Semester II

F.Y.B.Sc. (Mathematics) SEMESTER II

Major Course- III

COURSE TITLE: Matrix Theory

COURSE CODE: MHMJ-S2P1-3CR24 [CREDITS - 03]

Course learning outcome		
At the end of this course, Students will be able to 1. Understand the concept of matrices and types of matrices, operations on matrices. 2. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, compute rank of a matrix and inverse of matrix by elementary row operations and Quadratic form. 3. Find trace of matrix and its properties and solve the system of homogeneous and non-homogeneous linear equation by row-reduced echelon form. 4. Calculate eigenvalues and corresponding eigenvectors for a square matrix and apply Cayley- Hamilton theorem to find inverse of a matrix and understand method of diagonalization.		
Module 1	**Some special types and operations on matrices & Row reduced Echelon form**	**[15L]**
Learning Objective This module is intended to 1. Understand the use of some special types of matrices and to implement procedures of different properties of addition, subtraction, multiplication and scalar multiplication on matrices. 2. Study Row Elementary operations on matrices and to obtain inverse of matrix.		
Learning Outcomes: At the end of this module the learner will be able to 1. Understand the concept of matrices and some special types of matrices and operations on matrices. 2. Apply row reduced echelon form to find the inverse of a Matrix.		
1.1	Introduction of various types of Matrices, Definitions and illustrations.	[1L]
1.2	Operations on Matrices	[2L]
1.3	Properties of operations of Matrices	[2L]

1.4	Elementary row operations.	[3L]
1.5	Row-reduced Echelon form	[3L]
1.6	Inverse of matrix by Row–reduced Echelon form	[4L]
Module 2	**Rank of Matrix and Homogeneous & non-homogeneous system of linear equations**	[15L]

Learning Objective

This module is intended to

1. Understand how to compute Row rank of a matrix and Quadratic form.
2. Study trace of matrix with its properties and to solve the system of linear equation by Elementary row operations

Learning Outcomes:

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

1. Apply the concept of trace of matrix and its properties to solve the examples of Matrices.
2. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank and inverse of matrix by Elementary row operations and Quadratic form.

2.1	Row rank of a matrix	[3L]
2.2	Quadratic form	[4L]
2.3	Trace of matrix and its properties	[3L]
2.4	Solution of homogeneous and non-homogeneous system of linear equations using Row–reduced Echelon form.	[5L]
Module 3	**Eigen values and Eigen vectors**	**[15L]**

Learning objectives:

This module is intended to

1. Study the basic concepts of eigenvalues and corresponding eigenvectors for a square matrix and use of Cayley- Hamilton theorem to find inverse of a matrix.
2. Introduce to apply method of diagonalization.

Learning outcome:

After the successful completion of the module, the learner will be able to

1. Compute eigenvalues and corresponding eigenvectors for a square matrix
2. Understand the use of method to find Characteristic equation using determinant and minors of a matrix

3. Apply Cayley- Hamilton theorem and find inverse of a matrix using Cayley-Hamilton theorem. 4. Apply Method of diagonalization on matrix.		
3.1	Characteristic equation of a matrix	[2L]
3.2	Method to find Characteristic equation using determinant and minors of a matrix	[3L]
3.3	Eigen values and Eigen vectors of a matrix	[4L]
3.4	Cayley-Hamilton theorem and its application to find an inverse of a matrix	[3L]
3.5	Method of diagonalization.	[3L]

References:

1. Shanti Narayan: Text book of Matrices, 1/e, S. Chand and Co., New Delhi, Reprint 2020
2. James E. Gentle: Matrix Algebra, 2/e, Springer, 2017.
3. Suddhendu Biswas: Textbook of Matrix Algebra, 3/e, PHI Learning Private Limited, New Delhi, 2012.
4. H. K. Dass, H. C. Saxena, M. D. Raisinghania: Simplified course in Matrices, S. Chand and Co., New Delhi. Edition 1999.
5. H. Anton and C. Rorres: Elementary Linear Algebra, 10/e, Wiley-India Pvt. Ltd., New Delhi.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Understand the concept of matrices and types of matrices, operations on matrices.	X	X	X			
Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, compute rank of matrix and inverse of matrix by elementary row operations and Quadratic form.	X	X	X	X		
Find trace of matrix and its properties and solve the system of homogeneous and non-homogeneous linear equation by row-reduced echelon form.	X	X				
Calculate eigenvalues and corresponding eigenvectors for a square matrix and use of Cayley- Hamilton theorem and inverse of a matrix using Cayley-Hamilton theorem, Method of diagonalization.	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	05%	15%	40%	-	40%	-	100%
III	10%	20%	40%	-	30%	-	100%

F.Y.B.Sc. (MATHEMATICS) SEMESTER II

COURSE TITLE: LAB COURSE II

COURSE CODE: MHMJ-S2PR1-1CR24 [Credit- 01]

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 -I (MHMJ-S2PR1-1CR24) (Lab Course-I)	
1	Examples of operation on Matrix
2	Examples of the Row Echelon form and Row Reduced Echelon form of the matrix
3	Examples of finding Rank of matrix using Row Reduced Echelon form
4	Examples of finding Inverse of Matrix by using Row Reduced Echelon form
5	System of Homogeneous linear equations
6	System of Non-Homogeneous linear equations
7	Eigen vector of the Matrix
8	Verification of Cayley -Hamilton theorem and Inverse of Matrix by using Cayley -Hamilton theorem

F.Y.B.Sc. (Mathematics) SEMESTER II

Major Course- II

COURSE TITLE: Integral Calculus & ODE

COURSE CODE: MHMJ-S2P2-3CR24 [CREDITS - 03]

