Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure for B.Sc. Mathematics (2022 Pattern)

F. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	USMT111	Algebra	2	36
	USMT112	Calculus-I	2	36
	USMT113	Practical based on USMT111 and USMT112	2	48
II	USMT121	Geometry	2	36
	USMT122	Calculus and Differential Equations	2	36
	USMT123	Practical based on USMT121 and USMT122	2	48

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

T.Y.B.Sc Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
V	USMT351	Metric Spaces	3	48
	USMT352	Real Analysis I	3	48
	USMT353	Group Theory	3	48
	USMT354	Ordinary Differential Equation	3	48
	USMT355	Number Theory	3	48
	USMT356(A)	Operation Research	3	48
	USMT356(B)	C Programming	3	48
	USMT357	Practical based on USMT351 and USMT352	2	48
	USMT358	Practical based on USMT353 and USMT354	2	48
	USMT359	Practical based on USMT355 and USMT356	2	48
VI	USMT361	Complex Analysis	3	48
	USMT362	Real Analysis II	3	48
	USMT363	Ring Theory	3	48
	USMT364	Partial Differential Equation	3	48
	USMT365	Lebesgue Integration	3	48
	USMT366(A)	Optimization Techniques	3	48
	USMT366(B)	Python Programming	3	48
	USMT367	Practical based on USMT361, USMT362, and USMT363	2	48
	USMT368	Practical based on USMT364, USMT365, and USMT366	2	48
	USMT369	Mathematics Project	2	48

Equivalence of the old syllabus with the new syllabus

Sem III

Old Course		New Course	
MAT2301	Multivariable Calculus-I	USMT231	Calculus of Several Variables
MAT2302	Laplace Transform & Fourier Series	USMT232	Laplace Transform & Fourier Series
MAT2303	Practical Based on MAT2301 & MAT2302	USMT233	Practical based on USMT231 and USMT232

Academic Year 2023-24

Class	**:** S.Y.B.Sc. (Semester – III)	**Course Code**	**: USMT 231**
Title of the Course	**:** Calculus of Several Variables	**Course**	**: I**
Credit	**: 3**	**No. of lectures:**	**48**

A) Learning Objectives

- Understand the fundamental concepts of vectors including representation, magnitude, and direction.
- Apply dot product operations to compute angles, projections, and work done by forces.
- Apply cross product operations to compute areas of parallelograms and volumes of parallelepipeds.
- Analyze vector functions and space curves in three dimensions.
- Calculate derivatives and integrals of vector functions for velocity, acceleration, and displacement.
- Determine arc length and curvature of space curves.
- Analyze motion in space using velocity and acceleration vectors.
- Understand functions of several variables and their domains.
- Compute partial derivatives and interpret their geometric meaning.
- Apply optimization techniques including directional derivatives, gradients, and Lagrange multipliers to solvereal-world problems.

B) Learning Outcomes

- Students will be able to represent vectors geometrically and algebraically and perform basic operations on vectors.
- Students will demonstrate proficiency in computing dot and cross products and interpreting their geometricsignificance.
- Students will be able to differentiate and integrate vector functions and interpret the results in terms of motionin space.
- Students will be able to compute arc length and curvature of space curves and apply them in practicalscenarios.
- Students will understand the concept of partial derivatives and apply them to functions of several variables.
- Students will be able to calculate directional derivatives and use them to analyze the rate of change ofmultivariable functions in given directions.
- Students will apply optimization techniques to find maximum and minimum values of functions of severalvariables and solve constrained optimization problems using Lagrange multipliers.

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:

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	2	2	2	2	3
PO3							1
PO4	2	2	2	2	2	2	3
PO5	3	3	3	3	3	3	3
PO6	1	1	1	1	1	1	2
PO7	2	2	2	2	2	2	3
PO8	2	2	2	2	2	2	2
PO9	1	1	1	1	1	1	1
PO10	1	1	1	1	1	1	1
PO11							
PO12	2	2	2	2	2	2	2
PO13							

Justification for the mapping

PO1: Comprehensive Knowledge and

Understanding

All course outcomes directly contribute to this programme outcome as they cover fundamental concepts andoperations related to vectors and multivariable functions.

PO2: Practical, Professional and Procedural Knowledge

CO7 directly relates to practical problem-solving skills by applying optimization techniques, making it a strong connection. Other course outcomes also contribute by providing foundational knowledge applicable in various professional contexts.

PO3: Entrepreneurial Mindset and Knowledge

While vector calculus may not directly relate to entrepreneurial activities, understanding mathematical concepts and problem-solving skills (especially evident in CO7) can foster an entrepreneurial mindset indirectly.

PO4: Specialized Skills and Competencies

All course outcomes contribute to specialized skills and competencies in mathematics, particularly in vector representation, operations, differentiation, integration, optimization, etc.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

All course outcomes involve problem-solving and analytical reasoning, especially CO7 which deals explicitly with optimization, making them directly linked to this programme outcome.

