key theorems in measure theory, such as the Lebesgue Dominated Convergence Theorem and Fatou's Lemma, in various contexts.
6. To enhance students' ability to work with abstract mathematical concepts and apply them to solve complex problems in analysis.
7. To prepare students for further studies in real analysis, functional analysis, and other areas of mathematics that require a deep understanding of measure and integration.

B) Course Outcomes:

1. Students will be able to describe and characterize measurable sets, understanding their significance in measure theory.
2. Students will demonstrate proficiency in defining and working with measurable functions, including analyzing their sequences.
3. Students will be able to compute and apply Lebesgue integrals for both bounded and unbounded functions, understanding their properties and applications.
4. Students will effectively apply the Lebesgue Dominated Convergence Theorem and Fatou's Lemma to solve problems in integration theory.
5. Students will develop strong analytical and problem-solving skills, particularly in the context of measure and integration.
6. Students will be well-prepared for advanced courses in real and functional analysis, having gained a solid foundation in measure theory and integration.
7. Students will be equipped with the knowledge and skills necessary to engage in research or further study in mathematical analysis and related fields.

TOPICS/CONTENTS:

Unit 01: Measurable Sets [*12 Lectures*]

- Length of open sets and closed sets
- Inner and outer measure
- Measurable sets
- Properties of measurable sets

Unit 02: Measurable Functions [*12 Lectures*]

Unit 03: The Lebesgue integrals [*24 Lectures*]

- Definition and example of the Lebesgue integrals for bounded functions
- Properties of Lebesgue integrals for bounded measurable functions
- The Lebesgue integral for unbounded functions
- Some fundamental theorems

Text-Book:

Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970).
(Chapter No. 11, 11.1 to 11.8).

Reference Books:

1. Tom Apostol, Advanced Calculus, 2nd Edition, Prentice Hall of India, (1994).
2. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis, Narosa Publishing House, (1997).
3. R.G. Bartle and D.R. Scherbert, Introduction to real analysis 2nd Edition, John Wiley, (1992).
4. Inder K. Rana, Measure and Integration

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Lebesgue Integration **Course Code:** MAT 3606
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	2	3	3	3	3	3
PO3	1	1	1	1	1	1	1
PO4	2	2	3	3	3	3	3
PO5	1	1	2	2	2	2	3
PO6	2	2	2	2	3	3	3
PO7	1	1	1	1	1	1	1
PO8	1	1	1	1	1	1	1
PO9	2	2	3	3	3	3	3

Justification for the mapping

PO1: ***Disciplinary Knowledge*** - Comprehensive understanding of measurable sets, functions, and Lebesgue integrals is foundational in measure theory.

PO2: ***Critical Thinking and Problem Solving*** - The course develops critical problem-solving skills, especially in integration and advanced analysis techniques.

PO3: ***Social Competence*** - Social competence has minimal relevance in this technical mathematical context.

PO4: ***Research-related Skills and Scientific Temper*** - In-depth engagement with complex theorems fosters research skills and analytical thinking.

PO5: ***Trans-disciplinary Knowledge*** - Trans-disciplinary knowledge is moderately engaged in applications of measure theory in other fields of analysis.

PO6: ***Personal and Professional Competence*** - Mastery of measure theory enhances professional competence, especially for advanced mathematical research.

PO7: ***Effective Citizenship and Ethics*** - Ethical considerations are not directly involved in this mathematical course.

PO8: ***Environment and Sustainability*** - Environment and sustainability are not relevant in this context.

PO9: ***Self-directed and Life-long Learning*** - Measure theory equips students with the self-learning capacity needed for advanced topics in analysis and research.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3607
Course: 7 **Title of the Course:** Practical based on MAT 3601, MAT 3602 and MAT 3603
Credit: 2 **No. of Lectures:** 60

A) Course Objectives:

1. Comprehend and apply the fundamental concepts of complex analysis, including complex functions, contour integration, and residue theorem, to solve practical problems in engineering, physics, and applied mathematics.
2. Analyze and understand the behavior of complex functions and their applications in real-world scenarios such as fluid dynamics, electrical circuits, and signal processing.
3. Develop the skills necessary to utilize complex analysis tools proficiently, including the application of Cauchy's integral theorem and its implications for practical problem-solving.
4. Understand the fundamental principles of Riemann integrals and their practical application in modeling real-world problems in physics, engineering, and economics.
5. Develop proficiency in employing Riemann integrals to solve practical problems involving areas, volumes, work, and other physical quantities, demonstrating computational and analytical skills.
6. To equip students with the skills to evaluate and solve problems involving improper integrals, enabling them to comprehend and address complex practical challenges.
7. To analyze and understand the convergence, divergence, and applications of sequences and series of functions in real-world scenarios, such as engineering systems or economic models.
8. Understand the fundamental concepts and properties of rings, including ring homomorphisms, ideals, factor rings, and the structures of specific classes of rings.
9. Apply ring theory principles to solve practical problems in diverse fields such as cryptography, computer science, and algebraic geometry.

B) Course Outcomes:

1. Ability to model and solve practical problems in various fields using complex analysis techniques, demonstrating proficiency in applying the principles learned to real-world situations.
2. Proficiently analyze and interpret complex functions and their behavior, exhibiting a comprehensive understanding of how these concepts are practically relevant in solving problems encountered in applied disciplines.
3. Students will be able to proficiently utilize Riemann integrals to analyze and solve practical problems in diverse fields such as physics, engineering, and economics, showcasing an ability to translate theoretical knowledge into practical applications.
4. Students will proficiently apply improper integrals to model and solve practical problems in diverse fields, demonstrating their ability to bridge theoretical concepts with real-world applications.
5. Students will be able to model and solve practical problems, such as signal processing or financial forecasting, by applying the concepts of convergence and divergence of sequences and series of functions.

6. Ability to analyze and demonstrate applications of ring theory in practical scenarios, such as coding theory, cryptography algorithms, and polynomial factorization in computer science.
7. Proficiency in utilizing ring theoretic concepts to solve real-world problems, enabling students to employ abstract algebraic structures in various mathematical and applied contexts.

Title of experiments:
Complex Analysis:

- Complex Numbers
- Analytic functions
- Elementary Functions
- Integrals
- Series
- Residues and Poles

Real Analysis 2:

- Riemann Integral
- Improper Integrals
- Sequences of functions
- Series of functions

Ring Theory:

- Ring
- Integral Domains
- Ideals and Factor Rings
- Homomorphism of Rings
- Polynomial Ring
- Factorization of Polynomial
- Divisibility in Integral Domain

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Practical based on MAT 3601, MAT 3602 and MAT 3603 **Course Code:** MAT 3607
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							
CO 2	3	3		1	1				
CO 3	3	3							
CO 4	2	2							
CO 5	3	2		1	1			1	1
CO 6	2	2							
CO 7	3	2		1					1

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Proficient application of complex analysis enables practical problem-solving across diverse fields, showcasing adaptability and mastery in translating theoretical principles to real-world scenarios within Disciplinary Knowledge.

CO2: Expert comprehension of complex functions allows practical problem-solving across various disciplines, fostering innovative solutions.

CO3: Students proficient in Riemann integrals can analyze and solve real-world problems across physics, engineering, and economics by effectively translating theoretical understanding into practical applications.

CO4: Application of improper integrals equips students to bridge theory with practicality, solving real-world problems across diverse disciplines.

CO5: Understanding convergence and divergence of sequences and series empowers students to tackle real-world challenges in signal processing and financial forecasting through practical modeling and problem-solving.

CO6: Understanding ring theory enables the application of abstract algebraic concepts essential for coding theory, cryptography algorithms, and polynomial factorization, crucial in computer science's practical problem-solving.

CO7: Proficiency in ring theoretic concepts empowers students to apply abstract algebra in diverse mathematical and practical scenarios, fostering problem-solving skills across disciplines.

PO2: Critical Thinking and Problem Solving

CO1: Proficiently applying complex analysis enables tackling real-world problems across diverse fields, showcasing critical thinking and problem-solving expertise.

CO2: Proficient analysis of complex functions enables practical problem-solving across diverse disciplines by understanding their behavior and relevance in applied scenarios.

CO3: Students mastering Riemann integrals will demonstrate critical thinking by effectively applying abstract mathematical concepts to solve real-world problems in physics, engineering, and economics, showcasing the translation of theory into practical solutions.

