BHARATHI WOMEN'S COLLEGE
(AUTONOMOUS)

CHENNAI – 600 108

DEPARTMENT OF MATHEMATICS

(SEMESTER WITH CHOICE BASED CREDIT SYSTEM)

PG SYLLABUS

M.Sc. MATHEMATICS

(2019 - 2020 onwards)

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS), CHENNAI – 108

M.Sc. MATHEMATICS

(CBCS Syllabus for PG students admitted from the academic year 2019-20)

SEMESTER I

Course Component	Code	Title of the paper	Credit	Hrs /week	ESE	CIA	Total
Core T-1	19MAA	Abstract Algebra	5	6	75	25	100
Core T-2	19MAB	Real Analysis - I	5	6	75	25	100
Core T-3	19MAC	Ordinary differential Equations	5	6	75	25	100
Core T-4	19MAD	Python programming	5	6	75	25	100
Core Elective -1 (Any one)	19EA1	Graph theory	5	6	75	25	100
	19EA2	Finite Element Method	5	6	75	25	100
	19EA3	Programming in C++ - Theory	5	6	75	25	100
Soft Skill -1	19MS1	Essentials of Language & Communication Skills	2	-	75	25	100

SEMESTER II

Course Component	Code	Title of the paper	Credit	Hrs /week	ESE	CIA	Total
Core T-5	19MAE	Linear Algebra	4	5	75	25	100
Core T-6	19MAF	Real Analysis - II	4	5	75	25	100
Core T-7	19MAG	Mathematical Statistics	4	5	75	25	100
Core P-1	19MA1	Python Programming - Practical	5	6	60	40	100
Core Elective-2 (Any one)	19EA4	Mathematical Methods	4	5	75	25	100
	19EA5	Difference Equations	4	5	75	25	100
	19EA6	Analytic Number Theory	4	5	75	25	100
Supp. Course -1	19SA1	Tensor Analysis	3	4	75	25	100
Soft Skill-2	19MS2	Life and Managerial Skills	2	-	75	25	100

SEMESTER III

Course Component	Code	Title of the paper	Credit	Hrs /week	ESE	CIA	Total
Core T-8	19MAH	Topology	5	6	75	25	100
Core T-9	19MAJ	Differential Geometry	5	5	75	25	100
Core T-10	19MAK	Operations Research	4	5	75	25	100
Core T-11	19MAL	Classical Mechanics	4	5	75	25	100
Core Elective-3 (Any one)	19EA7	Number Theory and Cryptography	4	5	75	25	100
	19EA8	Algebraic Topology	4	5	75	25	100
	19EA9	Stochastic Processes	4	5	75	25	100
Supp. Course- 2	19SA2	Formal Languages and Automata	3	4	75	25	100
Soft Skill-3	19MS3	Essentials of Spoken and Presentation skills	2	-	75	25	100
Internship	19MS5	Internship (2 weeks)	2	-			100

SEMESTER IV

Course Component	Code	Title of the paper	Credit	Hrs /week	ESE	CIA	Total
Core T-12	19MAM	Complex Analysis	5	6	75	25	100
Core T-13	19MAN	Functional Analysis	5	6	75	25	100
Project/ AOP	19MAP	Fuzzy sets and their Application	6	6	75	25	100
Core Elective -4 (Any one)	19EA10	Partial Differential Equations	5	6	75	25	100
	19EA11	Discrete Mathematics	5	6	75	25	100
	19EA12	Algebraic Number Theory	5	6	75	25	100
Core Elective-5 (Any one)	19EA13	Fluid Dynamics	5	6	75	25	100
	19EA14	Financial Mathematics	5	6	75	25	100
	19EA15	Mathematical Modelling	5	6	75	25	100
Soft Skill-4	19MS4	Computing Skills - Advanced	2	-	75	25	100

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS)
CHENNAI-600 108

DEPARTMENT OF MATHEMATICS

INTERNAL ASSESSMENT PATTERN FOR PG

THEORY PAPERS

INTERNAL MARKS: 25

TEST = 10

ASSIGNMENT = 10

MODEL EXAM = 25

ATTENDANCE = 5

TOTAL = 50

Reduced to = 25

PRACTICAL

INTERNAL: Total Marks 40

Submission of Record - 10
Result and Accuracy - 10
Test - 5
Model Exam - 10
Attendance - 5

EXTERNAL: Total Marks 60

Answer 2 out of 4 questions
2 x 25 = 50
Record = 10

ATTENDANCE BREAK UP

Below 50% - REDO the Semester

50% to 64% - Not Eligible for the current Semester - 2 marks

65% to 74% - Condonation - 3 marks

75% to 89% - 4 marks

90% to 100% - 5 marks

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS)
CHENNAI-600 108

DEPARTMENT OF MATHEMATICS

GENERAL INSTRUCTIONS

CBCS FOR PG: 2019 – 2020

Total Core Papers	**: 14**	**Total Credits for Core Papers**	**: 65**
Elective Papers	**: 5**	**Credits for Elective Papers**	**: 23**
Application Oriented Paper	**: 1**	**Credits for Application Oriented Paper**	**: 6**
Supportive Electives (SE)	**: 2**	**Credits for Supportive Electives (SE)**	**: 6**
Soft skills	**: 4**	**Credits for Soft skills**	**: 8**
Internship	**: 1**	**Credits for Internship**	**: 2**
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TOTAL	**27**		**110**
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Website for Online Reference : http://nptel.ac.in

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS)
CHENNAI-600 108

DEPARTMENT OF MATHEMATICS

QUESTION PATTERN (Core/Core Elective) **TOTAL MARKS: 75**

SECTION A **10 x 2 = 20**

Answer All questions
(From Q. No. 1 to 10)

SECTION B **5 x 5 = 25**

Answer any FIVE questions
(From Q. No. 11 to 17)

SECTION C **3 x 10= 30**

Answer anyTHREE questions
(From Q. No. 18 to 22)

QUESTION PATTERN (SE) **TOTAL MARKS: 75**

SECTION A **5 * 5 = 25**
Answer any 5 questions
(From Q.No. 1 to 7)

SECTION B **5 * 10 = 50**
Answer any 5 questions
(From Q.No. 8 to 15)

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - I ABSTRACT ALGEBRA
(For the students admitted from the year 2019 -2020)

HOURS/WEEK: 6 **SEMESTER : I**
CREDITS : 5 **SUBJECT CODE: 19MAA**

OBJECTIVES

To introduce the basic ideas of counting principle, Sylow subgroups, Field theory and Galois Theory .

To apply Galois Theory to solvability of polynomial equations by radicals.

UNIT I

Another counting principle – Sylow's theorem I part (I proof only), II part and III part - Internal Direct products.

Chapter 2: 2.11, 2.12(omit Lemma 2.12.1, Lemma 2.12.2, Lemma 2.12.5) and 2.13.

UNIT II

Extension fields – Finite extension - Algebraic element - Roots of polynomials.

Chapter 5: 5.1, 5.3.

UNIT III

Polynomial rings –The division algorithm - Finite fields.

Chapter 3: 3.9 and Chapter 7: 7.1.

UNIT IV

The elements of Galois theory- Fixed field – Galois group – Normal extension – Fundamental theorem of Galois Theory.

Chapter 5: 5.6 .

UNIT V

Solvability by radicals - Solvable groups – Radical extension.

Chapter 5: 5.7.

BOOK FOR STUDY

I.N.Herstein, *Topics in Algebra*, 2nd Edition, John Wiley & Sons, 2011.

BOOKS FOR REFERENCE

1. John. B. Fraleigh, *A First Course in Abstract Algebra*, 7th Edition, Pearson, 2013.
2. David S. Dummit & Richard M.Foote, *Abstract Algebra*, 3rd Edition, Wiley India Pvt Ltd, 2003.
3. J.J. Rotman, *Advanced Modern Algebra*, 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
4.www.ime.usp.br/~aholguin/LIVROS/Beachy.pdf

OUTCOME OF LEARNING

Students will be able to

- Find the number of Sylow subgroups.
- Find the splitting field, Galois group of the given polynomial.
- Check whether the given polynomial is solvable by radicals or not.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - II REAL ANALYSIS I
(For the students admitted from the year 2019-2020)

HOURS/WEEK: 6 **SEMESTER : I**
CREDITS : 5 **SUBJECT CODE: 19MAB**

OBJECTIVE

To enable the students to understand the concepts on functions of bounded variation, Riemann Stiltjes integration, convergence of infinite series and infinite products, uniform convergence of sequence and series of functions and power series.

UNIT I

Functions of Bounded Variation: Properties of Monotonic Functions – Functions of Bounded Variation- Total Variation - Additive Property of Total Variation – Total Variation on [a , x] as a function of x – Functions of Bounded variation expressed as the difference of increasing Functions – Continuous Functions of Bounded Variation.

Chapter-VI: Sections 6.2 - 6.8

UNIT II

Riemann-Stieltjes Integral: Notation – The definition of Riemann-Stieltjes Integral – Linear Properties – Integration by parts – Change of Variable in a Riemann-Stieltjes Integral – Reduction to a Riemann Integral – Euler's Summation Formula – Monotonically Increasing Integrators: Upper and Lower Integrals – Riemann's Condition – Comparison Theorems.
Chapter-VII: Sections 7.2 - 7.7, 7.10 – 7.11, 7.13 – 7.14.

UNIT III

Riemann-Stieltjes Integral (Continued): Sufficient Conditions for the existence of Riemann-Stieltjes Integral – Necessary Conditions for the existence of Riemann-Stieltjes Integral – Mean Value Theorems for Riemann-Stieltjes Integrals – The Integral as a function of the interval – Second Fundamental Theorem of Integral Calculus – Second Mean Value Theorem for Riemann Integrals - Lebesgue's Criterion for the existence of Riemann Integrals.
Chapter-VII: Sections 7.16-7.20, 7.22 and 7.26.

