

THIRUVALLUVARUNIVERSITY
SERKKADU
VELLORE- 632115

M.Sc. Mathematics –2022-2023 onwards

Programme Objectives:

1. Develop the student with critical thinking and analytical skills.
2. Enhance the knowledge of students for pursuing higher studies.
3. Provide in-depth knowledge to design the mathematical models in real life problems.
4. Expertise the students to excel in their professional career.
5. Provide the students to understand the mathematical concepts visually.

Programme Educational Objectives:

1. Provide a strong foundation in pure and applied Mathematics.
2. Motivate the students to pursue higher studies.
3. Prepare the students to work effectively in a group or individually.
4. Enrich the student to follow the ethical and professional values to serve the community.
5. Encourage the student for lifelong learning.

Programme Specific Outcomes:

1. Understand the theoretical knowledge of Mathematical concepts.
2. Develop the problem-solving skills.
3. Collaborate with the multi-disciplinary areas.
4. Creatively applying the knowledge of Mathematics in selected real life situations.
5. Appreciate the emphasis given on teaching the mathematical concepts through counter examples.
6. Get the knowledge of inter-disciplinary approach of learning.
7. Develop the skill to solve problems which appear in the various examinations like CSIR-NET, SET, IAS, etc
8. Inculcate the creative and develop research level thinking in the field of pure and applied Mathematics.
9. Encourage to go for higher learning in research.
10. Understand the ethical values and human values to appreciate the cultural diversity and promote the social harmony.

Programme Outcomes:

1. Acquire in-depth knowledge of Mathematics both in theory and application.
2. Identify mathematical and computational methods in order to solve comprehensive problems.
3. Recognize the various specialized areas of advanced mathematics and its applications.
4. Analyze and interpret data to create and design new knowledge for complex problems.
5. Develop the mathematical models for the applications of mathematics in real life situations.
6. Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
7. Develop the skills to crack the various competitive examinations.
8. Ability to engage in life-long learning in the context of the rapid developments in the field.
9. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
10. Commitment to professional ethics and social responsibilities.

THIRUVALLUVARUNIVERSITY
MASTER OF SCIENCE
(With effect from 2022–2023)

The Course of Study and the Scheme of Examination

@Compulsory Courses don't change this category. Number of core papers & Practical may be changed

Sl. No.	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
SEMESTER I								
	Core		6	5	Algebra-I	25	75	100
			6	5	Real Analysis –I	25	75	100
			6	4	Ordinary Differential Equations	25	75	100
Internal Elective for same major students (Choose any one)								
	@ Core Elective	Paper-1	6	3	A. Probability Theory B. Mechanics C. Graph Theory	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	Paper-1	6	3	A. Basic Mathematics B. Mathematical Foundations C. Mathematical Modeling	25	75	100
			30	20				
SEMESTER II								
	Core		6	5	Algebra-II	25	75	100
			6	5	Real Analysis –II	25	75	100
			6	4	Partial Differential Equations	25	75	100
Internal Elective for same major students (Choose any one)								
	@ Core Elective	Paper-2	5	3	A. Mathematical Statistics B. Fuzzy Set Theory C. Difference Equations	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	Paper-2	5	3	A. Fundamentals of Insurance B. Numerical Methods C. Fundamentals of Business Statistics	25	75	100
	@ Compulsory Paper		2	2	Human Rights & Duties	25	75	100
			30	22				

Sl. No.	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks			
	Course Title					CIA	Uni. Exam	Total	
SEMESTER III									
	Core		6	6	Complex Analysis –I	25	75	100	
			6	5	Topology	25	75	100	
			6	5	Differential Geometry	25	75	100	
Internal Elective for same major students (Choose any one)									
	@ Core Elective	Paper-3	6	3	A. LaTeX B. Discrete Mathematics C. Operations Research	25	75	100	
External Elective for other major students (Inter/multi disciplinary papers)									
	@ Open Elective	Paper-3	6	3	A. Mathematical Biology B. Quantitative Techniques C. SCILAB	25	75	100	
	@MOOC Courses		-	2				100	
	@Field Study			2		100		100	
			30	26					
SEMESTER IV									
	Core		5	4	Complex Analysis –II	25	75	100	
				5	4	Fluid Dynamics	25	75	100
				5	5	Functional Analysis	25	75	100
	@ Core	Project Compulsory	5	5	Project with <i>viva voce</i>	100 (75 Project +25 viva)		100	
Internal Elective for same major students (Choose any one)									
	@Core Elective	Paper-4	5	3	A. Number Theory and Cryptography B. Advanced Numerical Analysis C. Calculus of Variations and Integral Equations	25	75	100	
External Elective for other major students (Inter/multi disciplinary papers)									
	@ Open Elective (Non-Major)	Paper-4	5	3	A. Mathematical Economics B. Entrepreneurial Development C. Programming in C++	25	75	100	
			30	24					
			120	92					

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : Algebra-I

Hours of Teaching:90 hrs

Course Objectives:

The objective of this course are to:

1. Study and develop the concept of group action and learn Sylow's theorem and its applications.
2. Introducing structure theorem on abelian group and studying its applications.
3. Get the knowledge on algebraic structure Modules and its properties
4. Understand canonical forms of linear transformations.
5. Demonstrate insight into Linear algebra with focus on properties of matrix of transformations.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Demonstrate ability to think group actions critically by Cayley's theorem and apply the Sylow's theorems to describe the structure of certain finite abelian groups
- CO2** Understand the concept of the internal and external direct product of groups. Also, apply the structure theorem on abelian groups to find the non-isomorphic abelian groups of certain orders.
- CO3** Check the irreducibility of given polynomial in the defined Field
- CO4** Know about Module and, difference between the Algebraic structures, Vector space and Module.
- CO5** Acquire the knowledge of the Linear transformation in canonical forms. Also, the matrix form of linear transformation and its properties.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	No	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Group Theory 18 hours

Another counting principle - class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, Only First proof)

Chapter 2: Sections 2.11 and 2.12

Unit – 2 Group Theory (Continuation) 18 hours

Direct products - Finite abelian groups

Chapter 2: Sections 2.13 and 2.14 (Only Theorem 2.14.1))

Unit – 3 Ring Theory 18 hours

Polynomial Rings – Polynomials over the Rational Field

Chapter 3: Sections 3.9 to 3.10

Unit – 4 Modules and Linear Transformations 18 hours

Modules – Linear Transformations: Nilpotent transformations - Jordan form - rational canonical form.

Chapter 4: Section 4.5

Chapter 6: Sections 6.5 to 6.7

Unit – 5 Linear Transformations 18 hours

Hermitian, unitary, normal transformations, real quadratic form.

Chapter 6: Sections 6.10 and 6.11

Text book:

I.N. Herstein, Topics in Algebra, 2nd Edition. Wiley. 1975

Reference Books:

1. D.S.Dummit and R.M.Foote. Abstract Algebra. Wiley 2003
2. M. Artin, Algebra, Prentice Hall of India, 1991
3. J.A. Gallian. Contemporary Abstract Algebra. 4th Edition. Narosa Publishing 2011
4. P.B.Battacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra(II Edition) Cambridge University Press, 1997.(Indian Edition)
5. I.S. Luther and I.B.S. Passi, Algebra, Vol.I – Groups(1996), Vol. II Rings, Narosa Publishing House, New Delhi, 1999.
6. L. Smith, Linear transformation: Example and Applications. In: Linear Algebra, Undergraduate texts in Mathematics, Springer, New york. NY, 1998.

E-Materials:

<https://nptel.ac.in/courses/111108098/>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	S	S
CO2	S	S	M	M	M	S	M	S	S	S
CO3	S	S	M	M	S	S	M	S	S	S
CO4	S	S	M	M	S	S	M	S	S	S
CO5	S	S	M	M	S	S	M	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : RealAnalysis– I

Hours of Teaching:90 hrs

Course Objectives:

The objectives of the course is to

1. Work comfortably with functions of bounded variation
2. Study the Riemann-Stieltjes Integration
3. Expertise the students to excel in integration under integral sign.
4. Get the knowledge about the convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.
5. Provide the students to understand uniform convergence and continuity of functions.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Understand the concept of functions of bounded variation.
- CO2** Acquires knowledge on Riemann Stieltjes integration and to solve its related problems.
- CO3** Work effectively in integration under integral sign.
- CO4** Provide a strong foundation in the study of the convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.
- CO5** Know about the convergence of sequences of functions.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 5 Sequence of Functions**18 hours**

Pointwise convergence of sequences of functions - Examples of sequences of real-valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter 9** : Sections 9.1 to 9.6, 9.8, 9.10, 9.11, 9.13

Text Book:

Tom M. Apostol: Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, (1997).

Reference Books:

1. R.G. Bartle, Real Analysis, (1976), John Wiley and Sons Inc.
2. W. Rudin, Principle of Mathematical Analysis (1976), McGraw Hill Company, New York.
3. S.C. Malik and Savita Arora, Mathematical Analysis (1991), Wiley Eastern Limited, New Delhi.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis (1991), Satya Prakashan, New Delhi.
5. A.L. Gupta and N.R. Gupta, Principle of Real Analysis (2003), Pearson Education.

E-Materials

<https://mathworld.wolfram.com/>

https://onlinecourses.nptel.ac.in/noc21_ma63/preview

<https://ocw.mit.edu/courses/mathematics/18-100a-introduction-to-analysis-fall-2012/>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	S	M
CO2	S	S	M	M	S	M	S	S	S	M
CO3	S	S	M	M	S	M	S	S	S	M
CO4	S	S	M	M	S	M	S	S	S	M
CO5	S	S	M	M	S	M	S	S	S	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core

Credit : 4

Paper code :

Name of the Paper : Ordinary Differential Equations

Hours of Teaching:90 hrs

Course Objectives:

The main objectives of this course are to:

1. Understand the theory and methods of Ordinary Differential Equations (ODEs).
2. Apply and solve ODEs applications from various emerging technologies.
3. Know about the concepts and solving methods of Second and n^{th} order linear differential equations.
4. Study the concepts and solving methods of differential equations with variable coefficients and regular singular point.
5. Examine the existence and uniqueness of solutions of differential equations.

Course Outcomes:

After successful completion of the course the student will be able to

- CO1** Analyze the methods of second order homogeneous and non-homogeneous equations.
- CO2** Apply and solve the higher order homogeneous and non-homogeneous equations.
- CO3** Define the methods to solve linear equations with variable coefficients.
- CO4** Discuss the linear equations with regular singular points.
- CO5** Construct the solutions for first order equations.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	No	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Linear Equations with Constant Coefficients 18 hours

Second order homogeneous equations - Initial value problems for second order - Linear dependence and independence - A formula for the Wronskian - The non - homogeneous equation of order two.

Chapter 2: Sections 1 to 6

Unit – 2 Linear Equations with Constant Coefficients (Continuation) 18 hours

Homogeneous equations of order n - Initial value problems for order n - equations with real constants - Non-homogeneous equations of order n - Annihilator method - Algebra of constant coefficient operators.

Chapter 2: Sections 7 to 12

Unit – 3 Linear Equations with Variable Coefficients 18 hours

Initial value problems - Existence and Uniqueness theorems - Solutions to solve a non-homogeneous equation – The Wronskian and linear independence - Reduction of the order of homogeneous equations - Homogeneous equation with analytic coefficients – The Legendre-Equation.

Chapter 3: Sections 1 to 8

Unit – 4 Linear Equations with Regular Singular Points 18 hours

Euler equation - Second order equations with regular singular points - general and exceptional cases - Bessel equation.

Chapter 4: Sections 1 to 4 and 6 to 8

Unit – 5 Existence and Uniqueness of Solutions to First Order Equations 18 hours

Equation with variables separated - Exact equations - The method of successive approximations - The Lipschitz condition - Convergence of the successive approximations.

Chapter 5: Sections 1 to 6

Text Book:

Earl A. Coddington, An introduction to ordinary differential equations (Indian Reprint), Prentice- Hall of India Ltd., New Delhi, 2009.

Reference Books:

1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and sons, New York, 1967.
2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974.
3. W.T.Reid, Ordinary differential equations, John Wiley and sons, New York, 1971.
4. M.D.Raisinghania, Advanced differential equations, S.Chand & Company Ltd.,New Delhi, 2001.
5. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.

E-Materials:

1. <https://nptel.ac.in/courses/111104031>
2. <https://nptel.ac.in/courses/122107037>
3. <https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/>
4. <https://nptel.ac.in/courses/111108081/>
5. <https://ocw.mit.edu/courses/mathematics/18-034-honors-differential-equations-spring-2009/syllabus/>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	M	L
CO2	S	S	M	L	S	M	S	S	M	M
CO3	S	S	M	S	M	S	M	M	M	S
CO4	S	S	M	M	M	S	M	M	M	S
CO5	S	S	M	L	S	S	S	S	M	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Probability Theory

Hours of Teaching:90 hrs

Course Objectives:

The main objectives of this course are to:

1. Study basic notions of experiments, events, probability, random variables and probability distributions.
2. Acquire knowledge on various parameters and measures of the probability distributions.
3. Educate the characteristic functions and its properties.
4. Inculcate the special types of discrete and continuous probability distributions.
5. Learn the strong theoretical background about the limit theorems and its consequences

Course Outcomes:

After successful completion of the course the student will be able to

- CO1** Analyze the basics of probability and random variables.
CO2 Understand to handle parameters of the distribution.
CO3 Define the properties and functionalities of characteristic functions.
CO4 Discuss the various special probability distributions.
CO5 Construct the solutions for real time applications using limits theorem.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	Yes
2	Yes	Yes	Yes	No	Yes	No
3	No	Yes	Yes	Yes	Yes	No
4	No	Yes	Yes	Yes	Yes	No
5	No	Yes	Yes	Yes	Yes	Yes

Unit – 1 Probability and Random Variables 18 hours

Random Experiments – Sample Space – Random Events – Probability Axioms – Conditional Probability – Mutual Exclusive Events – Independent Events – Addition and Product Theorems on Probability – Theorem of Total Probability – Baye’s Theorem – Random Variables – Probability Mass and Density Functions – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent Random Variables – Functions of Random Variables.

Chapter 1 : Sections 1.1 to 1.7

Chapter 2: Sections 2.1 to 2.9

Unit – 2 Parameters of the Distribution 18 hours

Mathematical Expectation – Moments – The Chebyshev Inequality – Absolute Moments – Order Parameters – Moments of Random Vectors – Regression of the First and Second Types.