Course Learning Outcomes		
At the end of this course, students will be able to 1. Trace the curve of Cartesian and parametric equations. 2. Apply integral calculus to find length of a curve and intrinsic equations. 3. Solve linear differential equations of first order, exact equations, Bernoulli's equations, Lagrange's equation, Clairaut's equation 4. Solve linear differential equations with constant coefficients.		
Module 1	**Curve Tracing and Application of Integral Calculus**	**[15L]**
Learning objectives: The module is intended to 1. Develop the skill of tracing the curves. 2. Develop the skill to use the integral calculus to different problems.		
Learning outcomes: After the successful completion of the module, the learner will be able to 1. Trace the curve of Cartesian and parametric equations. 2. Apply integral calculus to find length of a curve and intrinsic equations.		
1.1	Curve Tracing: Equation of the form $y = f(x)$	[3L]
1.2	Curve Tracing: Equation of the form $y^2 = f(x)$	[3L]
1.3	Curve Tracing: Parametric equations.	[3L]
1.4	Application of Integral Calculus: Length of a Curve.	[3L]
1.5	Application of Integral Calculus: Intrinsic equation (except polar coordinates).	[3L]
Module 2	**Reduction formulae for integration**	**[15L]**
Learning Objective 1. To develop the skill of solving complex problems of integration using reduction formula.		

Learning Outcomes:

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

1. Able to derive the reduction formula of integration of various functions.

2.1	Reduction formulae for integration of $sin^n x, cos^n x$	[5L]
2.2	Reduction formulae for integration of $tan^n x, cot^n x, sec^n x, cosec^n x$	[5L]
2.3	Reduction formulae for integration $sin^p x cos^q x, x^m cosnx, x^m sinnx$	[5L]
Module 3	**Differential equations of first order and higher degree**	**[15L]**

Learning objectives:

This module is intended to

1. Give knowledge of methods to solve differential equations of first order and higher degree.

Learning outcome:

After the successful completion of the module, the learner will be able to

1. Solve linear differential equations of first order, exact equations, Bernoulli's equations, Lagrange's equation, Clairaut's equation
2. Solve linear differential equations with constant coefficients.

3.1	Differential equations of first order and higher degree: Solvable for x, y, p	[4L]
3.2	Lagrange's equation	[3L]
3.3	Clairaut's equation	[3L]
3.4	Solution of Linear Differential Equations with constant coefficients: Complimentary functions, Particular Integral, General Solution	[5L]

References:

1. Shanti Narayan and Dr. P.K. Mittal: Integral Calculus, 35/e, S. Chand and Co. New Delhi, 2022.
2. George A. Osborne: Differential and Integral Calculus, D. C. Heath & Co. Publishers, Chicago, Edition 1903.
3. Hari Kishan: Integral Calculus, Atlantic Publishers and Distributer(p) Ltd., Edition 2005.
4. Bansi Lal: Topics in Integral Calculus, 6/e, Firewall Media, 2006.
5. Joseph Edwards: Integral Calculus for Beginners, McMillan and Co., London., Edition 1896

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Trace the curve of Cartesian and parametric equations.		X	X		X	
Apply integral calculus to find length of a curve and intrinsic equations.	X		X			
Solve linear differential equations of first order, exact equations, Bernoulli's equations, Lagrange's equation, Clairaut's equation.	X		X		X	
Solve linear differential equations with constant coefficients.		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%	30%	30%	-	30%	-	100%
III	10%	30%	40%	-	20%	-	100%

F.Y.B.Sc. (MATHEMATICS) SEMESTER II

COURSE TITLE: LAB COURSE II

COURSE CODE: MHMJ-S2PR2-1CR24 [Credit- 01]

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 -II (MHMJ-S2PR2-1CR24) (Lab Course-II)	
1	Trace the Cartesian Curves
2	Trace the Parametric Curves
3	Length of the Cartesian Curves and Parametric Curves
4	Intrinsic equation of the Cartesian Curves and Parametric Curves
5	Solution of the various types of differential equations; e.g. solvable for x, y, p
6	Solution of Lagrange's equation and Clairaut's equation
7	Finding General solution of the Differential equation: e^{ax} ,$Sinax$, $Cosax$ and polynomial in terms of x
8	Finding General solution of the Differential equation: $x.V$ and $e^{ax}V$

F.Y.B.Sc. (Mathematics) SEMESTER II

Minor Course- II

COURSE TITLE: Integral Calculus and Matrices

COURSE CODE: MHMN-S2P2-2CR24 [CREDITS - 02]

Course learning outcome		
1. Able to derive the reduction formula of integration of various functions 2. Understand the concept of matrices and some special types of matrices and operations on matrices. 3. Apply row reduced echelon form to find the inverse of a Matrix.		
Module 1	**Reduction formulae for integration**	**[15L]**
Learning Objective 1. To develop the skill of solving complex problems of integration using reduction formula.		
Learning Outcomes: At the end of this module the learner will be able to 1. Derive the reduction formula of integration of various functions.		
1.1	Reduction formulae for integration of $sin^n x, cos^n x$	**[5L]**
1.2	Reduction formulae for integration of $tan^n x$, $cot^n x$, $sec^n x$, $cosec^n x$	**[5L]**
1.3	Reduction formulae for integration $sin^p x cos^q x$, $x^m cosnx$, $x^m sinnx$	**[5L]**
Module 2	**Some special types and operations on matrices & Row reduced Echelon form**	**[15L]**
Learning Objective This module is intended to 1. Understand the use of some special types of matrices and to implement procedures of different properties of addition, subtraction, multiplication and scalar multiplication on matrices. 2. Perform Row Elementary operations on matrices and to obtain inverse of matrix.		
Learning Outcomes: At the end of this module the learner will be able to 1. Understand the concept of matrices and some special types of matrices and operations on matrices. 2. Apply row reduced echelon form to find the inverse of a Matrix.		
2.1	Introduction of various types of Matrices, definitions and illustrations.	[2L]