UNIT IV

Infinite Series and Infinite Products and Sequences of Functions: Double Sequences – Double Series –Multiplication of Series – Cesaro Summability – Infinite Products - Point wise Convergence of Sequence of Functions- Examples of Sequence of Real Valued Functions – Definition of Uniform Convergence – Uniform Convergence and Continuity – The Cauchy Condition for Uniform Convergence.
Chapter-VIII and IX: Sections 8.20, 8.21, 8.24 – 8.26, 9.1 – 9.5

UNIT V

Series of Functions: Uniform Convergence of Infinite Series of Functions – Uniform Convergence and Riemann Stieltjes Integration – Sufficient Conditions for Uniform Convergence of a Series – Uniform Convergence and Double Sequences – Power Series - The Taylor's Series generated by a function –

Bernstein's Theorem – The Binomial Series – Abel's Limit Theorem – Tauber's Theorem.
Chapter-IX: Sections 9.6, 9.8, 9.11 – 9.12, 9.14, 9.19– 9.23

BOOK FOR STUDY

Tom M. Apostal, *Mathematical Analysis,* 2nd edition, Narosa Publishing house, New Delhi, 1985.

BOOKS FOR REFERENCES:

1. Bartle R.G., *Real Analysis,* 2nd Edition, John-Wiley & Sons, Inc. 1976.
2. Rudin W, *Principles of Mathematical Analysis,* 3rd Edition, McGraw-Hill.1976.

OUTCOME OF LEARNING

Students will be able to

- Gain the knowledge on functions of bounded variations, Riemann Stiltjes Intgration and sequence and series of functions.
- Develop their abstract thinking that pervades modern analysis.
- Understand the subjects' topology, measure theory and functional analysis.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - III ORDINARY DIFFERENTIAL EQUATIONS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6 **SEMESTER :I**
CREDITS : 5 **SUBJECT CODE: 19MAC**

OBJECTIVES

To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations.

UNIT I

Linear Equations with Constant Coefficient: Introduction - Second order homogenous equations - Initial value problem for second order equations - Linear dependence and independence - A formula for Wronskian.
Chapter - 2: Sections 1 to 5

UNIT II

Linear Equations with Constant Coefficient (Cont'd): The Non- homogenous equations of order two-homogenous and Non - homogenous equations of order n - Initial value problems for nth order equations- Annihilator method to solve non- Homogenous equation.
Chapter -2: Sections 6 to 11

UNIT III

Linear Equations with Variable Coefficients: Initial value problem - Existence and uniqueness theorem - The Wronskian and linear independence - Reduction of the order of a homogenous equation - The non- Homogenous equation - Homogenous equations with analytic coefficients - The Legendre equations.

Chapter- 3: Sections 1 to 8

UNIT IV

Linear Equations With Regular Singular Points: The Euler equations - Second order equations with regular singular points - Exceptional cases - The Bessel equation – The Bessel equation contd.
Chapter -4: Sections 1, 2, 3, 4,6,7,8

UNIT V

Existence And Uniqueness Of Solutions To First Order Equations: Equations with variable separated - Exact equations - The method of successive approximation - The Lipschitz Condition - Convergence of the successive approximation - Non-local existence of solutions - Approximations to and uniqueness of solutions.
Chapter -5: Sections 1 to 8

BOOK FOR STUDY

Earl A. Coddington, *An Introduction to Oridinary Differential Equations,* Prentice – Hall of India Private Limited, New Delhi 2008.

BOOKS FOR REFERENCE

1. Williams E. Boyce and Richard C. Diprima, *Elementary Differential Equations and Boundary Value Problems,* 10th edition John Wiley and Sons, New York 2012.

2. M.D. Raisinghania, *Advanced Differential Equations,* S. Chand & Company Ltd., New Delhi 2012

3. George F. Simmons, *Differential Equations with Application and Historical Notes,* Tata McGraw Hill, New Delhi 1974

4. B. Rai, D.P. Choudhury and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House Pvt. Ltd, New Delhi 2012.

5.Ravi P. Agarwal and Ramesh C. Gupta, *Essentials of Ordinary Differential Equations,* McGraw Hill, New York, 1991.

OUTCOME OF LEARNING

Students will be able to

- Apply the fundamental concepts of ordinary differential equation.
- Obtain solution of the homogeneous equation with constant co-efficient and Non-homogeneous equation of order n.
- Comprehend the Bessel equation and regular singular points at infinity.
- Use computational tools to solve problems and applications of ordinary differential equations.
- Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - IV PYTHON PROGRAMMING

(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6 **SEMESTER :I**
CREDITS : 5 **SUBJECT CODE: 19MAD**

OBJECTIVES

· To do input/output with files in Python.
· To use Python data structures - lists, tuples, and dictionaries.
· To define Python functions and call them.
· To develop Python programs with conditionals and loops.
· To read and write simple Python programs.

UNIT I

The way of the program – The Python programming language - formal and natural languages, variables, expressions and statement**s** – values and types- variables- variable names and keywords - statements- Evaluating expressions- operators and operands- Order of operations - operations on strings.

Chapter 1: 1.1-1.4
Chapter 2: 2.1- 2.8

UNIT II

Functions- Function calls- Type conversion- type coercion- Math functions- Composition- Adding new functions- Definitions and use- Flow of execution- Parameters and arguments- Variables and parameters are local- stack diagrams- Functions with results.

Conditionals and recursion – The modulus operator- Boolean expressions- Logical operators- Conditional execution- Alternative execution- Chained conditionals- Nested conditionals- The return statement- Recursion- Stack diagrams for recursive functions- Infinite recursion

Chapter 3: 3.1-3.12
Chapter 4: 4.1- 4.11

UNIT III

Fruitful functions – Return values- program development- composition- Boolean functions- More recursion- Leap of faith,examples.

Iteration – Multiple assignment- The while statement- Tables- Two –dimensional tables- Encapsulation and generalization- more encapsulation- local variables- more generalization functions.

Chapter 5: 5.1-5.7
Chapter 6: 6.1-6.9

UNIT IV

Tuples – Mutability and tuples- Tuple assignment – Tuples as return values – Random numbers – List of random numbers – Counting – Many buckets – a single –pass solution.

Dictionaries - Dictionary operations – Dictionary methods – Aliasing and copying – Sparse matrices – Hints – Long integers – Counting letters.

Chapter 9: 9.1-9.8
Chapter 10: 10.1-10.7

UNIT V

Files and exception: Text files – Writing variables – Directories- pickling – Exceptions.
Classes and objects: User-defined compound types – Attributes – Instances as arguments – Sameness – Rectangles – Instances as return values-Objects are mutable-copying.
Chapter 11: 11.1-11.5

Chapter 12: 12.1-12.8

BOOK FOR STUDY

Allen B. Downey, *Think Python: How to Think Like a Computer Scientist,* 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.

BOOKS FOR REFERENCE

1. Wesley J. Chun, *Core Python Programming,* Prentice Hall Pub, Second Edition, 2006.
2. Charles Dierbach, *"Introduction to Computer Science using Python: A Computational Problem-Solving Focus,* Wiley India Edition, 2013.
3. John V Guttag, *"Introduction to Computation and Programming Using Python",* Revised and expanded Edition, MIT Press , 2013.
4. Paul Gries, Jennifer Campbell and Jason Montojo, *"Practical Programming: An Introduction to Computer Science using Python 3",* Second edition, Pragmatic Programmers, LLC,2013.

OUTCOME OF LEARNING

Students will be able to

- Create algorithm to solve simple programming problems.
- Design, implement and test programs that use lists, tuples, dictionaries, conditional, loops and functions.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE ELECTIVE PAPER- I GRAPH THEORY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER :I**
CREDITS : 5	**SUBJECT CODE: 19EA1**

OBJECTIVES

In this course we introduce the basic concepts of graphs, trees, Eulerian and Hamiltonian graphs, matching, vertex and edge colouring and planarity. It has wide application in the field of electrical engineering, computer science, linguistics etc.

UNIT I

Introduction to Graphs and Trees: The Definition of a graph – More Definitions – Vertex Degrees – Sub graphs – Paths and cycles - Definition and simple properties – Bridges – Spanning Trees.
Chapter 1: Sections 1.1, 1.3 - 1.6 and Chapter 2: Sections 2.1 - 2.3

UNIT II

Connectivity and Euler Tours and Hamiltonian Cycles: Cut vertices and Connectivity – Whitney's Theorem**-** Euler tours – Fleury's Algorithm – Hamiltonian graphs – Dirac's Theorem – Bondy and Chvatal theorem.
Chapter 2: Sections 2.6 and Chapter 3: Sections 3.1, 3.3

UNIT III

Matchings and Planar graphs: Matchings and Augmenting Paths – Perfect Matching –Maximum Matching – Berge's Theorem – The Marriage Problem – Hall's Theorem**-** Plane and Planar graphs – Euler's formula.
Chapter 4: Sections 4.1, 4.2 and Chapter 5: Sections 5.1, 5.2

UNIT IV

Colouring(Vertex): Vertex Colouring – Chromatic Number – Brook's Theorem-Vertex Colouring Algorithms **-** The Simple Sequential Colouring Algorithm – The Largest - First Sequential Algorithms(Welsh and Powell) – The Smallest - Last Sequential Algorithms - Critical Graphs.
Chapter 6: Sections 6.1 – 6.3

UNIT V

Colouring (Edge): Edge colouring – Edge Chromatic Number – Vizing Theorem – Map Colouring. (Omit theorems 6.19 and 6.20)
Chapter 6: Section 6.5, 6.6

BOOK FOR STUDY

John Clark and Derek Allan Holton, *'A First Look at Graph Theory",* Allied Publishers, ISBN 81 - 7023

BOOKS FOR REFERENCE

1. J.A. Bondy and U.S.R. Murthy, *Graph Theory and Applications,* Macmillan, London, 1976.
2. R. Gould, *Graph Theory*, Benjamin / Commings, Menlo Park, 1989.
3. R.J. Wilson and J.J. Watkins, *An Introductory Approach*, John Wiley and Sons, New York, 1989.

