Semester-IV

S.Y.B.Sc. (Mathematics) Semester-IV

Major Course- VIII

COURSE TITLE: Numerical Methods-II

COURSE CODE: MHMJ-S4P8-2CR25 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. Develop a thorough understanding of least squares curve fitting techniques, including fitting straight lines, multiple linear regression, and nonlinear models using polynomials and sums of exponentials. 2. Learn the principles and applications of numerical differentiation, focusing on the calculation of first and second-order derivatives. 3. Gain expertise in numerical integration methods, including the Trapezoidal Rule, Simpson's 1/3 Rule, and Simpson's 3/8 Rule, and understand their applications in solving real-world problems. 4. Apply various numerical methods for solving ordinary differential equations, including Taylor's series, Picard's approximation, Euler's method, Modified Euler's method, and the Runge-Kutta (2nd and 4th order) methods.

Module 1	Curve fitting	[15L]
Learning Objective 1. Understand and apply the least squares method for fitting straight lines and multiple linear models to data. 2. Learn the process of linearizing nonlinear relationships and applying them in curve fitting. 3. Gain proficiency in fitting curves using polynomial models and sums of exponentials.		
Learning Outcomes: At the end of this module the learner will be able to 1. Implement least squares curve fitting techniques for both simple and multiple linear regression problems. 2. Linearize nonlinear equations and apply them effectively to fit data. 3. Use polynomial and exponential models to fit data and analyze the best-fit solutions.		
1.1	Least squares Curve fitting procedures, Fitting a straight line, Multiple Linear least squares.	**[6L]**
1.2	Linearization of nonlinear laws	**[3L]**
1.3	Curve fitting by polynomials	**[3L]**
1.4	Curve fitting by sum of exponentials	**[3L]**

Module 2	Numerical Differentiation and Integration	[15L]

Learning Objective

1. Understand and implement numerical differentiation techniques.
2. Derive and apply numerical integration formulas.
3. Compare different numerical integration methods for accuracy.
4. Understand the need for numerical solutions to ordinary differential equations.
5. Derive and apply various numerical methods for solving ODEs.
6. Analyze the accuracy and efficiency of different numerical methods.

Learning Outcomes:

At the end of this module the learner will be able to

1. Compute numerical derivatives using finite differences.
2. Apply numerical integration techniques to approximate definite integrals.
3. Evaluate the efficiency of different numerical integration methods.
4. Solve ODEs using Taylor's series, Picard's approximation, and Euler's method.

2.1	Numerical Differentiation: First and Second-Order Derivatives	**[4L]**
2.2	General Integration Formula	**[1L]**
2.3	Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule	**[4L]**
2.4	Solution of Ordinary Differential Equations by Taylor's series method, Picard's approximation method, Euler's Method, Modified Euler's method, R-K Method (2^{nd} and 4^{th}).	**[6L]**

References:

1. James I. Buchanan, Peter R. Turner: Numerical Methods and Analysis, Mc Graw Hill Book Co., London., 1992.
2. S. S. Sastry: Introductory methods of Numerical Analysis, Prentice-Hall of India Pvt. Ltd.; 5/e.
3. Kaiser A. Kunz: Numerical Analysis, Mc Graw Hill Book Co., London.,2011.
4. Goel, Mittal: Numerical Analysis, Pragati Prakashan, Meerut.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Develop a thorough understanding of least squares curve fitting techniques, including fitting straight lines, multiple linear regression, and nonlinear models using polynomials and sums of exponentials.	X	X	X			
Learn the principles and applications of numerical differentiation, focusing on the calculation of first and second-order derivatives.	X	X	X	X		
Gain expertise in numerical integration methods, including the Trapezoidal Rule, Simpson's 1/3 Rule, and Simpson's 3/8 Rule, and understand their applications in solving real-world problems.	X	X	X	X		
Apply various numerical methods for solving ordinary differential equations, including Taylor's series, Picard's approximation, Euler's method, Modified Euler's method, and the Runge-Kutta (2nd and 4th order) methods.	X	X	X		X	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total Marks
I	10%	-	50%	-	40%	-	100%
II	10%	-	50%	-	40%	-	100%

S.Y.B.Sc. (Mathematics) Semester-IV

COURSE TITLE: MAJOR LAB COURSE

COURSE CODE: MHMJ-S4PR8-2CR25 [Credit- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Demonstrate Mathematical skills. 2. Correlate their Mathematical theory concepts through practical.