PO6: Communication Skills and Collaboration

While the course focuses more on mathematical concepts and operations, the ability to communicate solutions and collaborate on problem-solving can be developed through assignments and discussions related to these course outcomes.

PO7: Research-related Skills
Understanding vector calculus concepts and their applications can contribute to research skills, especially in fields like physics, engineering, computer graphics, etc.
PO8: Learning How to Learn Skills
Mastering vector calculus requires self-directed learning and problem-solving skills, contributing to the developmentof learning how to learn skills.
PO9: Digital and Technological Skills
Although not directly related to digital or technological skills, the course provides foundational knowledge necessaryfor understanding and applying mathematical concepts in various technological contexts.
PO10: Multicultural Competence, Inclusive Spirit and Empathy
While vector calculus itself may not directly relate to multicultural competence or empathy, the problem-solvingskills developed in this course can be applied in diverse cultural and social contexts.
PO12: Autonomy, Responsibility and Accountability
Mastering vector calculus requires autonomy in learning, taking responsibility for understanding concepts, and beingaccountable for problem-solving accuracy, contributing indirectly to this programme outcome.

Class: S.Y. B. Sc. (Semester- III) **Title of Paper:** Laplace Transform & Fourier Series
Paper Code: USMT232 **Credit:** 3
Paper: II **No. of lectures:** 48

A) Learning Objectives:

1. To equip the students with the knowledge of Laplace and Fourier Transforms and their Inverses.
2. To train the students to convert Differential Equations into algebraic equations by applying Laplace transformand solve them.
3. To develop proficiency in manipulating Fourier Series to analyze periodic functions and solve differentialequations with periodic boundary conditions.
4. To understand the significance of these mathematical tools in various applications such as electrical circuits,control systems, heat transfer, vibrations, and signal analysis.
5. To analyze the advantages and limitations of Laplace Transforms and Fourier Series compared to othermathematical methods.
6. Apply Laplace Transforms and Fourier Series techniques to model and solve real-world problems inengineering, physics, signal processing, and other related fields.
7. To interpret and visualize the results obtained from numerical computations.

B) Learning Outcome:

1. Demonstrate a through understanding of the principles and concepts of Laplace Transforms, Inverse LaplaceTransform and Fourier Series.
2. Understand the required conditions for transforming variables in functions by the Laplace transform.
3. Find Laplace transforms of derivatives, integrals and periodic functions.
4. Solve differential equations with initial conditions using Laplace transform.
5. Understand some special functions such as Gamma Function, Unit Step function and Dirac Delta Function.
6. Apply Laplace Transforms and Fourier Series techniques to model and analyze engineering and physicalsystems, including electrical circuits, control systems, heat transfer problems, and vibrations.
7. Develop the skills and motivation to seek out and engage with advanced topics related to Laplace Transforms,Fourier Series, and related mathematical techniques.

Topic/ 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.

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	2	3	3	3	3
PO3				2		2	2
PO4							
PO5	2	2	2	2	2	2	2
PO6							
PO7	2	2	2	2	2	2	2
PO8	1	1	2	2	2	2	2
PO9							
PO10							
PO11							
PO12							
PO13							

Justification for the mapping

PO1:Comprehensive Knowledge and

Understanding

All of these course outcomes (COs) contribute to the development of student's disciplinary knowledge in mathematics. For example, CO1, CO2, CO3, CO4, CO5 requires student to develop deep learning of Laplace transform, inverse Laplace transform, Solution of differential equation using Laplace transform and Fourier series. CO6, CO7 requires students to apply the concepts of Laplace Transform and Fourier series in many

fields like engineering and computer science.

PO2: Practical, Professional and Procedural Knowledge

All of these course outcomes contribute to acquire practical skills and expertise essential for professional tasks withintheir field. For example, CO4, CO5, CO5, CO6, CO7 course outcomes with the ability to apply this knowledge effectively in real-world problem in various field like Physics and Computer Science.

PO3: Entrepreneurial Mindset and Knowledge

The course outcomes CO4, CO6 &CO7 will demonstrate students' proficiency in problem solving relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

All of these course outcomes (COs) contribute to the student's capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn. For example, CO1, CO2, CO3, CO4, CO5, CO6 requires students to apply Laplace transform and Fourier series as tools in various fields like Physics, Engineering and Computer science.

PO7: Research-related Skills

CO5, CO6, CO7 contribute to the development of students research related skills and scientific temper. CO7 requires students to develop their ability to think critically and apply knowledge to various field. CO6 requires students to apply knowledge of special function and apply to solve real world problem.

PO8: Learning How to Learn Skills

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.