OUTCOME OF LEARNING

Students will be able to apply principles and concepts of Graph Theory in practical situations.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – I FINITE ELEMENT METHOD
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6 **SEMESTER :I**
CREDITS : 5 **SUBJECT CODE: 19EA2**

OBJECTIVE: To give a basic expertise in the use of Finite Element Method Techniques.

UNIT-I: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION

Finite element models Background – Basic steps of finite element analysis– Model boundary value problem–Discretization of the domain–Derivation of element equations–Connectivity of elements–Imposition of- boundary conditions–Solution of equations–Post computation of the solution–Some Remarks.

Chapter 3: Sections: 3.1 to 3.3

UNIT-II: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION: APPLICATIONS

Axi-symmetric problems–Model equation–weak form–finite element model–preliminary comments–Discrete systems–Linear elastic spring– Torsion of circular shafts–Electrical resistor circuits –Fluid flow through pipes– Heat transfer – Governing equations –Finite element models – Fluid mechanics – Governing equations – Finite element model.

(Numerical Examples 3.4.1, 4.2.1, 4.2.2, 4.3.1, 4.4.1 only)

Chapter 3: Section: 3.4 , Chapter 4: Sections: 4.1– 4.4.

UNIT-III: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION: APPLICATIONS

Solid and Structural Mechanics–Preliminary Comments–Finite Element Model of Bars and cables – Plane trusses: Introduction – Basic truss element–General truss element – Constraint equations – Penalty approach – Direct approach. (Numerical Examples4.6.1,4.6.2,4.6.5only)

Chapter4: Sections: 4.5 to 4.6

UNIT-IV: BEAMS AND FRAMES

Introduction–Euler-Bernoulli beam element–Governing equation–Discretization of the domain – Derivation of element equations – Assembly of Element Equations – Imposition of boundary conditions– Post processing of solution – Timoshenko beam elements–Governing equations – Weak form–General finite element model.

Chapter5: Sections:5.1,5.2 (5.2.1to5.2.6),5.3 (5.3.1to 5.3. 3)

UNIT-V: EIGEN VALUE AND TIME DEPENDENT PROBLEMS

Eigen value problems: Introduction – Formulation of Eigen value problems – Finite element formulation.Time dependent problems: Introduction–Semi discrete finite element models– Parabolic equations–Time Approximation (Numerical Example 6.1.1 only).

(Chapter 6: Sections: 6.1 (6.1.1to 6.1.3), 6.2 (6.2.1 to 6.2.3)

BOOK FOR STUDY

J.N.Reddy, *An Introduction to the Finite Element Method* (Third Edition) Tata McGraw - Hill Publishing Company Limited, New Delhi, 2005.

BOOKS FOR REFERENCE.

1. George R.Buchanan, Finite element analysis,Tata McGraw Hill company Limited, New Delhi, 2006.
2. David V.Hutton, Fundamentals of Finite element Analysis, Tata McGraw Hill company Limited, New Delhi, 2005.
3. Klaus Jurgen Bathe, Edward L. Wilson, Numerical methods in finite element Analysis, Prentice Hall of India private Limited, New Delhi,1987.
4. C.S.Krishnamoorthy, Finite element Analysis Theory and Programming (Eighteenth Reprint), Tata McGraw Publishing company Limited, New Delhi, 2007.

OUTCOME OF LEARNING: Students understand and trained in solving second order differential equations numerically.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – I : PROGRAMMING IN C++ - THEORY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6 **SEMESTER :I**
CREDITS : 5 **SUBJECT CODE: 19EA3**

OBJECTIVES: This courses introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.

* Functions in C++ - Classes and Objects.
* Constructors and destructors - Operator Overloading
* Inheritance : Pointers and Polymorphism.

UNIT- I: PRINCIPLES OF OBJECT-ORIENTED PROGRAMMING

Software Evolution – OOP paradigm _ Basic concepts of OOP –Benefits of OOP – Applications of OOP. Tokens, Expressions And control Structures - Tokens –Keywords – Identifiers –variables –Operators in C++ - Manipulators –Expressions –Control Structures. Chapter: 1 Sections: 1.2 to 1.8, Chapter: 3 Sections: 3.2 to 3.8, 3.10 to 3.19, 3.24 .

UNIT- II: FUNCTIONS IN C++

Main Function – Function prototyping – Call by Reference – Return by Reference – Inline Functions – Function Overloading – Friend and Virtual Functions. Classes And Objects - Specifying a class – Defining Member Functions – Private Member Functions – Memory Allocation for Objects – Static Data Members – Static Member Functions – Object as Function Arguments – Friendly Functions – Returning Objects – Pointers to Members.
Chapter: 4 Sections: 4.2 to 4.6, 4.9,4.10, Chapter: 5 Sections: 5.3 – 5.8, 5.10- 5.18

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UNIT- III: CONSTRUCTORS AND DESTRUCTORS

Constructors -Parameterized Constructors – Multiple Constructors in a Class – Copy Constructor – Dynamic constructor – Destructors. Operators Overloading And Type Conversions - Definition – Overloading Unary, Binary Operators and Binary Operators Using Friends – Manipulation of Strings Using Operators – Rules – Type Conversions.
Chapter 6: Sections: 6.2-6.4, 6.7-6.11, Chapter 7: Sections: 7.2-7.5, 7.7, 7.8 .

UNIT-IV: INHERITANCE

Definition – Types of inheritance – Virtual base classes – Constructers in derived classes. Pointers, Virtual Functions And Polymorphism. Pointer to objects – This pointer - Pointer to derived classes - Virtual functions. Chapter 8: sections: 8.2-8.11, Chapter 9: sections: 9.2-9.5

UNIT –V: MANAGING CONSOLE I/O OPERATIONS

C++ Stream Classes – Unformatted I/O Operations – Formatted Console I/O Operations – Managing output with Manipulators.Working With Files. Classes for File Streams – Opening and Closing a File – File modes – File Pointers – Sequential I/O Operators – Updating File – Error handling – Command – Line Arguments.
Chapter 10 Sections: 10.3-10.6, Chapter 11 Sectiions:11.2-11.10.

BOOK FOR STUDY

Balagurusamy E., *Object Oriented Programming with C++*, Tata McGraw- Hill Book Company, New Delhi,1999.

BOOKS FOR REFERENCE

D.Ravichandran,*Programming with C++*, Tata McGraw hill, New Delhi,1996

OUTCOME OF LEARNING: Students will be able to create algorithm and to solve simple programming problems.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - V LINEAR ALGEBRA
(For the students admitted from the year 2019 -2020)

HOURS/WEEK : 5	**SEMESTER :II**
CREDITS : 4	**SUBJECT CODE: 19MAE**

OBJECTIVE

To study the generalized form of a vector space namely modules and various canonical forms of linear transformations under certain conditions on finite dimensional vector spaces.

UNIT I

Modules - Direct sum – Module homomorphism – Cyclic module – Finitely generated module.

Chapter 4: 4.5.

UNIT II

Canonical forms: Nilpotent transformation - Canonical forms: Jordan canonical form.

Chapter 6: 6.5, 6.6.

UNIT III

Canonical forms: Rational canonical form – Trace and Transpose.

Chapter 6: 6.7, 6.8.

UNIT IV

Determinants - Properties of determinants - Cramer's rule - Cayley – Hamilton theorem.

Chapter 6: 6.9

UNIT V

Hermitian, Unitary and Normal transformations - Positive definite transformation – Hermitian adjoint of a transformation

Chapter 6: 6.10.

BOOK FOR STUDY

I.N.Herstein**,** *Topics in Algebra,* 2nd Edition, John Wiley & Sons, 2011.

BOOKS FOR REFERENCE

1. Kenneth M .Hoffman and Ray Kunze, *Linear Algebra*, 2nd Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.
2. J.J. Rotman, A*dvanced Modern Algebra*, 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
3. G. Strang, *Introduction to Linear Algebra*, 2ndEdition, Prentice Hall of India Pvt. Ltd, 2013.

OUTCOME OF LEARNING

Students will be able to find the minimal polynomials, Nilpotent, Jordan and Rational canonical forms of transformations.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - VI REAL ANALYSIS II
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5 **SEMESTER :II**
CREDITS : 4 **SUBJECT CODE: 19MAF**

OBJECTIVE

To acquire the knowledge on Lebesue measurability, integrability and Fourier series and to have a deep study in multi variable calculus which enable the students to study advanced analysis in any other fields like statistics.

UNIT I

Measure on the Real Line: Lebesgue Outer Measure – Measurable Sets – Regularity – Measurable Functions.

Chapter-II: Sections 2.1-2.4

UNIT II

Integration of Functions of A Real Variable: Integration of non-negative functions –The general integral - Riemann and Lebesgue integrals.

Chapter-III: Sections 3.1, 3.2, 3.4

UNIT III

Fourier Series: Orthogonal System of Functions – The Theorem on the Best Approximation – The Fourier Series of a Function relative to an Orthonormal System – Properties of the Fourier Coefficients – the Riesz-Fisher Theorem – The Convergence and representation problems for trigonometric series – The Riemann-Lebesgue lemma – The Dirichlet integrals - An integral representation for the partial sums of a Fourier Series – Riemann's Localization theorem – Sufficient condition for convergence of a Fourier Series at a particular point – Ceasaro Summability of Fourier Series – Consequence of Fejer's theorem – The Weierstrass approximation theorem.