Chapter 3 : Sections 3.1 to 3.8

Unit – 3 Characteristic Functions 18 hours

Properties of Characteristic Functions – Characteristic Functions and Moments – Semi-Invariants – Characteristic Function of the Sum of the Independent Random Variables – Determination of Distribution Function by the Characteristic Function – Characteristic Function of Multidimensional Random Vectors – Probability Generating Functions.

Chapter 4 : Sections 4.1 to 4.7

Unit – 4 Special Probability Distributions 18 hours

Discrete Probability Distributions: One Point – Two Point – Bernoulli Trials – Binomial – Poisson – Polya – Hypergeometric Distributions – Continuous Probability Distributions: Uniform – Normal – Gamma – Beta – Cauchy – Laplace Distributions.

Chapter 5 : Sections 5.1 to 5.10

Unit – 5 Limit Theorems 18 hours

Stochastic Convergence – Bernoulli Law of Large Numbers – Convergence of Sequence of Distribution Functions – Levy-Cramer Theorems – The de Moivre-Laplace Theorem – The Lindeberg-Levy Theorem – Lapunov Theorem.

Text Book:

M.Fisz, *Probability Theory and Mathematical Statistics*, 3rd Edition, John Wiley and Sons Inc., New York, 1963.

Reference Books:

1. R.B.Ash, *Real Analysis and Probability*, Academic Press, New York, 1972.
2. K.L.Chung, *A Course in Probability*, 2nd Edition, Academic Press, New York, 1974.
3. R.Durrett, *Probability: Theory and Examples*, 5th Edition, Cambridge University Press, New York, 2019.
4. V.K.Rohatgi and A.K.Md.Ehsanes Saleh, *An Introduction to Probability Theory and Mathematical Statistics*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1988.
5. B.R.Bhat, *Modern Probability Theory – An Introductory Textbook*, 4th Edition, New Age International Pvt.Ltd., New Delhi, 2014.

E-Materials:

1. <https://ocw.mit.edu/resources/res-6-012-introduction-to-probability-spring-2018/>
2. <https://www.coursera.org/learn/introductiontoprobability>
3. https://swayam.gov.in/nd1_noc20_ma18/preview
4. https://onlinecourses.nptel.ac.in/noc21_ma24/preview

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	M	M	M	M
CO2	S	S	S	S	M	S	M	M	S	M
CO3	S	S	S	S	M	M	M	S	M	M
CO4	S	S	M	M	S	M	M	S	S	S
CO5	S	S	M	S	M	M	M	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Mechanics

Hours of Teaching:90 hrs

Course Objectives:

The main objectives of this course are to:

1. Understand mechanical systems under generalized coordinate systems.
2. Apply mechanics techniques in virtual work.
3. Develop the student's ability to deal with Energy and momentum.
4. Look at the concept of Hamilton, Lagrange.
5. Discuss the Canonical Transformation.

Course Outcomes

After the successful completion of this course the students will be able to:

- CO1** Explain the basic concepts of mechanical systems under generalized coordinate systems.
- CO2** Identify the Lagrange's equations and its application.
- CO3** Derive the Hamilton Equation.
- CO4** Analyze the Hamilton's Principle and Hamilton-Jacobi Equation and separability.
- CO5** Discuss the Lagrange and Poisson brackets.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 Mechanical Systems 18 hours

The Mechanical system- Generalized coordinates- Constraints- Virtual work- Energy and Momentum.

Chapter 1: Sections 1.1 to 1.5

Unit – 2 Lagrange's Equations 18 hours

Derivation of Lagrange's equations- Examples - Integrals of motion.

Chapter 2: Sections 2.1 to 2.3

Unit – 3 Hamilton's Equations 18 hours

Hamilton's Principle - Hamilton's Equation - Other variational principle.

Chapter 4: Sections 4.1 to 4.3

Unit – 4 Hamilton-Jacobi Theory 18 hours

Hamilton Principal function - Hamilton-Jacobi Equation – Separability.

Chapter 5: Sections 5.1 to 5.3

Unit – 5 Canonical Transformation 18 hours

Differential forms and generating functions - Lagrange and Poisson brackets.

Chapter 6: Sections 6.1 and 6.3

Text Book:

D.T.Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.

Reference Books:

1. H.Goldstein, *Classical Mechanics*, (2nd Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffith, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co., New York, 1970.

E-Materials:

<https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/>

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	L	M	S	L	S	L
CO2	M	S	M	S	S	L	M	S	L	M
CO3	S	S	M	S	M	L	S	S	M	L
CO4	M	L	M	L	S	M	M	L	L	S
CO5	S	S	M	S	L	M	M	S	L	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Graph theory

Hours of Teaching: 90 hrs

Course Objectives:

The main objective of this course are to:

1. Formally study and develop the basic concepts of Graphs.
2. Familiar with the notion and properties of varied types of graphs.
3. Understand concepts that helps to model real life situations into graphs.
4. Formulate and prove central theorems about trees, matching, connectivity, coloring and planarity of graphs.
5. Learn the proving techniques that are existing in each and every section of the unit and, motivate to do research in various fields of Graph theory.

Course Outcomes

After the successful completion of this course the students will be able to:

- CO1** Grasp features and properties of various types of graphs.
- CO2** Demonstrate capacity of illustration for mathematical reasoning through analyzing, providing and explaining concepts of Eulerian circuits and Hamiltonicity in graphs.
- CO3** Understand the definitions and properties of matching and independent sets.
- CO4** Apply the concepts of graphs to model them in real life situations.
- CO5** Explicate the applications of planarity and colorability.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 Graphs, Subgraphs And Trees **18 hours**

Graphs - Graph Isomorphism - The Incidence and Adjacency Matrices - Subgraphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices- Cayley's formula- Application: The shortest path problem.

Chapter 1: Sections 1.1 to 1.8

Chapter 2: Sections 2.1 to 2.4

Unit – 2 Connectivity, Euler Tours and Hamilton Cycles **18 hours**

Connectivity - Blocks - Euler tours - Hamilton Cycles. Application: The travelling Salesman Problem.

Chapter 3: Sections 3.1 to 3.3

Chapter 4: Sections 4.1 to 4.2

Unit – 3 Matchings, Edge Colourings **18 hours**

Matchings - Matchings and Coverings in Bipartite Graphs –Perfect matchings- Edge Colourings: Edge Chromatic Number - Vizing's Theorem. Application: Optimal Assignment Problem.

Chapter 5: Sections 5.1 to 5.3, 5.5

Chapter 6: Sections 6.1 to 6.2

Unit – 4 Independent Sets And Cliques, Vertex Colourings **18 hours**

Independent sets - Ramsey's Theorem – Vertex Colourings: Chromatic Number - Brooks' Theorem – Hajos Conjecture- Chromoatic polynomial.

Chapter 7: Sections 7.1 to 7.2

Chapter 8: Sections 8.1 to 8.2, 8.4

Unit – 5 Planar Graphs **18 hours**

Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture- Directed graphs.

Chapter 9: Sections 9.1 to 9.6 and 10.1

Text Book:

J.A.Bondy and U.S.R. Murthy, *Graph Theory and Applications*, Macmillan, London, 1976.

Reference books:

1. Narsingh Deo, *Graph Theory with applications to engineering and computerscience*, Prentice Hall of India, New Delhi,2001
2. G.Chartrand and L.Lesniak, *Graphs and Digraphs*, Chapman and Hall, CRC, Fourth Edition, 2005
3. R.J. Wilson, *Introduction to Graph Theory*, Pearson Education, 4th Edition, 2004,Indian Print.
4. S. A. Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.
5. J. Clark and D.A. Holton , *A First look at Graph Theory*, Allied Publishers, NewDelhi, 1995.
6. A. Gibbons, *Algorithmic Graph Theory*, Cambridge University Press, Cambridge,1989.

E- Materials:

<https://nptel.ac.in/courses/111106050/>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	S	S
CO2	S	S	M	M	S	S	S	S	S	S
CO3	S	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type:OpenElective

Credit : 3

Paper code :

Name of the Paper : BasicMathematics

Hours of Teaching: 90 hrs

CourseObjectives:

The main objective of this course are to:

1. Studyexponentialandlogarithmicseries.
2. Understandaboutmatricesanditsapplications.
3. Formulateandsolvethethepartialdifferentialequations.
4. Discuss the properties of Laplace and inverse Laplace transformation.
5. Learnthe expansiontechniquesofFourierseries.

CourseOutcomes:

Aftersuccessfulcompletionofthecoursethe student willbeableto

- CO1** Evaluate the exponentialandlogarithmicseries.
CO2 Explainaboutmatricesanditsapplications.
CO3 Solvethethepartialdifferentialequations.
CO4 Solvethedifferentialequations using Laplacetransform.
CO5 Analysethethe techniques of Fourierseries.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	No	No	Yes	No
3	Yes	Yes	Yes	No	Yes	No
4	Yes	Yes	No	No	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Exponential and Logarithmic series 18 hours

Exponential series – Logarithmic series

Chapter 1: Section 1.1 – 1.2

Unit – 2 Matrices 18 hours

Determinant of a matrix – Characteristic equation of a matrix – Characteristic vectors of a matrix – Cayley-Hamilton Theorem – Inverse of a matrix.

Chapter 4: Section 4.1 – 4.5

Unit – 3 Partial Differential Equations 18 hours

Elimination of arbitrary constants – Elimination of arbitrary functions – Standard forms – Lagrange's Equations.

Chapter 9: Section 9.1 – 9.4

Unit – 4 Laplace transforms 18 hours

Properties of Laplace transform – Inverse Laplace transform – Partial Fractions.

Chapter 10: Section 10.1 – 10.3

Unit – 5 Fourier Series 18 hours

Properties of Integration – Odd and Even Functions – Half Range Fourier Series.

Chapter 11: Section 11.1 – 11.3

Text Book:

G. Britto Antony Xavier, V. Balaji, S. U. Vasantha Kumar, B. Govindan, Mathematical Sciences, Jayalakshmi Publications, 2-e, 2015.

Reference Books:

1. P. Balasubramaniam, K. G. Subramanian, Ancillary Mathematics, Volume – I, Tata McGraw Hill publishing company limited, New Delhi, 1996.
2. P. Durai Pandian, S. Udaya Baskaran, Allied Mathematics, Volume – I, Muhil publishers, 1st Edition, Chennai, 1997.
3. P. Kandsamy and K. Thilagavathy, Allied Mathematics volume – I, Volume – II, S. Chand & Company, New Delhi, 2004.
4. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand & Co, New Delhi, 2005.
5. A. Singaravelu, Allied Mathematics, Meenakshi Agency, Chennai, 2001.
6. P. R. Vittal, Allied Mathematics, Margham Publications, Chennai, 1999.

E-Materials:

http://mathforum.org/library/drmath/sets/elem_2d

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	S	S	S	L	S
CO2	S	S	M	M	S	S	S	S	L	S
CO3	S	S	M	M	S	S	S	S	M	S
CO4	S	S	M	M	S	S	S	S	M	S
CO5	S	S	M	M	S	S	S	S	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I **Paper type : Open Elective** **Credit : 3**
Paper code : **Name of the Paper : Mathematical Foundations**
Hours of Teaching: 90 hrs

Course Objectives:

The main objective of this course are to

1. Study the logical operators, Propositional function, quantifiers, rules of inference.
2. Understand about fundamental mathematical concepts such as sets, relations, functions and composition of functions
3. Know the types of binary operations and boolean algebra.
4. Formulate and solve the differentiation and applications of differentiation
5. Acquire the knowledge of two dimensional analytical geometry

Course Outcomes:

After successful completion of the course the student will be able to

- CO1** Apply mathematical logical operators.
- CO2** Improve knowledge in set theory, functions with some problems.
- CO3** Classify the types of binary operations and know about the boolean algebra.
- CO4** Solve problems on applications of differentiation
- CO5** Evaluate problems on Straight lines, circles and conics.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	No	No	Yes	Yes
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	No	No	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Symbolic Logic**18 hours**

Proposition, Logical operators, conjunction, disjunction, negation, conditional and Bi-conditional operators, converse, inverse, contrapositive, logically equivalent, tautology and contradiction, Arguments and validity of argument.

Chapter 1: Sections 1.1–1.5**Unit – 2 Set Theory****18 hours**

Set, Set operations, Venn diagram, Properties of sets, number of elements in a set, Cartesian product, relation & functions, Relation: Equivalence relation. Equivalence class, Partially and Totally ordered sets, Functions: Types of Functions, Composition of Functions.

Chapter 2: Sections 2.1–2.8**Unit – 3 Binary Operations****18 hours**

Types of Binary operations: Commutative, Associative, Distributive and identity, Boolean algebra: properties, Permutations and combinations.

Chapter 3: Sections 3.1–3.3**Unit – 4 Differentiation****18 hours**

Simple problem using standard limits, $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a}$, $\lim_{x \rightarrow 0} \frac{\sin x}{x}$, $\lim_{x \rightarrow 0} \frac{\tan x}{x}$, $\lim_{x \rightarrow 0} e^x$, $\lim_{n \rightarrow 0} \frac{(1 + 1/n)^n}{n}$,

 $\lim_{n \rightarrow 0} (1 + n)^{1/n}$,

Differentiation,

successive differentiation, Leibnitz theorem, partial Differentiation, Applications of differentiation, Tangent and normal, angle between two curves, Maximum and minimum values [second derivative test], curvature and radius of curvature [Cartesian coordinates], Envelopes.

Chapter 4: Sections 4.1 – 4.9**Unit – 5 Two Dimensional Analytical Geometry****18 hours**

Straight lines – pair of straight lines – circles – System of Circles – Conics [parabola, Ellipse and Hyperbola].

Chapter 5: Sections 5.1 – 5.5**Text Book:**

U. Rizwan, Mathematical Foundations Volume I, Nelliappar Publications, Chennai 2017.

ReferenceBooks:

1. P.R.Vittal,MathematicalFoundations,MarghamPublication,Chennai.
2. V.Sundaram &others,DiscreteMathematicalFoundations,A.P.Publication,Sirkali
3. P.Duraipandian&Others,AnalyticalGeometryof2and3Dimensions,EmeraldPublication
1992 Reprint.

E-Materials:

<http://www.mathfoundation.com>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	L	S	S	M	S
CO2	S	S	M	M	S	M	S	M	M	S
CO3	S	S	M	M	S	S	S	S	M	S
CO4	S	S	S	L	S	S	S	S	M	S
CO5	S	S	S	S	M	S	S	S	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : I

Paper type : OpenElective

Credit : 3

Paper code :

Name of the Paper : MathematicalModeling

Hours of Teaching:90 hrs

Course objective:

The main objective of this course are to

1. Provide an introduction to modeling and simulation.
2. Solve and interpret real life problems using different Mathematical perspectives.
3. Apply the Mathematical Modeling through difference equations.
4. Develop the Mathematical modeling through Graphs.
5. To have a proper understanding of calculus of variations and Dynamics Programming.