Class: S.Y. B. Sc. (Sem- III) **Title of Paper:** Practical based on USMT231 and USMT232
Paper Code: USMT233 **Credit:** 2
Paper: III **No. of lectures:** 48

A. Learning Objectives:

- Understand the concept of linear differential equations with constant coefficients.
- Identify and solve differential equations using the method of auxiliary equations.
- Distinguish between distinct roots, repeated roots, and complex roots in differential equations and solve themaccordingly.
- Apply the method of particular solutions to solve non-homogeneous differential equations.
- Utilize the operator $1/(D)$ to evaluate functions like x^m, e^{mx}, $e^{axv}v$.
- Apply the operator $1/(D^2 + a^2)$ to solve differential equations involving $\sin ax$ and $\cos ax$.
- Construct non-homogeneous differential equations from specified solutions.
- Solve non-homogeneous differential equations using the method of undetermined coefficients.
- Employ the method of variation of parameters to solve second-order linear differential equations.
- Solve differential equations using power series solutions, identifying ordinary points and regular singularpoints.

B. Learning outcome:

- Demonstrate proficiency in solving linear differential equations with constant coefficients using variousmethods.
- Apply mathematical techniques to classify roots of characteristic equations and solve correspondingdifferential equations.
- Develop skills in solving non-homogeneous differential equations through the method of undeterminedcoefficients.
- Demonstrate understanding and application of reduction of order and variation of parameters methods insolving differential equations.
- Apply power series solutions to solve differential equations near ordinary points and regular singular points.
- Analyze convergence of power series solutions and their implications on the solutions of differentialequations.
- Demonstrate problem-solving skills by applying learned methods to real-world problems involvingdifferential equations.

Title of experiments:

Calculus of Several Variables:

1. Why One Variable Just Isn't Enough!
2. Taking Derivatives in Multiple Dimensions: Because Life is Complicated Enough Already
3. Calculus for the Multidimensional Thinker: Get Ready to Expand Your Mind
4. Calculating the Impossible: Tackling Complex Calculus Problems with Multivariable Calculus

5. Calculus in the Real World: How Multivariable Calculus Can Help You Understand the Universe
6. "Calculus in the Digital Age: How Software Makes Multivariable Calculus Accessible and Fun"

Laplace Transform & Fourier Series:

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

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PO2	3	3	3	3	3	3	3
PO3							1
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	1	1	1	1	1	1	1
PO7	2	2	2	2	2	2	3
PO8	2	2	2	2	2	2	2
PO9	1	1	1	1	1	1	2
PO10	1	1	1	1	1	1	2
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	2
PO13	1	1	1	1	1	1	2

Justification for the mapping

PO1: Comprehensive Knowledge and

Understanding

All course outcomes are directly related to understanding and proficiency in solving differential equations, makingthem strongly connected to this programme outcome.

PO2: Practical, Professional and Procedural Knowledge

Solving differential equations involves practical and procedural knowledge, especially

evident in CO7 wherestudents apply learned methods to real-world problems.

PO3: Entrepreneurial Mindset and Knowledge

While differential equations themselves may not directly relate to entrepreneurial activities, the problem-solvingskills developed in this course, especially in CO7, can foster an entrepreneurial mindset indirectly.

PO4: Specialized Skills and Competencies

All course outcomes contribute to specialized skills and competencies in mathematics, particularly in the area ofdifferential equations and their solutions.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

All course outcomes involve problem-solving and analytical reasoning, especially evident in CO7 where studentssolve real-world problems using differential equations.

PO6: Communication Skills and Collaboration

Communication skills and collaboration are not directly addressed in the course outcomes, but students may developthese skills through collaborative problem-solving sessions or presenting solutions.

PO7: Research-related Skills

While the course outcomes themselves may not directly relate to research skills, the problem-solving techniqueslearned can be applied in research contexts where differential equations arise.

PO8: Learning How to Learn Skills

Mastering differential equations requires self-directed learning and problem-solving skills, contributing to thedevelopment of learning how to learn skills.

PO9: Digital and Technological Skills

Differential equations may not directly relate to digital or technological skills, but understanding mathematicalconcepts is foundational for various technological applications.

PO10: Multicultural Competence, Inclusive Spirit and Empathy

While differential equations themselves may not directly relate to multicultural competence or empathy, the problem-solving skills acquired can be applied in diverse cultural and social contexts.

PO11: Value Inculcation and Environmental Awareness

The course outcomes do not directly contribute to value inculcation or environmental awareness, but problem-solving skills acquired can be utilized to address environmental challenges indirectly.

PO12: Autonomy, Responsibility and Accountability

Mastering differential equations requires autonomy in learning, taking responsibility for understanding concepts, andbeing accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

PO13: Community Engagement and Service

While the course outcomes themselves do not directly relate to community engagement or service, the problem-solving skills acquired can be utilized in community-oriented projects or initiatives.