PRACTICAL Major MHMJ-S4PR8-2CR25 (Lab Course - VIII)	
1	Lagrange 's Interpolation Formula
2	Newton's Divided Difference Interpolation Formula
3	1st and 2nd order derivatives based on Newton's forward difference interpolation formula
4	1st and 2nd order derivatives based on Newton's backward difference interpolation formula
5	Numerical Integration: Trapezoidal Rule
6	Numerical Integration: Simpson's I/3-Rule, Simpson's 3/8-Rule
7	Solution of ordinary Differential Equations by Taylor's series method
8	Solution of Ordinary Differential Equations by Picard's approximation method and Euler's method

S.Y.B.Sc. (Mathematics) Semester-IV

Major Course- IX

COURSE TITLE: Multivariate Integral Calculus

COURSE CODE: MHMJ-S4P9-2CR25 [CREDITS - 02]

Course learning outcome		
At the end of this course, Students will be able to 1. Apply double integrals in polar coordinates for solving integration problems. 2. Evaluate triple integrals in Cartesian, cylindrical, and spherical coordinate systems. 3. Apply the Jacobian determinant to transform integrals into more convenient coordinate systems. 4. Utilize the Fundamental Theorem for Line Integrals to evaluate path-independent integrals in conservative vector fields. 5. Use Green's Theorem to convert line integrals into double integrals and compute areas.		
Module 1	**Double and Triple Integrals**	**[15L]**
Learning Objective 1. Evaluate double integrals over rectangular and non-rectangular regions. 2. Apply double integrals in polar coordinates for solving integration problems. 3. Compute triple integrals over parallelepipeds and other solid regions. 4. Evaluate triple integrals in cylindrical and spherical coordinate systems. 5. Apply the change of variables technique in double and triple integrals for simplification.		
Learning Outcomes: At the end of this module the learner will be able to 1. Explain the significance of double and triple integrals in calculus. 2. Evaluate double integrals over both rectangular and non-rectangular regions. 3. Apply triple integration to find volumes of different solid regions. 4. Compute volumes of three-dimensional regions using triple integrals. 5. Evaluate triple integrals in cylindrical and spherical coordinates. 6. Apply the Jacobian determinant for changing variables in multiple integrals.		
1.1	Double integration over rectangular and nonrectangular regions	**[3L]**
1.2	Double integrals in polar coordinates	**[3L]**
1.3	Triple integral over a parallelepiped and solid regions	**[2L]**
1.4	Volume by triple integral	**[3L]**
1.5	Triple integration in cylindrical and spherical coordinates	**[2L]**
1.6	Change of variables in double and triple integrals.	**[2L]**

Module 2	Line Integral	[15L]

Learning Objective

1. explore the applications of line integrals in calculating mass and work.
2. Understand the Fundamental Theorem for Line Integrals and its relation to conservative vector fields.
3. Understand and apply Stokes' Theorem in vector calculus.
4. explore the Gauss Divergence Theorem and its applications in fluid flow and electromagnetism.

Learning Outcomes:

At the end of this module the learner will be able to

1. Use line integrals to calculate physical quantities such as mass and work.
2. Apply the Fundamental Theorem for Line Integrals to evaluate path-independent integrals in conservative vector fields.
3. Use Green's Theorem to convert line integrals into double integrals and compute areas.
4. Apply Stokes' Theorem to relate surface integrals of curl fields to line integrals.
5. Use the Gauss Divergence Theorem to compute flux integrals

2.1	Line integrals – Introduction and Applications of line integrals: Mass and Work	**[3L]**
2.2	Fundamental theorem for line Integrals and Conservative vector fields	**[3L]**
2.3	Green's theorem and Area as a line integral.	**[2L]**
2.4	Surface integrals and integrals over parametrically defined surface.	**[3L]**
2.5	Stokes' theorem.	**[1L]**
2.6	Gauss divergence theorem.	**[3L]**

References:

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.) Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.
2. A.K. Sharma, Text book of Multiple Integrals, Discovery Publishing House, New Delhi, 2005.
3. David V. Widder: Advanced Calculus, PHI Learning Pvt. Ltd, New Delhi.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Apply double integrals in polar coordinates for solving integration problems.	X	X			X	
Evaluate triple integrals in Cartesian, cylindrical, and spherical coordinate systems.	X	X	X		X	
Apply the Jacobian determinant to transform integrals into more convenient coordinate systems.	X	X	X		X	
Utilize the Fundamental Theorem for Line Integrals to evaluate path-independent integrals in conservative vector fields.	X	X			X	
Use Green's Theorem to convert line integrals into double integrals and compute areas	X	X	X	X	X	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	10%	20%	40%	-	30%	-	100%
II	10%	20%	40%	-	30%	-	100%

S.Y.B.Sc. (Mathematics) Semester-IV

COURSE TITLE: MAJOR LAB COURSE-IX

COURSE CODE: MHMJ-S4PR9-2CR25 [Credit- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Demonstrate Mathematical skills. 2. Correlate their Mathematical theory concepts through practical.