2.2	Operations on Matrices	[2L]
2.3	Properties of operations of Matrices	[2L]
2.4	Elementary row operations.	[2L]
2.5	Row-reduced Echelon form	[3L]
2.6	Inverse of matrix by Row–reduced Echelon form	[4L]

References:

1. Hari Kishan: Differential Calculus, Atlantic Publishers and Distributer(p) Ltd., Edition 2007.
2. George A. Osborne: Differential and Integral Calculus, D. C. Heath & Co. Publishers, Chicago, Edition 1903.
3. Shanti Narayan and Dr. P.K. Mittal: Differential Calculus, 35/e, S. Chand and Co. New Delhi, 2022.
4. Shanti Narayan: Text book of Matrices, 1/e, S. Chand and Co., New Delhi, Reprint 2020.
5. James E. Gentle: Matrix Algebra, 2/e, Springer, 2017.
6. Suddhendu Biswas: Textbook of Matrix Algebra, 3/e, PHI Learning Private Limited, New Delhi, 2012.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Able to derive the reduction formula of integration of various functions	X	X	X		X	
Understand the concept of matrices and some special types of matrices and operations on matrices.	X	X	X		X	
Apply row reduced echelon form to find the inverse of a Matrix.	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%	25%	35%	-	30%	-	100%

F.Y.B.Sc. (MATHEMATICS) SEMESTER II

COURSE TITLE: MINOR LAB COURSE II

COURSE CODE: MHMN-S2PR1-2CR24 [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 Minor (MHMN-S2PR1-2CR24) (Lab Course - Minor)	
1	Examples of Reduction formulae for $\sin^{n} x, \cos^{n} x$.
2	Examples of Reduction formulae for $\tan^{n} x, \cot^{n} x$.
3	Examples of Reduction formulae for $\sec^{n} x, \operatorname{cosec}^{n} x$.
4	Examples of Reduction formulae for $\sin^{p} x \cos^{q} x, x^{m} \cos nx, x^{m} \sin nx$.
5	Examples of operations on Matrix
6	Examples of the Row Echelon form and Row Reduced Echelon form of the matrix
7	Examples of finding Rank of matrix using Row Reduced Echelon form
8	Examples of finding Inverse of Matrix by using Row Reduced Echelon form

F.Y.B.Sc. (Mathematics) SEMESTER II

Minor Course- I

COURSE TITLE: Correlation and Regression

COURSE CODE: STMN-S2P1-2CR24 [CREDITS - 02]

<table>
<tr><th colspan="3">Course learning outcome</th></tr>
<tr><td colspan="3">At the end of this course, Students will be able to
1. The student will demonstrate an understanding of the correlation of two variables
2. Discuss basic ideas of linear regression and correlation.
3. examine the degree and direction of the relationships between two variables
4. Calculate and interpret the correlation coefficient
5. The student will demonstrate an understanding of regression analysis for two variables
6. Calculate and interpret linear regression equations and predict the future values.
7. Understand and interpret coefficient of determination.</td></tr>
<tr><th>Module 1</th><th>Linear Correlation</th><th>[15L]</th></tr>
<tr><td colspan="3">Learning Objective
1. Interpret the nature of relationship between two variables.
2. Analyze the data and predict the future values using regression lines.
3. Understand applications of correlation theory in various fields, viz., agriculture, business, medical science, industry etc</td></tr>
<tr><td colspan="3">Learning Outcomes:
At the end of this module the learner will be able to
1. Describe how correlation is used to identify linear relationships between variables
2. Critically examine the degree and direction of the relationships between two variables</td></tr>
<tr><td>1.1</td><td>Bi-variate data Concept about Correlation, definition and Types of correlation</td><td>[2L]</td></tr>
<tr><td>1.2</td><td>Methods of obtain correlation coefficient
(i) Scatter diagram method (with merits and limitations).
(ii) Karl Pearson's product moment method (with merits and limitations)
(iii) Spearmen’s Rank Correlation method (with derivation, merits and limitations)</td><td>[3L]</td></tr>
</table>

1.3	Interpretation correlation coefficient	**[1L]**
1.4	Properties of correlation coefficient: $-1 \le r \le 1$ & change of origin & scale, etc.	**[3L]**
1.5	Numerical Problems of above topics	**[6L]**
Module 2	**Linear Regression**	**[15L]**

Learning Objective

1. Define the explanatory variable as the independent variable (predictor), and the response variable as the dependent variable (predicted).
2. Plot the explanatory variable (x) on the x-axis and the response variable (y) on the y-axis, and fit a linear regression equation y = ax + b
3. Understand applications of regression theory in various fields, viz., agriculture, business, medical science, industry etc

Learning Outcomes:

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

1. Knowing the difference about Correlation & Regression
2. Fitting regression lines by using minimum least square methods
3. Define correlation of determination.

2.1	Meaning of Linear Regression: Definition	**[1L]**
2.2	Fitting Regression lines by principal of least squares	**[3L]**
2.3	Regression coefficients and their properties	**[2L]**
2.4	Angle between two regression lines & interpretations	**[1L]**
2.5	Coefficients of determinations & interpretations	**[1L]**
2.6	Application of regression analyze in various field, Difference between correlation & regression	**[1L]**
2.7	Numerical problems	**[6L]**

References:

- A. M. Gun, M. K. Gupta & B. Dasgupta: Fundamentals of Statistics (Volume One) - World Press Private Ltd (1 August 2013)
- S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics – 12/e, Sultan Chand and Sons;
- Barbara Illowsky, Openstax, Susan Dean: Introductory Statistics - Open Stax Textbooks (23 March 2022)
- Neil Weiss: Introductory Statistics – 10/e, Pearson;
- Marvin E Johnson: Basic Statistics - Independently Published; Illustrated Edition. (11 July 2020)
- Prem S. Mann: Introductory Statistics – 10/e, John Wiley & Sons Inc.
- 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
The student will demonstrate an understanding of the correlation of two variables	X	X				
Discuss basic ideas of linear regression and correlation.	X	X				
examine the degree and direction of the relationships between two variables		X	X			
Calculate and interpret the correlation coefficient.	X	X	X			
The student will demonstrate an understanding of regression analysis for two variables by	X	X				
Calculate and interpret linear regression equation x on y and y on x and analyze the data and predict the future values.			X	X	X	
Understand and interpret coefficient of determination,	X	X				

