Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Department of Mathematics

2019 Pattern

S. Y. B. Sc. (Mathematics)

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
III	USMT231	Calculus of Several Variables	3	48
	USMT232	Laplace Transform & Fourier Series	3	48
	USMT233	Practical based on USMT231 and USMT232	2	48
IV	USMT241	Vector Calculus	3	48
	USMT242	Linear Algebra	3	48
	USMT243	Practical based on USMT241 and USMT242	2	48

Equivalence of the old syllabus with the new syllabus

Old Course		New Course	
MAT 2301	Multivariable Calculus I	USMT231	Calculus of Several Variables
MAT 2302	Laplace Transform & Fourier Series	USMT232	Laplace Transform & Fourier Series
MAT 2303	Practical based on MAT 2301 and MAT 2302	USMT233	Practical based on USMT231 and USMT232

Choice Based Credit System Syllabus (2022 Pattern)

Class: S.Y.B.Sc. (Semester – III)
Course Code: USMT231
Course: 1 **Title of the Course:** Calculus of Several Variables
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To introduce students to fundamental concepts of vectors, including vector operations, vector spaces, and vector geometry in three-dimensional space.
2. To enable students to apply vector techniques to solve problems related to lines, planes, surfaces, and spatial relationships in geometry.
3. Demonstrate proficiency in comprehending, manipulating, and graphing vector functions in multiple dimensions.
4. Apply differentiation and integration techniques to vector functions, including finding derivatives, integrals, tangent vectors, and areas under curves.
5. Analyze and interpret the concepts of curvature, tangent, and normal vectors in relation to vector functions, applying these concepts to solve problems in various contexts.
6. To comprehend the fundamental concepts of partial derivatives, including their geometric interpretations and applications in various fields such as physics, economics, and engineering.
7. To develop proficiency in computing partial derivatives, determining tangent planes, and utilizing implicit differentiation methods for solving equations involving multiple variables.
8. To apply partial differentiation techniques to analyze and interpret level curves, limits, continuity, and their significance in multivariable functions, with an emphasis on their practical applications.
9. To provide students with a comprehensive understanding of directional derivatives, maximum and minimum values, and the Lagrange multiplier method in the context of optimizing scalar fields.
10. Enable students to apply acquired knowledge effectively in solving real-world optimization problems involving scalar fields, demonstrating proficiency in techniques like directional derivatives, identification of extrema, and the use of Lagrange multipliers.

B) Course Outcomes:

1. Students will be able to perform vector operations, such as addition, subtraction, scalar multiplication, dot and cross products, and apply these operations to solve problems in three-dimensional space.
2. Students will demonstrate the ability to apply vector concepts and techniques to analyze and solve problems in geometry involving lines, planes, distance, angles, intersections, and other spatial relationships.
3. Students will be able to manipulate and analyze vector functions using differentiation and integration methods, and interpret their graphical representations accurately.
4. Students will demonstrate the ability to solve problems involving curvature, tangent, and normal vectors associated with vector functions, illustrating a deep understanding of their geometric interpretation and mathematical application.

5. Students will be able to compute partial derivatives accurately, interpret level curves, evaluate limits, ascertain continuity, and apply these concepts to analyze and solve problems involving multivariable functions.
6. Students will be capable of employing partial differentiation and implicit differentiation methods to model and solve real-world problems, such as optimization, economics, physics, and engineering scenarios involving multiple variables and constraints.
7. Students will be able to compute directional derivatives, identify critical points, determine extrema, and solve optimization problems involving scalar fields using various approaches including gradient methods and the Lagrange multiplier method.
8. Develop students' analytical and critical thinking abilities in evaluating and interpreting the significance of optimization results in different fields such as economics, engineering, physics, and other relevant disciplines where scalar field optimization is applied.

TOPICS/CONTENT

Unit 1: Vectors and the geometry of space **[08 Lectures]**

1.1 Vectors and its components
1.2 The Dot product and projection
1.3 The Cross product and triple product
1.4 Equations of lines and planes
1.5 Cylinders and quadratic surfaces

Unit 2: Vector functions **[12 Lectures]**

2.1 Vector functions and space curves
2.2 Differentiation of vector functions
2.3 Integration of vector functions
2.4 Arc length
2.5 Curvature
2.6 The normal and binormal vectors
2.7 Motion in space: velocity and acceleration

Unit 3: Partial differentiation **[16 Lectures]**

3.1 Functions of several variables
3.2 Level curves
3.3 Limits and continuity
3.4 Partial derivatives
3.5 Tangent planes
3.6 Linear approximation
3.7 The chain rule
3.8 Implicit differentiation

Unit 4: Optimization of scalar fields **[12 Lectures]**

4.1 Directional derivatives
4.2 The gradient vector
4.3 Maximizing the directional derivative
4.4 Maximum and minimum values
4.5 Lagrange multipliers

Text Book:

James Stewart, *Calculus with early transcendental function*, Cengage learning, Indian edition, 2008.