PRACTICAL Major MHMJ-S4PR9-2CR25 (Lab Course - IX)	
1	Evaluation of Double Integrals Over Rectangular and Non-Rectangular Regions
2	Computation of Double Integrals in Polar Coordinates
3	Volume Calculation Using Triple Integrals in Cartesian, Cylindrical, and Spherical Coordinates
4	Change of Variables in Double and Triple Integrals Using the Jacobian Determinant
5	Evaluation of Line Integrals in Scalar and Vector Fields with Applications to Mass and Work
6	Verification of Green's Theorem and its Application in Computing Areas
7	Computation of Surface Integrals Over Parametrically Defined Surfaces
8	Verification and Application of Stokes' Theorem and Gauss Divergence Theorem in Vector Fields

S.Y.B.Sc. (Mathematics) Semester-IV

Major Course - X

COURSE TITLE: Linear Algebra-II

COURSE CODE: MHMJ-S4P10-4CR25 [CREDITS - 04]

Course learning outcome
At the end of this course, Students will be able to 1. Understand the concept of linear transformations as a tool to provide an elementary knowledge of Linear Algebra. 2. Prove basic results in linear algebra using appropriate proof-writing techniques such as properties of linearity, injectivity and surjectivity of functions, Properties of Inner product spaces. 3. Understand the proof of Rank-Nullity theorem, consequences of Rank-Nullity theorem, the space $L(U,V)$ and study the inverse of linear transformation. 4. Study the concept of composition of linear transformations and how matrix and linear transformations are associated with each other. 5. Understand some mathematical problems which can be solved by some advanced concepts in linear Algebra such as Least Square Approximation method, linear transformation of quadratic form and canonical forms or sum of squares using linear and orthogonal transformations respectively.

Module 1	Linear Transformation	[15L]
Learning Objective This module is intended to 1. Explore the concept of Linear transformations as a tool to provide an elementary knowledge of Linear Algebra. 2. Use of Linear map to compute range and kernel of a linear transformation.		
Learning Outcomes: At the end of this module the learner will be able to 1. Understand the concept of linear transformations as a tool to provide an elementary knowledge of Linear Algebra. 2. Apply the use of linear map to compute range and kernel of a linear transformation.		
1.1	Definition of Linear transformation, examples and results	**[4L]**
1.2	Operations and theorems on Linear transformation	**[5L]**
1.3	Range of a Linear transformation and examples	**[3L]**
1.4	Kernel of a Linear transformation and examples	**[3L]**

Module 2	Rank-Nullity Theorem	[15L]

Learning Objective

This module is intended to

1. Study the proof of Rank-Nullity theorem, consequences of Rank-Nullity theorem and the space $L(U,V)$ in the context of Linear transformation.
2. Introduce the concept of Inverse linear transformation with theory and its illustrations.

Learning Outcomes:

At the end of this module the learner will be able to

1. Prove basic results in linear algebra using appropriate proof-writing techniques such as properties of linearity, injectivity and surjectivity of functions.
2. Understand the proof of Rank-Nullity theorem, consequences of Rank-Nullity theorem, verification of Rank-Nullity theorem and the space $L(U,V)$ in the context of linear transformation.
3. Understand the concept of Inverse linear transformation with theory and its illustrations in detail.

2.1	Rank and Nullity of a Linear transformation	**[3L]**
2.2	Rank-Nullity theorem and examples of Rank-Nullity theorem, verification	**[3L]**
2.3	Consequences of Rank-Nullity Theorem	**[3L]**
2.4	The Space $L(U,V)$ and examples	**[2L]**
2.5	Inverse of a Linear transformation	**[4L]**

Module 3	Relation between Matrix and Linear transformations	[15L]

Learning objectives:

This module is intended to

1. Study the concept of composition of linear transformations, how to compute matrix for given linear transformation and vice-versa.
2. Discuss Rank-Nullity theorem of matrices and verification of Rank-Nullity theorem for matrices.

Learning outcome:

At the end of this module the learner will be able to

1. Study the concept of composition of linear transformations and how matrix and linear transformations are associated with each other.
2. Apply the concept of Rank-Nullity theorem of matrices along with verification of Rank-Nullity theorem for matrices.
3. Range, Rank, Kernel and Nullity using Rank-Nullity theorem for matrices.

3.1	Composition of Linear transformations	**[3L]**
3.2	Matrix Associated with a Linear map and examples	**[4L]**

3.3	Linear Map Associated with a Matrix and examples	**[4L]**
3.4	Rank and Nullity of matrices and verification of Rank-Nullity theorem for matrices	**[4L]**
Module 4	**Least Square approximations**	**[15L]**

Learning objectives:

This module is intended to

1. Identify some mathematical problems which can be solved by some advanced concepts in linear Algebra such as Least Square Approximation method.
2. Study and use of linear transformation to compute quadratic form and canonical forms or sum of the squares using linear transformations and orthogonal transformations respectively.

Learning outcome:

At the end of this module the learner will be able to

1. Compute some mathematical problems using Least Square Approximation method.
2. Compute linear transformation of quadratic form and Index and signature of the quadratic form.
3. Apply linear transformations and orthogonal transformations to compute Canonical forms or sum of the squares.