CO4: Students' mastery of improper integrals enables them to seamlessly connect theoretical concepts to real-world challenges, fostering critical thinking and problem-solving skills across diverse fields.

CO5: Understanding convergence and divergence of sequences and series of functions enables practical problem-solving in signal processing and financial forecasting through accurate mathematical modeling and analysis.

CO6: Ring theory applications offer indispensable tools for coding theory, cryptography, and polynomial factorization, enhancing critical thinking by enabling robust problem-solving in computer science.

CO7: Proficiency in ring theoretic concepts cultivates critical thinking by empowering students to apply abstract algebra in diverse mathematical and applied scenarios, fostering problem-solving skills.

PO4: Research-related skills and Scientific temper

CO2: Proficient analysis of complex functions facilitates problem-solving across applied disciplines by applying a deep understanding of their behavior, essential for research-based solutions and fostering a scientific mindset.

CO5: Understanding convergence and divergence of sequences and series of functions equips students with essential tools to tackle real-world problems in fields like signal processing and financial forecasting, fostering research skills and a scientific mindset.

CO7: Proficiency in ring theory facilitates the application of abstract algebraic structures to address real-world challenges, fostering a research-oriented mindset and scientific adaptability in students.

PO5: Trans-disciplinary Knowledge

CO2: Proficient analysis of complex functions facilitates problem-solving across diverse fields by understanding their practical relevance and application in trans-disciplinary knowledge.

CO5: Understanding convergence and divergence of sequences and series empowers students to tackle real-world challenges like signal processing and financial forecasting through versatile mathematical modeling.

PO8: Environment and Sustainability

CO5: Understanding convergence and divergence of sequences and series enables students to address real-world challenges in signal processing, financial forecasting, and environmental sustainability through advanced modeling and problem-solving.

PO9: Self-directed and Life-long Learning

CO5: Understanding convergence and divergence of sequences and series of functions enables students to solve real-world problems in signal processing and financial forecasting, fostering self-directed and lifelong learning.

CO7: Proficiency in ring theory empowers students to apply abstract algebra to solve real-world problems, fostering self-directed and lifelong learning across diverse mathematical and applied fields.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3608
Course: 8 **Title of the Course:** Practical based on MAT 3604, MAT 3605 and MAT 3606
Credit: 2 **No. of Lectures:** 60

A) Course Objectives:

1. Comprehend the fundamental theory and techniques related to partial differential equations (PDEs) and their practical significance in various scientific fields and engineering applications.
2. Develop proficiency in solving and analyzing diverse types of linear and nonlinear partial differential equations using appropriate mathematical methods, including separation of variables, Fourier series, and numerical techniques.
3. Apply the acquired knowledge of partial differential equations to model and solve real-world problems in physics, engineering, biology, or other relevant practical domains.
4. Understand the fundamentals of network analysis, enabling students to model and solve real-world problems using network optimization techniques.
5. To introduce undergraduate students to the fundamental concepts and strategies of game theory applied in Operations Research, enabling them to analyze and optimize decision-making in practical scenarios.
6. To introduce students to the principles and methodologies of Replacement Models, enabling them to analyze and optimize resource allocation scenarios in practical contexts.
7. Understand the fundamental concepts of Lebesgue measure and its application in analyzing complex sets in real analysis.
8. Develop proficiency in Lebesgue integration techniques, enabling students to solve practical problems in areas such as probability, signal processing, and functional analysis.

B) Course Outcomes:

1. Ability to formulate and solve practical problems using partial differential equations, demonstrating competence in applying mathematical techniques to analyze physical phenomena or engineering systems.
2. Proficiency in interpreting and communicating solutions obtained from partial differential equations, demonstrating a deep understanding of their implications in practical scenarios and their relevance in addressing complex real-world challenges.
3. Students will be proficient in applying network analysis methods to optimize transportation, logistics, and resource allocation problems, demonstrating practical problem-solving skills in diverse operational scenarios.
4. Students will be proficient in employing game theory models to strategize and solve real-world operational problems, demonstrating a practical understanding of decision-making in competitive situations.
5. Students will be able to design and apply replacement models to solve real-world problems, optimizing decision-making processes related to equipment replacement, asset management, and cost-effective resource utilization in various industries.
6. Ability to analyze and measure sets of real numbers using Lebesgue measure, facilitating a deeper understanding of the structure and properties of complex mathematical constructs.

