SYLLABUS

FOR

B. Sc. Sem. V & VI

Program: B. Sc.

Course: Mathematics

From

Academic year

2026-27

Content

T.Y.B.Sc. (Mathematics) Semester-V

Major Course- CC - XI

COURSE NAME: Real Analysis-I

COURSE CODE: MHMJ-S5P11-2CR26 [CREDITS – 02]

Course learning outcome		
At the end of this course, Students will be able to 1. Understand and apply concepts of sets, functions, equivalence relations, and countability in discrete and infinite structures. 2. Apply algebraic and order properties of real numbers, including absolute value, supremum, and infimum, to solve inequalities and bounds. 3. Use the completeness property of $\mathbb{R}$ (least upper bound) to solve problems involving intervals and bounded sets. 4. Analyze sequences and subsequences, determine limits, and classify them as convergent, divergent, bounded, or monotone. 5. Perform operations on sequences, study lim sup and lim inf, and relate Cauchy sequences to convergence in $\mathbb{R}$.		
Module 1	**The Real Number System**	**[15L]**
Learning Objective 1. To develop a rigorous understanding of sets, functions, finite and infinite sets, equivalence relations, countability, and the algebraic and order properties of real numbers. 2. To understand absolute value and its geometric interpretation, the completeness of $\mathbb{R}$, the supremum property, and analyze different types of intervals in $\mathbb{R}$		
Learning Outcomes: At the end of this course, Students will be able to: 1. apply concepts of sets, functions, equivalence relations, countability, and finite/infinite sets in problem solving. 2. use algebraic and order properties of real numbers in proofs and inequalities, and interpret absolute value geometrically. 3. determine bounds, supremum, and infimum, apply the least upper bound property, and analyze intervals and completeness of $\mathbb{R}$.		
1.1	Sets and functions, finite and infinite sets, Equivalence Set and Countability	**[5L]**
1.2	The algebraic and order properties of $\mathbb{R}$, absolute value and the real line, the completeness properties of $\mathbb{R}$, application of supremum property and intervals	**[10L]**
Module 2	**Sequences of Real Numbers**	**[15L]**
Learning Objective 1. To introduce the concept of sequences and subsequences of real numbers. 2. To understand limits of sequences, convergence/divergence, bounded and monotone sequences, and perform algebraic operations.		

3. To explain lim sup, lim inf, and Cauchy sequences, and relate them to convergence in $\mathbb{R}$.		
Learning Outcomes: At the end of this module the learner will be able to 1. define sequences and subsequences and construct subsequences. 2. evaluate limits using the ε–N definition and determine convergence or divergence. 3. analyze boundedness and monotonicity, apply the Monotone Convergence Theorem, and perform operations on sequences. 4. compute lim sup and lim inf, identify Cauchy sequences, and relate them to convergence in $\mathbb{R}$.		
2.1	Sequence and sub sequence of real numbers, limit of a sequence, convergence and divergence of a sequence, Bounded sequences, Monotone sequences.	**[8L]**
2.2	Operation on convergent and Divergent sequences, Lim sup and Lim inf, Cauchy Sequence.	**[7L]**

References:

1. R. G. Bartle and D. R. Sherbert: Introduction to Real Analysis, 4/e, Wiley India Edition. New Delhi (2015).
2. R. R. Goldberg: Methods of Real Analysis, Oxford and IBH Publishing Co. (2020).
3. T. M Apostol: Mathematical Analysis, 2/e, Narosa Publishing House, India (1985).
4. W. Rudin: Principles of Mathematical Analysis, 3/e, McGraw-Hill, New York, (2017).
5. H. L. Royden and P.M. Fitzpatrick, Real Analysis, 4/e, Pearson (2010).

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Understand and apply concepts of sets, functions, equivalence relations, and countability in discrete and infinite structures.	X				X	
Apply algebraic and order properties of real numbers, including absolute value, supremum, and infimum, to solve inequalities and bounds.	X	X				X
Use the completeness property of $\mathbb{R}$ (least upper bound) to solve problems involving intervals and bounded sets.		X	X	X		X
Analyze sequences and subsequences, determine limits, and classify them as convergent, divergent, bounded, or monotone.	X	X			X	X
Perform operations on sequences, study lim sup and lim inf, and relate Cauchy sequences to convergence in $\mathbb{R}$.		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%	40%	30%	-	20%	-	100%
II	10%	50%	20%	-	20%	-	100%

T.Y.B.Sc. (Mathematics) Semester-V

COURSE NAME: LAB COURSE- IX

COURSE CODE: MHMJ-S5PR9-2CR25 [CREDITS- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. understand and classify finite, infinite, and countable sets, and analyze equivalence relations and real number properties. 2. apply concepts of absolute value, supremum, and infimum in solving problems on the real line. 3. study sequences and subsequences, and determine their convergence using boundedness and monotonicity. 4. evaluate advanced concepts such as limit superior, limit inferior, and Cauchy sequences to analyze convergence behavior.