Unit 1 – Sections 12.1 to 12.6 *Unit 2* – Sections 13.1 to 13.4
Unit 3 – Sections 14.1 to 14.5 *Unit 4* – Sections 14.6 to 14.8

Reference Book:

1. Joel Hass, Christopher Heil, Maurice D. Weir, *Thomas' Calculus*, Pearson Indian Education Services Pvt. Ltd., 14th Edition.
2. Jerrold E. Marsden, Anthony J. Tromba, Alan Weinstein, *Basic Multivariable Calculus*, Springer-Verlag, Indian Edition.
3. Robert Wrede, Murry R. Spiegel, *Advanced Calculus*, Schaum's Outline Series, 3rd Edition.
4. Davide V. Widder, *Advanced Calculus*, Prentice-Hall, Inc., 2nd Edition, 1947.
5. Sudhir R. Ghorpade, Balmohan V. Limaye, *A course in Multivariable Calculus and Analysis*, Springer,
6. Tom M. Apostol, *Calculus*: *volume 2*, John Wiley, 2nd Edition, 1967.

Mapping of Program Outcomes with Course Outcomes

Class: SYBSc (Sem III) **Subject:** Mathematics
Course: Calculus of Several Variables **Course Code:** USMT231
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							
CO 2	3	3							
CO 3	3	3							
CO 4	3	3							
CO 5	3	3							
CO 6	3	3							
CO 7	3	3							
CO 8	3	3							

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Understanding vector operations empowers students to manipulate spatial elements effectively, facilitating problem-solving across three-dimensional space within their disciplinary field.
CO2: This objective demonstrates the practical application of vector concepts, essential in geometry, enabling students to analyze and solve spatial problems effectively, particularly concerning lines, planes, distances, angles, intersections, and other geometric relationships within the disciplinary framework of mathematics.
CO3: Students will adeptly handle vector functions through differentiation and integration techniques, enabling a comprehensive interpretation of their graphical representations, fostering a strong grasp of disciplinary knowledge in mathematics and applied sciences.
CO4: Students will showcase their proficiency in manipulating curvature, tangent, and normal vectors within vector functions, showcasing a profound grasp of their geometric representation and mathematical utilization essential for problem-solving within the discipline.

CO5: Students will develop essential analytical skills in multivariable calculus, enabling them to dissect complex functions, understand their behavior through level curves, and solve real-world problems by evaluating limits, ensuring continuity, and computing precise partial derivatives.
CO6: Students mastering partial and implicit differentiation can proficiently model and solve complex real-world problems in disciplines like optimization, economics, physics, and engineering by adeptly handling multi-variable scenarios and constraints, crucial for innovative problem-solving and application in various fields.
CO7: Students mastering directional derivatives, critical point identification, extrema determination, and optimization problem-solving with scalar fields using gradient methods and the Lagrange multiplier method will acquire essential analytical skills crucial for tackling diverse real-world challenges across multiple disciplines.
CO8: Enhancing students' analytical and critical thinking capacities enables them to adeptly assess and interpret optimization outcomes within diverse disciplines like economics, engineering, physics, and related fields, fostering a comprehensive understanding of how scalar field optimization fundamentally impacts various specialized domains.

PO2: Critical Thinking and Problem Solving

CO1: Proficiency in vector operations enables students to effectively navigate and solve complex problems in three-dimensional space, fostering critical thinking through the application of mathematical concepts to real-world scenarios.
CO2: The application of vector concepts in geometry fosters critical thinking by enabling students to analyze spatial relationships, facilitating problem-solving skills essential for tackling geometric complexities involving lines, planes, distances, angles, and intersections.
CO3: Students mastering vector function manipulation, differentiation, integration, and graphical interpretation cultivates critical thinking by enabling them to comprehend and analyze complex mathematical relationships crucial in problem-solving across various fields like physics, engineering, and computer science.
CO4: Mastering curvature, tangent, and normal vectors within vector functions equips students with advanced problem-solving skills, fostering a profound grasp of their geometric significance and mathematical utilization, crucial for critical thinking in complex scenarios.
CO5: Students mastering multivariable calculus techniques, including partial derivatives, level curve interpretation, limit evaluation, continuity determination, and their application, foster critical thinking by enabling rigorous analysis and problem-solving in complex, real-world scenarios involving multiple variables and functions.
CO6: Students will master partial and implicit differentiation techniques, enabling them to tackle intricate real-world challenges across diverse fields by adeptly handling multivariable scenarios, constraints, and optimization problems, fostering critical thinking and problem-solving skills essential in various domains like economics, physics, and engineering.
CO7: Students mastering directional derivatives, critical point identification, extrema determination, and optimization techniques such as gradient methods and the Lagrange multiplier method will develop advanced problem-solving skills essential for tackling complex scalar field optimization challenges through analytical and strategic thinking.
CO8: Developing students' analytical and critical thinking abilities in evaluating optimization results across diverse disciplines fosters a comprehensive understanding of how scalar field optimization techniques are pertinent, enabling nuanced interpretation and application in complex real-world scenarios, spanning economics, engineering, physics, and related fields.