Course Learning outcomes:

After the successful completion of this course, the students will be able to:

- CO1** Understand concept of modeling and simulation.
- CO2** Crete mathematical models of real world problems.
- CO3** Explain the population dynamics and genetics.
- CO4** Mathematical models using mathematical techniques.
- CO5** Discuss the calculus Variations and Dynamic Programming.

Matching table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	No	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 Mathematical Modelling through Systems of Ordinary differential Equations of the First Order 18 hours

Mathematical modelling in population dynamics, Mathematical modelling of epidemic through systems of ordinary differential equations of first order – Mathematical Models in Medicine, Arms Race, Battles and international Trade in terms of Systems of ordinary differential equations - Mathematical modelling in dynamics through systems of ordinary differential equations of first order.

Chapter 3: Sections 3.1, 3.2, 3.5 and 3.6

Unit – 2 Mathematical Modelling through difference equations 18 hours

The need for Mathematical modelling through difference equations - some simple models - Basic theory of linear difference equations with constant coefficients - Mathematical modelling through difference equations in economics and finance.

Chapter 5: Sections 5.1 to 5.3

Unit – 3 Mathematical Modelling through difference equations (contd.) 18 hours

Mathematical modelling through difference equations in population dynamics and genetics. Mathematical Modelling through difference equations in probability theory. Miscellaneous examples of Mathematical modelling through difference equations.

Chapter 5: Sections 5.4 to 5.6

Unit – 4 Mathematical modelling through Graphs 18 hours

Situations that can be modeled through graphs - Mathematical models in terms of directed graphs - Mathematical models in terms of signed graphs – Mathematical models in terms of weighted graphs.

Chapter 7: Sections 7.1 to 7.4

Unit – 5 Mathematical Modelling through calculus of Variations and Dynamic Programming 18 hours

Optimization principles and techniques - Mathematical modelling through calculus of variations - Mathematical Modelling through dynamic programming.

Chapter 9: Sections 9.1 to 9.3

Text Book:

J.N.Kapur, Mathematical Modelling, Willey Eastern Limited, Reprint, 2000.

ReferenceBooks:

1. D.J.G.JamesandJ.J.Macdonald,CasestudiesinMathematicalModelling,StanlyThames,C heltonham.
2. M.CrossandA.O.Mosrcadini,TheartofMathematicalModelling,EllisHarwoodandJohn Wiley.
3. C.Dyson,Elvery,PrinciplesofMathematicalModelling,AcademicPress,NewYork.
4. D.N.Burghes,ModellingwithDifferenceEquations,EllisHarwoodandJohnWiley.

E-Materials:

<http://www.mathfoundation.com>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	M	S	L	S	L
CO2	M	S	M	S	M	L	M	L	L	S
CO3	S	L	S	M	S	L	M	S	L	M
CO4	M	S	M	S	S	M	L	S	M	S
CO5	S	L	M	S	M	M	L	M	L	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : Algebra-II

Hours of Teaching:90 hrs

Course Objective:

The main objective of this course are to :

1. Attain depth knowledge about extension field and its types.
2. Study the concepts of existence of extension fields of polynomials over polynomial rings.
3. Understand Galois theory and develop Galois groups.
4. Know more about the finite fields and solvable groups.
5. Learn the important theorems related to division rings and its application.

Course Learning Outcomes:

After successful completion on the course the student will be able to:

- CO1** Understand fundamental concepts including extension fields, Algebraic extensions and Algebraic numbers.
- CO2** Determine existence and properties of extension fields of polynomials
- CO3** Demonstrate capacity of illustration for mathematical reasoning through analyzing, proving and explaining concepts from field extensions and Galois theory
- CO4** Apply knowledge of solvability of radicals over polynomials on finite fields
- CO5** Analyze the theorems related to division rings to apply them on relevant fields

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	No	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Field Theory **18 hours**

Extension fields - Transcendence of 'e'.

Chapter 5: Section 5.1 and 5.2

Unit – 2 Polynomials and Roots **18 hours**

Roots of Polynomials- More about roots.

Chapter 5: Sections 5.3 and 5.5

Unit – 3 Galois theory **18 hours**

Elements of Galois theory.

Chapter 5: Section 5.6

Unit – 4 Finite Fields **18 hours**

Solvability by Radicals - Finite fields - Wedderburn's theorem on finite division rings.

Chapter 5: Section 5.7

Chapter 7: Sections 7.1 and 7.2 (Only Theorem 7.2.1)

Unit – 5 Solvability by Radicals **18 hours**

A theorem of Frobenius - Integral Quaternions and the Four -Square theorem.

Chapter 7 : Sections 7.3 and 7.4

Text Book:

I.N. Herstein, Topics in Algebra, 2nd Edition. Wiley.1975

Reference Books:

1. D.S.Dummit and R.M.Foote. Abstract Algebra. Wiley 2003.
2. M. Artin, Algebra, Prentice Hall of India, 1991.
3. J.A. Gallian. Contemporary Abstract Algebra. 4th Edition. Narosa Publishing 2011.
4. P.B.Battacharya, S.K.Jain and S.R.Nagpaul, Basic Abstract Algebra(II Edition) Cambridge University Press, 1997.(Indian Edition)
5. I.S. Luther and I.B.S.Passi, Algebra, Vol.I – Groups(1996), Vol. II Rings, Narosa Publishing House, New Delhi, 1999.
6. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, Second Indian Reprint 2006, Springer Verlag, Newyork.
7. L. Smith(1998). Linear transformation: Example and Applications. In: Linear Algebra, Undergraduate texts in Mathematics, Springer, Newyork.

E-Materials:

1. <https://www.jmilne.org->FTe6>
2. http://www.math.iitb.ac.in/~srg/Lecnotes/galois_des.html
3. <https://www.jmilne.org>math>
4. <https://nptel.ac.in/courses/111108098/> (Video Lecture)

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	S	S	S
CO2	S	S	M	M	M	S	S	S	S	S
CO3	S	S	M	M	M	M	S	S	S	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	M	M	M	M	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : Real Analysis-II

Hours of Teaching:90 hrs

Course Objectives:

The objectives of the course is to

1. know the Lebesgue Integral
2. understand the concept of Riesz-Fischer theorem
3. study Fourier Series and Integrals in depth
4. understand the concepts of multivariable calculus.
5. acquire knowledge about implicit functions and the extremum values of functions.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** know about the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.
- CO2** develop the properties of inner products, norms and measurable functions.
- CO3** understand the concept of Fourier Series and Integrals.
- CO4** acquire the knowledge of multivariable calculus.
- CO5** enrich the students to work effectively on implicit functions and the extremum values of functions.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	No	Yes	No

Unit – 1 Lebesgue Integral**18 hours**

Introduction- The integral of a step function – Monotonic sequences of step functions – Upper functions and their integrals – Riemann-Integrable functions as examples of upper functions – The class of Lebesgue- Integrable functions on a general interval – Basic properties of the Lebesgue integral – Lebesgue integration and sets of measure zero – The Levi monotone convergence theorems-Lebesgue Dominated Convergence Theorem.

Chapter 10: Sections 10.1 to 10.10**Unit – 2 Lebesgue Integral Contd.****18 hours**

Lebesgue integrals on unbounded intervals as limits of integrals on bounded intervals –Improper Riemann integrals – Measurable functions – Continuity of functions defined by Lebesgue integrals – Differentiation under the integral sign – Inner products and norms – The set $L^2(I)$ of square-integrable functions – The set $L^2(I)$ as a semi-metric space – A convergence theorem for series of functions in $L^2(I)$ – The Riesz-Fischer theorem.

Chapter 10: Sections 10.12 to 10.16, 10.21 to 10.25**Unit – 3 Fourier Series and Fourier Integrals****18 hours**

Introduction–Orthogonal system of functions–The theorem on best approximation–
The Fourier series of function relative to an orthonormal system–Properties of Fourier Coefficients–
The Riesz-Fischer Theorem–The convergence and representation problems for trigonometric series–
The Riemann-Lebesgue Lemma–The Dirichlet Integrals–
An integral representation for the partial sums of Fourier series–Riemann's localization theorem–
Sufficient conditions for convergence of a Fourier series at a particular point–
Cesaro summability of Fourier series–Consequences of Fejes's theorem–
The Weierstrass approximation theorem.

Chapter 11: Sections 11.1 to 11.15

Unit – 4 Multivariable Differential Calculus **18 hours**

Introduction–The Directional derivative–Directional derivative and continuity–The total derivative–The total derivative expressed in terms of partial derivatives–An Application to Complex–Valued Functions–The matrix of linear function–The Jacobian matrix–The chain rule–Matrix form of chain rule–The mean-value theorem for differentiable functions–A sufficient condition for differentiability–A sufficient condition for equality of mixed partial derivatives– Taylor’s theorem for functions of \mathbb{R}^n to \mathbb{R}^1 .

Chapter 12: Sections 12.1 to 12.14

Unit – 5 Implicit Functions and Extremum Problems **18 hours**

Introduction–Functions with non-zero Jacobian determinants–The inverse function theorem–The Implicit function Theorem–Extrema of real valued functions of one variable and several variables–Extremum problems with side conditions.

Chapter 13: Sections 13.1 to 13.7

Text Book:

Tom M. Apostol, Mathematical Analysis (Second Edition) (1981), Addison–Wesley Publishing Company Inc. New York.

Reference Books:

1. J.C. Burkill, The Lebesgue Integral (1951), Cambridge University Press.
2. M.E. Munroe, Measure And Integration (1971), Addison–Wiley.
3. H.L. Roydon, Real Analysis (1988), Macmillan Pub. Company, New York.
4. W. Rudin, Principles of Mathematical Analysis (1979), McGraw Hill Company, New York.
5. S.C. Malik and Savita Arora, Mathematical Analysis (1991), Wiley Eastern Limited, New Delhi.
6. Sanjay Arora and Bansilal, Satya Prakashan, Introduction To Real Analysis, (1991), New Delhi.

E-Materials:

https://onlinecourses.nptel.ac.in/noc21_ma63/preview

<https://mathworld.wolfram.com/>

<https://ocw.mit.edu/courses/mathematics/18-100b-analysis-i-fall-2010/>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	S	M
CO2	S	S	M	M	S	M	S	S	S	M
CO3	S	S	M	M	S	M	S	S	S	M
CO4	S	S	M	M	S	M	S	S	S	M
CO5	S	S	M	M	S	M	S	S	S	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core

Credit : 4

Paper code :

Name of the Paper : Partial Differential Equations

Hours of Teaching:90 hrs

Course Objectives:

The main objective of this course are to:

1. Understand the theory and methods of Partial Differential Equations (PDEs).
2. Apply and solve PDEs applications from various emerging technologies.
3. Provide solution for First and second order partial differential equations.
4. Introduce the concepts and solving methods of Elliptical, paraboloid, hyperbolic differential equations.
5. Examine the existence and uniqueness of solutions of differential equations.

Course Outcomes:

After successful completion of the course the student will be able to

- CO1** Analyze the methods for first order partial differential equations.
- CO2** Understand the fundamentals of second order partial differential equations.
- CO3** Define the methods to solve elliptical differential equations.
- CO4** Discuss the formation and solutions of paraboloid differential equations.
- CO5** Construct the solutions for hyperbolic differential equations and identify the research problem where PDE can be used to model the problem.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 Partial Differential Equations of First Order 18 hours

Formation and solutions of first order PDE – Integral surfaces – The Cauchy problem for first order equation –Orthogonal surfaces – First order non-linear equations – characteristics– compatible systems of first order equations - Charpit’s method.

Chapter 0:Sections 0.4 to0.11. (omit 0.11.1))

Unit – 2 Fundamentals of Second Order PDE 18 hours

Introduction – classification of second order PDE – canonical forms – Adjoint operators.

Chapter 1:Sections 1.1 to 1.4

Unit – 3 Elliptic Differential Equations 18 hours

Derivation of Laplace and Poisson equations – Boundary value problem – Separation of variables – Dirichlet’s and Newmann problems for a rectangle – Solution of Laplace equation in Cylindrical and spherical coordinates.

Chapter 2: Sections 2.1, 2.2, 2.5 to 2.7,2.11 to 2.12

Unit – 4 Parabolic Differential Equations 18 hours

Formation and elementary solution of diffusion equation with boundary conditions – Dirac-Delta function – Separation of variable method - Solution of diffusion equation in cylindrical and spherical coordinates.

Chapter 3: Sections 3.1 to 3.7

Unit – 5 Hyperbolic Differential Equations 18 hours

Derivation and solution of 1-D wave equation by canonical reduction – Initial Value Problem ; D’Alembert’s solution – IVP and BVP for 2-D wave equation – Periodic solution for 1-D wave equation in cylindrical and spherical coordinates systems –Uniqueness of the solution for 1-D wave equation – Duhamel’s principle.

Chapter 4: Sections 4.1 to 4.4, 4.7 to 4.9, 4.11 and 4.12

Text Book:

K.Sankara Rao, Introduction to Partial differential equations (Third edition), Prentice-Hall of India Ltd., New Delhi, 2016.

Reference Books:

1. I.N. Sneddon, Elements of partial differential equations, McGraw Hill book company, Singapore, 1957
2. R. Dennemeyer, Introduction to partial differential equations and boundary value problems, McGraw Hill, New York, 1968.
3. R.C. McOwen, Partial differential equations, 2nd edition, Pearson education, New Delhi, 2005.
4. M.D.Raisinghania, Advanced differential equations, S.Chand& Company Ltd. New Delhi, 2001.
5. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.