4.1	Least Square Approximations	**[3L]**
4.2	Approximation to an Inconsistent System	**[2L]**
4.3	Linear transformation of a quadratic form	**[2L]**
4.4	Canonical form or Sum of the squares form using Linear transformation	**[3L]**
4.5	Canonical form or Sum of the squares form using orthogonal transformation	**[3L]**
4.6	Index and signature of the quadratic form	**[2L]**

References:

1. V. Krishnamurthy, V. P. Mainra & J. L. Arora: An Introduction to Linear Algebra, Affiliated East-West Press Prv. Ltd., New Delhi. Edition 2019 (Reprint).
2. H. Anton and C Rorres: Elementary Linear Algebra with supplemental applications, International Student Verson, Wiley India Prv. Ltd, New Delhi, 11/e, 2023 (Reprint).
3. David C. Lay: Linear Algebra and its applications, pearson Education, Inc. and Dorling Kindersley Publishing inc, 3/e, 2003.
4. S. Kumaresan: Linear Algebra: A Geometric Approach, Prentice Hall of India, 2004.
5. G. Strang : Linear Algebra and its applications, Brooks/Cole, a part of Cengage Learning India Private Ltd., New Delhi, 4/e, 2008 (Reprint).
6. Serge Lang: Introduction to Linear Algebra, Springer, India. Addition-Wesley Publication Co. (Student Edition).
7. Balakrishnan: Linear Algebra, Tata-McGraw Hill Edition.
8. I. H. Sheth :Linear Algebra, Nirav Prakashan.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Prove basic results in linear algebra using appropriate proof-writing techniques such as properties of linearity, injectivity and subjectivity of functions, Properties of Inner product spaces.	X	X	X	X	X	
Understand the proof of Rank-Nullity theorem, consequences of Rank-Nullity theorem, the space $L(U,V)$ and study the inverse of linear transformation.	X	X	X	X	X	
Study the concept of composition of linear transformations and how matrix and linear transformations are associated with each other.	X	X	X	X		
Study the properties of inner product spaces and apply Gram-Schmidt's process to orthogonalize sets and use orthogonal and orthonormal bases to solve application problems.	X	X	X	X	X	
Understand some mathematical problems which can be solved by some advanced concepts in linear Algebra such as Least Square Approximation method, linear transformation of quadratic form and canonical forms or sum of squares using linear and orthogonal transformations respectively.	X	X	X	X	X	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	10%	30%	30%	-	30%	-	100%
II	10%	40%	30%	-	20%	-	100%
III	10%	30%	30%	-	30%	-	100%
IV	10%	20%	20%	-	50%	-	100%

S.Y.B.Sc. (Mathematics) Semester-IV

Minor Course- III

COURSE TITLE: Differential Calculus of Several Variables

COURSE CODE: MHMN-S4P3-2CR25 [CREDITS - 02]

Course learning outcome
1. Define and use fundamental concepts of Differential Calculus of multivariate variables including limits, continuity and differentiability along with Domain and Range, Graphs Level Curves. 2. Recognize mathematical formulae and methods of derivation of multivariable functions. 3. Evaluate partial derivatives and understand various applications of partial differentiation. 4. Apply and use the concept of an applications of partial differentiation to solve some practical problems involving partial differentiation to estimate maxima and minima of multivariable function. 5. To understand the method of Lagrange's multipliers and to find Taylor's and Maclaurin's series expansions of multivariable function.

Module 1	Limits, Continuity and Partial Derivatives	[15L]
Learning Objective This module is intended to 1. Provide students with fundamental concepts and techniques of multivariable calculus. 2. Study the limit of a Bivariate function and verify continuity of function for two variables. 3. Understand partial derivatives and establish the relationship between partial derivative of a function and the product of functions with its degree.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and use fundamental concepts of Differential Calculus of multivariate variables including limits, continuity and differentiability along with Domain and Range, Graphs Level Curves. 2. Recognize mathematical formulae and methods of derivation of multivariable functions. 3. Evaluate partial derivatives and examples based on it.		
1.1	Functions of Several Variables: Functions of two variables, Domain and Range, Graphs, Level Curves, Functions of Three or More Variables.	**[3L]**

1.2	Limits and Continuity of functions of two variables.	**[3L]**
1.3	Partial derivatives -Definition and examples, Mixed derivative theorem, Differentiability for function of two variables,	**[4L]**
1.4	Chain Rule, Implicit and Explicit functions, composite functions, Total Differential.	**[5L]**
Module 2	**Euler's theorem and Extreme Values**	**[15L]**

Learning Objective

This module is intended to

1. Understand partial derivatives and establish the relationship between partial derivative of a function and the product of functions with its degree.
2. Develop student understanding and skills for applications of partial differentiation to other areas.

Learning Outcomes:

At the end of this module the learner will be able to

1. Evaluate partial derivatives and understand various applications of partial differentiation.
2. Apply and use the concept of an applications of partial differentiation to solve some practical problems involving partial differentiation to estimate maxima and minima of multivariable function.
3. To understand the method of Lagrange's multipliers and to find Taylor's and Maclaurin's series expansions of multivariable function.