Choice Based Credit System Syllabus (2022 Pattern)

Class: S.Y.B.Sc. (Semester – III)
Course Code: USMT232
Course: 2 **Title of the Course:** Laplace Transform and Fourier Series
Credit: 3 **No. of Lectures:** 48

A) Course Objectives:

1. To understand the Laplace Transforms, Inverse Laplace transforms and its properties.
2. To understand the required conditions for transforming variables in functions by the Laplace transform.
3. To find Laplace transforms of derivatives, integrals and periodic functions.
4. To solve differential equations with initial conditions using Laplace transform.
5. To understand some special functions such as Gamma Function, Unit Step function and Dirac Delta Function.
6. To evaluate Fourier series of continuous functions and familiar with its basic properties.
7. To apply the concepts of Laplace transforms and Fourier series in various fields for solving real world problems.

B) Course Outcomes:

1. Students will able to understand the Laplace Transforms, Inverse Laplace transforms and its properties.
2. Students will able to understand the required conditions for transforming variables in functions by the Laplace transform.
3. Students will able to find Laplace transforms of derivatives, integrals and periodic functions.
4. Students will be able to solve differential equations with initial conditions using Laplace transform.
5. Students will able to understand some special functions such as Gamma Function, Unit Step function and Dirac Delta Function.
6. Students will able to evaluate Fourier series of continuous functions and familiar with its basic properties.
7. Students will able to apply the concepts of Laplace transforms and Fourier series in various fields for solving real world problems.

TOPICS/CONTENT

Unit-1: The Laplace Transform: [18]

1.1 Definition, Laplace Transform of some elementary functions.
1.2 Some important properties of Laplace Transform.
1.3 Laplace Transform of derivatives, Laplace Transform of Integrals.
1.4 Methods of finding Laplace Transform, Evaluation of Integrals.
1.5 The Gamma function, Unit step function and Dirac delta function.

Unit-2: The Inverse Laplace Transform [18]

2.1 Definition, Some inverse Laplace Transform.
2.2 Some important properties of Inverse Laplace Transform.
2.3 Inverse Laplace Transform of derivative, InverseLaplace Transform of integrals.
2.4 Convolution Theorem, Evaluation of Integrals.

Unit-3: Applications of Laplace Transform: [04]

3.1 Solution of Ordinary Differential Equations with constant coefficients.

Unit-4: Fourier Series [08]

4.1 Definition and examples of Fourier Series.

Text-Book:

1. Schaum's Outline Series - Theory and Problems of Laplace Transform by Murray R. Spiegel.

Unit-1: Chapter 1, Unit-2: Chapter 2, Unit-3: Chapter 3 Unit-4: Chapter 6

Reference Books:

1. Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970).Art.12.1

Reference Books:

2. Joel L. Schiff: The Laplace Transforms - Theory and Applications, Springer- Verlag New York 1999.
3. Dyke: An Introduction to Laplace Transforms and Fourier Series, Springer International Edition, Indian Reprint 2005.

Mapping of Program Outcomes with Course Outcomes

Class: SYBSc (Sem III) **Subject:** Mathematics

Course: Laplace Transform and Fourier Series **Course Code:** USMT232

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	2							2
CO 3	3	2			3				2
CO 4	3	2			2				2
CO 5	3	2		2	2				2
CO 6	3	2			2				2
CO 7		3		2					2

Justification for the mapping

PO 1: Disciplinary Knowledge:

All of these course outcomes (COs) contribute to the development of student's disciplinary knowledge in mathematics. For example, CO1, CO2, CO3, CO4, CO5, CO6 requires student to develop deep learning of Laplace transform, inverse Laplace transform, Solution of differential equation using Laplace transform and Fourier series. CO4 requires students to apply the concepts of Laplace Transform and Fourier series in many fields like engineering and computer science.

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, CO2, CO5, CO7 requires students to think critically and apply these to solve problems in various filed like engineering and physics.

PO4: Research-related skills and Scientific temper:

CO5, CO7 contribute to the development of student's research related skills and scientific temper. CO7 requires students to develop their ability to think critically and apply knowledge to various field. CO5 requires students to apply knowledge of special function and apply to solve real world problem.