Chapter-XI: Sections 11.2-11.15

UNIT IV

Multivariable Differential Calculus: Introduction - The Directional derivative – Directional derivatives and continuity – The total derivative – The total derivative expressed in terms of partial derivative – An application to complex valued functions – The matrix of a linear function – The Jacobian Matrix – The chain rule – Matrix form of the 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 Formula for functions from Rn to R^1.

Chapter-XII: Sections 12.1-12.14

UNIT V

Implicit Functions: Introduction - Functions with nonzero Jacobian determinant- The inverse function theorem- The implicit function theorem.

Chapter-XIII: Sections 13.1-13.4.

BOOKS FOR STUDY

1. G.De Barra, *Measure Theory And Integration,* New Age International Pvt Ltd. Publishers (for Units I and II)
2. Tom M. Apostal, *Mathematical Analysis,* 2nd edition, Narosa Publishing house, New Delhi, 1985. (for Units III, IV and V)

BOOKS FOR REFERENCES:

1. Bartle R.G., *Real Analysis,* 2nd Edition, John-Wiley & Sons, Inc. 1976.
2. Rudin W, *Principles of Mathematical Analysis,* 3rd Edition, McGraw-Hill.1976.

OUTCOME OF LEARNING

Students will be able to understand the measurable sets, measurable functions, Lebesgue integration, the conditions for the convergence of Fourier series and the differential calculus of functions of one or more variables.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - VII MATHEMATICAL STATISTICS
(For the students admitted from the year 2019 -2020)

HOURS/WEEK : 5	**SEMESTER :II**
CREDITS : 4	**SUBJECT CODE: 19MAG**

OBJECTIVE

This study aims to understand the concepts of mathematical expectations, marginal and conditional distributions, the gamma and chi-square distributions, the t & F distributions and their applications, moment generating function technique and the Central Limit Theorem.

UNIT I

Probability: Introduction – Sample Space – Probability Axioms – Combinatories – Probability on finite sample spaces – Conditional Probability and Bayes theorem – Independence of Events.
Chapter 1: Section 1.1 to 1.6

UNIT II

Random Variables and Their Probability Distributions: Introduction – Random Variables – Probability – Discrete and Continuous Random Variables – Functions of a Random Variable.
Chapter 2: Section 2.1 to 2.5

UNIT III

Moments Generating Functions and Characteristic Functions: Introduction – Moments of a Distribution Function – Generating Functions – Some Moment Inequalities.
Chapter 3: Sections 3.1 to 3.4

UNIT IV

Some Special Distributions: Introduction – Some Discrete Distributions – Some continuous distributions. Central
Limit Theorem.
Chapter5: Sections 5.1 to 5.3, Chapter – 6: Section 6.6 only.

UNIT V

Sample Moments and Their Distributions: The Chi-square, t and F distributions – Large sample theory – Distribution of ($\bar{X}\bar{X}$ and S^2S^2) in Sampling from a Normal Population – Sampling from a Bivariate Normal Distribution.
Chapter 7: Sections 7.1 to 7.7.

BOOK FOR STUDY

V.K. Rohatgi, *An Introduction to Probability Theory and Mathematical Statistics,* Wiley Eastern Ltd., New Delhi, 1988(3rd print)

BOOKS FOR REFERENCE

1. M. Fisz, *Probability Theory and Mathematical Statistics,* John Wiley and sons, New York 1963.
2. R.B. Ash, *Real Analysis and Probability,* Academic Press, New York, 1972.
3. K.L. Chung, *A Course in Probability Theory,* Academic Press, New York 1974.
4. Y.S. Chow and H.Teicher, *Probability Theory,* Springer Verlag., Berlin, 1988(2nd edition)
5. R.Durrett, *Probability: Theory and Examples,* 2nd edition, Duxbury Press, New York 1996.
6. S.I. Resnick, *Probability: Theory and Examples,* Birhauser, Berlin, 1999.

OUTCOME OF LEARNING

Students will be able to understand a systematic introduction to modern probability theory and mathematical statistics.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PRACTICAL - I PYTHON PROGRAMMING - PRACTICAL
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER :II**
CREDITS : 5	**SUBJECT CODE: 19MA1**

OBJECTIVE

To learn Python thoroughly and comprehensively and to do any project using Python programming.

UNIT I

Implementing programs on Strings, Working with Lists and Tuples, Dictionary, conditional loops – if, else if, conditional expressions – for, while, break, continue.

To Remove Punctuation from a String
To Check Whether a String is Palindrome or Not
To Sort Words in Alphabetic Order
To produce a list that consists of all palindrome numbers between two given numbers
To list the factors of a given integer.
To remove key values pairs from a list of dictionaries.
To convert a string to a list.
To replace the last element in a list with another list
To convert a pair of values into a sorted unique array
To insert an element before each element of a list.
To Print the Fibonacci sequence
To Check Leap Year
To Find the Factorial of a Number
To Print all Prime Numbers in an Interval
To Find LCM
To Find HCF or GCD
To Solve Quadratic Equation
To print the first n rows of Pascal's triangle
To find the area and circumference of a circle whose radius is given?

UNIT II

To solve Non Linear Equations
1. Bisection Method
2. Secant Method
3. Regula-falsi Method
4. Fixed Point Iteration
5. Newton – Raphson Method

UNIT III

Numerical Differentiation (to find first and second derivatives) and Numerical Integration

1. Newton's forward formula
2. Newton's backward formula
3. Trapezoidal Rule
4. Simpson's 1/3rd Rule

UNIT IV

To find the Numerical solution to Differential Equations

1. Euler's Method
2. Taylor's Method
3. Runge-Kutta Method of order 2
4. Runge-Kutta Method of order 4

BOOK FOR STUDY

Wesley J. Chun, *"Core Python Programming"*, 2nd Edition, Pearson Education LPE, New Delhi, 2007.

BOOKS FOR REFERENCE

1. Mark Summerfield, *Programming in Python 3*, Pearson Education LPE, New Delhi, 1996.

2. Paul Gries, Jennifer Campbell and Jason Montojo, *"Practical Programming: An Introduction to Computer Science using Python 3"*, Second edition, Pragmatic Programmers, LLC, 2013.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE ELECTIVE PAPER - II MATHEMATICAL METHODS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5	**SEMESTER :II**
CREDITS : 4	**SUBJECT CODE: 19EA4**

OBJECTIVES

To tackle functional, to learn more about different type of integrals and to solve problems using Fourier and Hankel Transforms. This enables the students to solve different types of integral equations.

UNIT I

Method of Variations with fixed boundaries: Variation and its properties – Euler's equations – Functional dependent on first and higher order derivatives – Functions of several independent variables – Variational problems in parametric form – Some applications – problems.

Chapter VI

UNIT II

Variational Problems Involving A Conditional Extremum: Constraints of the form $\varphi(x, y_1, y_2, \ldots, y_n) = 0$, Isoperimetric problems.

Chapter IX

UNIT III

Integral Equations: Types of Integral Equations-equation with separable Kernal - Integral fredholm alternative-approximate method.

Sections: 1.1, 1.2, 1.3, 1.7, 2.1, 2.2, 2.3, 2.4, 2.5.

UNIT IV

Fourier Transforms: Fourier Transform – Fourier sine and cosine Transform – Inversion formula – properties – Modulation theorem – convolution – Parseval's Identity – Finite Fourier sine and cosine transforms.

Chapter VI: Sec 6.1 - 6.13 and 6.17-6.19 & Chapter VII: sec 7.1-7.4

UNIT V

Hankel Transform: Definition – inversion formula – some important results for Bessel's function – Linearity property – Hankel transform of derivatives of a function – Hankel transform of differential operators – Parseval's theorem.

Chapter IX Sec 9.1 – 9.7

BOOKS FOR STUDY

1. L.Elsgolts, *Differential equations and Calculus of Variations,* MIR Publishers, Moscow, 1973. **(For Units I, II)**
2. K.P.Kalwal, *Linear Integral Equations-Theory and Technique,* Academic Press, New York 1971. **(For Unit -III)**

3. A.R. Vasishtha, R.K. Gupta, *Integral Transforms,* Krishna Prakashan Media Private Ltd., India.1990. **(For Units IV and V)**

BOOK FOR REFERENCE

A.S. Gupta, *Calculus of Variations with Applications,* Prentice Hall of India Pvt Ltd., New Delhi, 2005.

OUTCOME OF LEARNING

Students will be able to understand the different types of integrals and to solve problems using Fourier and Hankel Transforms.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – // DIFFERENCE EQUATIONS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5
CREDITS :4
SEMESTER :I I
SUBJECT CODE: 19EA5

OBJECTIVES: To study about difference calculus,difference equations and also solving difference equations. This course introduce Z-Transforms and Stability theory.

UNIT-I
Difference Calculus: Difference operator-Summation-Generating Functions and approximate summation.
Chapter 2: sections2.1-2.3

UNIT-II
Linear Difference Equations: First order equations – General Results for Linear Equations-solving Linear equations.
Chapter 3: sections 3.1to 3.3

UNIT-III
Linear Difference Equations (Contd.): Equations with variable coefficients – Nonlinear Equations that can be Linearized.
Chapter 3: sections 3.5 and 3.6

UNIT – IV
Linear Difference Equations: Z transform.
Chapter 3: sections 3.7

UNIT-V
Stability Theory: Initial value problems for linear systems – Stability of linear systems.
Chapter 4: sections 4.1 and 4.2

BOOK FOR STUDY
W.G.Kelley and A.C.Peterson: *Difference equations, An introduction with applications,* Second Editions Academic Press, New York, 2001.