PRACTICAL Major MHMJ-S5PR9-2CR25 (Lab Course - IX)	
1	Practical based on Finite and Infinite Sets; Countability of Sets.
2	Practical based on Equivalence Relations and Equivalence Classes.
3	Practical based on Algebraic and Order Properties of Real Numbers (ℝ).
4	Practical based on Absolute Value and Representation on the Real Line.
5	Practical based on n Supremum, Infimum and Completeness Property of ℝ.
6	Practical based on Sequences and Sub sequences of Real Numbers.
7	Practical based on Bounded and Monotone Sequences.
8	Practical based on Limit Superior, Limit Inferior and Cauchy Sequences.

T.Y.B.Sc. (Mathematics) Semester-V

Major Course- CC - XII

COURSE NAME: Introduction to Group Theory

COURSE CODE: MHMJ-S5P12-2CR26 [CREDITS – 02]

Course learning outcome		
At the end of this course, Students will be able to 1. understand and apply the definition and elementary properties of groups to identify groups, subgroups and cyclic groups. 2. determine the order of groups and elements and solve problems using basic results of group theory. 3. apply concepts of right and left cosets and important theorems such as Lagrange's, Euler's and Fermat's theorem to solve algebraic problems. 4. understand normal subgroups and quotient groups and generalize results to solve complex problems in Group theory.		
Module 1	**Fundamentals of Group Theory**	**[15L]**
Learning Objective 1. To understand the definition of a group, elementary properties of groups and examples of groups. 2. To study finite groups, the order of a group, subgroups, cyclic groups and the order of an element.		
Learning Outcomes: At the end of this module the learner will be able to 1. understand and apply the definition and elementary properties of groups to identify groups, subgroups and cyclic groups. 2. determine the order of groups and elements and solve problems using basic results of group theory.		
1.1	Definition of a Group along with their examples, results and theorems	**[3L]**
1.2	Elementary Properties of a Group	**[2L]**
1.3	Finite Groups and Order of a Group	**[2L]**
1.4	Subgroups with their examples and results	**[3L]**
1.5	Cyclic Groups and their examples and results	**[3L]**
1.6	Order of an element of a Group	**[2L]**
Module 2	**Introduction of some theorems on Group Theory**	**[15L]**
Learning Objective 1. Understand the foundational structure and types of rings. 2. Analyse ring operations and mappings through homomorphisms, ideals, and quotient constructions.		
Learning Outcomes: At the end of this module the learner will be able to 1. identify and construct examples of rings, integral domains, and fields, and		

verify their algebraic properties.

2. apply the concept of ring homomorphisms to determine kernels and images, and use ideals to form quotient rings.
3. demonstrate understanding of polynomial rings and field of quotients, and explain the role of Euclidean domains in divisibility theory.

2.1	Concepts of right and left Cosets, theorems and results based on Cosets	**[2L]**
2.2	Congruence Relation in a Group	**[2L]**
2.3	Lagrange's theorem and Euler's theorem	**[3L]**
2.4	Fermat's theorem	**[3L]**
2.5	Counting principle	**[1L]**
2.6	Normal Subgroups and Quotient Groups	**[4L]**

References:

1. I. N. Herstein, Topics in Algebra, 2/e, Wiley Eastern Limited, New Delhi, 2016.
2. P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul: Basic Abstract Algebra, 2/e, Cambridge University Press,1997 (Reprint).
3. Vijay K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, 5/e, Vikas Publishing House Pvt Limited, 1993.
4. Serge Lang, Algebra, (Graduate Text Book in Mathematics), 3/e, Springer Verlag, New York,2002.
5. N. S. Gopal Krishnan, University Algebra, 3/e, New Age International Private Ltd, New Delhi,2023.
6. Shanti Narayan, Text Book of Modern Abstract Algebra, 2/e, S. Chand and Co., New Delhi,1965 (Reprint).
7. I. H. Sheth, Abstract Algebra, 2/e, PHI, Delhi, 2009.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Understand and apply the definition and elementary properties of groups to identify groups, subgroups, and cyclic groups.	X	X	X		X	
Determine the order of groups and elements and solve problems using basic results of group theory.	X	X	X		X	
Apply concepts of right and left cosets and important theorems such as Lagrange's, Euler's and Fermat's theorem to solve algebraic problems.	X	X	X	X	X	
Understand normal subgroups and quotient groups and generalize results to solve complex problems in group theory.	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%	40%	40%	-	10%	-	100%
II	10%	40%	30%	-	20%	-	100%

T.Y.B.Sc. (Mathematics) Semester-V

COURSE NAME: LAB COURSE- X

COURSE CODE: MHMJ-S5PR10-2CR26 [CREDITS- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. apply mathematical theories and formulae to solve practical and computational problems. 2. correlate theoretical mathematical concepts with practical experiments and graphical interpretations. 3. analyze and interpret mathematical data using appropriate methods and tools. 4. develop logical reasoning and problem-solving skills through mathematical investigations and practical applications.

