Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for B.Sc. Mathematics

F. Y. B. Sc. Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
I	MAT1101	Algebra	2
	MAT1102	Calculus-I	2
	MAT1103	Practical Based on MAT1101 & MAT1102	2
II	MAT1201	Geometry	2
	MAT1202	Calculus-II	2
	MAT1203	Practical Based on MAT1201 & MAT1202	2

S. Y. B. Sc. Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
III	MAT2301	Multivariable Calculus-I	3
	MAT2302	Laplace Transform & Fourier Series	3
	MAT2303	Practical Based on MAT2301 & MAT2302	2
IV	MAT2401	Linear Algebra	3
	MAT2402	Multivariable Calculus-II	3
	MAT2403	Practical Based on MAT2401 & MAT2402	2

T.Y.B.Sc Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
V	MAT3501	Metric Spaces	3
	MAT3502	Real Analysis I	3
	MAT3503	Problem Course based on MAT3501 & MAT3502	2
	MAT3504	Group Theory	3
	MAT3505	Ordinary Differential Equation	3
	MAT3506	Problem Course based on MAT3504 & MAT3505	2
	MAT3507	Operation Research	3
	MAT3508	Number Theory	3
	MAT3509	Practical based on MAT3507 & MAT3508	2
VI	MAT3601	Complex Analysis	3
	MAT3602	Real Analysis II	3
	MAT3603	Problem Course based on MAT3601 & MAT3602	2
	MAT3604	Ring Theory	3
	MAT3605	Partial Differential Equation	3
	MAT3606	Problem Course based on MAT3604 & MAT3605	2
	MAT3607	Optimization Techniques	3
	MAT3608	Lebesgue Integration	3
	MAT3609	Practical based on MAT3607 & MAT3608	2
	MAT3610	Project	2

SYLLABUS (CBCS) FOR S. Y. B. Sc. MATHEMATICS
(w.e.f. June, 2020)

Academic Year 2020-2021

Class : S.Y. B. Sc. (Semester- III)
Paper Code : MAT2301
Paper : I **Title of Paper:** Multivariable Calculus -I
Credit : 3 **No. of lectures:** 48

TOPICS/ CONTENT:

Unit 01: Differential Calculus of Scalar and Vector Fields [28 lectures]

- Functions of $\mathbf{R}^n$ to $\mathbf{R}^m$. Scalar and vector fields.
- Open balls and open sets, Limits and continuity
- The derivative of scalar field with respect to a vector
- Directional derivative and partial derivatives
- Partial derivatives of higher order
- Directional derivatives and continuity, The total derivative
- The gradient of a scalar field
- A sufficient condition for differentiability
- A chain rule for derivatives of scalar fields
- Level sets, tangent planes, Derivatives of vector fields
- Differentiability implies continuity, The chain rule for derivatives of vector fields, Matrix form of the chain rule
- Sufficient condition for the equality of mixed partial derivatives

Unit 02: Applications of the Differential Calculus [20 lectures]

- Partial differential equations, Derivatives of function defined implicitly
- Maxima, minima and saddle point
- Second order Taylor formula for scalar fields
- The nature of stationary point determined by the eigenvalues of the Hessian matrix, Second derivative test for extrema of functions of two variables
- Extrema with constraints. Lagrange's multipliers

Text Book:

Tom M. Apostol, Calculus Vol. II, John Wiley, New York (Second Edition)
Chapters: 8 and 9 (Excluding 9.2, 9.3, 9.16 and 9.17)

Reference Books:

1) G. B. Thomas, Thomas' Calculus, Pearson Edition 2012.
2) Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A. Weinstein, Springer
3) Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company.
4) D.V. Widder, Advanced Calculus (2nd Edition), Prentice Hall of India , New Delhi.

Class **:** S.Y. B. Sc. (Semester- III)
Paper Code **:**MAT2302
Paper **:** II **Title of Paper:** Laplace Transform & Fourier series
Credit **:** 3 **No. of lectures:** 48

TOPICS/ CONTENT:

Unit 01: The Laplace Transform [18 lectures]

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

Unit 02: The Inverse Laplace Transform [18 lectures]

- Definition, Some inverse Laplace Transform.
- Some important properties of Inverse Laplace Transform.
- Inverse Laplace Transform of derivative, InverseLaplace Transform of integrals.
- Convolution Theorem, Evaluation of Integrals.

Unit 03: Applications of Laplace Transform [04 lectures]

- Solution of Ordinary Differential Equations with constant coefficients.

Unit 04: Fourier Series [08 lectures]

- Definition and examples of Fourier Series.

Text-Book:

1.Schaum's Outline Series - Theory and Problems of Laplace Transform by
Murray R. Spiegel.Articles 1, 2, 3.
2.Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970).Art.12.1
3.Prepared by the BOS Mathematics, SPPUniversity Pune

Reference Books:

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

Class **:** S.Y. B. Sc. (Semester- III)
Paper Code **:**MAT2303
Paper **:** III **Title of Paper:** Practical Based on MAT2301& MAT2302
Credit **:** 2 **No. of lectures:** 48

TOPICS/ CONTENT:

Title of experiments:
Multivariable Calculus -I:
- Limit and Continuity
- Derivatives of scalar field
- Directional Derivatives
- Chain rule problems
- Extreme Values
- Numerical Analysis Methods
- Use of software to study Multivariable Calculus

Laplace Transform & Fourier Series:
- Laplace Transform I
- Laplace Transform II
- Inverse Laplace Transform
- Applications of Laplace Transform
- Fourier Series
- Numerical Analysis Problems
- Use of software to study Laplace Transform and Fourier Series

Choice Based Credit System Syllabus (2019 Pattern)

Class: S.Y.B.Sc. (Semester – III)
Course Code: MAT 2301
Course: 1 **Title of the Course:** Multivariable Calculus I
Credit: 2 **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.

Mapping of Program Outcomes with Course Outcomes

Class: SYBSc (Sem III) **Subject:** Mathematics
Course: Multivariable Calculus I **Course Code:** MAT 2301
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.

Class: S.Y.B.Sc.

Paper Code: MAT2302

Title of Paper: Laplace Transform and Fourier Series

Course Outcomes:

C01 Students will able to understand the Laplace Transforms ,Inverse Laplace transforms and its properties.
C02 Students will able to understand the required conditions for transforming variables in functions by the Laplace transform.
C03 Students will able to find Laplace transforms of derivatives, integrals and periodic functions.
C04 Students will be able to solve differential equations with initial conditions using Laplace transform.
C05 Students will able to understand some special functions such as Gamma Function, Unit Step function and Dirac Delta Function.
C06 Students will able to evaluate Fourier series of continuous functions and familiar with its basic properties.
C07 Students will able to apply the concepts of Laplace transforms and Fourier series in various fields for solving real world problems.

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (Sem III) **Subject:** Mathematics

Course: Laplace Transform & Fourier Series **Course Code: MAT2302**

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 students 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 Fouries 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 students 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 students 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.