BOOK FORREFERENCE
1. S.N.Elaydi, *An introduction to Difference Equations,* Springer Verlag, New York, 1996.
2. S.Goldberg, *Introduction to Difference Equations,* Dover Publications, 1986.
3. R.P.Agarwal, *Difference Equations and Inequalities*, Mercel Dekker, New York, 2000.

OUTCOME OF LEARNING:

Students acquired knowledge in difference equations, Z-Transforms and Stability theory and trained to solve problems numerically.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS), CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – II ANALYTIC NUMBER THEORY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5 **SEMESTER :II**
CREDITS : 4 **SU BJECT CODE: 19EA6**

OBJECTIVES:

This course introduces arithmetic function and Dirichlet multiplication, averages of arithmetic function, congruence and quadratic residues.

UNIT-I

Arithmetical function and Dirichlet multiplication.
Chapter 2: All sections

UNIT-II

Averages of Arithmetical function.
Chapter 3: All sections

UNIT-III

Congruence - Finite Abelian Groups and their characters
Chapter 5:5.1-5.9; Chapter 6: 6.1 to 6.4

UNIT-IV

Finite Abelian Groups and their characters (contd. . .) - Dirichlet's theorem on Primes in Arithmetic Progressions
Chapter 6: 6.5 to 6.10; Chapter 7: All sections except 7.9

UNIT-V

Quadratic residues and quadratic reciprocity law.
Chapter 9 :9.1-9.8.

BOOK FOR STUDY

Tom Apostol, Introduction to Analytic Number theory, Narosa Publications, New Delhi.

BOOK FOR REFERENCE

1. I. Niven and Zuckermann H.S. : An Introduction to the theory of numbers, Wiley Eastern Ltd. 1972
2. C.Y. Hsiung : Elementary Theory of Numbers, Allied Publishers.
3. W.W. Adams and L. J. Goldstein, Introduction to Number Theory, Prentice Hall Inc.
4. S.G. Telang, Number Theory.

OUTCOME OF LEARNING:

Students will able to train in solving arithmetic function and Dirichlet multiplication, averages of arithmetic function, congruence and quadratic residues.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
SUPPORTIVE ELECTIVE PAPER I – TENSOR ANALYSIS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 4	**SEMESTER :II**
CREDITS : 3	**SUBJECT CODE: 19SA1**

OBJECTIVE

The basic concepts of Tensor analysis are introduced to study the physical loss which is independent of any particular coordinate system.

UNIT I

Space of N-dimensions – Transformation of coordinates – Summation, indicial convention – Dummy suffix – Contravariant and covariant vectors – Tensors of second order – Higher rank – Invariant or scalar – Addition and subtraction, contraction, product, inner product, symmetric and skew-symmetric tensors – Quotient law – Conjugate symmetric, relative tensor - Related problems.

Chapter-1: 1.1 -1.16

UNIT II

The metric tensor – Fundamental contravariant tensor – Length of a curve and null curve – Associated tensors, Raising and Lowering of idices – Magnitude of a vector – Angle between two vectors – Coordinates curves – Hypersurface – Angle between two hypersurfaces and two coordinate hypersurfaces – Related problems.

Chapter-2: 2.1 – 2.8.

UNIT III

N-ply Orthogonal system of hypersurfaces in a Vn – Congruence of curves – Orthogonal ennuple – Principal directions for a symmetric covariant tensor of second order, Homogeneous space – Euclidean space of m-dimensions – Gradient - Related problems.

Chapter-2: 2.9 – 2.14.

UNIT IV

The Christoffel three index symbols – Transformation of Christoffel symbols – Covariant differentiation of vectors, tensors – Intrinsic derivative of tensor – Laws of covariant differentiation tensors – Covariant derivative of a scalar – Ricci's theorem – Divergence and curl of a vector, Laplacian operator – Some important identities - Related problems.

Chapter-3: 3.1 3.10.

UNIT V

Completely symmetric, skew-symmetric and e-system – Generalized Kronecker Delta – Contraction - Related problems.

Chapter-9: 9.1 – 9.4.

BOOK FOR STUDY

D.C.Agarwal, *Tensor Calculus and Riemannian Geometry,* Krishna Prakashan Media Pvt Ltd. 19th Edition, 2003.

BOOK FOR REFERENCE

Murray R Spiegel, Seymour Lipschutz, Dennis Spellman, *Vector Analysis,* Tata McGraw Hill Education Pvt. Ltd.

OUTCOME OF LEARNING

Students will be able to understand the notation and properties of different types of tensors.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - VIII TOPOLOGY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER : III**
CREDITS : 5	**SUBJECT CODE: 19MAH**

OBJECTIVE

The objective is to teach the fundamentals of point set topology, countable spaces, and separable spaces and to gain knowledge about properties of topological spaces in terms of continuity, connectedness and compactness.

UNIT I

Topological Spaces: Topological Spaces – Basis for a topology – The order topology – The product topology on X x Y – The subspace topology – Closed sets and limits points (Results based on Box topology to be deleted).

Chapter 2: Sections 12 to 17.

UNIT II

Continuous functions – The product topology, metric topology.

Chapter 2: Sections 18 to 20.

UNIT III

The Metric topology (Continued) – Connected spaces – connected subspaces of the real line.

Chapter 3: Section 21, 23, 24.

UNIT IV

Compact spaces – Compact subspaces of the real line – Limit Point compactness.

Chapter 3: Section 26 to 28.

UNIT V

Countability and Separation Axiom: The Countability axioms – The Separation axioms – normal spaces – The Urysohn Lemma – Urysohn Metrization theorem- the Tietze Extension theorem. (All results and examples on box topology to be excluded.)

Chapter 4: Sections 30 to 35.

BOOK FOR STUDY

James R. Munkres, *Topology,* 2nd Edition, Pearson Education Pvt. Ltd., Delhi 2002(3rd Indian Reprint)

BOOKS FOR REFERENCE

1. J. Dungundiji, *Topology,* Prentice Hall of India, New Delhi 1975.
2. George F.Simmons, *Introduction toTopology and Modern Analysis,*McGraw Hill BookCo.,1963.
3. J.L. Kelly, *General Topology,* Van Nostrand, Reinhold Co., New York.
4. L. Steen and J.Seeback, *Counter Examples in Topology*, Holt, Rine hart and Winston, New York, 1970.

OUTCOME OF LEARNING

Students will be able to apply the basics which form the foundation for future study in Analysis,

Geometry and Algebraic Topology.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - IX DIFFERENTIAL GEOMETRY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5	**SEMESTER : III**
CREDITS : 5	**SUBJECT CODE: 19MAJ**

OBJECTIVE

To learn about space curve, contact between curves and surfaces, surface of revolution and to introduce the concepts of Geodesics.

UNIT I

Space Curves: Definition of a Space Curve – Arc Length – Tangent, Normal and Binormal – Curvature and Torsion.

Chapter 1: Sections 1.1 to 1.5

UNIT II

Space Curves: Contact between curves and Surfaces – Tangent Surfaces – Involutes and Evolutes – Intrinsic Equations – Fundamental Existence Theorem for Space Curves – Helices.

Chapter 1: Sections 1.6 to 1.9

UNIT III

Intrinsic Properties of a Surface: Definition of a Surface – Curves on a Surface – Surface of Revolution – Helicoids – Metric – Direction Co – efficient.

Chapter 2: Sections 2.1 to 2.6

UNIT IV

Geodesics: Families of Curves – Isometric Correspondence – Intrinsic Properties Geodesics – Canonical Geodesic Equations.

Chapter 2: Sections 2.7 to 2.11

UNIT V

Geodesics (Contd.): Normal Property of Geodesics – Existence Theorems – Geodesic Parallels – Geodesic Curvature – Gauss – Bonnet Theorem.

Chapter 3: Sections 2.12 to 2.16

BOOK FOR STUDY

T.J. Willmore, *An Introduction to Differential Geometry,* Oxford University Press (17th Impression), New Delhi 2002. (Indian Print)

BOOKS FOR REFERENCE

1. M.L.Khanna, *Differential Geometry,* Jai Prakash nath & Co., Meerut.
2. D. Somasundaram, *Differential Geometry,*A First Course,Narosa Publishing House.

OUTCOME OF LEARNING

Students will be able to know about space curve, contact between curves and surfaces, surface of revolution, curvature and Torsion and concept of involutes, Evolutes, Intrinsic Equations and Geodesics.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - X OPERATIONS RESEARCH
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5 **SEMESTER :III**
CREDITS : 4 **SUBJECT CODE: 19MAK**

OBJECTIVES

To develop and understand of the techniques used to solve linear optimization models using their mathematical structure. To learn the techniques for the solution and analysis non-linear models in operations research.

UNIT I

Integer Programming: Introduction – Pure and Mixed Integer Programming Problems - Gomory's All Integer Programming problem method- Construction of Gomory's Constraints – Fractional Cut Method - Branch and Bound Method.
Chapter- 7: Section: 7.1 – 7.7

UNIT II

Dynamic Programming Problems: Introduction – The Recursive Equation Approach – Characteristics of Dynamic Programming - Dynamic Programming Algorithm – Solution of Discrete D.P.P – Some Applications - Solution of Linear Program Problem by Dynamic Programming.
Chapter 13: Section: 13.1 to 13.7.

