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

Autonomous

Course Structure for B.Sc. Mathematics

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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

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:** MultivariableCalculus -I
Credit : 3 **No. of lectures:** 48

A) Learning Objectives:

- Find partial derivatives numerically and use them to analyze and interpret the way a function varies.
- Develop mathematical ability like finding extreme values to apply them to solve problems in science and problems in real life situations

B) Learning Outcome:

Learning multivariable calculus will develop skills of students to solve complex problems in mathematics and science.

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 (2_{nd} 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

A) Learning Objectives:

- To learn Laplace transform and use it to solve ordinary differential equation which naturally comes in every pattern of the universe locally and globally
- To learn Fourier Series and their application in science.

B) Learning Outcome:

Able to solve differential equation using Laplace Transform and to calculate Fourier Series of functions.

Unit 01: TheLaplace 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

A) Learning Objectives:

- Problem solving in Multivariable Calculus and learning its applications'.
- Problem solving in Laplace Transform and Fourier Series to improve analytical thinking.

B) Learning Outcome:

Inculcate problem solving skills in students and understanding applications of Mathematics in science and real life problems. Student will be able to use software in solving problems.

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

Class : S.Y. B. Sc. (Semester- IV)
Paper Code : MAT2401
Paper : I **Title of Paper:** Linear Algebra
Credit : 3 **No. of lectures:** 48

A) Learning Objectives:

- Understanding real vector spaces and their properties.
- Learn proof writing techniques in independence of vector spaces, linear transformation etc. and solving problems related to them

B) Learning Outcome:

Student will able to solve problems on vector spaces, matrices, linear transformation and apply these techniques in other subjects of mathematics, science.

Unit 01: Vector Spaces [14 lectures]

- Definitions and Examples.
- Vector Subspaces.
- Linear Independence.
- Basis and Dimensions of a Vector Space.
- Row and Column Spaces of a matrix.
- Row rank and Column rank.

Unit 02: Linear Transformations [12 lectures]

- Linear Transformation, representation by a matrix.
- Kernel and Image of a Linear Transformation.
- Rank-Nullity theorem.
- Linear Isomorphism.
- L (V, W) is a vector space. Dimension of L(V,W) (Statement only)

Unit 03: Inner Product spaces: [16 lectures]

- The Euclidean space and dot product.
- General inner product spaces.
- Orthogonality, Orthogonal projection onto a line, Orthogonal basis.
- Gram-Schmidt Orthogonalization.
- Orthogonal Transformation.

Unit 04: Eigen values and Eigen vectors: [6 lectures]

- Rotation of axes of conics.
- Eigenvalues and eigenvectors.

Text Book:

S. Kumaresan , Linear Algebra: A Geometric Approach, Prentice Hall of India, New Delhi, Chapters: 2, 4, 5 (excluding Arts 4.4.10 -4.4.12, 5.3. 5.6, 5.7, 5.9), 7.1, 7.2.

Reference Books:

(1) M. Artin, Algebra, Prentice Hall of India , New Delhi, (1994).
(2) K. Hoffmann and R. Kunze Linear Algebra, Second Ed. Prentice Hall of India
(3) S. Lang, Introduction to Linear Algebra, Second Ed. Springer-Verlag, New Yark,.
(4) A. Ramchandra Rao and P. Bhimasankaran, Linear Algebra, Tata McGraw Hill, New.
(5) G. Schay, Introduction to Linear Algebra, Narosa, New Delhi, (1998).
(6) L. Smith, Linear Algebra, Springer –Verlag, New York, (1978).
(7) G. Strang, Linear Algebra and its Applications. Third Ed. Harcourt Brace Jovanovich,
(8) T. Banchoff and J. Werner, Linear Algebra through Geometry. Springer-Verlag
(9) H. Anton and C. Rorres, Elementary Linear Algebra with Applications, Seventh Ed., Wiley, (1994)

Class : S.Y. B. Sc. (Semester- IV)
Paper Code : MAT2402
Paper : II **Title of Paper:** MultivariableCalculus - II
Credit : 2 **No. of lectures:** 48

A) Learning Objectives:

- Solving problems on line integral and understanding their applications in physics
- To study Multiplication integration problem solving using Greens Theorem, Stokes Theorem, Gauss Divergence Theorem

B) Learning Outcome:

Student will able to solve problems in integration which are critical in some science subjects. They will enhance ability of problem solving and will improve analytical thinking.

Unit 01:Line Integral [16 lectures]

- Introduction, Paths and line integrals
- Other notations for line integrals, Basic properties of line integrals
- The concept of work as a line integral, Line integral with respect to arc length
- Further applications of line integrals
- Open connected sets. Independence of the path
- The second fundamental theorem of calculus for line integral
- The first fundamental theorem of calculus for line integral
- Necessary and sufficient condition for a vector field to be a gradient

Unit 02: Multiple Integrals [16 lectures]

- Introduction, Partitions of rectangles, step functions
- The double integral of a step function
- The definition of the double integral of a function defined and bounded on a rectangle, Upper and lower double integrals
- Evaluation of a double integral by repeated one dimensional integration
- Geometrical interpretation of the double integral as a volume
- Integrability of continuous functions, Integrability of bounded functions with discontinuities, Double integral extended over more general regions
- Applications to area and volume, Green's theorem in the plane
- Green's theorem for multiply connected regions

Unit 03: Surface Integrals [16 lectures]

- Parametric representation of a surface, The fundamental vector product
- The fundamental vector product as a normal to the surface
- Area of a parametric surface, Surface integrals
- Change of parametric representation, Other notations for surface integrals
- The theorem of Stokes, The curl and divergence of a vector field
- Further properties of the curl and divergence, Reconstruction of a vector field from its curl, The Gauss divergence theorem (without proof)

Text Book:

Tom M. Apostol, Calculus Vol. II, John Wiley, New York (Second Edition)
Chapters: 10, 11 and 12

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 (2_{nd} Edition), Prentice Hall of India , New Delhi.

Class : S.Y. B. Sc. (Semester- IV)
Paper Code : MAT2403
Paper : III **Title of Paper:** Practical Based on MAT2401 & MAT2402
Credit : 2 **No. of lectures:** 48

A) Learning Objectives:

- Problem solving in Linear Algebra and understanding its importance in mathematics and science.
- Problem solving in Multivariable Calculus II and use of multiple integration for solving problems in physics and other sciences

B) Learning Outcome:

Inculcate problem solving skills in students and understanding applications of Mathematics in science and real life problems. Student will be able to use software in solving problems.

Title of experiments:

Linear Algebra

- Vector Spaces I
- Vector Space II
- Linear Transformation
- Inner Product Spaces
- Eigenvalues and Eigenvectors
- Numerical Analysis methods II
- Use of software to study Linear Algebra

Multivariable Calculus II

- Line Integral
- Multiple Integral
- Greens Theorem
- Surface Integral
- Stokes Theorem and Divergence Theorem
- Numerical Analysis Problems II
- Use of software to study Multivariable Calculus II