2.1	Homogeneous Functions, Euler's theorem.	**[3L]**
2.2	Necessary conditions for extreme values, Extreme values of functions of two variables for the functions of two variables.	**[4L]**
2.3	Method of Lagrange Undetermined Multipliers.	**[3L]**
2.4	Taylor's series and Maclaurin's series for the functions of two variables.	**[5L]**

References:

1. James Stewart, Multivariable Calculus, Brooks/Cole, 7/e, Cengage Learning, 2012.
2. T.M. Apostol, Calculus Vol. II, 2/e, John Wiley, New York, (1967).
3. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba, A. Weinstein, Springer Verlag (Indian Edition).
4. Shanti Narayan, R.K. Mittal, Differential Calculus, S. Chand and Company.
5. N. S. Piskunov, Differential and Integral Calculus, CBS Publishers and Distributors, India, 1969.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Define and use fundamental concepts of Differential Calculus of multivariate variables including limits, continuity and differentiability along with Domain and Range, Graphs Level Curves.	X	X	X		X	
Recognize mathematical formulae and methods of derivation of multivariable functions.	X	X	X		X	
Evaluate partial derivatives and understand various applications of partial differentiation.	X	X	X			
Apply and use the concept of an applications of partial differentiation to solve some practical problems involving partial differentiation to estimate maxima and minima of multivariable function.	X	X	X		X	
To understand the method of Lagrange's multipliers and to find Taylor's and Maclaurin's series expansions of multivariable function.	X	X	X		X	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	10%	20%	40%	-	30%	-	100%
II	10%	20%	40%	-	30%	-	100%

S.Y.B.Sc. (Mathematics) Semester-IV

COURSE TITLE: MINOR LAB COURSE

COURSE CODE: MHMN-S4PR3-2CR25 [Credit- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Demonstrate Mathematical skills. 2. Correlate their Mathematical theory concepts through practical.

PRACTICAL Major MHMJ-S4PR3-2CR25 (Minor Lab Course)	
1	Exploration of Functions of Two Variables: Domain, Range, Graphs, and Level Curves
2	Limits and Continuity of Functions of Two Variables: Analysis and Visualization
3	Calculation and Interpretation of Partial Derivatives, Mixed Derivative Theorem, and Differentiability for Functions of Two Variables
4	Application of Chain Rule, Implicit and Explicit Functions, and Total Differential in Multivariable Calculus
5	Analysis of Homogeneous Functions and Application of Euler's Theorem
6	Identification and Calculation of Extreme Values for Functions of Two Variables
7	Application of Lagrange's Method of Undetermined Multipliers in Optimization Problems
8	Expansion of Functions of Two Variables Using Taylor's and Maclaurin's Series

S.Y.B.Sc. (Mathematics) Semester -IV

Minor Course- III (Statistics)

COURSE TITLE: Probability functions & Discrete Probability distributions

COURSE CODE: STMN-S4P3-2CR25 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. Apply the idea of random variables and their expected values to study the behaviour of random phenomenon occurring in business, industry and daily life activities. 2. Demonstrate the skill of finding moment generating function of different probability distributions. 3. Demonstrate the skill of finding function of random variables and finding their measure of central tendency and measure of dispersion. 4. Apply Bernoulli and Binominal Probability Distribution and compute related probabilities, expected values, M.G.F, and limiting form. 5. Apply Poisson & Geometric Probability Distribution and compute related probabilities & expected values M.G.F, and limiting form. 6. Apply Negative Binominal & Hyper Geometric Probability Distribution and compute related probabilities, expected values, and limiting form.

Module 1	Random Variable, Probability functions and Moment generating function	[15L]

Learning Objective

1. Understand basic concept of random variables.
2. Know about Probability mass function (p.m.f), Probability density function (p.d.f) and Cumulative distribution function (c.d.f.) and Moments generating function (M.G.F).
3. Understand Bivariate random variable and properties.
4. Learn Mathematical Expectation & various types of Measure of central tendency, Measure of dispersion and Moments.

Learning Outcomes:

At the end of this module the learner will be able to

1. Distinguish between random and non-random experiments.
2. Identify Random variable and their mathematical expectation.
3. Interpret the expectation, variance and standard deviation of a discrete and continuous random variable.
4. Understand measure of central tendency and measure of dispersion related to random variables.
5. Obtain different moments of a probability distribution.