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	15%	30%	40%	-	15%	-	100%
II	10%	40%	30%	-	20%	-	100%

F.Y.B.Sc. (MATHEMATICS) SEMESTER II

COURSE TITLE: MINOR LAB COURSE (Statistics)

COURSE CODE: STMN-S2PR1-2CR24 [Credit- 02]

Course Learning Outcomes	
After the successful completion of the Course, the learner will be able to: 1. Compute and interpret a correlation coefficient 2. Compute linear regression lines 3. Define and provide examples of dependent and independent variables in a study of a regression 4. Compute and interpret a coefficient of determination.	
PRACTICAL Minor (STP-ME-201) (Lab Course - Minor)	
1	Calculate of the correlation coefficient by Karl Pearson's' method for simple series
2	Calculate of the correlation coefficient by Karl Pearson's' method for d_x & d_y where $d_x = x - a$ & $d_y = y - b$.
3	Calculate of the correlation coefficient by Karl Pearson's' method for d_x & d_y where $d_x = \frac{x-a}{i}$ & $d_y = \frac{y-b}{j}$.
4	Calculate of the correlation coefficient by Karl Pearson's' method for bivariate frequency distribution
5	Calculate the correlation coefficient by Spearman's rank method
6	Calculate the regression coefficients for simple series
7	Fitting a regression line X on Y
8	Fitting a regression line Y on X
9	Predict the value of dependent variable by using independent variable
10	Calculate the coefficient of determination & interprets.
Minimum number of experiments: 8	

F.Y.B.Sc. (Mathematics) SEMESTER II

Multidisciplinary Course

COURSE TITLE: Matrices and Determinants

COURSE CODE: MHMDC-S2P1-4CR24 [CREDITS - 04]

<table>
<tr><th colspan="3">Course learning outcome</th></tr>
<tr><td colspan="3">After the successful completion of the Course, the learner will be able to:
1. Understand the concept of matrix and different types of matrices. Also understand conjugate and transpose of a matrix.
2. Understand concept of determinants, minors and cofactors. Also, able to find inverse of a matrix.
3. Understand special types of matrices and able to solve system of linear equations in three variables by Martin's Rule, Cramer's rule.
4. Understand characteristic equation, eigen values, eigen vectors. Able to apply, Cayley-Hamilton theorem to find the inverse of a matrix.</td></tr>
<tr><th>Module 1</th><th>Types of Matrices</th><th>[15L]</th></tr>
<tr><td colspan="3">Learning objectives:
The module is intended to
1. Learn the basics of Matrices and transpose & conjugate of matrix.</td></tr>
<tr><td colspan="3">Learning outcomes:
After the successful completion of the module, the learner will be able to
1. Understand the concept of matrix and different types of matrices. Also understand conjugate and transpose of a matrix.</td></tr>
<tr><td>1.1</td><td>Matrix, Types of Matrices, Operation on matrices</td><td>[5L]</td></tr>
<tr><td>1.2</td><td>Transpose of a matrix</td><td>[5L]</td></tr>
<tr><td>1.3</td><td>Conjugate of a matrix.</td><td>[5L]</td></tr>
<tr><th>Module 2</th><th>Determinants</th><th>[15L]</th></tr>
<tr><td colspan="3">Learning objectives:
This module is intended to
1. Give knowledge of determinants and their properties.
2. Develop skill to derive the inverse of a matrix.</td></tr>
</table>

Learning outcome: After the successful completion of the module, the learner will be able to 1. Understand concept of determinants, minors and cofactors. Also, able to find inverse of a matrix.		
2.1	Determinants, Properties of determinant, Minors, Cofactors.	[6L]
2.2	Adjoint of a matrix	[3L]
2.3	Inverse of a square matrix, Singular and Non-singular Matrices.	[6L]
Module 3	**Special types of Matrices**	**[15L]**
Learning objectives: This module is intended to 1. Give the understanding about special types of matrices. 2. Make students aware of methods to solve system of linear equations by matrix.		
Learning outcome: After the successful completion of the module, the learner will be able to 1. Understand special types of matrices and able to solve system of linear equations in three variables by Martin's Rule, Cramer's rule.		
3.1	Special types of Matrices: Symmetric and Skew Symmetric, Hermitian and skew Hermitian, Orthogonal, Unitary.	[5L]
3.2	Methods to solve system of linear equations in three variables: Martin's Rule	[5L]
3.3	Methods to solve system of linear equations in three variables: Cramer's rule.	[5L]
Module 4	**Eigen values and Eigen vectors**	**[15L]**
Learning objectives: This module is intended to 1. Give the knowledge of eigen values and vectors of matrix. 2. Develop the skill to find the inverse of a matrix using theorem.		
Learning outcome: After the successful completion of the module, the learner will be able to 1. Understand characteristic equation, eigen values, eigen vectors. Able to apply, Cayley-Hamilton theorem to find the inverse of a matrix.		
4.1	Characteristics equation of a matrix, Eigen values, Eigen vectors	[7L]
4.2	Cayley-Hamilton theorem and its application to find an inverse of a matrix.	[8L]

References:

1. Vasistha and Vasistha: Matrices, 18/e, Krishna Prakashan, 2008.
2. Serge Lang: Basic Mathematics, 1/e, Addison -Wesley Publishing Company, 1971.
3. Shanti Narayan: Text book of Matrices, 1/e, S. Chand and Co., New Delhi.
4. Shanti Narayan and P. K. Mittal: A textbook of Matrices, S. Chand, 1953.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Understand the concept of matrix and different types of matrices. Also understand conjugate and transpose of a matrix.	X					
Understand concept of determinants, minors and cofactors. Also, able to find inverse of a matrix.	X		X			
Understand special types of matrices and able to solve system of linear equations in three variables by Martin's Rule, Cramer's rule.	X		X			
Understand characteristic equation, eigen values, eigen vectors. Able to apply, Cayley-Hamilton theorem to find the inverse of a matrix.	X		X		X	

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	10%	30%	30%	-	30%	-	100%
II	05%	15%	40%	-	40%	-	100%
III	10%	20%	40%	-	30%	-	100%
IV	10%	20%	40%	-	30%	-	100%

F.Y.B.Sc. (Mathematics) SEMESTER II

Multidisciplinary Course

COURSE TITLE: Ordinary Differential Equations

COURSE CODE: MHMDC-S2P2-4CR24 [CREDITS - 04]

Course learning outcome		
After the successful completion of the Course, the learner will be able to: 1. Understand concept of differential equations and solve differential equation of first order. 2. Derive solution of differential equations by separable variable and homogeneous differential equations. 3. Understand and solve exact differential equation, linear differential equation and Bernoulli's equation. 4. Apply this knowledge to solve problems on Linear decay models, Models for growth of Science and Scientists.		
Module 1	**Differential equation of first order**	**[15L]**
Learning objectives: The module is intended to 1. Learn to solve First- Order Differential Equations		
Learning outcomes: After the successful completion of the module, the learner will be able to 1. Understand concept of differential equations and solve differential equation of first order		
1.1	Introduction of Differential Equation, Order and Degree of a differential equation	[5L]
1.2	Solution and constants of integration, Derivation (Formation) of a differential equation	[5L]
1.3	General solution, Particular solution.	[5L]
Module 2	**Solution of Differential equations**	**[15L]**
Learning objectives: This module is intended to 1. Learn to solve various types of Differential Equations		
Learning outcome: After the successful completion of the module, the learner will be able to 1. Derive solution of differential equations by separable variable and homogeneous differential equations.		
2.1	Differential equations of first order and first degree, Separable variable	[5L]
2.2	Homogeneous differential equations	[5L]
2.3	Differential equations reducible to Homogeneous form	[5L]

Module 3	**Exact differential equations**	**[15L]**
Learning objectives: This module is intended to 1. Learn to solve differential equations by certain techniques.		
Learning outcome: After the successful completion of the module, the learner will be able to 1. Solve exact differential equation, linear differential equation and Bernoulli's equation.		
3.1	Exact differential equations, Necessary and sufficient condition for exact differential equations	[5L]
3.2	Integrating factor, Linear differential equations	[5L]
3.3	Differential equations reducible to Linear form (Bernoulli's equation)	[5L]
Module 4	**Application of differential equations**	**[15L]**
Learning objectives: This module is intended to 1. Develop skill to solve problem of different discipline using differential equations.		
Learning outcome: After the successful completion of the module, the learner will be able to 1. Apply this knowledge to solve problems on Linear decay models, Models for growth of Science and Scientists.		
4.1	Application: Linear decay models	[7L]
4.2	Application: Linear decay models, Models for growth of Science and Scientists	[8L]

References:

1. D.A. Murray: Introductory Course in Differential Equations, Orient Longmans, Bombay, 11th Impression 2003.
2. B. S. Grewal: Higher Engineering Mathematics, 42/e, Khanna Publishers, New Delhi, 2012.
3. Zafar Ahasan: Differential Equations and their Applications, 2/e, PHI, New Delhi, 2009.

4. Hari Kishan: Differential Equations, Atlantic Publishers and Distributors, New Delhi, Edition 2006.
5. J. N. Kapoor: Mathematical Modelling, New Age International Publishers, New Delhi, Reprint 2023.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Understand concept of differential equations and solve differential equation of first order.	X	X				
Derive solution of differential equations by separable variable and homogeneous differential equations.		X	X			
Solve exact differential equation, linear differential equation and Bernoulli's equation.		X	X		X	
Apply this knowledge to solve problems on Linear decay models, Models for growth of Science and Scientists.		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	05%	15%	40%	-	40%	-	100%
III	10%	20%	40%	-	30%	-	100%
IV	10%	20%	40%	-	30%	-	100%

F.Y.B.Sc. (Mathematics) SEMESTER II

Multidisciplinary Course

COURSE TITLE: Descriptive Statistics-II

COURSE CODE: MHMDC-S2P3-4CR24 [CREDITS - 04]

<table>
<tr><th colspan="3">Course learning outcome</th></tr>
<tr><td colspan="3">At the end of this course, Students will be able to
1. Familiar with basic concepts of probability
2. Understand the difference between a discrete and a continuous random variable.
3. Know about probability mass functions (p.m.f), probability density functions (p.d.f) Cumulative distribution function (c.d.f.) and obtain probability functions.
4. Understand measure of central tendency and measure of dispersion related to random variables.
5. Distinguish between univariate and bivariate random variables;
6. Understand joint, marginal and conditional p.m.f. and p.d.f .of two random variables;
7. Distinguish different types of correlation
8. Calculate Karl Pearson's correlation coefficient & spearman's rank coefficient.
9. Understand the purpose of a linear regression equation;
10. Learn about importance of measures of association & understand different types of measures of association.
11. Calculate measures of association using different methods.</td></tr>
<tr><th>Module 1</th><th>Probability</th><th>[12L]</th></tr>
<tr><td colspan="3">Learning Objective
1. Understand axioms of probability and various theorems on probability;
2. Find the probabilities of various events;
3. Understand the concepts of conditional probability and independence of events;</td></tr>
<tr><td colspan="3">Learning Outcomes:
At the end of this module the learner will be able to
1. Use of probability to solve real life problem, social science problem, industrial problem and problem arise in science.</td></tr>
<tr><td>1.1</td><td>➢ Concepts in probability
➢ Some important terms: Random experiment, Sample space, Event, Favourable cases, Mutually exclusive events, Exhaustive events, Equally likely events, Independent events.
➢ Classical and statistical definition of probability,
➢ Axiomatic approach to probability,
➢ Theorem based on above topics (Without proof)</td><td>[08L]</td></tr>
</table>