PRACTICAL Major MHMJ-S5PR10-2CR25 (Lab Course - X)	
1	Practical based on Group and the elementary properties of Group.
2	Practical based on special types of groups, cyclic group.
3	Practical based on Subgroup.
4	Practical based on Right and left Cosets.
5	Practical based on Lagrange's theorem.
6	Practical based on Euler's theorem and Fermat's theorem.
7	Practical based on Counting Principle.
8	Practical based on Normal Subgroups and Quotient Groups.

T.Y.B.Sc. (Mathematics) Semester-V

Major Course- CC- XIII

COURSE NAME: Fundamentals of Complex Analysis

COURSE CODE: MHMJ-S5P13-2CR26 [CREDITS – 02]

Course learning outcome
At the end of this course, Students will be able to: 1. Analyze complex functions, evaluate limits, continuity, differentiability, verify Cauchy–Riemann equations, and identify analytic and harmonic functions. 2. Study elementary complex functions (exponential, logarithmic, trigonometric, hyperbolic, and their inverses) and their properties and branches. 3. Evaluate contour integrals and apply Cauchy–Goursat theorem to compute integrals of analytic functions. 4. Apply Cauchy's Integral Formula and its consequences (Liouville's theorem, Fundamental Theorem of Algebra) to analyze analytic functions. 5. Use the Maximum Modulus Principle to study boundedness and behavior of analytic functions.
Module 1 | Analytic functions | [15L]
Learning Objective 1. To introduce the concept of functions of a complex variable and study their limits, continuity, and differentiability. 2. To develop understanding of Cauchy–Riemann equations and characterize analytic and harmonic functions. 3. To study elementary complex functions such as exponential, logarithmic, trigonometric, hyperbolic, inverse trigonometric, and inverse hyperbolic functions. 4. To analyze the properties, behavior, and applications of these functions in complex analysis.
Learning Outcomes: At the end of this module the learner will be able to 1. evaluate limits, continuity, and differentiability of complex functions and verify the Cauchy–Riemann equations to determine analyticity. 2. establish the relationship between analytic and harmonic functions and construct harmonic conjugates where applicable. 3. define and analyze elementary complex functions including exponential, logarithmic, trigonometric, hyperbolic, inverse trigonometric, and inverse hyperbolic functions with their principal values and properties.

4. apply theoretical concepts of analytic functions to solve computational and proof-based problems in complex analysis.		
1.1	Functions of Complex Variable, Limits, Continuity, Differentiability, Cauchy-Riemann equations, Analytic functions, Harmonic functions	**[8L]**
1.2	Elementary functions: Exponential, Logarithmic, Trigonometric, Hyperbolic, Inverse trigonometric, Inverse hyperbolic.	**[7L]**
Module 2	**Complex Integration**	**[15L]**
Learning Objective 1. To introduce contour integration and the concept of primitives in complex analysis. 2. To develop understanding of the Cauchy–Goursat theorem and its extension for analytic functions. 3. To study Cauchy's Integral Formula, its consequences, and the Maximum Modulus Principle.		
Learning Outcomes: At the end of this module the learner will be able to 1. evaluate contour integrals of complex functions and determine primitives where they exist. 2. apply the Cauchy–Goursat theorem and its extension to compute integrals of analytic functions over suitable contours. 3. use Cauchy's Integral Formula and its consequences to analyze analytic functions and apply the Maximum Modulus Principle to study their behavior.		
2.1	Introduction, Contour Integral, Primitives	**[3L]**
2.2	Cauchy-Goursat theorem, Extension of Cauchy-Goursat theorem	**[4L]**
2.3	Cauchy integral formula, Consequences of Cauchy integral formula, Concept of Maximum Moduli of functions	**[8L]**

References:

1. R. V. Churchill and J. W. Brown: Complex Variables and Applications, 8/e, McGraw Hill International Edition, 2009.
2. H. S. Kasana, Complex Variables Theory and Applications, 2/e, Phi Learning Pvt. Ltd.
3. L. V. Ahlfors: Complex Analysis. McGraw-Hill Book Company, 1979.
4. J. B. Conway: Functions of One complex variable Narosa Publishing, 2000.
5. H. A. Priestly: Introduction to Complex Analysis Claredon Press, Orford, 1990.
6. S. Ponnusamy: Foundations of Complex Analysis, Narosa Publishing House, 1997.
7. E. C. Titchmarsn: The Theory of Functions, Oxford University Press, London.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Analyze complex functions, evaluate limits, continuity, differentiability, verify Cauchy–Riemann equations, and identify analytic and harmonic functions.	X	X	X			X
Study elementary complex functions (exponential, logarithmic, trigonometric, hyperbolic, and their inverses) and their properties and branches.		X	X			X
Evaluate contour integrals and apply Cauchy–Goursat theorem to compute integrals of analytic functions.		X	X		X	X
Apply Cauchy's Integral Formula and its consequences (Liouville's theorem, Fundamental Theorem of Algebra) to analyze analytic functions.		X	X	X		X
Use the Maximum Modulus Principle to study boundedness and behavior of analytic functions.		X	X	X		X