6. Understand joint, marginal and conditional p.m.f. and p.d.f .of two random variables. 7. Obtain moment generating function of a probability function.		
1.1	Probability: Basic concept, Theorem of probability (without proof), Numerical Examples based on probability. Random variables: Discrete and Continuous.	**[3L]**
1.2	Probability functions: Probability mass function (p.m.f), Probability density function (p.d.f) and Cumulative distribution function (c.d.f.) with properties. Mathematical expectation and standard deviation with properties.	**[3L]**
1.3	Bivariate Random Variables: Joint, marginal and conditional p.m.f. and p.d.f. of two random variables, Independence of two random variables, Bivariate Mathematical expectation and standard deviation with properties.	**[3L]**
1.4	Moments (of a random variable): Raw moments, Central moments with relationship. Moment generating function (m.g.f.) about origin and mean with properties and their relationship.	**[3L]**
1.5	Measure of Central tendency: Mean, Mode, Median, Harmonic mean and Geometric mean. Measure of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation.	**[3L]**
Module 2	**Discrete Probability distributions**	**[15L]**
Learning Objective 1. To apply standard discrete probability distribution to different situations. 2. To learn different properties of discrete probability distribution.		
Learning Outcomes: At the end of this module the learner will be able to 1. Know the applications of discrete probability distribution in different situations. 2. Understand some standard discrete probability distributions such as Binomial, Poisson, Geometric, Hyper geometric, Negative binomial, with real life situations.		
2.1	**Bernoulli distribution:** Definition, Mean, Variance, M.G.F. about origin and mean, β_1, β_2, γ_1 and γ_2, Additive property. **Binomial Distribution:** Definition, Condition for application of it, Uses, Mean, Variance, M.G.F. about origin and mean, β_1, β_2, γ_1 and γ_2, Additive property, Limiting form.	**[4L]**

2.2	**Poisson Distribution:** Definition, Condition for application of it, Uses, Mean, Variance, M.G.F. about origin and mean, β_1, β_2, γ_1 and γ_2, Additive property.	**[3L]**
2.3	**Geometric distribution:** Definition, Condition for application of it, Applications, Mean, Variance, M.G.F. about origin.	**[3L]**
2.4	**Hyper geometric distribution:** Definition, Condition for application of it, Applications, Mean, Variance.	**[2L]**
2.5	**Negative-Binomial distributions:** Definition, Condition for application of it, Applications, Mean, Variance, M.G.F. about origin.	**[3L]**

References:

1. S. C. Gupta, V. K. Kapoor: Fundamentals of Mathematical Statistics -12/e, Sultan Chand & Sons
2. Gupta S.P: Statistical Methods -34/e, S. Chand & Sons., New Delhi.
3. Goon A.M., Gupta M. K. and Dasgupta 8: Fundamentals of Statistics, Vol I., 8/e, The world press, Kolkata.
4. Neil Weiss: Introductory Statistics – 10/e, Pearson.
5. Roxy Peck, Chris Olsen, Jay L. Devore: Introduction to Statistics and Data Analysis – 5/e, Cengage Leaning

Mapping of COs and PSOs

Course Learning Outcomes	**Programme Outcomes**					
	1	**2**	**3**	**4**	**5**	**6**
Apply the idea of random variables and their expected values to study the behaviour of random phenomenon occurring in business, industry and daily life activities.	**X**			**X**	**X**	**X**
Demonstrate the skill of finding moment generating function of different probability distributions.			**X**		**X**	**X**
Demonstrate the skill of finding function of random variables and finding their measure of central tendency and measure of dispersion.	**X**					
Apply Bernoulli and Binominal Probability Distribution and compute related probabilities, expected values, M.G.F, and limiting form.		**X**	**X**		**X**	
Apply Poisson & Geometric Probability Distribution and compute related probabilities & expected values M.G.F, and limiting form.		**X**	**X**		**X**	
Apply Negative Binominal & Hyper Geometric Probability Distribution and compute related probabilities, expected values, and limiting form.		**X**	**X**		**X**	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total Marks
1	10%	30%	25%	-	35%	-	100%
2	15%	25%	35%	-	25%	-	100%

S.Y. B. Sc. (Mathematics) Semester-IV

Skill Enhancement Course-I

COURSE TITLE: Mathematical Modelling

COURSE CODE: MHSEC-S4P1-2CR25 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. Apply ODEs to model the growth of populations, the spread of infectious diseases, and the diffusion of technological innovations. 2. Develop and solve models based on the logistic law of population growth and other related biological phenomena. 3. Apply mathematical modelling techniques to simulate real-world processes such as the spread of technological innovations and infectious diseases. 4. Analyze complex systems, formulate differential equations to represent them, and interpret the results to solve real-world problems.

PRACTICAL SEC (MHSEC-S4P1-2CR25)	[60L]
1	Modelling Linear Growth Using First-Order Differential Equations
2	Modelling Linear Decay with First-Order Differential Equations
3	Mathematical Modelling for Growth of Science and Scientists
4	Non-Linear Growth and Decay Models Using Differential Equations
5	Modelling Population Growth Using the Logistic Law
6	Mathematical Modelling of the Spread of Technological Innovation
7	Modelling the Spread of Infectious Diseases Using Differential Equations
8	Simulating Exponential Growth and Decay in Biological Systems
9	Solving Simple Geometrical Problems Using Ordinary Differential Equations
10	Mathematical Modelling of Orthogonal Trajectories
11	Modelling the Paths of Curves and Their Tangents Using ODEs
12	Exploring Geometrical Properties of Families of Curves via First-Order ODEs
13	Solving Problems of Curvature and Radius Using Differential Equations
14	Orthogonal Trajectories in Heat Transfer Problems
15	Modelling Physical Systems Involving Geometrical Constraints Using ODEs
16	Using ODEs to Solve Problems in Engineering with Geometrical Relationships