PO5: Trans-disciplinary Knowledge:

CO1, CO3, CO4, CO5 & CO6 requires students to apply Laplace transform and Fourier series as tools in various fields like Physics, Engineering and Computer science.

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 real life 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 (2022 Pattern)

Class: S.Y.B.Sc. (Semester – III)
Course Code: USMT233
Course: 3 **Title of the Course:** Practical based on USMT231 & USMT232
Credit: 2 **No. of Lectures:** 60

A) Course Objectives:

1. To enable students to apply vector techniques to solve problems related to lines, planes, surfaces, and spatial relationships in geometry.
2. Analyze and interpret the concepts of curvature, tangent, and normal vectors in relation to vector functions, applying these concepts to solve problems in various contexts.
3. To develop proficiency in computing partial derivatives, determining tangent planes, and utilizing implicit differentiation methods for solving equations involving multiple variables.
4. To provide students with a comprehensive understanding of directional derivatives, maximum and minimum values, and the Lagrange multiplier method in the context of optimizing scalar fields.
5. To understand the Laplace Transforms, Inverse Laplace transforms and its properties.
6. To solve differential equations with initial conditions using Laplace transform.
7. To apply the concepts of Laplace transforms and Fourier series in various fields for solving real world problems.

B) Course Outcomes:

1. Students will demonstrate the ability to apply vector concepts and techniques to analyze and solve problems in geometry involving lines, planes, distance, angles, intersections, and other spatial relationships.
2. Students will demonstrate the ability to solve problems involving curvature, tangent, and normal vectors associated with vector functions, illustrating a deep understanding of their geometric interpretation and mathematical application.
3. Students will be capable of employing partial differentiation and implicit differentiation methods to model and solve real-world problems, such as optimization, economics, physics, and engineering scenarios involving multiple variables and constraints.
4. Develop students' analytical and critical thinking abilities in evaluating and interpreting the significance of optimization results in different fields such as economics, engineering, physics, and other relevant disciplines where scalar field optimization is applied.
5. Students will able to understand the Laplace Transforms, Inverse Laplace transforms and its properties.
6. Students will be able to solve differential equations with initial conditions using Laplace transform.
7. Students will able to apply the concepts of Laplace transforms and Fourier series in various fields for solving real world problems.

Title of experiments:
Calculus of Several Variables:

- Why One Variable Just Isn't Enough!
- Taking Derivatives in Multiple Dimensions: Because Life is Complicated Enough Already
- Calculus for the Multidimensional Thinker: Get Ready to Expand Your Mind
- Calculating the Impossible: Tackling Complex Calculus Problems with Multivariable Calculus
- Calculus in the Real World: How Multivariable Calculus Can Help You Understand the Universe
- "Calculus in the Digital Age: How Software Makes Multivariable Calculus Accessible and Fun"

Laplace Transform & Fourier Series:

- Transforming Your Understanding: Unpacking the Magic of Laplace Transforms and Fourier Series
- The Art of Transformation: Exploring the Beauty of Laplace Transforms and Fourier Series
- From Sine Waves to Signals: Analyzing Real-World Problems with Laplace Transforms and Fourier Series
- Transforming the Future: How Laplace Transforms and Fourier Series are Revolutionizing Engineering and Science
- Mastering Transformations: How Software Tools Make Laplace Transforms and Fourier Series Accessible to All
- Mathemagic: Exploring Laplace Transforms and Fourier Series with Interactive and Animated Software

Mapping of Program Outcomes with Course Outcomes

Class: SYBSc (Sem III) **Subject:** Mathematics
Course: Practical based on USMT231 & USMT232 **Course Code:** USMT233
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
CO 2	3	3				2			2
CO 3	3	3				2			2
CO 4	3	3		2	3	2			2
CO 5	3	3		2		2			2
CO 6	3	3				2			2
CO 7	3	3		2	1	2			2

Justification for the mapping

PO 1: Disciplinary Knowledge:
All of these course outcomes (COs) contribute to the development of student's disciplinary knowledge in mathematics. For example, CO1, CO2, CO3, CO5, CO6 requires student to develop deep learning of vector spaces, linear transformation, inner product spaces. CO4 requires students to apply the concepts of linear algebra in many fields like engineering, statistics and computer science.

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:
CO1, CO4, CO5, CO7 contribute to the development of student's research related skills and scientific temper. For example, CO4 and CO7 requires students to develop their ability to think critically and apply knowledge to various field. CO1 and CO5 requires students to apply knowledge of system of linear equations and inner product spaces and apply to solve real world problem.

PO5: Trans-disciplinary Knowledge:
CO4, CO7 requires students to apply linear algebra tools in various fields like Physics, Engineering and Computer science.

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.