Question Paper Template

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

T.Y.B.Sc. (Mathematics) Semester-V

COURSE NAME: LAB COURSE- XI

COURSE CODE: MHMJ-S5PR11-2CR26 [CREDITS- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. understand functions of complex variables, limits, continuity, and differentiability, and identify analytic functions using Cauchy-Riemann equations. 2. analyze harmonic functions and study properties of elementary, trigonometric, hyperbolic, and their inverse functions. 3. apply contour integration techniques and evaluate integrals using Cauchy-Goursat theorem and Cauchy Integral Formula. 4. interpret advanced concepts like Maximum Modulus Principle and develop analytical skills for solving complex variable problems.

PRACTICAL Major MHMJ-S5PR11-2CR26 (Lab Course - V)	
1	Practical based on Functions of Complex Variable, Limits, Continuity and Differentiability.
2	Practical based on Cauchy-Riemann Equations and Analytic Functions.
3	Practical based on Harmonic Functions and Their Properties.
4	Practical based on Elementary Functions (Exponential, Logarithmic, Trigonometric and Hyperbolic Functions).
5	Practical based on Inverse Trigonometric and Inverse Hyperbolic Functions.
6	Practical based on Contour Integrals and Primitives of Complex Functions.
7	Practical based on Cauchy-Goursat Theorem and Its Extension.
8	Practical based on Cauchy Integral Formula and Its Consequences.
9	Practical based on Maximum Modulus Principle of Analytic Functions.

T.Y.B.Sc. (Mathematics) Semester-V

Minor Course-IV

COURSE TITLE: Vector Calculus and Applications

COURSE CODE: MHMJ-S5P4-2CR26 [CREDITS – 02]

Course learning outcome
At the end of this course, Students will be able to 1. apply vector algebra to compute dot product, cross product, and triple products. 2. analyse scalar and vector functions using gradient, directional derivatives, divergence, and curl. 3. interpret the geometrical and physical significance of vector calculus concepts in mathematical and applied problems. 4. evaluate line, surface, and volume integrals of vector fields. 5. apply Green's Theorem, Stokes' Theorem, and Gauss Divergence Theorem to simplify and solve integra problems. 6. interpret the physical and geometrical meaning of vector integral theorems in practical applications.

Module 1	Vector Differential Calculus	[15L]
Learning Objective 1. To understand the fundamental concepts of vectors and operations such as scalar product, vector product and triple products. 2. To learn differentiation of scalar and vector functions including gradient, directional derivative, and normal derivative. 3. To understand vector field operations such as divergence and curl along with their geometrical and physical interpretations.		
Learning Outcomes: At the end of this module the learner will be able to 1. apply vector algebra to compute dot product, cross product, and triple products. 2. analyse scalar and vector functions using gradient, directional derivatives, divergence, and curl. 3. interpret the geometrical and physical significance of vector calculus concepts in mathematical and applied problems.		
1.1	Elementary concept of vectors.	**[1L]**
1.2	Scalar Product and vector product of vectors.	**[2L]**
1.3	Scalar triple product and vector triple product.	**[2L]**
1.4	Differentiation of vectors and Scalar and vector point functions.	**[2L]**
1.5	Gradient of a scalar function and Geometrical meaning of Gradient.	**[2L]**

1.6	Normal and Directional derivatives.	**[2L]**
1.7	Divergence of a Vector Function and physical Interpretation of Divergence.	**[2L]**
1.8	Curl, its properties and applications, physical meaning of Curl.	**[2L]**
Module 2	**Vector Integral Calculus**	**[15L]**

Learning Objective

1. To understand the concepts of line integrals, surface integrals, and volume integrals of vector fields.
2. To learn the fundamental theorems of vector calculus including Green's Theorem, Stokes' Theorem, and Gauss Divergence Theorem.
3. To develop the ability to apply these theorems to evaluate integrals and solve physical and geometrical problems.

Learning Outcomes:

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

1. evaluate line, surface, and volume integrals of vector fields.
2. apply Green's Theorem, Stokes' Theorem, and Gauss Divergence Theorem to simplify and solve integra problems.
3. interpret the physical and geometrical meaning of vector integral theorems in practical applications.