E-Materials:

1. <https://nptel.ac.in/courses/111103021/>
2. [onlinecourses.nptel.ac.in > noc21_ma18](https://onlinecourses.nptel.ac.in/noc21_ma18)
3. [onlinecourses.nptel.ac.in > noc22_ma28](https://onlinecourses.nptel.ac.in/noc22_ma28)
4. [onlinecourses.nptel.ac.in > noc21_ma33](https://onlinecourses.nptel.ac.in/noc21_ma33)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	M	M
CO2	S	S	M	M	M	S	M	S	M	S
CO3	S	S	S	M	M	S	S	M	M	S
CO4	S	S	S	M	M	M	S	M	M	S
CO5	S	S	S	M	M	M	S	M	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Mathematical Statistics

Hours of Teaching: 75 hrs

Course Objectives:

The main objective of this course are to:

- 1 Introduce the basic notions of sample, population, sample moments and their functions.
- 2 Give an insight about the parametric and non-parametric tests for small and large samples.
- 3 Educate the various measures of estimation theory
- 4 Inculcate the concepts of ANOVA and testing of hypothesis.
- 5 Indoctrinate the strong background about the sequential analysis and its consequences.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Know the basic notions of sample, population, sample moments and their functions.
- CO2** Comprehend the parametric and non-parametric tests for small and large samples.
- CO3** Understand the various measures of estimation theory.
- CO4** Acquire the knowledge in the concept of ANOVA and, apply them in real life situations for testing of hypothesis.
- CO5** Procure the strong background about the sequential analysis and its consequences

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	No	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Sample Moments and Their Functions 15 hours

Notion of a Sample and a Statistic – Distribution of the Arithmetic Mean of Independent Normally Distributed Random Variables – The Chi-Square Distribution – The Distribution of the Statistics – Student's t-Distribution – Fisher's Z-Distribution – Snedecor's F Distribution – Distribution of Sample Mean from Non-Normal Populations.

Chapter 9: Sections: 9.1–9.8

Unit – 2 Significance Tests 15 hours

Kolmogorov Theorem – Smirnov Theorem – The Concept of a Statistical Test – Parametric Tests for Small Samples and Large Samples – Chi-Square Test – Tests of Kolmogorov and Smirnov Type – The Wald-Wolfowitz and Wilcoxon-Mann-Whitney Tests – Independence Tests by Contingency Tables.

Chapter 10: Sections: 10.1–10.11

Chapter 12: Sections: 12.1–12.7

Unit – 3 Estimation Theory 15 hours

Preliminary Notion – Consistent Estimators – Unbiased Estimates – Sufficiency of an Estimate – Efficiency of an Estimate – Asymptotically Most Efficient Estimates – Methods of Finding Estimates – Confidence Interval.

Chapter 13: Sections: 13.1–13.8

Unit – 4 Analysis of Variance and Hypotheses Testing 15 hours

ANOVA Test: One-Way Classification and Two-Way Classification. Hypotheses Testing: The Power Functions and OC Function – Most Powerful Test – Uniformly Most Powerful Test – Unbiased Test.

Chapter 15: Sections 15.1–15.2

Chapter 16: Sections 16.1–16.5

Unit – 5 Elements of Sequential Analysis 15 hours

SPRT – Auxiliary Theorem – Wald's Fundamental Identity – OC Function and SPRT – The Expected Value of (n) – Determination of A and B – Testing a Hypothesis Concerning p of Zero-One Distribution – Testing a Hypothesis Concerning the Expected Value m of a Normal Population.

Chapter 17: Sections: 17.1–17.9

Text Book:

M. Fisz, Probability Theory and Mathematical Statistics, 3rd Edition, John Wiley and Sons Inc., New York, 1963.

Reference Books:

1. V.K. Rohatgi and A.K.Md.E. Saleh, An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1988.
2. E.J. Dudewicz and S.N. Mishra, Modern Mathematical Statistics, John Wiley and Sons, New York, 1988.
3. G.G. Roussas, A First Course in Mathematical Statistics, 2nd Edition, Academic Press, USA, 1997.
4. B.L.V.D. Waerden, Mathematical Statistics, Springer-Verlag, New York, 1969.
5. R.E. Walpole, R.H. Myers, S.L. Mayers and K. Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson Education Inc., 2012.

E-Materials:

1. <https://ocw.mit.edu/courses/18-655-mathematical-statistics-spring-2016/>
2. <https://dspace.mit.edu/bitstream/handle/1721.1/96865/18-175-fall-2008/contents/lecture-notes/index.htm>
3. https://swayam.gov.in/nd1_noc20_ma19/preview
4. <http://mathworld.wolfram.com>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Fuzzy Set Theory

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to

1. Introduce Fuzzy sets.
2. Define some operations on Fuzzy sets.
3. Understand the properties of Fuzzy sets.
4. Discuss about the operations on Fuzzy sets.
5. Calculate the arithmetic operations on Fuzzy numbers.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Understand the basic concepts of Fuzzy Sets.
CO2 Discuss the Fuzzy sets versus crisp sets.
CO3 Analyze the operations on Fuzzy sets and Fuzzy complements.
CO4 Acquire the knowledge of various combination of operations.
CO5 Apply the concepts of Fuzzy mathematics in real life situation.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	No	No
2	Yes	Yes	No	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	No	Yes	Yes

Unit – 1 From Classical (Crisp) Sets to Fuzzy Sets 15 hours

Introduction – Crisp sets: An overview – Fuzzy sets – Basic types – Basic concepts – Characteristics – Significance of the paradigm shift.

Chapter 1: Sections 1.1 to 1.5

Unit – 2 Fuzzy Sets Versus Crisp Sets 15 hours

Additional properties of α - Cuts – Representation of Fuzzy sets – Extension principle for Fuzzy sets.

Chapter 2: Sections 2.1 to 2.3

Unit – 3 Operations on Fuzzy Sets 15 hours

Types of Operation – Fuzzy complements – Fuzzy intersection – t-norms

Chapter 3: Sections 3.1 to 3.3

Unit – 4 Operations on Fuzzy Sets 15 hours

Fuzzy unions – t conorms – Combinations of operations – Aggregation operations.

Chapter 3: Sections 3.4 to 3.6

Unit – 5 Fuzzy Arithmetic 15 hours

Fuzzy numbers – Linguistic Variables – Arithmetic operation on intervals – Arithmetic operation on Fuzzy numbers.

Chapter 4: Sections 4.1 to 4.4

Text book :

G. J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic : Theory and Applications, PHI, New Delhi, 2005.

Reference Books:

1. H. J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers, 1996.
2. A. Kaufman, Introduction to the theory of Fuzzy Subsets, Academic Press, 1975.
3. V. Novak, Fuzzy Sets and their Applications, Adam Hilger, Bristol, 1969.

E-Materials:

<http://nptel.ac.in/courses/105108081/module9/lecture36/lecture.pdf>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	L	S	S	L	L
CO2	S	S	M	M	S	L	S	S	L	L
CO3	S	S	M	M	S	L	S	S	L	L
CO4	S	S	M	M	S	L	S	S	L	M
CO5	S	S	S	S	S	L	S	S	M	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Difference Equations

Hours of Teaching:75hrs

Course Objectives:

The main objectives of the course are to

1. To provide basic knowledge about the discretization process, the discrete version of difference equations.
2. Understand the Linear periodic systems.
3. Develop the students ability to difference equations using Z-transforms.
4. To enable to use of Oscillation Theory.
5. Study oscillation and asymptotic behavior of solutions of certain classes of difference equations.

Course Learning Outcomes:

After the successful completion of this course, the students will be able to:

- CO1** Solve problem on Linear Difference Equations of Higher order.
CO2 Understand the system of Linear Difference Equations.
CO3 Apply Z-transform techniques in difference equations.
CO4 Explain on Oscillation Theory.
CO5 Discuss on Asymptotic Behavior of Difference Equation.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 Linear Difference Equations of Higher order 15 hours

Difference Calculus-General Theory of Linear Difference Equations-Linear Homogeneous Equations with Constant coefficients – Non-homogeneous equations: Method of Undetermined Coefficients, the method of variation of constants - Limiting behavior of Solutions.

Chapter 2: Sections 2.1 to 2.5

Unit – 2 System of Linear Difference Equations 15 hours

Autonomous Systems - The Basic Theory - The Jordan form - Linear periodic systems.

Chapter 3: Sections 3.1 to 3.4

Unit – 3 The Z-transform Method 15 hours

Definitions and Examples, Properties of Z-transform-The Inverse Z-transform and Solutions of Difference Equations: Power series method, partial fraction method, the inverse integral method - Volterra Difference Equation of convolution type - Volterra Systems.

Chapter 6: Sections 6.1 to 6.3, 6.5

Unit – 4 Oscillation Theory 15 hours

Three-term difference Equations – Self-Adjoint Second Order Equations-Nonlinear Difference Equations.

Chapter 7: Sections 7.1 to 7.3

Unit – 5 Asymptotic Behaviour of Difference Equation 15 hours

Tools of Approximation - Poincaré's Theorem - Asymptotically Diagonal Systems – High-Order Difference Equations - Second Order Difference Equations.

Chapter 8: Sections 8.1 to 8.5

Text Book:

Saber N. Elaydi, *An Introduction to Difference Equations*, Third Edition, Springer Verlag, New York, 2005 (First Indian Reprint 2008).

Reference Books:

1. Ronald E. Mickens, *Difference Equations Theory, Applications and Advanced Topics*, Third Edition, CRC Press, New York, 2015.
2. R.P. Agarwal., *Difference Equations and Inequalities*, Marcel Dekker, 1999.
3. S. Goldberg, *Introduction to Difference Equations*, Dover Publications, 1986

4. V.Lakshmikantham and Trigiante, *Theory of Difference Equations Numerical Methods and Applications*, Second Edition, Academic Press, New York, 1988.
5. Walter G. Kelly, Allan C. Peterson, *Difference Equations, An Introduction with Applications*, Academic Press, New York, 2001 (First Indian Reprint 2006).

E-Materials:

1. <http://people.math.aau.dk/~matarne/11-imat/notes2011a.pdf>,
2. <http://pj.freefaculty.org/guides/stat/Math/DifferenceEquations/DifferenceEquations-guide.pdf>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	L	M	S	L	S	L
CO2	M	S	M	S	S	M	M	S	L	M
CO3	S	S	L	S	L	S	S	M	L	L
CO4	M	L	M	L	S	M	M	S	M	S
CO5	S	M	S	S	M	L	M	L	L	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Fundamentals of Insurance

Hours of Teaching:75hrs

Course Objectives:

The main objective of this course are to:

- 1 Introduce the concept of insurance.
- 2 Study about the Life Insurance and claims.
- 3 Understand the concepts of Fire and Marine insurance.
- 4 Know about motor and other insurances.
- 5 Get the knowledge of getting job in insurance companies.

Course Outcomes

After successful completion on the course the student will be able to

- CO1** understand the principles and regulations of Insurance
CO2 analyse the benefits of life insurance policies
CO3 discuss the fire and marine insurance and its benefits
CO4 analyse the various insurance sectors
CO5 Understand the duties of an insurance agent and procedure to get license.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	No	No
2	Yes	Yes	Yes	No	No	No
3	Yes	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	Yes	No	No

Reference Books:

- 1 Insurance principles and practice- Periasamy. P, Margham publications, Chennai
- 2 Insurance principles and practice - Mishra. M. N, Sultan Chand & Sons, NewDelhi
- 3 Insurance principles and practice- Balu. V. &Premilan, Margham publications, Chennai

E-Materials:

- <https://ocw.mit.edu/courses/economics/14-73-the-challenge-of-world-poverty-spring-2011/video-lectures/lecture-15-risk-and-insurance/>
- <https://ocw.mit.edu/courses/economics/14-73-the-challenge-of-world-poverty-spring-2011/video-lectures/lecture-16-insurance/>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	M	S	S	S	S	L	M
CO2	M	M	M	M	S	S	S	S	L	M
CO3	M	L	L	S	S	S	S	S	L	M
CO4	M	M	L	M	S	S	S	S	L	M
CO5	S	M	M	S	S	S	S	S	L	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : NumericalMethods

Hours of Teaching: 75hrs

Course Objectives:

The objectives of the course are to

1. Understand the concept of solving algebraic and transcendental equations.
2. Study the various methods to obtain interpolation with equal and unequal intervals.
3. Get knowledge about numerical differentiation.
4. Demonstrate the numerical integration.
5. Solve the ordinary differential equations using various numerical methods.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Solve algebraic and transcendental equations.
- CO2** Acquire the knowledge of interpolation for equal and unequal intervals.
- CO3** Enrich the students to work effectively on numerical differentiation.
- CO4** Provides a foundation in the study of numerical integration.
- CO5** Knows to solve ordinary differential equations using various numerical methods.

Matching Table

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1 Solution of numerical algebraic and transcendental Equations 15 hours

Bisection method – Iteration Method – Newton-Raphson method
Solution of simultaneous linear algebraic equations: Gauss elimination method – Gauss-Jordan elimination method – Gauss-Jacobin method – Gauss-Seidel method – Simple Problems.

Chapter 3: Sections 3.1, 3.1.1, 3.2, 3.4

Chapter 4: Sections 4.1, 4.2, 4.2.1, 4.8, 4.9.

Unit – 2 Interpolation 15 hours

Introduction – Newton's forward and backward formulae – Central differences – Gauss forward and backward formulae – Stirling's formula – Divided differences – Properties – Relations between divided differences and forward differences – Newton's divided differences formula – Lagrange's formula.

Chapter 6: Sections 6.1, 6.2, 6.3

Chapter 7: Sections 7.1, 7.3, 7.4, 7.5

Chapter 8: Sections 8.2, 8.3, 8.4, 8.5, 8.7

Unit – 3 Numerical Differentiation 15 hours

Newton's forward and backward formulae to compute the derivatives – Derivative using Stirling's formulae – to find maxima and minima of the function given the tabular values. **Chapter 9:** Sections 9.2, 9.3, 9.4, 9.6

Unit – 4 Numerical Integration 15 hours

Newton – Cotes's formula – Trapezoidal rule – Simpson's 1/3rd and 3/8th rules – Weddle rule. **Chapter 9:** Sections 9.8, 9.9, 9.13, 9.14, 9.15

Unit – 5 Numerical solution of ordinary differential equations 15 hours

Euler's method – Improved Euler's method – Modified Euler's method – Runge-Kutta method (Fourth order only).

Chapter 11: Sections 11.9, 11.10, 11.11, 11.12, 11.13.

Text Book:

Kandasamy. P, Thilagavathi. K and Gunavathi. K “Numerical methods” – S. Chand and Company Ltd, New Delhi – Third Revised Edition 2016.

ReferenceBooks:

1. Venkataraman M. K., "Numerical Methods in Science and Engineering" NationalPublishingcompanyV Edition 1999.
2. Sankara Rao K., "Numerical Methods for Scientists and Engineers" 2nd EditionPrenticeHallIndia 2004.
3. GuptaB.D., NumericalAnalysis, KonarkPublishersPvt. Ltd.

E-Materials:

1. <http://nptel.ac.in/courses/122102009/>
2. <http://www.math.ust.hk/~machas/numerical-methods.pdf>
3. <https://mathworld.wolfram.com/>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	S	S
CO2	S	S	M	M	S	M	S	S	S	S
CO3	S	S	M	M	S	M	S	S	S	S
CO4	S	S	M	M	S	M	S	S	S	S
CO5	S	S	M	M	S	M	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : II

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Fundamentals of Business Statistics

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to:

- 1 Provide basic knowledge of the origin and evolution of Statistics
- 2 Apply statistical techniques for interpreting and drawing conclusion for business problems.
- 3 Develop the students ability to deal with numerical and quantitative issues in business
- 4 Enable the use of statistical, graphical and algebraic techniques where ever relevant
- 5 Have a proper understanding of Statistical applications in Economics and Management.