<table>
<tr><td>1.2</td><td>➢ Conditional Probability Theorem based on above topics (Without proof)</td><td>[04L]</td></tr>
<tr><td>Module 2</td><td>Random Variables, Probability functions:</td><td>[12L]</td></tr>
<tr><td colspan="3">Learning Objective
1. Develop a clear understanding of random variables.
2. Learn to apply various probability functions to determine probabilities and distributions for different random variables.
3. Interpret expected values and variances of random variables.</td></tr>
<tr><td colspan="3">Learning Outcomes:
At the end of this module the learner will be able to
1. Define random variables and distinguish between discrete and continuous random variables.
2. Use probability mass functions (p.m.f), probability density functions (p.d.f) Cumulative distribution function (c.d.f.) to calculate and understand distribution characteristics.
3. Calculate the mean, variance, and standard deviation of random variables.</td></tr>
<tr><td>2.1</td><td>➢ Random variables: Discrete and Continuous,
➢ Probability functions: Probability mass function (p.m.f),
➢ Probability density function (p.d.f) and Cumulative distribution function (c.d.f.) with properties,</td><td>[08L]</td></tr>
<tr><td>2.2</td><td>➢ Mathematical expectation and Variance with properties.</td><td>[04L]</td></tr>
<tr><td>Module 3</td><td>Bivariate Random Variables, Probability functions:</td><td>[16L]</td></tr>
<tr><td colspan="3">Learning Objective
1. Develop an understanding of bivariate random variables.
2. Understand to derive marginal and conditional distributions from joint distributions.
3. Analyse the dependence or independence between two random variables.
4. Interpret expected values and variances of Bivariate random variables.</td></tr>
<tr><td colspan="3">Learning Outcomes:
At the end of this module the learner will be able to
1. Define bivariate random variables and distinguish between univariate and bivariate random variables.
2. distinguish between their joint, marginal, and conditional distributions.
3. Compute probabilities using joint probability mass functions and joint probability density functions.
4. Determine if two random variables are independent or dependent.
5. Calculate the mean, variance, and standard deviation of random variables.</td></tr>
<tr><td>3.1</td><td>➢ Bivariate Random Variables:
▪ Joint, marginal and conditional p.m.f. and p.d.f. of two random variables,
▪ Independence of two random variables,</td><td>[08L]</td></tr>
<tr><td>3.2</td><td>➢ Bivariate mathematical expectation and variance with properties,</td><td>[03L]</td></tr>
</table>

<table>
<tr><td>3.3</td><td>➢ Examples of above topics for only continuous random variables.</td><td>[05L]</td></tr>
<tr><td>Module 4</td><td>Linear Correlation, Linear Regression and Measures of association</td><td>[20L]</td></tr>
<tr><td colspan="3">Learning Objective
1. Give introduction & types of correlation
2. Interpret the nature of relationship between two variables
3. Find the correlation coefficient using different methods
4. Find regression line and interpret it.
5. Understand the concept of measures of association.</td></tr>
<tr><td colspan="3">Learning Outcomes:
At the end of this module the learner will be able to
1. Gain knowledge of basic concept of correlation.
2. Distinguish different types of correlation
3. Calculate Karl Pearson's correlation coefficient & spearman's rank coefficient.
4. Thoroughly understand and analyze the given problems with the regression line.
5. Distinguish different types of measures of association and interpretation.</td></tr>
<tr><td>4.1</td><td>➢ Linear Correlation:
▪ Meaning, Definition and Types of correlation,
▪ Methods of studying correlation:
(i) Scatter diagram method
(ii) Karl Pearson's product moment method
(iii)Spearman's Rank Correlation method (Without proof)
▪ Interpretation correlation coefficient,
▪ Properties (Without proof)</td><td>[08L]</td></tr>
<tr><td>4.2</td><td>➢ Linear Regression:
▪ Concept of linear regression,
▪ Regression coefficients and Regression lines and their properties (Without proof),
▪ Coefficient Determination and its interpretation,
▪ Utility of study of regression,</td><td>[08L]</td></tr>
<tr><td>4.3</td><td>➢ Measures of association
▪ Idea of notations and terminology for classification of attributes, Contingency table, Consistency of data,
▪ Types of association,
▪ Methods of measures of association (for two attributes):
▪ (i) Proportion method (ii) Method of Probability
(iii) Yule's Coefficient of association (with its characteristics) (iv) Coefficient of contingency,
▪ Comparison between measure of association and correlation.</td><td>[04L]</td></tr>
</table>

References:

1. A. M. Gun, M. K. Gupta & B. Dasgupta: Fundamentals of Statistics (Volume One) - World Press Private Ltd (1 August 2013)
2. Sheldon Ross: A First Course in Probability – 10/e, Pearson Education;
3. Seymour Lipschutz, Marc Lipson: Schaum's Outline of Probability – 3/e, McGraw Hill;
4. Barbara Illowsky, Openstax, Susan Dean: Introductory Statistics - Open Stax Textbooks (23 March 2022)
5. Neil Weiss: Introductory Statistics – 10/e, Pearson;
6. Marvin E Johnson: Basic Statistics - Independently Published; Illustrated Edition. (11 July 2020)
7. Prem S. Mann: Introductory Statistics – 10/e, John Wiley & Sons Inc.
8. Daren Starnes, Josh Tabor: The Practice of Statistics: For the Ap Exam – 6/e, W.H.Freeman & Co Ltd.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Familiar with basic concepts of probability	X	X				
Understand the difference between a discrete and a continuous random variable.	X	X				
Know about probability mass functions (p.m.f), probability density functions (p.d.f) Cumulative distribution function (c.d.f.) and obtain probability functions.	X	X	X	X		
Understand measure of central tendency and measure of dispersion related to random variables.	X	X				
Distinguish between univariate and bivariate random variables;	X	X				
Understand joint, marginal and conditional p.m.f. and p.d.f .of two random variables.		X	X			
Distinguish different types of correlation	X	X			X	X
Calculate Karl Pearson's correlation coefficient & spearman's rank coefficient.		X	X		X	
Understand the purpose of a linear regression equation		X		X	X	

Learn about importance of measures of association & understand different types of measures of association.	X	X			X	X
Calculate measures of association using different methods.		X			X	

Question Paper Template

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

F.Y. B. Sc. (Mathematics) SEMESTER II

Skill Enhancement Course

COURSE TITLE: Fundamentals of Vedic Mathematics - II

COURSE CODE: MHSEC-S2PR1-2CR24 [CREDITS - 02]

Course Learning Outcome	
After the successful completion of the Course, the learner will be able to: 1. Apply Vedic Mathematics techniques to perform rapid and accurate calculation practically. 2. Demonstrate computational skills in the government competitive examinations. 3. Correlate their mathematical concepts through practical. 4. Distinguish between squaring numbers ending in 5 and squaring numbers near number 50 and manage to simplify algebraic squaring. 5. Apply reverse squaring to find square root of number ending in 5 and manage to solve the square root of perfect square. 6. Identify cube and cube roots, understand and apply division by 9. 7. Understand the concept of division by using straight division.	
PRACTICAL (MHSEC-S2PR1-2CR24) (Lab Course - SEC)	**[60L]**
1	Problems based on applications in finding squaring of numbers ending in 5 by Ekadhikena Purvena Sutra and squaring of numbers ending in 1.
2	Problems based on applications in finding squaring of numbers ending in 4 and 6.
3	Calculation of Squaring by Yavdunam Tavadunikritya Varganca Yojyet sutra, squaring of numbers less than the base.
4	Calculation of squaring by Dwandvayoga sutra, squaring numbers nearest 50 and near base, sub-base.
5	Calculation of squares of Triple digit numbers and squares of four-digit numbers
6	Obtain square roots of perfect square by Vilokanam, general method of square roots.
7	Obtain cubes by Anurupeyana sutra and cubes of numbers close to the base by Yavadunam.
8	Obtain cube roots of exact cubes by Vilokanam sutra.
9	Problems based on Recurring decimals and fractions: Denominator Ending in 9, Proportionality and longer numbers.
10	Problems based on Recurring decimals and fractions: Denominators ending in 1, 2, 3, 4.
11	Problems based on Recurring decimals and fractions: Denominators ending in 6, 7, 8.
12	Examples based on division by Nikhilam sutra and straight divison.
13	Examples based on division by Paravartya sutra and divison by double digit numbers by Dhvajanka.
14	Examples based on division of special cases with alternate remainder by Sankalana Vyavakalanabhyam.

15	Obtain square root of any random number upto many decimal places.
16	Calculate factors of general second-degree equation by Lopsthapanabhayam Sutra.

References:

1. Sri Bharatikrishna Tirthaji: Vedic Mathematics, Published by Motilal Banarsidass, 1965.
2. Williams K.R.: Discover Vedic Mathematics, Vedic Mathematics Research Group, 1984.
3. Wiliams K.R. and M. Gaskell: The Cosmic Calculator, Motilal Banarsidass, 2002.
4. Nicholas A.P., Williams, J. Pickles: Vertically and Crosswise, Inspiration books, 1984.
5. Kenneth R. Williams: Vedic Mathematics- Teacher's manual. (Elementary and Advanced level), Inspiration books, 2009.
6. Vandana Singhal: Vedic Mathematics for all ages-A beginner's guide, Motilal Banarsidass Publishers, 2014.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Apply Vedic Mathematics techniques to perform rapid and accurate calculation practically.	X	X	X			
Demonstrate computational skills in the government competitive examinations.	X	X	X			
Correlate their mathematical concepts through practical.	X	X	X		X	
Distinguish between squaring numbers ending in 5 and squaring numbers near number 50 and manage to simplify algebraic squaring.	X	X	X	X		
Apply reverse squaring to find square root of number ending in 5 and manage to solve the square root of perfect square.	X	X	X	X	X	
Identify cube and cube roots, understand and apply division by 9 and denominator ending in 1,2,3,4,6,7,8,9.	X	X	X	X	X	
Understand the concept of division by using straight Division and division by double digit numbers.	X	X	X	X		

F.Y.B.Sc. (Mathematics) SEMESTER II

Skill Enhancement Course

COURSE TITLE: Coordinate Geometry- II

COURSE CODE: MHSEC-S2PR2-2CR24 [CREDITS - 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Analyse real-world situations using coordinate geometry techniques effectively, such as modelling orbits or designing structures. 2. Develop and enhanced mathematical skills with practical problems after studying coordinate geometry in detail. 3. Apply the concept of circle and conics along with some basic common results. 4. Understand the basic concept of circles and conics in terms of parametric representations and able to apply it practically. 5. Understand and apply concept of system of circles. 6. Understand the concept of radical axis of circles and orthogonal coaxial system.