2.1	Line Integrals of Vector Fields and applications of Line Integrals	**[3L]**
2.2	Green's Theorem (For a Plane)	**[2L]**
2.3	Surface Integrals of vector fields	**[2L]**
2.4	Stoke's Theorem	**[3L]**
2.5	Volume Integrals	**[3L]**
2.6	Gauss theorem of Divergence	**[2L]**

References:

1. Shantinarayan, P. K. Mittal, A text book of Vector Calculus, 4/e, S.Chand and Co., New Delhi,1987.
2. Hari Kishan, Vector Algebra and Caculus,Atlantic Pub & Ditributors Private limited, New Delhi.
3. E. Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley, New York, 2011.
4. B.S. Grewal, Higher Engineering Mathematics, 142/e, Khanna Publishers, 2012.
5. H. K. Dass, Advanced Engineering Mathemaitcs,22/e, S.Chand and Company private limited, 2020.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Apply vector algebra to compute dot product, cross product, and triple products.	X	X	X		X	
Analyse scalar and vector functions using gradient, directional derivatives, divergence, and curl.	X	X	X	X	X	
Interpret the geometrical and physical significance of vector calculus concepts in mathematical and applied problems.	X	X	X	X	X	
Evaluate line, surface, and volume integrals of vector fields.	X	X	X	X	X	
Apply Green's Theorem, Stokes' Theorem, and Gauss Divergence Theorem to simplify and solve integra problems.	X	X	X	X	X	
Interpret the physical and geometrical meaning of vector integral theorems in practical applications.		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%	10%	40%	-	40%	-	100%
II	10%	-	50%	-	40%	-	100%

T.Y.B.Sc. (Mathematics) Semester-V

COURSE NAME: LAB COURSE- IV

COURSE CODE: MNMJ-S5PR4-2CR26 [CREDITS- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. apply mathematical theories and formulas to solve practical and computational problems. 2. correlate theoretical mathematical concepts with practical experiments and graphical interpretations. 3. analyses and interpret mathematical data using appropriate methods and tools. 4. develop logical reasoning and problem-solving skills through mathematical investigations and practical applications.

PRACTICAL Minor MHMN-S5PR4-2CR26 (Lab Course – IV)	
1	Practical based on the elementary concept of vectors, scalar product and vector product of vectors.
2	Practical based on scalar triple product, vector triple product and differentiation of vectors and scalar and vector point functions.
3	Practical based on Gradient, Normal and Directional derivatives.
4	Practical based on Divergence, curl and their properties.
5	Practical based on the line integral and surface integral.
6	Practical based on Green's Theorem.
7	Practical based on Stoke's Theorem.
8	Practical based on volume Integrals and Gauss's theorem of Divergence.

T.Y.B.Sc. (Mathematics) Semester-V

Minor Course- V

COURSE NAME: Laplace Transform

COURSE CODE: MHMN-S5P5-2CR26 [CREDITS – 02]

Course learning outcome		
At the end of this course, Students will be able to 1. introduce the concept, definition and properties of Laplace transforms. 2. compute the Laplace transforms of elementary functions. 3. apply Laplace transforms to differentiation and integration of functions. 4. study properties of Inverse Laplace transforms. 5. apply the partial fraction method to determine Inverse Laplace transforms and learn applications to differential equations. 6. study Laplace transforms of special functions such as Heaviside unit step function and unit impulse function.		
Module 1	**Fundamentals of Laplace Transform**	**[15L]**
Learning Objective 1. Identify the definition of the Laplace transform with suitable examples. 2. Identify Laplace transforms of elementary functions. 3. Understand the differentiation and integration of Laplace transforms.		
Learning Outcomes: At the end of this module the learner will be able to 1. introduce the concept and definitions of Laplace Transform. 2. compute Laplace transforms of elementary functions. 3. apply Laplace Transforms to differentiation and integration of functions.		
1.1	Definition of Laplace transform along with examples and results	**[2L]**
1.2	Existence condition for the Laplace transform	**[2L]**
1.3	Laplace Transforms of Elementary Functions	**[3L]**
1.4	Basic Properties of Laplace transforms	**[3L]**
1.5	Differentiation and Integration of Laplace Transforms	**[3L]**
1.6	Laplace Transforms of derivatives and integrals	**[2L]**
Module 2	**Inverse Laplace transforms and applications of Laplace transforms**	**[15L]**
Learning Objective		

1. Identify the concept of inverse Laplace transform.
2. Understand the partial fraction method for inverse Laplace transforms.
3. Understand Laplace transforms of special functions such as Heaviside unit step function and unit impulse function.

Learning Outcomes:

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

1. study properties of Inverse Laplace transforms.
2. apply the partial fraction method to determine Inverse Laplace transforms and applications to differential equations.
3. study Laplace transforms of special functions such as Heaviside unit step function and unit impulse function.