Course Outcomes

After successful completion of the course the student will be able to

CO1 Classify about the Partial and Multiple Correlation

CO2 Explain the basic concepts of Probability and Theoretical Distributions

CO3 Identify the educated guess (hypothesis)

CO4 Analyze the statistical inferences- Test of Hypothesis, Chi square and goodness of

Fit and F-Test

CO5 Discuss and design the Analysis of Variance

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	No	No	Yes	No
3	Yes	Yes	Yes	No	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	No	Yes	Yes	Yes

Unit – 1 Partial and Multiple Correlation 15 hours

Introduction-Partial Correlation-Multiple Correlation-Multiple Regression Analysis-Reliability of Estimates-Miscellaneous Illustrations

Volume-II: Chapter 9: Pages: 1109 to 1135

Unit – 2 Theory of Probability and Theoretical Distributions 15 hours

Introduction-Probability Defined-Importance of the Concept of Probability-Calculation of Probability-Theorem of Probability-Conditional Probability-Bayes' theorem-Probability Distribution-Binomial Distribution-Poisson Distribution.

Volume-II: Chapter 1: Pages: 751 to 770 and 774 to 788;

Chapter 2: Pages: 806 to 823, 826 to 833 and 858 to 879

Unit – 3 Statistical Inference- Test of Hypothesis 15 hours

Introduction-Sampling Error and Sampling Distribution-Estimation-Test of Significance for Large Samples-Test of Significance for Small Samples-Miscellaneous Illustrations.

Volume-II: Chapter 3: Pages: 882 to 951)

Unit – 4 Chi-Square and Goodness of Fit 15 hours

Introduction-Chi-Square defined-Conditions of Additive Chi-Square Test-Yate's Corrections-Uses of Chi-Square Test-Additive Property of Chi-Square-Chi-Square Test for Specified Value of Population Variance-Miscellaneous Illustrations.

Volume-II: Chapter 4: Pages: 953 to 1003

Unit – 5 F-Test and Analysis of Variance 15 hours

The F Test or the Variance Ratio Test-Application F Test-Analysis of Variance-Assumptions in Analysis of Variance-Technique of Analysis of Variance-Coding data-Analysis of Variance in Two-Way Classification Model.

Volume-II: Chapter 5: Pages: 1006 to 1038

Text Book:

S.P. Gupta, Statistical Methods, Sultan Chand & Sons, New Delhi, 2009.

Reference Books:

1. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2004.
2. S.P.Gupta & M.P.Gupta, Business Statistics, 14th enlarged edition, Sultan Chand & Sons, Educational publishers, New Delhi, reprint 2007.
3. Richard I Levin and David S. Rubit, Statistics for Management, Seventh edition, Pearson Education, New Delhi, 2002.
4. P.R.Vittal, Business Mathematics and Statistics, Margham Publications, Sixth revised edition, 2011.

E-Materials:

<http://mathworld.wolfram.com>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	S	S	S	M	S
CO2	S	S	M	M	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	M	S
CO4	S	S	S	M	M	S	S	S	M	S
CO5	S	S	M	M	S	S	S	S	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
M.Sc. Mathematics – 2022-2023 Onwards

Semester : III

Paper Type : Core

Credit : 6

Paper Code :

Name of the Paper : Complex Analysis – I

Hours of Teaching : 90 Hours

Course Objectives

The objectives of this course are to

- 1 Introduce the notions of differentiability, analyticity and power series.
- 2 Discuss the complex integration, Cauchy theorem and its properties.
- 3 Educate the conformal mappings and Mobius transformations.
- 4 Inculcate the concepts of maximum principle, Schwarz's lemma and Liouville's theorem.
- 5 Indoctrinate the singularities and its classification.

Course Outcomes

After the successful completion of this course, the students will be able to

- CO1** Understand the notions of differentiability, analyticity, power series and its consequences.
- CO2** Comprehend the complex integration, Cauchy theorem and its properties.
- CO3** Know the conformal mappings and Mobius transformations.
- CO4** Acquire the concepts of maximum principle, Schwarz's lemma and Liouville's theorem.
- CO5** Procure the singularities and its classification.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	No	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	No	No	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1: Analytic Functions and Power Series**18 Hours**

Differentiability and Cauchy-Riemann Equations – Harmonic Functions – Power Series as an Analytic Function – Exponential and Trigonometric Functions – Logarithmic Functions – Inverse Functions.

Chapter 3: Sections: 3.1 to 3.6**Unit – 2: Complex Integration****18 Hours**

Curves in the Complex Plane – Properties of Complex Line Integrals – Cauchy-Goursat Theorem – Consequence of Simply Connectivity – Winding Number or Index of a Curve – Cauchy Integral Formula – Taylor's Theorem – Zeros of Analytic Functions – Laurent Series.

Chapter 4: Sections: 4.1 to 4.5, 4.7, 4.10 to 4.12**Unit – 3: Conformal Mappings and Mobius Transformations****18 Hours**

Principle of Conformal Mapping – Basic Properties of Mobius Maps – Fixed Points and Mobius Maps – Triples to Triples under Mobius Maps – The Cross-Ratio and its Invariance Property – Conformal Self-maps of Disks and Half-planes.

Chapter 5: Sections: 5.1 to 5.6**Unit – 4: Maximum Principle, Schwarz's Lemma and Liouville's Theorem****18 Hours**

Maximum Modulus Principle - Hadamard's Three Circles/Lines Theorems - Schwarz's Lemma and its Consequences - Liouville's Theorem - Doubly Periodic Entire Function - Fundamental Theorem of Algebra - Zeros of Certain Polynomials.

Chapter 6: Sections: 6.1 to 6.7**Unit – 5: Classification of Singularities****18 Hours**

Isolated and Non-isolated Singularities – Removable Singularities – Poles – Further Illustrations through Laurent's Series – Isolated Singularities at Infinity – Meromorphic Functions – Essential Singularities and Picard's theorem.

Chapter 7: Sections: 7.1 to 7.7**Text Book:**

S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2012.

Reference Books:

1. Lars V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw-Hill Inc., New York, 1979.
2. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, 8th Edition, McGraw-Hill Higher Education, New York, 2009.
3. J.B. Conway, *Functions of One Complex Variable*, 2nd Edition, Narosa Publishing House, New Delhi, 1996.
4. V. Karunakaran, *Complex Analysis*, 2nd Edition, Narosa Publishing House, New Delhi, 2005.
5. H.A. Priestley, *Introduction to Complex Analysis*, 2nd Edition, Oxford University Press Inc., New York, 2005.

E-Materials:

1. <https://nptel.ac.in/courses/111106141>
2. <https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-spring-2018/>
3. <https://www.coursera.org/learn/complex-analysis>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	S	S
CO2	S	S	M	M	M	S	S	S	S	S
CO3	S	S	M	M	M	S	S	S	S	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	M	M	M	S	S	S	S	S

*PO – Programme Outcome, CO – Course Outcome.

*S – Strong, M – Medium, L – Low.

Semester : III

Paper Type : Core

Credit : 5

Paper Code :

Name of the Paper : Topology

Hours of Teaching : 90 Hours

Course Objectives

The objectives of this course are to

- 1 Introduce the mathematical analysis of open and closed sets and the significance of the topological spaces.
- 2 Discuss about the continuous functions on topological spaces, product topology and topology induced by the metric.
- 3 Educate the connected spaces, connected subspaces, components and local connectedness.
- 4 Inculcate the notions of compactness, compact subspaces, limit point compactness and local compactness.
- 5 Indoctrinate the strong theoretical background about the countability axioms, the separation axioms and the consequences theorems.

Course Outcomes

After the successful completion of this course, the students will be able to

- CO1** Know the basics on open and closed sets and the significance of the topological spaces.
- CO2** Comprehend the continuous functions on topological spaces, product topology and topology induced by the metric.
- CO3** Understand the connected spaces, connected subspaces, components and local connectedness.
- CO4** Acquire the notions of compactness, compact subspaces, limit point compactness and local compactness.
- CO5** Procure the strong theoretical background about the count ability axioms, the separation axioms and the consequences theorems.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	No	No
2	Yes	Yes	Yes	Yes	No	No
3	Yes	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit-1 : Topological Spaces **18 Hours**
Topological Spaces – Basis for a Topology – The Order Topology – The Product Topology on $X \times Y$
– The Subspace Topology – Closed Sets and Limit Points.

Chapter 2: Sections 12–17

Unit-2 : Continuous Functions **18 Hours**
Continuous Functions – The Product Topology – The Metric Topology.

Chapter 2: Sections 18–21

Unit-3 : Connectedness **18 Hours**
Connected Spaces – Connected Subspaces of the Real Line – Components and Local Connectedness.

Chapter 3: Sections 23–25

Unit-4 : Compactness **18 Hours**
Compact Spaces – Compact Subspaces of the Real Line – Limit Point Compactness – Local Compactness.

Chapter 3: Sections 26–29

Unit-5 : Countability and Separation Axioms **18 Hours**
The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietz Extension Theorem.

Chapter 4: Sections 30–35

Text Books:

James R. Munkres, *Topology*, 2nd Edition, Pearson Education Pvt. Ltd., Delhi, 2002.

Reference Books:

1. J. Dugundji, *Topology*, Prentice Hall of India Pvt. Ltd., New Delhi, 1975.
2. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Education, New York, 1963.
3. J.L. Kelley, *General Topology*, Van Nostrand Reinhold Company, New York, 1955.
4. L.A. Steen and J.A. Seebach, *Counterexamples in Topology*, Holt, Rinehart and Winston, New York, 1970.
5. S. Willard, *General Topology*, Addison–Wesley Publishing Company, USA, 1970.

E-Materials:

1. <https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/index.htm>
2. <https://ocw.mit.edu/courses/mathematics/18-904-seminar-in-topology-spring-2011/index.htm>
3. https://swayam.gov.in/nd2_cec20_ma12/preview

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	S	S
CO2	S	S	M	M	M	S	S	S	S	S
CO3	S	S	M	M	M	S	S	S	S	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	M	M	M	S	S	S	S	S

*PO – Programme Outcome, CO – Course Outcome.

*S – Strong, M – Medium, L – Low.

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : III

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : Differential Geometry

Hours of Teaching:90 hrs

Course Objectives:

The main objective of this course are to:

- 1 Introduce space curves and its characterizations.
- 2 Study properties of curves on surfaces.
- 3 Understand the concepts of Geodesics and canonical Geodesics equations.
- 4 Teach some type of special surfaces such as Developable and Minimal surfaces.
- 5 Get the knowledge on differential geometry of surfaces.

Course Outcomes

After successful completion on the course the student will be able to

- CO1** Understand the concept of a space curve and compute its curvature and torsion.
- CO2** Acquire the knowledge of curves on a surface and its intrinsic properties.
- CO3** Analyze the geodesics and its normal properties and also familiar with Gauss Bonnet Theorem.
- CO4** Determine the second fundamental form and developable associated with space curves.
- CO5** Know Hilbert's Lemma and the fundamental existence theorem for surface theory.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	No	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Reference Books:

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1978.
4. J.A. Thorpe Elementary topics in Differential Geometry, Under - graduate Texts in Mathematics, Springer - Verlag 1979.

E-Materials:

<http://www.math.ku.dk/noter/filer/geom1.pdf>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	M	S	L	S	S	L	M
CO2	S	S	M	L	S	L	S	S	M	M
CO3	S	S	M	M	S	L	S	S	M	M
CO4	S	S	M	M	S	L	S	S	M	M
CO5	S	S	M	M	S	L	S	S	M	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : III

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : LaTeX

Hours of Teaching: 90hrs

Course Objectives:

The main objective of this course are to:

- 1 Inculcate the computer knowledge.
- 2 Introduce the LaTeX software
- 3 Train in the Preparation of Project and dissertations using LaTeX.
- 4 Educate the Latex coding.
- 5 Understand the concepts of Cross References, Footnotes, Margin pars and Endnotes

Course Outcomes

After successful completion on the course the student will be able to

- CO1** Understand the basic LaTeX document and the e-contents.
CO2 Construct the structures of contents, index, glossary and text.
CO3 Create the type setting equations
CO4 Discuss several types of boxes and floats.
CO5 Prepare the basic documentation

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	No	Yes
2	Yes	Yes	Yes	No	No	Yes
3	Yes	Yes	No	No	No	Yes
4	Yes	Yes	No	No	No	Yes
5	Yes	Yes	Yes	No	No	Yes

Unit - 1 Basic Document and Bibliography 18 hours

Whats is LATEX – Simple typesetting – Fonts Type size – Document class – page style – page numbering – Formatting lengths – parts of a document – Dividing the document – what next? – Introduction – natbib – The BIBTEX program – BIBTEX Style files – Creating a bibliographic database.

Chapter: 1 to 4

Unit - 2 Contents, Index, Glossary, Text, Row and Column 18 hours

Table of contents – Index – Glossary. Borrowed words – Poetry in typing – Making lists – When order matters – Description and definitions.

Chapter: 5 to 6

Unit - 3 Typesetting Equations and Theorems 18 hours

Keeping tabs – Tables – The basics – Custom commands – More on mathematics – mathematics miscellany – New operations– The many fact of mathematics – Symbols – Theory in LATEX – Designer theorem-the amsthm package – Housekeeping.

Chapter: 7 to 9

Unit - 4 Several Kinds of boxes and Floats, 18 hours

LR boxes – Paragraph boxes – Paragraph boxes with specific height – Nested boxes – Role boxes – The figure environment – The table environment.

Chapter: 10 to 11

Unit - 5 Cross References in LATEX, Footnotes, Marginpars and 18 hours

Endnotes

Why cross reference? – Let LATEX do it – Pointing to a page-the package varioref – Pointing outside-the package xr – Lost the keys? Use lables.tex – Footnotes – Marginal notes – Endnotes.

Chapter: 12 to 13

Text book :

A Primer, Latex Tutorials, Indian TEX users group, Trivandrum, India.

www.tug.org.in

Reference Books:

1. Peter Flynn, A beginner's introduction to typesetting with LATEX, Silmaril Consultants, Textual Therapy Division, 2003.
2. George Gratzer, More Math Into LATEX, 4th Edition, Springer Science (2007).
3. Frank Mittelbach, Michel Goossens, The LaTeX Companion, Second Edition, Addison-Wesley, 2004.