7. Proficient application of Lebesgue integration methods to solve practical problems in various fields, demonstrating competence in handling intricate mathematical calculations and interpreting results for real-world applications.

Title of experiments:
Partial Differential Equations:
- Surface and Curves in Three Dimensions
- Orthogonal Trajectories of a System of curves on a Surface.
- Pfaffian Differential Forms and Equations.
- Genesis of First Order Partial Differential Equations
- Linear Equations of the First Order
- Charpit's Method
- Jacobi's Method
- Quasi-Linear Equation.

Optimization Techniques:
- Network Models
- Decision Analysis and Games
- Replacement and Maintenance Models
- Sequencing Problems
- Classical Optimization Theory

Lebesgue Integration:
- Measurable Sets
- Measurable Functions
- The Lebesgue integrals

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Practical based on MAT 3604, MAT 3605 and MAT 3606 **Course Code:** MAT 3608
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	2	2		1	1			1	1
CO 3	3	2							
CO 4	2	2			1				1
CO 5	3	2							
CO 6	2	2							
CO 7	2	2							

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Proficiency in partial differential equations enables analysis of complex physical phenomena and engineering systems, fostering the ability to solve practical problems through mathematical techniques.

CO2: Proficiency in interpreting and communicating solutions from partial differential equations showcases a profound comprehension essential for tackling intricate real-world challenges across diverse fields by applying theoretical insights to practical scenarios.

CO3: Students will master network analysis for efficient transportation, logistics, and resource allocation, showcasing problem-solving prowess across various operational contexts.

CO4: Empowering students with game theory models fosters practical decision-making skills crucial for tackling real-world competitive scenarios in disciplinary knowledge.

CO5: Empowering students to create and implement replacement models enhances their ability to optimize resource allocation and decision-making across diverse industries.

CO6: Utilizing Lebesgue measure enables precise analysis and measurement of real numbers, fostering a profound comprehension of intricate mathematical structures and properties within various disciplines.

CO7: Proficient Lebesgue integration enables precise mathematical analysis, facilitating comprehensive understanding and solution of complex real-world problems across disciplines.

PO2: Critical Thinking and Problem Solving

CO1: Proficiency in partial differential equations facilitates analytical problem-solving by accurately modeling and understanding complex physical and engineering systems.

CO2: Proficiency in interpreting and communicating solutions from partial differential equations showcases advanced critical thinking and problem-solving skills vital for tackling intricate real-world challenges across various fields.

CO3: Proficiency in network analysis fosters adept problem-solving for optimizing transportation, logistics, and resource allocation, showcasing critical thinking in diverse operational contexts.

CO4: Students will develop strategic problem-solving skills by applying game theory models, enhancing their ability to make informed decisions in competitive real-world scenarios.

CO5: Empowering students to develop replacement models fosters critical thinking by enabling strategic problem-solving for efficient resource management across diverse industries.

CO6: The Lebesgue measure enables precise analysis and measurement of real numbers, fostering a profound comprehension of intricate mathematical concepts crucial for critical thinking and problem-solving.

CO7: Proficient Lebesgue integration enables rigorous analysis, facilitating nuanced solutions for diverse practical challenges by adeptly handling complex mathematical computations, fostering critical thinking, and delivering insights crucial for real-world applications.

PO4: Research-related skills and Scientific temper

CO2: Proficiency in interpreting and communicating solutions from partial differential equations showcases a profound grasp of their practical implications, vital for tackling intricate real-world challenges and advancing research by applying scientific principles rigorously.

PO5: Trans-disciplinary Knowledge

CO2: Proficiency in interpreting and communicating solutions from partial differential equations facilitates tackling multifaceted real-world issues by leveraging a comprehensive understanding of mathematical principles across diverse fields, fostering innovative solutions and insights.

CO4: Empowering students with game theory proficiency fosters strategic thinking for real-world problem-solving, enhancing decision-making across diverse disciplines.