PRACTICAL (MHSEC-S2PR2-2CR24) (Lab Course - SEC)	[60L]
1	Problems based on chord of contact of tangents and conjugate lines and conjugate points.
2	Obtain equation of chord in terms of its mid-point.
3	Obtain equation of pair of tangents.
4	Find parametric equation of Chord joining two points and circle
5	Find equation of Chord joining two points and parabola.
6	Obtain parametric equation of Chord joining two points and Ellipse.
7	Obtain parametric equation of Chord joining two points and Hyperbola..
8	Find the equation of the normal to the parabola at the point $(at^2,2at)$.
9	Find the equation of normal to the Ellipse at the point $(a\cos\theta, b\sin\theta)$.
10	Examples based on conjugate diameters of Ellipse and Eccentric angles of the Extremities of conjugate diameters.
11	Examples based on conjugate diameters of Hyperbola and Equi –conjugate diameters.
12	Examples based on rectangular Hyperbola, standard equation and parametric representation.
13	Examples based on two circles to cut orthogonally.
14	Obtain equation of radical axis of circles and radical centre.
15	Problems based on Coaxial system of circles and orthogonal coaxial system.
16	Problems based on Linear Asymptotes.

References:

1. S.L. Loney: Coordinate Geometry, 13/e, Arihant Prakashan, 2017.
2. P.Balasubrahmanyam, K.G.Subramanian & G.R. Venkataraman: Coordiante geometry of two and three dimensions, Tata Mc-graw Hill pub.co.Ltd, 1994.
3. Henry Burchard Fine & Henry Dallas Thompson: Coordinate Geometry, The Macmillan Comp., N.Y., Edition 1911.
4. P. R. Vittal: Analytical Geometry 2D & 3D, 1/e, Pearson, 2013.
5. S.K. Sharma: Introduction to Coordinate Geometry
6. R. S. Aggarwal: Coordinate Geometry, S. Chand Publishers.
7. Mishra Sanjay: Fundamentals of Mathematics- Coordinate Geometry, 2/e, Pearson, 2015.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Analyse real-world situations using coordinate geometry techniques effectively, such as modelling orbits or designing structures	X	X	X	X	X	
Develop and enhanced mathematical skills with practical problems after studying coordinate geometry in detail.	X	X	X	X	X	
Apply the concept of circle and conics along with some basic common results.	X	X	X		X	
Understand the basic concept of circles and conics in terms of parametric representations and able to apply it practically.	X	X	X	X	X	
Understand and apply concept of system of circles.	X	X	X		X	
Understand the concept of radical axis of circles and orthogonal coaxial system.	X	X	X		X	

F.Y.B.Sc. (Mathematics) SEMESTER II

Skill Enhancement Course

COURSE TITLE: Basic Mathematics-II

COURSE CODE: MHSEC-S2PR3-2CR24 [CREDITS - 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Promote problem-solving abilities, demonstrate real-life applications and enhance their employability in the academic field. 2. Study basic about mathematics to explore concepts and basic mathematics in terms of practical approach. 3. Develop and enhanced mathematical skills with practical problems after studying mathematical fundamental concepts. 4. Equip themselves with essential mathematical knowledge and skills. 5. Solve quadratic equations and simultaneous equations in two, three and more than three unknowns. 6. Understand concept of Arithmetic progression and solve Arithmetic means between two given quantities. 7. Obtain Geometric progression and Geometric means between given numbers a and b. 8. Understand Harmonical progression and obtain harmonic mean between a and b.

PRACTICAL (MHSEC-S2PR3-2CR24) (Lab Course - SEC)	[60L]
1	Solution of pure and affected quadratic equations and find out nature of roots.
2	Calculation of Symmetric expressions of roots of a quadratic equation.
3	Solution of simultaneous equations in two unknowns.
4	Solution of simultaneous equations in three and more than three unknowns.
5	Examples based relation between roots and coefficients cubic of a biquadratic equation.
6	Problems based on Carden's method of solving the cubic and roots of a cubic by inspection.
7	Problems based on Ferrari's method of solving a biquadratic equations.
8	Obtain Arithmetical progression, find the general term of a given arithmetical progression and the sum of finite number of quantities in A.P.
9	Problems based on to insert n arithmetic means between two given quantities.
10	Obtain Geometrical progression; find the nth term and the sum of nth terms of a G.P. progression.
11	Find the sum to infinity of a geometric progression whose common ratio is less than 1.
12	Obtain Geometric mean and find n geometric means between two given numbers a and b.

13	Obtain Harmonical progression and harmonic mean.
14	Problems based on to insert n harmonic means between a and b.
15	Obtain sum of first n natural numbers and sum of the squares of first n natural numbers.
16	Obtain sum of the cubes of first n natural numbers.

References:

1. Serge Lang: Basic Mathematics, 1/e, Addison -Wesley Publishing Company, 1971.
2. Behnke H. & at al: Fundamental of Mathematics-Volume-1, The MIT Press Cambridge. 1986. (Third Printing)
3. Sanjay Mishra: Fundamentals of Mathematics: Functions and Graphs, 2/e, Pearson, 2016.
4. Qazi Zameeruddin, V. K. Khanna and S.K. Bhambri: Business Mathematics, 2/e, Vikas Publishing House Pvt. Ltd., 2006.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Promote problem-solving abilities, demonstrate real-life applications and enhance their employability in the academic field	X	X	X	X	X	
Study basic about mathematics to explore concepts and basic mathematics in terms of practical approach	X	X	X		X	
Develop and enhanced mathematical skills with practical problems after studying mathematical fundamental concepts.	X	X	X	X	X	
Equip themselves with essential mathematical knowledge and skills.	X	X	X	X	X	
Solve quadratic equations and simultaneous equations in two, three and more than three unknowns.	X	X	X		X	
Understand concept of Arithmetic progression and solve Arithmetic means between two given quantities.	X	X	X		X	
Obtain Geometric progression and Geometric means between given numbers a and b.	X	X	X		X	
Understand Harmonical progression and obtain harmonic mean between a and b.	X	X	X		X	

***