UNIT III

Queueing Theory: Introduction - Queueing System – Elements of the Queueing System – Operating Characteristics of a Queueing System – Deterministic Queueing System – Probability Distribution in Queueing Systems – Classification of Queueing Models – Definition of Transient and Steady States – Poisson Queueing Systems – Model I to Model – III ((M/M/1) : (GD/∞/∞), (M/M/1) : (GD/N//∞))
Chapter 21: Section 21.1 – 21.9

UNIT IV

Specialized Poisson Queues: Generalized Model: Birth – Death Process Model IV – Model V (M/M/C) : (GD/∞/∞) – Model VI (M/M/C) : (GD/N//∞),C≤N.
Chapter 21: Section 21.9.

UNIT V

Non-Linear Programming: General Non-Linear Programming problem – Constrained optimization with equality constraints - Constrained optimization with inequality constraints -Kuhn Tucker conditions with non-negative constraints - Quadratic programming – Wolfe's Modified Simplex Method.
Chapter 27 : Sections 27.3 – 27.5 , Chapter – 28 Section 28.3 – 28.5

BOOK FOR STUDY

Kanti Swarup, P.K.Gupta and Man Mohan, *Operations Research,* S. Chand & Sons, New Delhi.

BOOKS FOR REFERENCE

1. Hardy A. Taha, *An Introduction to Operations Research,* 5th Edition, Prentice – Hall of India Private Limited, New Delhi – 110 001.
2. F.S. Hillier and G.J. Liebermann, *Introduction to Operations Research*.
3. Philips D.T. Ravindra A. and Solbey. J., *Operations Research.*
4. B.E. Gillet, *Operations Research.*

OUTCOME OF LEARNING

Students will be able to understand the concepts of IPP, DPP, NLPP and Queueing models that are needed to solve optimization problems.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - XI CLASSICAL MECHANICS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5 **SEMESTER :III**
CREDITS : 4 **SUBJECT CODE: 19MAL**

OBJECTIVES

To learn about different coordinate systems and to introduce the concept of Lagrange and Hamilton equation and to solve problems. Concepts of different transformations to solve various problem is also included.

UNIT 1

Introductory concepts: – Mechanical system – generalized coordinates – constraints – virtual work – energy and momentum.
Chapter 1: Sections 1.1 – 1.5

UNIT II

Lagrange's equations: – derivation of Lagrange's equations – examples – integral of the motion.
Chapter 2: Section 2.1 – 2.3

UNIT III

Hamilton's equations: – Hamilton's principle – Hamilton equations.
Chapter 4: Section 4.1, 4.2

UNIT IV

Hamilton Jacobi theory: - Hamilton's principle function – Hamilton – Jacobi equation.
Chapter 5: Section 5.1, 5.2

UNIT V

Canonical Transformation: Differential forms and generating functions – Special transformations – Lagrangian and Poisson brackets.
Chapter 6: Section 6.1 – 6.3

BOOK FOR STUDY

Donald J. Greenwood, *Classical Dynamics*, Prentice Hall – 1985.

BOOKS FOR REFERENCE

1. Goldstein, *Classical Mechanics*, Narosa Publishing House, New Delhi.
2. Synge and Griffith, *Principles of Mechanics*, McGraw Hill, New York.
3. Sankara Rao, *Classical Mechanics*, Prentice Hall of India, New Delhi.

OUTCOME OF LEARNING

Students will be able to understand the different coordinate systems and the concepts of Lagrange and Hamilton equations.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE ELECTIVE PAPER - III NUMBER THEORY AND CRYPTOGRAPHY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5	**SEMESTER :III**
CREDITS : 4	**SUBJECT CODE: 19EA7**

OBJECTIVE

This course aims to give elementary ideas from number theory which will have applications in cryptology.

UNIT I

Elementary Number Theory: Time Estimates for doing arithmetic - Divisibility and Euclidean algorithm
Chapter-I: Sections I.1 and I.2

UNIT II

Congruences - Applications to factoring.
Chapter-I: Sections I.3 and I.4.

UNIT-III :

Finite Fields and quadratic Residues: Finite fields - Quadratic residues and Reciprocity.
Chapter-II

UNIT IV

Cryptography: Some simple crypto systems - Enciphering matrices.
Chapter-III

UNIT V

Public Key Cryptography: The idea of public key cryptography - RSA - Discrete log
Chapter-IV: Sections IV.1 to IV.3

BOOK FOR STUDY

Neal Koblitz, *A Course in Number Theory and Cryptography*, Second Edition, Springer-Verlag, New York, 2002.

BOOKS FOR REFERENCE

1. Niven and Zuckermann, *An Introduction to Theory of Numbers,* (Edn. 3), 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.

OUTCOME OF LEARNING

Students will be able to develop a deeper conceptual understanding of Number theory and its applications in cryptology.

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – III ALGEBRAIC TOPOLOGY
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5
CREDITS : 4

SEMESTER :III
SU BJECT CODE: 19EA8

OBJECTIVES:
To introduce the ideas of algebraic topology to other branches of Mathematics.

UNIT – I: CALCULUS IN THE PLANE: PATH INTEGRALS

Angles and Deformations – Differntial forms and path Integrals – Independence of Path – Criterion for exactness. Angles and Deformations: Angle functions and Winding numbers – Reparametrizing and Deforming the Paths. Winding Numbers: Definition – Homotopy and Reparametrization – Varying the point – Degrees and Local Degrees.
Chapter – 1:Sections: (a) to (c); Chapter – 2: Sections: (a) to (b);
Chapter – 3: Sections: (a) to (d).

UNIT – II: COHOMOLOGY AND HOMOLOGY

De Rham Cohomology and the Jordan Curve Theorem. Definition of the De Rham Graphs – The Coboundary map – the Jordon Curve Theorem – Applications and Variations. Homology: Chains, Cycles, and H0U – Boundaries, H1U, and Winding Numbers – Chains on Grids – Maps and Homology – The First Homology Group for General Spaces.
Chapter 5: Sections: (a) to (d); Chapter 6: Sections: (a) to (e)

UNIT – III: HOLES AND INTEGRALS

Multiply connected regions – Integrations over continuous Paths and Chains – Periods of Integrals – Complex Integration.
Mayer – Victoris: The Boundary map – Mayer – Victoris for Homology – Variations and applications – Mayer – Victoris for Cohomology.
Chapter 9: Sections: (a) to (d); Chapter 10: Sections: (a) to (d)

UNIT – IV: COVERING SPACES AND FUNDAMENTAL GROUPS

Covering spaces: Definition – Lifting paths and Homotopies – G-coverings – Covering Transformations. The Fundamental Groups: Definitions and Basic Properties – Homotopy – Fundamental group and Homology. Fundamental Groups and Covering Spaces: Fundamental Group and Coverings – Automorphisms of Coverings – The Universal Covering – Coverings and Subgroups of the Fundamental Group.
Chapter 11: Sections: (a) to (d); Chapter 12: Sections: (a) to (c);
Chapter 13: Sections: (a) to (d).

UNIT – V: THE VAN KAMPEN THEOREM

G-Coverings from the Universal Covering – Patching Coverings together – The Van Kampen Theorem.

Cohomology: Patching Coverings and Cech cohomology – Cech Cohomology and Homology – De Rham Cohomology and Homology – Proof of Mayer – Victoris fro De Rham Cohomology.

Chapter 14: Sections: (a) to (d); Chapter 15: Sections: (a) to (d)

BOOK FOR STUDY:

William Fulton- *Algebraic Topology – A First Course*, Springer – Verlag, New York, 1995.

BOOK FOR REFERENCE :

1. M. K. Agoston, *Algebraic Topology – A First Course*. Marcel Dekker, 1992.
2. Satya Deo, *Algebraic Topology*, Hindustan Book Agency, New Delhi, 2003.
3. M. Greenberg and Harper, *Algebraic Topology – A First Course*, Benjamin / Cummings, 1981.
4. C. F. Maunder, *Algebraic topology*, Van Nastrand, New York, 1970.
5. J. R. Munkres, *Topology*, Prentica Hall of India, New Delhi, 2002, [3rd Indian Print].

OUTCOME OF LEARNING:

Students acquire knowledge in basic concepts of algebraic topology and develop to solve problems in topics in mathematics.

BHARATHI WOMEN'S COLLEGE (AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – III STOCHASTIC PROCESSES
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 5
CREDITS : 4

SEMESTER :III
SUBJECT CODE: 19EA9

OBJECTIVES : This course aims to introduce advanced topics in Markov process, Markov chains and Renewal theory.

UNIT – I : STOCHASTIC PROCESSES

Specification of stochastic processes – stationary processes – Markv Chains : Definitions and Examples – Higher transition probabilities – Generalization of independent Bernoulli trials.

Chapter 2 : 2.1 to 2.4; Chapter 3 : 3.1 to 3.3

UNIT - II : MARKOV CHAINS

Stability of Markov system – Graph theoretic approach – Markov chain with denumerable number of state – Reducible chains – Statistical inference for Markov chains.

Chapter 3 : 3.6 to 3.10

UNIT - III: MARKOV PROCESS WITH DISCRETE STATE SPACE

Poisson process: Poisson process and related distributions – Generalizations of Poisson process – Birth and death process – Markov process with discrete state space (Continuous time Markov chain).

Chapter 4 : 4.1 to 4.5

UNIT - IV: MARKOV PROCESS WITH CONTINUOUS STATE SPACE

Brownian motion – Weiner process – Differential equations for Weiner Process – Kolmogorov equations – First passage time distribution for Weiner process.

Chapter 5 : 5.1 to 5.5

UNIT - V : RENEWAL PROCESS AND THEORY

Renewal process and renewal equation – Stopping time – Wald's equation – Renewal theorem – Delayed and equilibrium renewal process.