E-Materials:

1. <https://www.latex-tutorial.com/tutorials/>
2. <https://www.latex-tutorial.com/>
3. <http://www.tug.org.in/tutorials.html>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	L	M	S	L	S	S	M
CO2	S	M	L	M	M	L	L	S	S	M
CO3	S	L	L	M	L	L	L	S	S	M
CO4	S	L	L	L	M	L	L	S	S	M
CO5	S	L	L	M	L	L	L	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115

M.Sc. Mathematics – 2022-2023 Onwards

Semester : III Paper Type : Core Elective Credit : 3

Paper Code : Name of the Paper : Discrete Mathematics

Hours of Teaching : 90 Hours

Course Objectives

The objectives of this course are to

- 1 Introduce the algebraic structures of lattices and Boolean algebra.
- 2 Construct the switching circuits with applications.
- 3 Educate the finite fields and its mathematics properties.
- 4 Inculcate the polynomials over finite fields, Irreducibility and factorization of polynomials.
- 5 Indoctrinate the coding theory with the linear and cyclic codes.

Course Outcomes

After the successful completion of this course, the students will be able to

CO1 Know the algebraic structures of lattices and Boolean algebra, and sketch the minimization of Boolean polynomials.

CO2 Model the switching circuits with applications.

CO3 Understand the finite fields and its mathematics properties.

CO4 Acquire the notions of the polynomials over finite fields, Irreducibility and factorization of polynomials.

CO5 Apply the coding theory with the linear and cyclic codes in cryptography.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	No	No	No
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	No	Yes	Yes	No
5	Yes	Yes	Yes	No	No	No

Unit-1: Lattices **18 hours**
Properties and Examples of Lattices – Distributive Lattices – Boolean Algebras – Boolean Polynomials - Minimal Forms of Boolean Polynomials.

Chapter 1: Sections 1–6

Unit-2 : Applications of Lattices **18 hours**
Switching Circuits – Applications of Switching Circuits.

Chapter 2:Sections 7–8

Unit-3 : Finite Fields **18 hours**
Finite Fields.

Chapter 3:Sections 13

Unit-4 : Polynomials **18 hours**
Irreducible Polynomials over Finite Fields - Factorization of Polynomials over Finite Fields.

Chapter 3:Sections 14–15

Unit -5: Coding Theory **18 hours**
Linear Codes – Cyclic Codes.

Chapter 4:Sections 17–18

Text Books:

Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra*, 2nd Indian Reprint, Springer Verlag, New York, 2006.

Reference Books:

1. A.Gill, *Applied Algebra for Computer Science*, Prentice Hall Inc., New Jersey.
2. J.L.Gersting, *Mathematical Structures for Computer Science*, 3rdEdn., ComputerScience Press, New York.
3. S.Wiitala, *Discrete Mathematics - A Unified Approach*, McGraw Hill Book Co.

E-Materials:

1. <http://www.discrete-math-hub.com/resources-and-help.html>
2. https://onlinecourses.nptel.ac.in/noc22_cs123/preview
3. https://onlinecourses.nptel.ac.in/noc22_cs85/preview

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	S	S
CO2	S	S	M	M	S	S	S	S	S	S
CO3	S	S	M	M	M	S	S	S	S	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	M	M	S	S	S	S	S	S

*PO – Programme Outcome, CO – Course Outcome.

*S – Strong, M – Medium, L – Low.

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115

M.Sc. Mathematics – 2022-2023 Onwards

Semester : III Paper Type : Core Elective Credit : 3

Paper Code : Name of the Paper : Operations Research

Hours of Teaching : 90 Hours

Course Objectives

The objectives of the course is to

1. Understand the steps in decision theory and tree analysis
2. Make distinctions among various types of replacement and maintenance techniques.
3. Solve an LPP using dynamic programming approach..
4. Use differential calculus based methods to obtain the optimal solutions.
5. Derive and use Kuhn-Tucker conditions necessary for optimal value of an objective function.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Make decision under various decision-making environments.
- CO2** Acquire the knowledge of replacement analysis in handling problems like staffing problem and equipment renewal problem etc.
- CO3** Work effectively on Dynamic Programming models and their applications in solving Decision problem.
- CO4** Provide a strong foundation in distinction between local, global and inflection extreme points.
- CO5** Solve non-linear programming problems.

Matching Table :

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit-1: Decision Theory **18 Hours**

Steps in Decision theory Approach – Types of Decision Making Environments – Decision Making Under Uncertainty – Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis – Decision Making with Utilities.

Chapter 11: Sections 11.1 to 11.8

Unit-2: Replacement and Maintenance Models **18 Hours**

Failure Mechanism of items – Replacement of Items Deteriorates with Time – Replacement of items that fail completely – other Replacement Problems

Chapter 17: Sections 17.1 to 17.5

Unit-3: Dynamic Programming **18 Hours**

Introduction – Dynamic Programming Terminology – Developing Optimal Decision Policy – Dynamic Programming under Certainty – Dynamic Programming Approach for Solving LPP.

Chapter 22: Sections 22.1 to 22.5

Unit-4: Classical Optimization Methods **18 Hours**

Introduction - Unconstrained Optimization - Constrained multivariable Optimization with inequality constraints – Problems.

Chapter 23: Sections 23.1 to 23.4

Unit-5: Non-Linear Programming Methods **18 Hours**

Introduction - General NLPP – Graphical Solution - Quadratic Programming – Problems.

Chapter 24: Sections 24.1 to 24.4

Text Book:

J.K.Sharma, Operations Research Theory and Applications (Sixth Edition), Trinity Press, Laxmi Publications Pvt. Ltd., New Delhi, Reprint 2017.

Reference Books:

1. F.S.Hillier and J.Lieberman, Introduction To Operations Research, (Eighth edition), Tata Mc Graw Hill Publishing Company, New Delhi, 2006.
2. C.Beightler, D.Phillips, and B.Wilde, Foundations of Optimization, (Second edition), Prentice Hall New York, 1979.

3. M.S.Bazaraa, J.J.Jarvis, and H.D.Sharall, John Wiley and sons, New York, 1990.
4. D.Gross and C.M.Harris, Fundamentals Of Queuing Theory [3rd Edition], Wiley and Sons, New York, 1998.
5. Hamdy A.Taha, Operations Research, (Sixth edition), Prentice–Hall of India Private Limited, New Delhi.

E-Materials:

https://onlinecourses.nptel.ac.in/noc19_ma29/prev

<https://archive.nptel.ac.in/courses/111/107/111107104/>

https://onlinecourses.nptel.ac.in/noc21_mg74/preview

<https://mathworld.wolfram.com/topics/Optimization.html>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	S	S
CO2	S	S	M	M	S	M	S	S	S	S
CO3	S	S	M	M	S	M	S	S	S	S
CO4	S	S	M	M	S	M	S	S	S	S
CO5	S	S	M	M	S	M	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : III

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Mathematical Biology

Hours of Teaching : 90 Hours

Course Objectives:

The main objectives of the course are to

1. Understand and know the discrete population growth models.
2. Develop the Model for the Distribution of drugs in the body
3. Apply the Model for the Spread of Technological Innovations
4. Study the continuous growth models and qualitative behavior of populations
5. Know the mathematical models in epidemiology.

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- CO1** Formulate the mathematical models for real world problems
- CO2** Understanding the concepts of Discrete Population Growth Models
- CO3** Discuss the Continuous Growth Models
- CO4** Explain the Logistic Model with Harvesting
- CO5** Analyze the Qualitative behavior of Populations and Mathematical Models in Epidemiology.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1:DiscretePopulationGrowthModels**18 hours**

Arithmetic Growth Model - Geometric Growth Model - Generalizations - Age Structured Populations.

Chapter2:Sections 2.2 to 2.5**Unit-2:ContinuousGrowthModels****18hours**

The Linear Model-The Exponential Model-Model for the Distribution of drugs in the body Coalition Models.

Chapter3:Sections 3.2 to 3.5**Unit-3:ContinuousGrowthModels(contd.)****18 hours**

Environmental Resistance - A Model for the Spread of Technological Innovations - The Gompertz Model - Bertalanffy Growth Model.

Chapter3:Sections 3.8 to 3.11**Unit-4:Qualitativebehaviorof Populations****18hours** Auton

omous Equations - Steady and Equilibrium State - Stability of Equilibrium State - Logistic Model with Harvesting - Fixed Points and their stability - The Logistic Map.

Chapter5:Sections 5.2 to 5.7**Unit-5:MathematicalModelsinEpidemiology****18hours**

Plant Epidemics - Some features of Human Epidemics - A Simple Deterministic Epidemic Model - A more General Epidemic: SIR Disease.

Chapter7:Sections 7.2 to 7.5**Text Book:**

C.R.Ranganathan,

A First Course in Mathematical Models of Population Growth (with MATLAB Program),
Associated Publishing Company, New Delhi, 2006.

Reference Books:

1. Pundir, BioMathematics, A Pragati Edition, 2006.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd., New Delhi, 1985.
3. Nicolas F. Britton, Essential Mathematical Biology, Springer International Edition, First Indian reprint, 2004.

4. Murray, Mathematical Biology, Springer
International Edition, First Indian reprint, 2004.

E-Materials:

1. <https://www.smb.org/>
2. <https://web.archive.org/web/20080827161431/http://www.biostatsresearch.com/repository/>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	M	S	M	S	L
CO2	M	M	M	S	S	L	M	S	L	M
CO3	S	M	S	S	L	L	S	L	M	L
CO4	S	M	S	L	M	M	M	S	L	S
CO5	S	S	M	L	S	M	M	L	L	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : III

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Quantitative Techniques

Hours of Teaching: 90hrs

Course Objectives:

The objectives of the course is to

1. Study the linear programming problem and its solving method.
2. Understand the transportation problem as a linear programming problem.
3. Understand the concept of assignment problem.
4. Understand the concept of inventory control.
5. Know about the network analysis and its solution methods, PERT and CPM.

Course Outcomes:

After successful completion on the course the student will be able to

CO1 Understand the concept of LPP and its solution.

CO2 Acquire the knowledge of transportation problems.

CO3 Work effectively on assignment models.

CO4 Provides a strong foundation in the study of the characteristics of inventory controls.

CO5 Use PERT-CPM technique for project management network problems.

Matching Table :

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit-1:LinearProgrammingProblem**18 hours**

Introduction–GraphicalSolutionMethod–SomeExceptionalCases–
GeneralLinearProgrammingProblem–FundamentalPropertiesofSolution–
TheComputationalProcedure-SimplexMethod.

Chapter3:Sections3.1to3.4**Chapter4:**Sections4.1 to 4.3**Unit- 2:TransportationProblem****18 hours**

Introduction -L.P Formulationof theTransportationProblem– Existence of Solution inT.P –
Transportation Table– Solution of a Transportation Problem– Finding InitialBasicFeasibleSolution-
Testforoptimality–EconomicInterpretationof u_j 'sand v_j 's–DegeneracyinTransportationProblem–
TransportationAlgorithm(ModiMethod).

Chapter10: Sections 10.1 to 10.3, 10.5, 10.8 to 10.13**Unit-3:Assignment Problem****18 hours**

Introduction-MathematicalFormulationoftheProblem-SolutionMethodsofAssignmentProblem–
SpecialCasesinAssignmentProblems–TravellingSalesmanProblem.

Chapter11:Sections 11.1 to 11.4, 11.7**Unit-4:Inventory Control****18hours**

Introduction – Types of Inventories – Reasons for Carrying Inventories – The InventoryDecisions –
Objective of Scientific Inventory Control –Costs Associated with Inventories –Factors Affecting
with Inventory Control – An inventory Control Problem - DeterministicInventoryproblem withNo
shortages.

Chapter 19:Sections 19.1 to 19.10**Unit-5:NetworkschedulingbyPERTandCPM****18 hours**

Introduction–Network:BasicComponents –LogicalSequencing-RulesofNetworkConstruction–
ConcurrentActivities–CriticalPathAnalysis–ProbabilityConsiderationsinPERT-Distinction between
PERT andCPM.

Chapter25

Text Book:

KantiSwarup,P.K.Gupta,ManMohan,OperationsResearch,SultanChand&Sons,NewDelhi, 2008.

ReferenceBooks

1. P.K.Gupta,OperationsResearch,8-e,KrishnaPrakasamMandir,Meerut,1993.
2. P.K.GuptaandD.S.Hira,OperationsResearch,S.Chand&Company,NewDelhi,2000.
3. J.K.Sharma,OperationsResearchTheoryandApplications,2-e,Mac MillianBusinessBooks, 2003.
4. HamdyA.Taha,OperationsResearch,PearsonEducation,NewDelhi,2002.

E-Materials:

<https://mathworld.wolfram.com/>

<https://nptel.ac.in/courses/112106134>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	S	S
CO2	S	S	M	M	S	M	S	S	S	S
CO3	S	S	M	M	S	M	S	S	S	S
CO4	S	S	M	M	S	M	S	S	S	S
CO5	S	S	M	M	S	M	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : III

Paper type : Open Elctive

Credit : 3

Paper code :

Name of the Paper : SCILAB

Hours of Teaching: 90hrs

Course Objectives:

The main objective of this course are to:

- 1 Understand the basic commands
- 2 Solve the system of equations
- 3 Construct the plotting lines and data.
- 4 Evaluate the polynomials
- 5 Solve the Ordinary differential equations.

Course Outcomes

After successful completion on the course the student will be able to

CO1 Acquire the practical knowledge of SCILAB

CO2 Understand the matrices, vectors in SCILAB

CO3 Visualize the mathematical objects in 2D and 3D

CO4 Acquire the knowledge of polynomials

CO5 Obtain the solution of Ordinary Differential equations

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	No	Yes	No

Unit-1 Introduction to SciLABB**18 hours**

Login - Talking between Scilab and the Editor - Basic Commands - Linear Algebra - Loops and Conditionals - Help in Scilab.

Chapter 1: Sections 1.1 to 1.7**Unit-2 Matrix Calculation****18 Hours**

Matrices and Vectors - Solving Equations - Creating Matrices - Systems of Equations.

Chapter 2: Section 2.2**Unit-3 Data and Function Plots****18 hours**

Plotting Lines and Data - Adding a Line - Hints for Good Graphs – Graphs - Function Plotting – Component Arithmetic - Printing Graphs - Saving Graphs.

Chapter 3: Sections 3.2, 3.3**Unit- 4 Polynomials****18 Hours**

Evaluation of Polynomials – Polynomials - Linear Least Squares (Heath Computer Problem).