PO6: Personal and Professional Competence
CO1: Proficiency in partial differential equations enables rigorous analysis of real-world problems in physics and engineering, fostering adeptness in employing mathematical tools to understand and resolve complex phenomena.

PO8: Environment and Sustainability
CO2: Proficiency in interpreting and communicating solutions from partial differential equations enables strategic problem-solving for complex environmental issues, fostering sustainable solutions through a comprehensive understanding of their practical implications.

PO9: Self-directed and Life-long Learning
CO2: Proficiency in interpreting and communicating solutions from partial differential equations showcases a profound grasp of their practical implications, crucial for tackling complex real-world challenges through self-directed, lifelong learning.
CO4: Equipping students with game theory empowers strategic thinking for solving real-life challenges, fostering continuous learning in decision-making within competitive environments.

Choice Based Credit System Syllabus (2019 Pattern)

Class: T.Y.B.Sc. (Semester – VI)
Course Code: MAT 3609
Course: 9
Title of the Course: Mathematics Project
Credit: 2
No. of Lectures: 60

A) Course Objectives:

1. Comprehend fundamental mathematical concepts and theories underpinning project-based mathematics.
2. Apply mathematical principles to solve real-world problems in diverse project scenarios.
3. Develop critical thinking skills to assess, analyze, and synthesize mathematical information within projects.
4. Cultivate teamwork and collaboration abilities while working on mathematical projects.
5. Communicate mathematical concepts and solutions effectively in both oral and written forms.
6. Enhance problem-solving techniques using mathematical tools and methodologies.
7. Conduct independent research and inquiries to explore mathematical topics relevant to projects.
8. Utilize mathematical software/tools effectively to support project-based learning.
9. Recognize and apply ethical principles while working on mathematical projects.
10. Foster a desire for continuous learning and self-improvement in mathematical concepts and applications.

B) Course Outcomes:

1. Demonstrate the ability to apply mathematical theories in solving real-world problems within project settings.
2. Exhibit enhanced analytical skills through the evaluation and interpretation of mathematical data in projects.
3. Present mathematical ideas and solutions coherently and concisely, both orally and in written formats.
4. Engage effectively in teamwork, showcasing the ability to collaborate within diverse groups.
5. Apply innovative and creative approaches to solve complex mathematical problems encountered in projects.
6. Conduct independent research, explore mathematical concepts, and integrate findings into project work.
7. Adapt mathematical methodologies to various project contexts and challenges, showcasing flexibility in approach.

Mapping of Program Outcomes with Course Outcomes

Class: TYBSc (Sem VI) **Subject:** Mathematics
Course: Mathematics Project **Course Code:** MAT 3609
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	2	2	2	3
PO2	2	3	3	2	3	2	3
PO3	1	1	2	3	2	3	2
PO4	3	2	3	2	2	3	3
PO5	2	2	3	2	3	2	3
PO6	3	2	2	3	3	3	2
PO7	1	1	1	2	2	1	2
PO8	1	1	2	2	2	1	2
PO9	3	2	3	2	3	3	3

Justification for the mapping

PO1: ***Disciplinary Knowledge*** **-** Understanding advanced mathematical concepts is key to solving complex problems and conducting research.

PO2: ***Critical Thinking and Problem Solving*** **-** Complex problem-solving and applying various techniques are essential in mathematical research and innovation.

PO3: ***Social Competence*** **-** Teamwork and effective communication foster collaboration in research and solving problems together.

PO4: ***Research-related Skills and Scientific Temper*** **-** COs emphasize research, innovation, and applying methods to mathematical problems.

PO5: ***Trans-disciplinary Knowledge*** **-** Using knowledge across fields helps apply math concepts in interdisciplinary research.

PO6: ***Personal and Professional Competence*** **-** Competence grows through innovation, teamwork, and presentation skills in research.

PO7: ***Effective Citizenship and Ethics*** **-** Applying ethical considerations and responsibility in research and problem-solving is part of professional growth.

PO8: ***Environment and Sustainability*** **-** Applying math in sustainable development requires innovative problem-solving with social impact.

PO9: ***Self-directed and Life-long Learning*** **-** Research and learning skills foster continuous development and adaptation in the field.