2.1	Definition of Inverse Laplace transforms and inverse Laplace transforms of elementary functions	**[2L]**
2.2	Properties of Inverse Laplace transforms	**[3L]**
2.3	Partial fraction method for Inverse Laplace transforms	**[2L]**
2.4	Applications to differential equations	**[3L]**
2.5	Convolution theorem and properties of Convolution theorem	**[3L]**
2.6	Laplace transform of some special functions-Heaviside's unit step functions, Unit Impulse function	**[2L]**

References:

1. Lokenath Debnath, Integral Transform and their applications, 3/e, CRC Press Taylor and Francis Group, 2015.
2. B. Davies: Integral Transforms and their applications, Springer - Verlag, 1978.
3. Baidyanath Patra, An Introduction to Integral Transforms, 1/e, CRC Press, Taylor Francis Group,2018. https://doi.org/10.1201/9780429503580
4. Poularikas, A. D., The Transforms and Applications, Hand Book, 2/e, CRC Press, 1999.
5. E. Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley, New York,2011.
6. Spiegel, M.R.: Theory and Problems of Laplace transforms, Schaum's series, 2011
7. Ian Sneddon: The use of Integral Transform,1/e, McGraw Hill, 1972.
8. A. R. Vasishta and R. K. Guptha, Integral Transforms, Krishna Publication Media,2016.
9. Boss M. L.: Mathematical Methods in Physical Sciences, John Wiley & Sons, 1983.
10. Andrews, L. G. & Shivamoggi B. K., Integral Transforms for Engineers,

PHI, 2003.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Introduce the concept, definition and properties of Laplace transforms.	X		X	X	X	
Compute the Laplace transforms of elementary functions.	X	X	X	X	X	
Apply Laplace transforms to differentiation and integration of functions.	X	X	X	X	X	
Study properties of Inverse Laplace transforms.	X	X	X	X	X	
Apply the partial fraction method to determine Inverse Laplace transforms and learn applications to differential equations.	X	X	X	X	X	
Study Laplace transforms of special functions such as Heaviside unit step function and the unit impulse function.	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%	20%	-	40%	-	100%
II	10%	30%	20%	-	40%	-	100%

T.Y.B.Sc. (Mathematics) Semester-V

COURSE NAME: LAB COURSE- V

COURSE CODE: MHMN-S5PR5-2CR26 [CREDITS- 02]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. apply mathematical theories and formulas to solve practical and computational problems. 2. correlate theoretical mathematical concepts with practical experiments and graphical interpretations. 3. analyses and interpret mathematical data using appropriate methods and tools. 4. develop logical reasoning and problem-solving skills through mathematical investigations and practical applications.

PRACTICAL Minor MHMN-S5PR5-2CR26 (Lab Course - V)	
1	Practical based on the Laplace transforms of elementary functions
2	Practical based on Properties of Laplace Transforms
3	Practical based on Differentiation and Integration of Laplace Transforms
4	Practical based on Laplace Transforms of Derivatives and Integrals
5	Practical based on Properties of Inverse Laplace Transforms
6	Practical based Inverse Laplace transforms by Partial fraction method
7	Practical based on the Convolution theorem and the properties of the Convolution theorem
8	Practical based on Applications of the Laplace transform to differential equations and Laplace transform of some special functions

T.Y.B.Sc. (Mathematics) Semester-V

Minor Course – IV (Statistics)

COURSE NAME: Continuous Probability distributions and Introduction to Sampling

COURSE CODE: STMN-S5PR4-2CR26 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. demonstrate the need of identifying the real-life situation to apply Normal and Exponential Distribution Probability Distributions and compute related probabilities & expected values. 2. apply the knowledge of Uniform and Gamma Probability Distributions for handling the real- life situations demanding computation of related probabilities and expected value. 3. apply the skill of drawing Simple Random Sample from the population and compute various estimates with their standard errors. 4. apply the skill of drawing Stratified and Systematic random sampling from the population and compute various estimates with their standard errors.

Module 1	Continuous Probability distributions	[15L]
Learning Objective 1. Understand the definitions and mathematical formulations of key continuous probability distributions. 2. Compute and interpret statistical measures (mean, variance, skewness, kurtosis) for various continuous distributions. 3. Derive moment-generating functions (MGFs) for different distributions and use them to find moments. 4. Apply these distributions to solve real-life problems in statistics, engineering, economics, and related fields.		
Learning Outcomes: At the end of this module the learner will be able to 1. define and explain the Normal, Exponential, Gamma, and Continuous Uniform distributions. 2. derive and calculate the mean, variance, and moment-generating function (MGF) for each distribution. 3. compute and interpret higher-order moments: β_1 (skewness measure), β_2 (kurtosis measure), γ_1 (skewness), and γ_2 (kurtosis) 4. select and apply the appropriate distribution model to solve theoretical and applied probability problems.		
1.1	• **Normal distribution:** Definition, Mean, Variance, M.G.F. about origin and mean, β_1, β_2, γ_1 and γ_2, Different	**[6L]**