Chapter 6 : 6.1 to 6.6

BOOK FOR STUDY :

J. Medhi, *Stochastic Processes* (2nd Edition), New Age International, 1992.

BOOK FOR REFERENCE :

1. S. Karlin, *A first course in Stochastic Processes*, (2nd Edition), Academic Press, 1958.
2. U.N. Bhat, *Elements of Applied Stochastic Prcesses*, John Wiley Sons, 1972.
3. E. Cinlar, *Introduction to Stochastic Processes*, PHI, 1975.

OUTCOME OF LEARNING : Students developed their skill to solve problems in advanced topics in Markov process, Markov chains and Renewal theory.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
SUPPORTIVE ELECTIVE PAPER II
FORMAL LANGUAGES & AUTOMATA

(For the students admitted from the year 2019-2020)

HOURS/WEEK : 4 **SEMESTER :III**
CREDITS : 3 **SUBJECT CODE: 19SA2**

OBJECTIVES

The objective of this course is to explore the theoretical foundations of computer science from the perspective of formal languages of different kinds such as regular and context-free languages and to define mathematical methods of computing devices namely Finite Automata.

UNIT I

Phrase-Structure languages, Closure properties: Four types of grammars, Chomskian hierarchy.
Chapter 2: Sections 2.1 – 2.4.

UNIT II

Closure operations, Derivation trees, Ambiguity.
Chapter 3: Sections 3.1, 3.2, Chapter 4: Sections 4.1, 4.2.

UNIT III

Normal form of CFG, Property of CFL- Auxiliary lemmas, Chomsky Normal form, u-v theorem.
Chapter 4: Sections 4.3, 4.4 (upto Theorem 4.1 and examples 4.10, 4.11, 4.12), 4.5 (up to Theorem 4.3 and example 4.15)

UNIT IV

Finite State Automata: Finite Automaton, Non-Deterministic Finite Automaton, Finite Automata and Regular sets.
Chapter 5: Sections 5.1, 5.2.

UNIT V

Closure properties of Regular sets - Characterization of the family of Regular sets.
Chapter 5: Sections 5.3, 5.4

BOOK FOR STUDY

Rani Siromoney, *Formal Languages and Automata,* CLS, 1984

BOOKS FOR REFERENCE

1. D.P. Acharjya, *Theory of Computation*, MJP Publications, 2010.
2. Peter Linz, *An Introduction to Formal Languages and Automata*, Narosa Publications, 4th Edn, 2010.
3. Kamala Krithivasan and R. Rama, *Introduction to Formal Languages, Automata Theory and Computation*, Pearson, Chennai, 2011.
4. T. Veerarajan, *Discrete Mathematics with Graph Theory and Combinatorics,* McGraw Hill Education (India) Private Ltd.

OUTCOME OF LEARNING

Students will be able to explain and manipulate the different concepts in automata theory and formal languages.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - XII COMPLEX ANALYSIS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER : IV**
CREDITS : 5	**SUBJECT CODE: 19MAM**

OBJECTIVE

To study General Form of Cauchy's Theorem, Evaluation of Definite Integrals and Harmonic functions, Riemann Zeta Function, Elliptic Functions and Weierstrass Theory.

UNIT I

General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions.
Chapter 4: Section: 4.1 – 4.7

UNIT II

The Calculus of Residues and Harmonic functions: The Residue Theorem, The Argument Principle, Evaluation of Definite Integrals, Definition of Harmonic functions and Basic Properties – Mean - Value Property – Poisson's formula – Schwarz's Theorem.
Chapter 4: Sections: 5.1 to 5.3 and 6.1 to 6.4

UNIT III

Partial Fractions, Factorization and Entire functions: Partial Fractions – Infinite Products - Canonical Products – Gamma Function – Stirling's Formula – Jensen's Formula – Hadamard's Theorem.
Chapter 5: Sections: 2.1 to 2.5 and 3.1 to 3.2

UNIT IV

Riemann Zeta Function: Product Development - Extension of □(S) to the Whole Plane – The Functional Equation - The Zeros of Zeta Function.
Chapter 5: Sections: 4.1 to 4.4

UNIT V

Elliptic Functions: Simply Periodic Functions - Doubly Periodic Functions - The Weierstrass $\mathcal{P}$-function - The functions $\zeta(z)$ and $\sigma(z)$- The differential equation - The modular function $\lambda(\tau)$ - The Conformal mapping by $\lambda(\tau)$
Chapter 7: Sections: 1.1 to 1.3; 2.1 to 2.4 and 3.1 to 3.3

BOOK FOR STUDY

Lars V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw Hill Book Company, New York, 1979.

BOOKS FOR REFERENCES:

1. John. B. Conway, *Functions of One Complex Variable*, Springer International Student Edition, Narosa Publishing House, 1980.
2. H. A. Priestly, *Introduction to Complex Analysis*, Clarendon Press, Oxford, 1990
3. M. Heins, *Complex Function Theory,* Academic Press, New York 1968.
4. S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing Pvt.Ltd.

OUTCOME OF LEARNING

Students will be able to apply the methods of Complex Analysis to evaluate definite integrals and to demonstrate understanding deeper aspects of Complex Analysis such as Riemann Zeta Function, Weierstrass $\mathcal{P}$-function.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE PAPER - XIII FUNCTIONAL ANALYSIS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER :IV**
CREDITS : 5	**SUBJECT CODE: 19MAN**

OBJECTIVES

The objective is to provide the basic concepts of normed spaces, Banach spaces which helps to distinguish between finite and infinite dimensional spaces. To study about Hilbert spaces, Spectral theory of operators, Banach algebras which serves as a tool for further research in analysis.

UNIT I

Banach Spaces: The definition and some examples – Holder's inequality – Minkowski's inequality - continuous linear transformations – The Hahn Banach Theorem.
Chapter 9: Sections - 46, 47, 48

UNIT II:

Natural imbedding of N in N ** - The Open Mapping Theorem – Closed graph theorem - The conjugate of an operator - Uniform boundedness theorem.
Chapter 9: Sections – 49, 50, 51.

UNIT III

Hilbert Spaces: The definition and some simple properties – Schwarz inequality - Orthogonal Complements – Orthonormal Sets – Bessel's inequality – Gram-Schmidt orthogonalization process -The conjugate Space H*- The Adjoint of an operator – Self Adjoint Operators.
Chapter 10: Sections – 52, 53, 54, 55, 56, 57.

UNIT IV

Normal and Unitary Operators – Projections – Matrices – Determinants and the spectrum of an operator – The spectral theorem.
Chapter 10: Sections: 58, 59, 60, 61, 62.

UNIT V

Preliminaries on Banach Algebra's: The definition and some examples – Regular and singular elements – Topological divisors of zero, the spectrum – Formula for Spectral radius – The radical and semi-simplicity.
Chapter 10: Sections: 64, 65, 66, 67, 68, 69.

BOOK FOR STUDY

G.F. Simmons, *Introduction to Topology and Modern Analysis*, Mc Graw Hill International Book Company, New York, 2004.

BOOKS FOR REFERENCE

1. W. Rudin, *Functional Analysis*, Tata McGraw Hill Publishing Company, New Delhi 1996.
2. E. Kreyzig, *Introductory Functional Analysis with Application*, John Wiley & Sons, New York, 1978.
3. Dr. D. Somasundaram*, Functional Analysis*, Viswanathan Publishers Pvt Ltd., 1999.

OUTCOME OF LEARNING

Students will be able to understand the application of open mapping theorem, closed graph theorem and the relevance of operator theorem in Banach space and Hilbert spaces.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
APPLICATION ORIENTED PAPER
FUZZY SETS AND THEIR APPLICATIONS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER :IV**
CREDITS : 6	**SUBJECT CODE: 19MAP**

OBJECTIVES

To inculcate the concepts of Fuzzy sets and Fuzzy logic which are powerful mathematical tools for modeling and controlling uncertain systems in industry.

UNIT I

Crisp and Fuzzy Sets: Introduction - Crisp sets- Basic types and concepts of fuzzy sets.
Chapter 1: 1.1-1.4.

UNIT II

Fuzzy Arithmetic and Fuzzy Relations: Fuzzy numbers - Linguistic variables -Arithmetic operations on intervals - Arithmetic operations on fuzzy numbers. Crisp versus fuzzy relations - Projections and cylindrical extensions - Binary fuzzy relations - Binary relations on a single Set - Fuzzy equivalence relations.
Chapter 4: 4.1- 4.4
Chapter 5: 5.1 – 5.5.

UNIT III

Fuzzy Logic: Classical logic – Multivalued logic – Fuzzy propositions – Fuzzy quantifiers.
Chapter 8: 8.1 – 8.4.

UNIT IV

Fuzzy Systems and Pattern Recognition: General discussion - Fuzzy controllers: An overview with an example - Introduction to pattern recognition - Fuzzy clustering - Fuzzy pattern recognition.
Chapter 12: 12.1 - 12.3
Chapter 13: 13.1 – 13.3.

UNIT V

Fuzzy Decision Making: General discussion - Individual decision making - Multiperson decision making -Multicriteria decision making - Multistage decision making - Fuzzy ranking methods.
Chapter 15: 15.1 – 15.6.

BOOK FOR STUDY

George J. Klir and Bo Yuan, *"Fuzzy Sets and Fuzzy Logic Theory and Applications"*, Pearson, 2018

BOOKS FOR REFERENCE

1. H.J. Zimmermann, *Fuzzy Set Theory and its Applications*, Allied Publishers, Chennai, 1996.
2. A. Kaufman*, Introduction to the Theory of Fuzzy Subsets*, Vol, I, Academic Press, New York, 1975.