Chapter 6: Sections 6.2, 6.3, 6.4**Unit-5 Differential Equation****18 Hours**

Differential Equations - Scalar ODE's - Order 2 ODE's .

Chapter 8: Sections 8.2**Text book :**

Graeme Chandler and Stephen Roberts, Scilab Tutorials for Computational Science, 2002.

Reference Books:

1. Scilab for very beginners, Scilab Enterprises, S.A.S, 143, bis rue Yves Le Coz – 78000 Versailles (France).
2. K. S. Surendran, SCILAB FOR DUMMIES, Version 2.6.
3. Some notes on SCILAB, Universit´e de Nice Sophia-Antipolis.

E-Materials:

<https://www.scilab.org/>

Mapping with Learning Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	L	S	S	M	L
CO2	S	S	M	L	S	L	S	S	L	M
CO3	S	S	S	S	S	L	S	S	M	L
CO4	S	S	M	M	S	L	S	S	L	L
CO5	S	S	M	S	S	L	S	S	M	L

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

Semester : IV

Paper Type : Core

Credit : 4

Paper Code :

Name of the Paper : Complex Analysis – II

Hours of Teaching : 75 Hours

Course Objectives

The objectives of this course are to

- 1 Introduce the concepts of residues and its properties.
- 2 Estimate the contour integrals and its applications.
- 3 Educate the analytic continuation and Poisson integral formula.
- 4 Inculcate the representations of meromorphic and entire functions.
- 5 Indoctrinate the applications of open mapping, Hurwitz and Riemann mapping theorems.

Course Outcomes

After the successful completion of this course, the students will be able to

CO1 Understand the concepts of residues and its properties.

CO2 Evaluate the contour integrals and its applications.

CO3 Know the analytic continuation and Poisson integral formula.

CO4 Acquire the representations of meromorphic and entire functions.

CO5 Procure the applications of open mapping, Hurwitz and Riemann mapping theorems.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	No	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	Yes	Yes	No

Unit – 1: Calculus of Residues**15 hours**

Residue at a Finite Point – Residue at the Point at Infinity – Residue Theorem – Number of Zeros and Poles – Rouché's Theorem.

Chapter 7: Sections 7.1 to 7.6**Chapter 8:** Sections 8.1 to 8.5**Unit – 2: Evaluation of Certain Integrals****15 hours**

Integrals of three types - Singularities on the Real Axis - Integrals Involving Branch Points - Estimation of Sums.

Chapter 9: Sections 9.1 to 9.6**Unit – 3: Analytic Continuation****15 hours**

Direct Analytic Continuation - Monodromy Theorem - Poisson Integral Formula - Analytic Continuation via Reflection.

Chapter 10: Sections 10.1 to 10.4**Unit – 4: Representation of Meromorphic and Entire Functions****15 hours**

Infinite Sums and Meromorphic Functions - Infinite Product of Complex Numbers - Infinite Products of Analytic Functions - Factorization of Entire Functions - The Gamma Function - The Zeta Function - Jensen's Formula - The Order and the Genus of Entire Functions.

Chapter 11: Sections 11.1 to 11.8**Unit –5: Mapping Theorems****15 hours**

Open Mapping Theorem and Hurwitz' Theorem - Basic Results on Univalent Functions - Normal Families - The Riemann Mapping Theorem - Bieberbach Conjecture - The Bloch-Landau Theorems - Picard's Theorem.

Chapter 12: Sections 12.1 to 12.7**Text Books:**

S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2012.

Reference Books:

1. Lars V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw-Hill Inc., New York, 1979.
2. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, 8th Edition, McGraw-Hill Higher Education, New York, 2009.
3. J.B. Conway, *Functions of One Complex Variable*, 2nd Edition, Narosa Publishing House, New Delhi, 1996.
4. V. Karunakaran, *Complex Analysis*, 2nd Edition, Narosa Publishing House, New Delhi, 2005.
5. H.A. Priestley, *Introduction to Complex Analysis*, 2nd Edition, Oxford University Press Inc., New York, 2005.

E-Materials:

1. <https://nptel.ac.in/courses/111106141>
2. <https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-spring-2018/>
3. <https://www.coursera.org/learn/complex-analysis>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	S	S
CO2	S	S	M	M	M	S	S	S	S	S
CO3	S	S	M	M	M	S	S	S	S	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	M	M	M	S	S	S	S	S

*PO – Programme Outcome, CO – Course Outcome.

*S – Strong, M – Medium, L – Low.

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Core

Credit : 4

Paper code :

Name of the Paper : Fluid Dynamics

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to:

- 1 Discuss kinematics of fluids in motion
- 2 Derive the equations of motion of a fluid
- 3 Introduce Three dimensional flows
- 4 Discuss Two dimensional image system
- 5 Analysis viscous flows

Course Outcomes

After successful completion of the course the student will be able to

- CO1** Understand the concepts of kinematics of fluids in motions.
CO2 Find the pressure at a point in a moving fluid.
CO3 Discuss Stokes stream function.
CO4 Analyse complex velocity potential for standard two dimensional flows.
CO5 Derive the Navier – Stokes equations of motion of a Viscous fluid.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	No	No
2	Yes	Yes	Yes	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	No	Yes	Yes	No

Unit-1: Kinematics of Fluids in Motion 15 hours

Real fluids and ideal fluids – Velocity of a fluid at a point, Stream lines, path lines, steady and unsteady flows – Velocity potential – The vorticity vector – Local and particle rates of changes – Equations of continuity – Worked examples – Acceleration of a fluid – Conditions at a rigid boundary.

Chapter 2: Sections 2.1 to 2.10

Unit-2: Equations of Motion of Fluid 15 hours

Pressure at a point in a fluid at rest – Pressure at a point in a moving fluid – Conditions at a boundary of two inviscid immiscible fluids – Euler's equation of motion – Discussion of the case of steady motion under conservative body forces.

Chapter 3: Sections 3.1 to 3.7

Unit-3: Some Three Dimensional Flows 15 hours

Introduction – Sources, sinks and doublets – Images in a rigid infinite plane – Axis symmetric flows – Stokes stream function.

Chapter 4: Sections 4.1, 4.2, 4.3, 4.5.

Unit-4: Some Two Dimensional Flows 15 hours

Meaning of two dimensional flow – Use of Cylindrical polar coordinate – The stream function – The complex potential for two dimensional, irrotational incompressible flow – Complex velocity potentials for standard two dimensional flows – Some worked examples – Two dimensional image systems – The Milne Thompson circle Theorem.

Chapter 5: Sections 5.1 to 5.8

Unit-5: Viscous Flows 15 hours

Stress components in a real fluid – Relations between Cartesian components of stress – Translational motion of fluid elements – The rate of strain quadric and principal stresses – Some further properties of the rate of strain quadric – Stress analysis in fluid motion – Relation between stress and rate of strain – The co-efficient of viscosity and Laminar flow – The Navier – Stokes equations of motion of a Viscous fluid.

Chapter 8: Sections 8.1 to 8.9

Text book :

F. Chorlton, Text Book of Fluid Dynamics, CBS Publications. Delhi ,1985.

Reference Books:

1. R.W.Fox and A.T.McDonald. Introduction to Fluid Mechanics, Wiley, 1985.
2. E.Krause, Fluid Mechanics with Problems and Solutions, Springer, 2005.
3. B.S.Massey, J.W.Smith and A.J.W.Smith, Mechanics of Fluids, Taylor and Francis, New York, 2005
4. P.Orlandi, Fluid Flow Phenomena, Kluwer, New Yor, 2002.
4. T.Petrila, Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics, Springer, berlin, 2004.

E-Materials:

<http://web.mit.edu/1.63/www/lecnote.html>

Mapping With Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	S	L	S	S	L	M
CO2	S	S	M	M	S	L	S	S	L	M
CO3	S	S	M	M	S	L	S	S	L	L
CO4	S	S	M	S	S	L	S	S	M	L
CO5	S	S	M	M	S	L	S	S	L	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Core

Credit : 5

Paper code :

Name of the Paper : Functional Analysis

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to:

1. Study the details of Banach Spaces and Continuous linear transformations
2. Get familiar with concepts of open mapping theorem also understand the properties of orthogonal complements.
3. Provide the concept of conjugate space H^* , adjoint, self-adjoint, normal and unitary operators.
4. Learn and understand the Preliminaries of Banach Algebras
5. Know about the structure of commutative Banach Algebras

Course Outcomes:

After successful completion of the course the student will be able to

CO1 Analyse the Banach space with examples and Able to work comfortably with Continuous linear transformations

CO2 Apply the conjugate operator and acquire the knowledge of open mapping theorem.

CO3 Discuss about the Hilbert spaces.

CO4 Acquire the knowledge of Banach Algebra and Outline of spectral radius.

CO5 Construct the Gelfand-Neumark theorem.

Matching table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	Yes	No	No
2	Yes	Yes	Yes	Yes	No	No
3	Yes	Yes	No	No	Yes	Yes
4	Yes	Yes	No	No	Yes	No
5	No	Yes	No	Yes	No	No

UNIT-I: Banach Spaces**15 hours**

Definition - Some examples - Continuous Linear Transformations - The Hahn -Banach Theorem.

Chapter 9: Sections 46 to 48**UNIT-II: Banach Spaces And Hilbert Spaces****15 hours**

Open mapping theorem - conjugate of an operator - Definition and some simple properties - Orthogonal complements – Orthonormal.

Chapter 9: Sections 50 and 51**Chapter 10:** Sections 52, 53 and 54**UNIT-III: Hilbert Space****15 hours**Conjugate space H^* - Adjoint of an operator - Self-adjoint operator - Normal and Unitary Operators – Projections.**Chapter 10:** Sections 55, 56, 57, 58 and 59**UNIT-IV: Preliminaries of Banach Algebras****15 hours** Definition

and some examples - Regular and single elements - Topological divisors of zero - spectrum - the formula for the spectral radius - the radical and semi-simplicity.

Chapter 12: Sections 64 to 69**UNIT-V: Structure of Commutative Banach Algebras****15 hours**Gelfand mapping – Application of the formula $r(x) = \lim \|x^n\|^{1/n}$ - Involutions in Banach Algebras -

Gelfand-Neumark Theorem.

Chapter 13: Sections 70 to 73**Text Book:**

G.F. Simmons, Introduction to topology and Modern Analysis, McGraw Hill International Book Company, New York, 1963.

Reference Books:

1. W. Rudin Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973
2. G. Bachman & L. Narici, Functional Analysis Academic Press, New York, 1966.
3. H.C. Goffman and G. Fedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987
4. E. Kreyszig Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
5. Balmohan V. Limaye, Linear Functional Analysis for Scientists and Engineers, Springer.

E-Materials

<http://www.math.ucdavis.edu/~hunter/book/ch5.pdf>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	S	S	S	M	S
CO2	S	S	M	M	S	S	S	S	M	S
CO3	S	S	M	M	S	S	S	S	M	S
CO4	S	S	M	M	S	S	S	S	M	S
CO5	S	S	M	M	S	S	S	S	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Number theory and Cryptography

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to:

1. Demonstrate ability to learn elementary ideas from number theory which will have applications in cryptography.
2. Introduce various cryptosystems and apply them in the necessary fields.
3. Understand the concepts of public key and primality
4. Learn the public key cryptography and RSA algorithm
5. Get the knowledge about Factoring concepts.

Course Outcomes:

After successful completion on the course the student will be able to

- CO1** Acquire the knowledge of elementary number theory
- CO2** Apply various cryptosystems and understand the concepts of quadratic, residues and reciprocity
- CO3** Develop the idea of public key cryptography, RSA Algorithms.
- CO4** Solve problems using the continued fraction method and the quadratic sieve method.
- CO5** Demonstrate ability to apply concepts of Fermat factorization and factor bases.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

UNIT-1 Some Topics in Elementary Number Theory 15 hours

Time Estimates for doing arithmetic – Divisibility and Euclidean Algorithm – Congruence's– Some applications to Factoring.

Chapter I

UNIT-2 Cryptography 15 hours

Some simple cryptosystems – Enciphering matrices.

Chapter III

UNIT-3 Quadratic Residues 15 hours

Quadratics – Residues and reciprocity.

Chapter II

UNIT-4 Public Key 15 hours

The idea of Public key Cryptography – RSA – Discrete Logarithm – Knapsack – Zero-Knowledge.**Chapter IV: Sections 1 to 5**

UNIT-5 Primality and Factoring 15 hours

Pseudo-primes – The rho method – Fermat factorization and factor bases – The continued fraction method – The quadratic sieve method.

Chapter V: Sections 1 to 5

Text Book:

Neal Koblitz, A Course in Number Theory And Cryptography, Springer-Verlag, New York, 1987.

Reference Books:

1. Niven and Zuckerman, An Introduction to Theory of Numbers, Third Edition, Wiley Eastern Ltd, New Delhi, 1976.
2. David M. Burton, Elementary Number Theory, Wm. C. Brown Publishers, Dubuque, Iowa, 1989.
3. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer-Verlag, 1972.

E-Materials:

1. <http://mathworld.wolfram.com>
2. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/resources/lecture-4-number-theory-i/>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	S	S	S	S
CO2	S	S	S	M	M	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	M	S	M	S	S	S	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Advanced Numerical Analysis

Hours of Teaching: 75hrs

Course Objectives:

The main objective of this course are to:

- 1 Introduce the derivation of numerical methods with error analysis
- 2 Study the transcendental and polynomial equations
- 3 Acquire the knowledge of system of linear algebraic equations
- 4 Understand the differentiation and integration
- 5 Solve problems on interpolation and ordinary differential equations

Course Outcomes:

After successful completion of the course the student will be able to

- CO1** Examine the solutions of transcendental and polynomial equations
- CO2** Understand the system of linear algebraic equations
- CO3** Analyse the interpolation and extrapolation
- CO4** Evaluate numerical differentiation and integrations
- CO5** Solve the differential equations by single and multi step methods

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	No	Yes	No
2	Yes	Yes	No	No	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	No	No	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

E-Materials:

1. <https://www.math.upenn.edu/~wilf/DeturckWilf.pdf>
2. <https://web.archive.org/web/20120225082123/http://kr.cs.ait.ac.th/~radok/math/mat7/stepsa.htm>
3. <https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	S	S	M	S
CO2	S	S	M	M	S	S	S	S	M	M
CO3	S	S	M	S	S	S	S	S	M	S
CO4	S	S	S	M	M	S	S	S	M	M
CO5	S	S	M	M	S	S	S	S	M	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115
M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Core Elective

Credit : 3

Paper code :

Name of the Paper : Calculus of Variation and Integral Equations

Hours of Teaching: 75hrs

Course Objectives:

The main objectives of this course are to:

1. Understand the concept of calculus of variation and its applications.
2. Introduce the various types of integral equations.
3. Solve variational problems with fixed and moving boundaries.
4. Study the methods of successive approximations and Fredholm theory.
5. Acquire knowledge on applications to Ordinary Differential Equations.