	properties	
1.2	• **Exponential distribution:** Definition, Mean, Variance, M.G.F. about origin, β_1, β_2, γ_1 and γ_2	**[3L]**
1.3	• **Gamma distribution:** Definition, Mean, Variance, M.G.F. about origin, β_1, β_2, γ_1 and γ_2	**[3L]**
1.4	• **Continuous uniform distribution:** Definition, Mean, Variance, M.G.F. about origin, β_1, β_2, γ_1 and γ_2	**[3L]**
Module 2	**Introduction to sampling**	**[15L]**
Learning Objective 1. provide a fundamental understanding of sampling techniques. 2. learn Simple random, stratified random and systematic sampling along with methods to estimate population parameters and analyze sampling errors. 3. understanding the concepts involved in planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results.		
Learning Outcomes: At the end of this module the learner will be able to 1. understand the principal steps in sample survey, how to use random number tables, basic principle of sample survey, errors in sampling, complete enumeration versus sampling. 2. understanding of simple random sampling with and without replacement, procedure of selecting a sample and determination of sample size. 3. know the concept of stratified random sampling and systematic sampling and estimation of mean and variance.		
2.1	• **Terminology & Simple Random Sampling**: o Define terms: Population, Sample, Complete enumeration, Sampling, Sampling unit, Sampling frame, Sampling and non-sampling errors, population study and sample study o Advantages and limitations of sampling o Characteristics of an ideal sample o Random sampling	**[3L]**
2.2	• **Simple random sampling (SRS) also for attributes:** o Simple random sampling with replacement (SRSWR) and Simple random sampling without replacement (SRSWOR) o Method of Selection of sample o Mean and variance (without proof) o Advantages and limitations o Examples of above topics	**[6L]**
2.3	• **Stratified random sampling:** o Concept of stratified random sampling	**[4L]**

	○ Method of Selection of sample ○ Mean and variance (without proof) ○ Advantages and limitations ○ Examples of above topics	
2.4	• **Systematic random sampling:** ○ Concept of systematic random sampling ○ Method of Selection of sample ○ Advantages and limitations ○ Examples of above topics	**[2L]**

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 & 11, 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 arid Data Analysis – 5/e, Cengage Leaning
6. Cochran W.G.1977. Sampling Techniques. John Wiley.
7. Murthy M. N. 1977. Sampling Theory and Methods. 2/e. Statistical Publ. Soc., Calcutta.
8. Des Raj 1968.Sampling theory. TATA McGraw-Hill Publishing Company Ltd. New Delhi.
9. Deming W.E. 1950. Some Theory of Sampling. Dover Publications, Inc. New York.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Demonstrate the need of identifying the real-life situation to apply Normal and Exponential Distribution Probability Distributions and compute related probabilities & expected values.	X		X	X	X	
Apply the knowledge of Uniform and Gamma Probability Distributions for handling the real- life situations demanding computation of related probabilities and expected value.	X	X	X	X	X	
Apply the skill of drawing Simple Random Sample from the population and compute various estimates with their standard errors.	X	X	X	X	X	
Apply the skill of drawing Stratified and Systematic random sampling from the population and compute various estimates with their standard errors.	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%	35%	25%	-	30%	-	100%
II	25%	25%	30%	-	20%	-	100%

SEMESTER VI

COURSE NAME: Minor Lab Course IV (Statistics practical)

COURSE CODE: STME-S5PR4-2CRC26 Credit- 02

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. understand and apply the properties of continuous probability distributions such as Normal, Exponential, and Gamma distribution. 2. apply appropriate random sampling techniques for data collection and analysis.

PRACTICAL Minor STMN-S5PR4-2CR26 (Lab Course - IV)	
1	Examples of Normal distribution using area properties.
2	Test goodness of fit for the Normal Distribution with area method.
3	Test goodness of fit for the Normal Distribution with ordinate method.
4	Find parameter of Normal Distribution
5	Test goodness of fit for the Exponential distribution.
6	Examples of Gamma distribution.
7	Examples of Simple random sampling with replacement.
8	Examples of Simple random sampling without replacement.
9	Examples of Stratified random sampling.
10	Examples of Systemic random sampling.

Minimum number of experiments: 08

T.Y.B.Sc. (Mathematics) Semester-V
Minor Course – V (Statistics)
COURSE NAME: Testing of Hypothesis
COURSE CODE: STMN-S5PR5-2CR26 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. define and explain statistical terms and concepts such as parameter, statistic, hypothesis, types of errors, p-value, test statistic, and significance levels used in hypothesis testing. 2. apply the procedure of hypothesis testing to formulate null and alternative hypotheses, determine critical regions, and make statistical decisions. 3. conduct and interpret significance tests for attributes and variables, including tests for proportions, means, and standard deviations for large sample test. 4. perform and interpret chi-square tests for goodness of fit, independence of attributes, and population variance, including using Yate's correction when applicable. 5. apply t-tests for means, paired and unpaired data, correlation significance, and F-test for comparison of variances under given assumptions.

Module 1	Large sample tests:	[15L]

Learning Objective

1. Understand and define key statistical terms related to hypothesis testing.
2. Learn the systematic procedure of conducting a test of hypothesis.
3. Study and apply significance tests for proportions, means and standard deviations in population-based decision-making for large sample test.
4. Solve practical problems related to hypothesis testing for attributes and variables for large sample test.