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Apply ODEs to model the growth of populations, the spread of infectious diseases, and the diffusion of technological innovations.	X		X	X	X	
Develop and solve models based on the logistic law of population growth and other related biological phenomena.	X	X	X	X	X	
Apply mathematical modelling techniques to simulate real-world processes such as the spread of technological innovations and infectious diseases.	X	X	X	X	X	
Analyze complex systems, formulate differential equations to represent them, and interpret the results to solve real-world problems.	X	X	X	X	X	

References:

1. J. N. Kapoor: Mathematical Modelling, New Age international Publishers, New Delhi, 2/e, 2012.
2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley. New York, 10/e 2023.
3. J. K. Shama: Operations Research Theory & Applications, Trinity Press, 6/e, 2017.
4. G. Hadley: Linear Programming, Narosa Publishing House, New Delhi,1995.

S.Y. B. Sc. (Mathematics) Semester-IV

Skill Enhancement Course-II

COURSE TITLE: Vedic Mathematics and its Techniques - IV

COURSE CODE: MHSEC-S4P2-2CR25 [CREDITS - 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Develop conceptual knowledge of mathematical concepts by applying Vedic Mathematics techniques practically. 2. Enhance computational proficiency and think critically and correlate their mathematical concepts through practical. 3. Use Vedic Mathematics concept in various areas of Mathematics such as Triple trigonometry, Calculus etc. through practical approach. 4. Use applications of triples in Coordinate Geometry to find the length of a perpendicular from a point onto a line, equation of line and obtain complex numbers to find products, quotients and square roots of complex numbers. 5. Obtain Compound angles by using triple trigonometry to solve various trigonometric problems, inverse functions and the use of general triple as applications of triple trigonometry. 6. Understand the concept of divisibility by 2, 5, 10, 3, 9, 4, 8 and 11, prime numbers and composite numbers. 7. Apply technique of Vedic Mathematics in Calculus to obtain Partial Fractions, Integration by 'parts', derivate of product and derivative of Quotient and solve differential equations. 8. Solve simple equations, general solution of simultaneous equations and solve equation as a common factor, as the product of the independent terms as the sum of the denominators and as a combination or total by using various vedic sutras.
PRACTICAL (MHSEC-S4P2-2CR24) (Lab Course - SEC) [60L]
1. Problems based on applications of triples in Coordinate Geometry: Find the length of a perpendicular from a point onto a line. 2. Problems based on applications of triples in Coordinate Geometry: Find Equation of line. 3. Applications of triples to obtain complex numbers: products, quotients and square roots of complex numbers. 4. Calculate Compound angles by using triple trigonometry to solve various trigonometric problems. 5. Solve the trigonometric equations giving the answers as triples alongwith special case. 6. Obtain inverse functions and the use of general triple to prove examples based on triple trigonometry. 7. Examples based on divisibility by 2, 5, 10, 3, 9, 4, 8 and 11. 8. Examples based on divisibility by prime numbers and divisibility by composite numbers.

9. Problems based on applications of Vedic Mathematics in Calculus: Obtain Partial Fractions.
10. Problems based on applications of Vedic Mathematics in Calculus: Find Integration by 'parts'.
11. Problems based on applications of Vedic Mathematics in Calculus: Obtain derivate of product and derivative of Quotient.
12. Problems based on applications of Vedic Mathematics in Calculus: Solve differential equations using vertically and crosswise Vedic mathematics technique.
13. Solve simple equations, more than one x-term and general solution of simultaneous equations by using Paravartya Yojayet vedic sutra.
14. Solve Quadratic equations, one in ratio the other one zero and mergers by using transpose and apply.
15. Solve equations by using Samuccaya as a common factor and Samuccaya as the product of the independent terms.
16. Solve equations by using Samuccaya as the sum of the denominators and Samuccaya as a combination or total.

References:

1. Sri Bharatikrishna Tirthaji: Vedic Mathematics, 17/e, Published by Motilal Banarsidass, 1965.
2. Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
3. Williams K.R.: Discover Vedic Mathematics, Vedic Mathematics Research Group, 1984. (Revised edition)
4. Wiliams K.R. and M. Gaskell: The Cosmic Calculator, 1/e, Motilal Banarsidass, 2002. (Revised 2005)
5. Nicholas A. P., Williams, J. Pickles: Vertically and Crosswise, 2/e, Inspiration books, 1984.
6. Kenneth R. Williams: Vedic Mathematics- Teacher's manual. (Elementary and Advanced level), 1/e, Inspiration books, 2002, (Revised 2009).
7. Vandana Singhal: Vedic Mathematics for all ages-A beginner's guide, 2/e, Motilal Banarsidass Publishers, 2014.
8. The Essential of Vedic Mathematics, Rajeshkumar Thakur, Rupa publications, New Delhi, 2019.
9. Learn Vedic Speed Mathematics Systematically, Chaitnaya A. Patil 2018.
10. Enjoy Vedic Mathematics, S M Chauthaiwale, R Kollaru, The Art of Living, Bangalore.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Develop conceptual knowledge of mathematical concepts by applying Vedic Mathematics techniques practically.	X	X	X	X	X	
Enhance computational proficiency and think critically and correlate their mathematical concepts through practical.	X	X	X	X	X	
Use Vedic Mathematics concept in various areas of Mathematics such as Triple trigonometry, Calculus etc. through practical approach.	X	X	X	X	X	X
Use applications of triples in Coordinate Geometry to find the length of a perpendicular from a point onto a line, equation of line and obtain complex numbers to find products, quotients and square roots of complex numbers.	X	X	X	X	X	X
Solve the trigonometric equations giving the answers as triples along with special case.	X	X	X	X	X	
Understand the concept of divisibility by 2, 5, 10, 3, 9, 4, 8 and 11, prime numbers and composite numbers.	X	X	X	X	X	
Apply technique of Vedic Mathematics in Calculus to obtain Partial Fractions, Integration by 'parts', derivate of product and derivative of Quotient and solve differential equations.	X	X	X	X	X	X
Use of triples in Coordinate Geometry to find gradients and solving circle problems.	X	X	X	X	X	X

S.Y.B.Sc. (Mathematics) Semester-IV

Indian Knowledge System- IV

COURSE TITLE: Ancient Indian Mathematicians

COURSE CODE: MHIKS-S4P2-2CR25 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. Have the knowledge of contribution of great Ancient Indian Mathematicians. 2. Expand understanding of contributions of Ancient Indian mathematicians in various branches of Mathematics. 3. Discuss the rich heritage of mathematical temper of Ancient India. 4. Apply the knowledge of Indian Mathematics in solving day to day problems in an easier way. 5. Appreciate the Mathematical advancements of Ancient Indian Mathematicians.

Module 1	Contribution of Indian Mathematicians (In light of Arithmetic and Algebra)	[15L]
Learning Objective This module is intended to 1. Make the present generations aware about contributions of great Indian Mathematicians to the world. 2. Familiarize the students to ancient Indian Mathematicians and stimulate an interest for their contributions in the field of Mathematics. 3. Foster the love for Mathematics by creating a positive attitude through the work of Ancient Indian Mathematicians.		
Learning Outcomes: At the end of this module the learner will be able to 1. Have the knowledge of Indian Mathematicians and their contributions to the society and the world. 2. Discuss the rich heritage of knowledge about Indian Mathematicians. 3. Expand understanding of contributions of Ancient Indian mathematicians in various branches of Mathematics.		
1.1	Aryabhatta I and II	**[3L]**
1.2	Brahmagupta	**[3L]**
1.3	Mahaveeracharya	**[2L]**
1.5	Varahmihir	**[3L]**
1.6	Neelkanth Somayya	**[2L]**

1.7	Narayan Pandita	**[2L]**
1.1	Aryabhatta I and II	**[3L]**
Module 2	**Contribution of Indian Mathematicians (In light of Algebra, Geometry and Trigonometry)**	**[15L]**

Learning Objective

Understand This module is intended to

1. Make the present generations aware about contributions of great Indian Mathematicians to the world.
2. Familiarize the students to ancient Indian Mathematicians and stimulate an interest for their contributions in the field of Mathematics.
3. Foster the love for Mathematics by creating a positive attitude through the work of Ancient Indian Mathematicians.

Learning Outcomes:

At the end of this module the learner will be able to

1. Have the knowledge of Indian Mathematicians and their contributions to the society and the world.
2. Discuss the rich heritage of knowledge about Indian Mathematicians.
3. Expand understanding of contributions of Ancient Indian mathematicians in various branches of Mathematics.

2.1	Bhaskaracharya I and II(In light of Algebra and Geometry)	**[3L]**
2.2	Madhavan	**[2L]**
2.3	Parmeshvaran	**[2L]**
2.4	Baudhayana	**[2L]**
2.5	Bharti Krishna Tirtha (In light of Arithmetic, Algebra and Geometry)	**[3L]**
2.6	Lilavati	**[3L]**

References:

1. Venugopal D. Heroor, The History of Mathematics and Mathematicians of India, Vidya Bharati, Bangalore, 2006.
2. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.
3. Beejganitam, Chokhambba Vidya Bhavan, Varanasi.
4. Leelavati, Chokhambba Vidya Bhavan, Varanasi.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Have the knowledge of contribution of great Ancient Indian Mathematicians.	X	X	X	X	X	
Expand understanding of contributions of Ancient Indian mathematicians in various branches of Mathematics.	X	X	X	X	X	
Discuss the rich heritage of mathematical temper of Ancient India.	X	X		X	X	
Apply the knowledge of Indian Mathematics in solving day to day problems in an easier way.	X	X	X	X	X	
Appreciate the Mathematical advancements of Ancient Indian Mathematicians.	X	X	X	X		X

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	30%	30%	20%	-	20%	-	100%
II	30%	20%	30%	-	20%	-	100%

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