Course Outcomes:

After successful completion of the course the student will be able to

CO1 Analyze the methods for variational problems with fixed boundaries.

CO2 Apply and solve the variational problems with moving boundaries.

CO3 Define the methods to solve integral equations.

CO4 Discuss the method of successive approximation and Fredholm theory.

CO5 Identify and Construct the solutions for real time applications.

Matching table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	No	Yes	Yes	No	Yes	No
2	No	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	No	Yes	No
4	No	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit–I: Variational Problems with Fixed Boundaries**15 hours**

The concept of Variation and its properties – Euler's equation – Variational problems for functionals of the form – Functionals dependent on higher order derivatives – Functionals dependent on Functions of several independent variables – Variational problem in parametric form – Some applications to problems of mechanics.

Book– 1: Chapter 1: Sections 1.1 to 1.7**Unit–II: Variational Problems with Moving Boundaries****15 hours**

Variational problem with a Movable boundary for a functional dependent on two functions – One sided variations – Reflection and Refraction of extremals – Diffraction of light rays.

Book–1: Chapter 2: Sections 2.2 to 2.5**Unit–III: Integral Equations****15 hours**

Introduction – Definition – Regularity conditions – Special kinds of Kernels – Eigen values and Eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples – Fredholm alternative – Examples – An approximation method.

Book–2: Chapter 1: Sections 1.1 to 1.5**Chapter 2:** Sections 2.1 to 2.5**Unit–IV: Method of Successive Approximations and Fredholm Theory****15**

hours Method of successive approximations – Iterative scheme – Examples – Volterra integral equations – Examples – Some results about the resolvent kernel – The method of solution of Fredholm equation – Fredholm first theorem – Examples.

Book–2: Chapter 3: Sections 3.1 to 3.5**Chapter 4:** Sections: 4.1 to 4.3**Unit–V: Applications to Ordinary Differential Equations****15 hours**

Initial value problems – Boundary value problems – Examples – Singular integral equations – The Abel integral equations – Examples.

Book–2: Chapter 5: Sections 5.1 to 5.3**Chapter 8:** Sections 8.1 to 8.2**Text Books:**

1. A.S.Gupta, *Calculus of Variations with Applications*, PHI, New Delhi, 2005.
2. Ram P.Kanwal, *Linear Integral Equations*, Theory and Techniques, Academic Press, New York, 1971.

ReferenceBooks:

1. M.D.Raisinghania,*IntegralEquationsandBoundaryValueProblems*,S.Chand&Co.,NewDelhi, 2007.
2. SudirK.PundirandRimplePundir,*IntegralEquationsandBoundaryValueProblems*,PragatiPrak asam, Meerut.2005.

E–Materials:

1. <http://www.maths.ed.ac.uk/~jmf/Teaching/Lectures/CoV.pdf>
2. <https://archive.nptel.ac.in/courses/111/104/111104025/>

Mapping with Learning outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	M	M	S
CO2	S	S	S	M	S	S	S	M	M	S
CO3	S	S	M	M	M	M	S	M	S	M
CO4	S	S	S	S	S	M	S	M	S	M
CO5	S	S	S	M	S	M	S	M	S	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Mathematical Economics

Hours of Teaching: 75hrs

Course Objectives:

The main objectives of the course are to

1. Provide basic knowledge of the origin of theory of FIRM
2. Study the CES Production Function
3. Develop the Perfect Competition
4. understand about market equilibrium
5. Discuss the Welfare Economics

Course Learning Outcomes

After the successful completion of this course, the students will be able to

CO1 understand the knowledge of FIRM theory and perfect competition

CO2 Analyze the CES production

CO3 To acquire the knowledge of market equilibrium

CO4 To control the stability of equilibrium

CO5 Discuss the welfare economics, taxes and subsidies

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: The Theory of FIRM**15 hours**

Basic Concepts - Optimizing Behavior - Input Demands - Cost Functions – Joint Products - Generalization to m variables.

Chapter 4: Sections 4.1 to 4.6**Unit-2: CES Production****15 hours**

Homogeneous Production functions – CES Production Function.

Chapter 5: Sections 5.1 and 5.2**Unit-3: Perfect Competition****15 hours**

Assumptions of Perfect Competition - Demand Functions - Supply Functions – Commodity-Market Equilibrium - An application to Taxation.

Chapter 6: Sections 6.1 to 6.5**Unit-4: Market Equilibrium****15 hours**

Factor-Market Equilibrium - Existence and Uniqueness of Equilibrium - Stability of Equilibrium - Dynamic Equilibrium with Lagged Adjustment.

Chapter 6: Sections 6.6 to 6.9**Unit-5: Welfare Economics****15 hours**

Pareto Optimality - the efficiency of Perfect competition - The efficiency of Imperfect competition - External Effects in consumption and Production - Taxes and Subsidies – Social Welfare functions - The theory of Second Best.

Chapter 11: Sections 11.1 to 11.7**Text Book:**

James M. Henderson and Richard

E. Quandt, *Micro Economic Theory A Mathematical Approach*, (3rd Edn.) Tata McGraw Hill, New Delhi, 2003.

Reference Books

1. William J. Baumol. *Economic Theory and Operations Analysis*, Prentice Hall of India, New Delhi, 1978
2. A.C. Chiang, *Fundamental Methods of Mathematical Economics*, McGraw Hill, New York, 1984
3. Michael D. Intriligator, *Mathematical Optimization and Economic Theory*, Prentice Hall, New York, 1971.

4. A.Kautsoyiannis,ModernMicroeconomics(2ndedn)MacMillan,NewYork,1979

E-Materials:

1. [https://curlie.org/Science/Math/Applications/Mathematical Economics and Financial Mathematics/](https://curlie.org/Science/Math/Applications/Mathematical_Economics_and_Financial_Mathematics/)
2. http://master-economics-gem.univ-paris1.fr/about/?no_cache=1

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	S	M	S	L	S	L
CO2	M	L	M	S	L	S	M	S	L	M
CO3	S	S	L	S	S	L	S	S	M	L
CO4	S	S	M	L	M	M	S	M	L	S
CO5	M	L	M	S	L	M	M	S	L	M

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632115

M.Sc. Mathematics – 2022 - 2023 onwards

Semester : IV

Paper type : Open Elective

Credit : 3

Paper code :

Name of the Paper : Entrepreneurial Development

Hours of Teaching: 75hrs

Course Objective:

The objectives of this course are to

- 1 Provide an understanding of basic concept in the area of entrepreneurship
- 2 Expose students to the idea generation, creating awareness of business opportunities, and familiarizing them with formal practices in effective project formation.
- 3 Understand an Project Management and Idea Generation
- 4 Develop the National Institute of Entrepreneurship and Small Business Development
- 5 Discuss the PMEGP– NEEDS– UYEGP

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- CO1 Understand the knowledge of entrepreneurship
- CO2 Develop the Entrepreneurial Development
- CO3 Analyze the entrepreneurial finance and role of various government agencies
- CO4 Develop the idea generation, creating awareness of business opportunities, and familiarizing them with formal practices
- CO5 Discuss the Government Policies and benefits.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

- Unit-1:Introduction** **15hours**
 EntrepreneurandEntrepreneurship–Concept–Definition-ClassificationofEntrepreneurWomen
 Entrepreneur - Functions of an Entrepreneur - Traits of successful Entrepreneur -
 EntrepreneursVsProfessionalManagers–RoleofanEntrepreneurinEconomicDevelopment-Future
 challenges.
- Unit-2:EntrepreneurialDevelopment** **15**
hoursEntrepreneurialDevelopmentProgrammes–Meaning-EvolutionandObjectivesofEDP-
 InstitutionaleffortstodevelopEntrepreneurship-NationalSkillDevelopmentCorporation(NSDC)-
 RoleofGovernment inOrganisingEDPs-Operational ProblemofEDPs.
- Unit-3:ProjectManagementandIdeaGeneration** **15**
hoursProjectManagement-ProjectIdentification-ProjectFormulation-
 ProjectDesignandNetworkAnalysis–OverviewofProjectAppraisal-ProjectReport-
 IdentificationandSelectionofBusinessOpportunity–IdeaGeneration–
 OverviewofTechniquesusedforIdeaGeneration.-Individual creativity.
- Unit-4:EntrepreneurialFinanceandDevelopmentAgencies** **15**
hoursSourcesofFinance–CommercialBanksandDevelopmentBanks-
 RoleofAgenciesinassistingEntrepreneurship-
 DistrictIndustriesCenters(DIC),SmallIndustriesServiceInstitute(SISI),EntrepreneurshipDevelopmentI
 nstituteofIndia(EDII),NationalInstituteofEntrepreneurship &Small
 BusinessDevelopment(NIESBUD),NationalEntrepreneurshipDevelopment Board(NEDB).
- Unit-5:Government PoliciesandBenefits** **15 hours**
 TaxBenefits–TaxHolidays–AllowancefordeductingDepreciation–RehabilitationAllowance–Benefits
 available forMSMEs: PMEGP– NEEDS– UYEGP.

Text Books:

1. Dr.S.S.Khanka,EntrepreneurshipDevelopment- S. Chand&Co.,NewDelhi.
2. JayashreeSuresh,EntrepreneurialDevelopment, MarghamPublication,Chennai.
3. VasantDesa,Dynamics ofEntrepreneurialDevelopment–HimalayaPublication.
4. RobertD.Hisrich,MichaelP.Peters&DeanA.Shepherd,Entrepreneurship,
TataMcGraw Hill PublishingCompanyLimited, New Delhi.
5. RavindranathV.Badi&Narayana,Entrepreneurship, VrindaPublication(P)Ltd,New Delhi.

ReferencesBooks:

1. RabindraN.Kanungo,EntrepreneurshipandInnovation,SagePublications,NewDelhi.
2. HoltD.H.,EntrepreneurshipNewVentureCreation.NewDelhi:PrenticeHallofIndia.
3. HisrichR,andPeters,M.,Entrepreneurship.New Delhi:TataMcGrawHill.
4. RajkonwarA.B.,Entrepreneurship,KalyaniPublisher, Ludhiana.
5. Charantimath,Poornima,EntrepreneurshipDevelopmentandSmallBusinessEnterprises,Pearson Education, New Delhi.

E-Materials:

1. <http://www.indcom.tn.gov.in/pmegp.html>
2. <http://www.indcom.tn.gov.in/needs.html>
3. <http://www.indcom.tn.gov.in/uyegp.html>

Mapping with Learning Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	M	S	M	S	L
CO2	M	M	M	S	S	L	M	S	L	M
CO3	S	M	S	S	L	L	S	L	M	L
CO4	S	M	S	L	M	M	M	S	L	S
CO5	S	S	M	L	S	M	M	L	L	S

* PO – Programme Outcome, CO – Course Outcomes

* S – Strong, M – Medium, L – Low

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115

M.Sc. Mathematics – 2022-2023 Onwards

Semester : IV

Paper Type : Open Elective

Credit : 3

Paper Code :

Name of the Paper : Programming in C++

Hours of Teaching: 75hrs

Course Objectives

The objectives of this course are to

1. Introduce the tokens expressions and control structures in C++.
2. Explore the usage of all basic functions in C++.
3. Educate the significance of various types of classes in C++.
4. Inculcate the inheritance structures in C++.
5. Indoctrinate the polymorphism concepts in C++.

Course Outcomes

After the successful completion of this course, the students will be able to

CO1 Know the tokens expressions and control structures in C++.

CO2 Understand the usage of all basic functions in C++.

CO3 Comprehend the significance of various types of classes in C++.

CO4 Acquire the knowledge about the inheritance structures in C++.

CO5 Apply the polymorphism concepts in C++.

Matching Table:

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	Yes	Yes	Yes	No	No	No
2	Yes	Yes	Yes	No	No	No
3	Yes	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	Yes	No	No

Unit-1 : Tokens Expressions and Control Structures **15 hours**

Tokens – Keywords – Identifiers and Constants – Basic Data Types – Uses Defined Data Types – Derived Data Types – Symbolic – Operators in C++ – Scope Resolution Operator – Manipulators – Operator Overloading – Control Structures.

Chapter 3: Sections 3.1 – 3.24

Unit-2 : Functions **15 hours**

Characteristic of OOP – Function Prototype – Default Arguments – Inline Functions – Function Overloading – Template Functions.

Chapter 4: Sections 4.2, 4.3, 4.6, 4.7, 4.9

Unit-3 : Classes in C++ **15 hours**

Classes – Constructors and Destructors – Friend functions – Template Classes – New and Delete Operators – Operator Overloading.

Chapter 5: Sections 5.1 – 5.15

Chapter 6: Sections 6.1 – 6.9

Chapter 7: Sections 7.1 – 7.5

Unit-4 : Inheritance **15 hours**

Single Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance – Virtual Functions.

Chapter 8: Sections 8.1 – 8.8

Unit-5: Polymorphism in C++ **15 hours**

Polymorphism.

Chapter 9: Sections 9.6 – 9.7

Text Books:

E. Balagurusamy, *Object Oriented Programming with C++*, 4thEdn., Tata McGraw Hill Publishing Company Ltd., New Delhi, 2001.

Reference Books:

1. E. Balagurusamy, *Numerical Methods*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1999.
2. John H. Mathews, *Numerical Methods for Mathematics, Science and Engineering*, 2ndEdn., Prentice Hall India Pvt. Ltd., 2003.

3. S.S. Sastry, *Introductory to Numerical Methods*, Prentice Hall India Pvt. Ltd., 2000.
4. H.C. Saxena, *Finite Differences and Numerical Analysis*, S. Chand & Company Ltd., New Delhi, 2005.

E-Materials:

1. https://onlinecourses.nptel.ac.in/noc21_cs02/preview
2. https://www.cet.edu.in/noticfiles/285_OOPS%20lecture%20notes%20Complete.pdf
3. <https://www.msuniv.ac.in/images/e-content/1.Object%20Oriented%20Programming%20with%20C%20and%20Java.pdf>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	S	S	S	S	S
CO2	S	S	M	M	S	S	S	S	S	S
CO3	S	S	M	M	S	S	S	S	S	S
CO4	S	S	M	M	S	S	S	S	S	S
CO5	S	S	M	M	S	S	S	S	S	S

*PO – Programme Outcome, CO – Course Outcome.

*S – Strong, M – Medium, L – Low.