Learning Outcomes:

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

1. define and explain core terms such as hypothesis, type I & II errors, p-value, test statistic, standard error, and significance levels.
2. describe and apply the step-by-step procedure for testing statistical hypotheses, including identifying null and alternative hypotheses, determining critical values, and interpreting results.
3. conduct and interpret significance tests for: Single proportions and difference of proportions (attributes), Single mean, difference of means, and difference of standard deviations (variables).
4. solve numerical problems and case studies involving both attribute and variable tests using correct statistical formulas and logic.

1.1	• **Terminology:** o Define terms: Parameter, Statistic, Sampling distribution of a statistic, Standard error, Hypothesis, Statistical hypothesis, Simple and composite hypothesis, Null and alternative hypothesis, Test of a statistical hypothesis, Type I and Type II errors, Power of a test, Level of significance, Rejection region, Critical value, Test statistic, Two-tailed and One-tailed test, Degrees of freedom, Concept of p value • Procedure for testing of hypothesis	**[6L]**
1.2	• **Significance tests for attributes:** (i) Test of significance for single proportion (ii) Test of significance for the difference of proportions • Problems of above topics	**[4L]**
1.3	• **Significance tests for variables:** (i) Test of significance for single mean (ii) Test of significance for the difference of means (iii) Test of significance for the difference of standard devotions • Problems of above topics	**[5L]**
Module 2	**Small sample tests**	**[15L]**

Learning Objective

1. Understand the theory, assumptions, and applications of the Chi-square test, including goodness of fit, independence of attributes with Yate's correction and variance testing for small sample.
2. Learn the concept, assumptions, and practical applications of the t-test for single mean, difference of means (independent and dependent samples), and significance of correlation coefficient.
3. Understand the F-test statistic, its assumptions, and its use in testing the equality of two population variances and develop problem-solving skills by applying these tests to real-world statistical data and interpreting the results.

Learning Outcomes:

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

1. explain the assumptions and applications of the Chi-square test, and perform tests for goodness of fit, independence of attributes, and population variance using the Chi-square variate and Yate's correction.
2. apply the t-test to test hypotheses involving a single mean, difference of means for independent and dependent samples, and assess the significance of correlation coefficients.
3. conduct the F-test to compare two population variances and interpret the outcomes correctly and solve numerical problems involving Chi-square, t-test, and F-test, demonstrating critical analysis of results.

2.1	• **Chi square test:** o Chi square variate, Assumptions of Chi square test o Applications: ▪ To test the goodness of fit ▪ To test the independence of attributes ▪ To test a specified value of the variance of the population o Yate's Correction o Problems of above topics	**[6L]**
2.2	• **t- Test:** o t- statistic, Assumptions of t - test o Applications: ▪ Test for single mean ▪ Test for difference of means: For independent samples and for dependent sample ▪ Test the significance of an observed sample correlation coefficient o Problems of above topics	**[6L]**
2.3	• **F- Test:** o F- statistic, Assumptions of F - test o Application: Test for equality of two population variances o Problems of above topics	**[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: Fundamentals of Statistics, Vol. I & 11, 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 arid Data Analysis – 5/e Cengage Leaning.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes					
	1	2	3	4	5	6
Define and explain statistical terms and concepts such as parameter, statistic, hypothesis, types of errors, p-value, test statistic, and significance levels used in hypothesis testing.	x					X
Apply the procedure of hypothesis testing to formulate null and alternative hypotheses, determine critical regions, and make statistical decisions.		x		x		
Conduct and interpret significance tests for attributes and variables, including tests for proportions, means, and standard deviations for large sample test.		x	x		x	
Perform and interpret chi-square tests for goodness of fit, independence of attributes, and population variance, including using Yate's correction when applicable.		x		x		
Apply t-tests for means, paired and unpaired data, correlation significance, and F-test for comparison of variances under given assumptions.		x	x		x	

Question Paper Template

Unit	Remembering/ Knowledge (1)	Understanding (2)	Applying (3)	Analysing (4)	Evaluating (5)	Creating (6)	Total marks
I	20%	60%	20%	-	-	-	100%
II	20%	60%	20%	-	-	-	100%

SEMESTER V

COURSE NAME: Statistics Minor Lab Course V

COURSE CODE: STME-S5PR5-2CRC26

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. apply the Chi-square (χ^2) test for analyzing categorical data and testing independence of attributes. 2. apply *t*-tests for analyzing sample means, differences between means, and correlation significance. 3. apply the F-test to compare population variances.

PRACTICAL V	STME-S5PR5-2CRC26	[60 Hr]

1	Examples of χ^2 test for independence of attributes of 2× 2 contengency table.
2	Examples of χ^2 test for independence of attributes.
3	Examples of χ^2 test for Population variance.
4	Examples of t test for single mean
5	Examples of t test for difference of means.
6	Examples of t test for independent samples and for dependent sample
7	Examples of t test the significance of an observed sample correlation coefficient.
8	Examples of F test for difference of variances.

Minimum number of experiments: 7