OUTCOME OF LEARNING

Students will be able to understand the concepts and its applications of Fuzzy sets and Fuzzy logic for modeling and controlling uncertain systems in industry

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE ELECTIVE PAPER - IV PARTIAL DIFFERENTIAL EQUATIONS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6 **SEMESTER :IV**
CREDITS : 5 **SUBJECT CODE: 19EA10**

OBJECTIVES

The aim of the course is to introduce to the students the various types of partial differential equations and how to solve these equations.

UNIT I

First Order Partial Differential Equations: Introduction – Partial Differential Equations of first order in two independent variables - Formulation of first order Partial Differential Equations – Solution of Linear First Order Partial Differential Equations (Lagrange's Method) – Integral Surfaces passing through a given curve – Surface of Orthogonal to a given system of surfaces – Compatibility of first order Partial Differential Equations – Classification of Solutions of first order Partial Differential Equations – Solution of non-linear Partial Differential Equations of First order.
Chapter 1: Section 1.1 – 1.9.

UNIT II

Second order Partial Differential Equations: Origin of second order partial Differential Equations – Linear partial Differential Equations with constant Coefficients – Method of Solving Linear Partial Differential Equations – Classification of Second order Partial Differential Equations- canonical forms.
Chapter 2: Section 2.1 – 2.4.

UNIT III

Elliptic Differential Equations: Boundary Value Problems – Separation of variables – Dirichlet problem for a rectangle – The Neumann Problem for a Rectangle – Interior Dirichlet Problem for a circle.
Chapter 2: Sections: 2.2, 2.5 – 2.8.

UNIT IV

Parabolic Differential Equations: Boundary Conditions – Elementary Solution of Diffusion Equation – Separation of variable method.
Chapter 3: Sections: 3.1, 3.3, 3.5.

UNIT V

Hyperbolic Differential Equations: Derivation of one dimensional wave equation – Solution of one dimensional wave equation by canonical reduction – The Initial value problem – D'Alembert's Solution – Vibrating String – Variable Separable Solution.
Chapter 4: Sections: 4.2 – 4.5.

BOOKS FOR STUDY

1. N.Sharma, Kehar Singh, *Partial Differential Equations for Engineers and Scientists* (For UNIT I &II)
2. K. Sankara Rao, *Introduction to Partial Differential Equations* (For UNIT III, IV and V)

BOOK FOR REFERENCE

M.D.Raisinghania, *Advanced Differential Equation*, S. Chand and Company Ltd.,New Delhi, 2001.

OUTCOME OF LEARNING

Students will be able to know the fundamental concept of PDE, formulate and solve PDE problems in the field of engineering and industrial.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – IV DISCRETE MATHEMATICS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6
CREDITS : 5
SEMESTER :IV
SU BJECT CODE: 19EA11

OBJECTIVES: The course aims to provide the basic concepts in Boolean Algebra, Lattices, Factorial polynomials and Coding theory.

UNIT-I : Lattices: Properties of Lattices: Lattice definitions – Modular and distributive lattice; Boolean algebras: Basic properties – Boolean polynomials, Ideals; Minimal forms of Boolean polynomials.
Chapter 1: Sections: 1(a) and (b) Sections: 2a and b and Sections: 3.

UNIT-II : Applications of Lattices: Switching Circuits: Basic Definitions – Applications.
Chapter 2: Sections:1(a) and (b)

UNIT-III : Finite Fields
Chapter 3: Section: 2

UNIT-IV : Polynomials : Irreducible Polynomials over Finite fields – Factorization of Polynomials.
Chapter 3: Section: 3 and 4.

UNIT-V: Coding Theory : Linear Codes and Cyclic Codes.
Chapter 4: Sections: 1 and 2

BOOK FOR STUDY:
Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra*, Spinger-Verlag, New York, 1984.

BOOK FOR REFERENCE :
1. A.Gill, *Applied Algebra for Computer Science*, Prentice Hall Inc., New Jersey.
2. J.L.Gersting, *Mathematical Structures for Computer Science*(3rd Edn.), Computer Science Press, New York.
3. S.Wiitala, *Discrete Mathematics*- A Unified Approach, McGraw Hill Book Co.

OUTCOME OF LEARNING:
Students will develope their skills to solve problems in Boolean Algebra, Factorial polynomials and Coding theory.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – IV ALGEBRAIC NUMBER THEORY
(For the students admitted from the year 2019-2020)
HOURS/WEEK : 6
CREDITS : 5
SEMESTER :IV
SU BJECT CODE: 19EA12

OBJECTIVES : The course aims to provide a study on modules over rings, finite fields, algebraic extensions, number fields and cyclotomic fields, Noetherian rings and modules and Dedekind rings.

UNIT-I : ALGEBRAIC BACKGROUND

Rings and Fields- Factorization of Polynomials - Field Extensions - Symmetric Polynomials - Modules - Free Abelian Groups.

Chapter 1: Sec. 1.1 to 1.6

UNIT-II : ALGEBRAIC NUMBERS

Algebraic numbers - Conjugates and Discriminants - Algebraic Integers - Integral Bases - Norms and Traces - Rings of Integers.

Chapter 2: Sec. 2.1 to 2.6

UNIT-III : QUADRATIC AND CYCLOTOMIC FIELDS

Quadratic fields and cyclotomatic fields : Factorization into Irreducibles : Trivial factorization - Factroization into irreducibles - Examples of non-unique factorization into irreducibles.

Chapter 3: Sec. 3.1 and 3.2 ; Chapter 4: Sec. 4.2 to 4.4

UNIT-IV: PRIME FACTROIZATION

Euclidean Domains - Euclidean Quadratic fields - Consequences of unique factorization - The Ramanujan -Nagell Theorem.

Chapter 4: Sec. 4.5 to 4.9.

UNIT-V : IDEALS

Prime Factorization of Ideals - The norms of an Ideal - Non-unique Factorization in Cyclotomic Fields..

Chapter 5 : Sec. 5.2 to 5.4

BOOK FOR STUDY:

1.Steward and D.Tall. *Algebraic Number Theory and Fermat's Last Theorem* (3rd edition) A.K.peters Ltd., Natrick, Mass. 2002.

BOOK FOR REFERENCE :

1. I. Niven and Zuckermann H.S. : *An Introduction to the theory of numbers*, Wiley Eastern Ltd. 1972

2. C.Y. Hsiung : *Elementary Theory of Numbers*, Allied Publishers.

OUTCOME OF LEARNING: Students will able to analysis the problems in modules over rings, finite fields, algebraic extensions, number fields and cyclotomic fields, Noetherian rings and modules and Dedekind rings.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108
M.Sc. - MATHEMATICS
CORE ELECTIVE PAPER - V FLUID DYNAMICS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6	**SEMESTER :IV**
CREDITS : 5	**SUBJECT CODE: 19EA13**

OBJECTIVE

To study the concepts of nature of fluids, motion of fluids. Different types of fluid flows are introduced. Discuss Navier -Stokes equation of a viscous fluid and solve different problems.

UNIT I

Kinematics of Fluids in Motion: 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: Section 2.1 to 2.10

UNIT II

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

Chapter 3: Section 3.1 to 3.7

UNIT III

Some Three Dimensional Flows: Introduction – Sources, sink 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 IV

Some Two Dimensional Flows: Meaning of two dimensional flow – Use of cylindrical polar coordinate – application only - the stream function, the complex potential for two dimensional, irrotational in - compressible flow – Complex velocity potential 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 V

Viscous Flows: Stress components in a real fluid – Relations between Cartesian components of stress – Translational motion of fluid elements – The rate of strain quadric and principle stresses – Properties of the rate of strain quadric - Stress analysis in fluid motion – Relation between stress and rate of strain – The coefficient of viscosity and Laminar flow – The Navier – Stokes equations of motion of a viscous fluid.

Chapter 8: Sections 8.1 to 8.9

BOOK FOR STUDY

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

BOOK FOR REFERENCE

Milne – Thomson, *Theoretical Hydrodynamics*, Macmillan, 1949.

OUTCOME OF LEARNING

Students will be able to understand the concepts of nature of fluids, motion of fluids, Different types of fluid flows and Navier -Stokes equation of a viscous fluid.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – V FINANCIAL MATHEMATICS
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6
CREDITS : 5

SEMESTER :IV
SU BJECT CODE: 19EA14

OBJECTIVES : The course aims to introduce mathematics in finance. It gives idea about different models ,binary models, Brownian motion and stochastic calculus.

UNIT-I : Single Period Models : Definitions from Finance – Pricing a forward One step Binary Model – a ternary Model – Characterization of no arbitrage – Risk-Neutral Probability Measure.
Chapter 1 : All sections

UNIT-II : Binomial Trees and Discrete parameter martingales: Multi-period Binary model – American Options – Discrete parameter martingales and Markov processes – Martingale Theorems – Binomial Representation Theorem – Overture to Continuous models.
Chapter 2: All sections

UNIT-III : Brownian Motion : Definition of the process – Levy's Construction of Brownian Motion – The Reflection Principle and Scaling – Martingales in Continuous time.
Chapter 3: All sections

UNIT-IV: Stochastic Calculus : Stock Prices are not differentiable – Stochastic Integration – Ito's formula – Integration by parts and Stochastic Fubini Theorem– Girsanov Theorem – Brownian Martingale Representation Theorem – Geometric Brownian Motion – The Feynman-Kac Representation.
Chapter 4 : All sections

UNIT-V : Block-Scholes Model : Basic Block-Scholes Model – Block-Scholes price and hedge for European Options – Foreign Exchange – Dividends – Bonds – Market price of risk.
Chapter 5: All sections

BOOK FOR STUDY:

Alison Etheridge, *A Course in Financial Calculus*, Cambridge University Press, Cambridge, 2002.

BOOK FORREFERENCE:

1. Martin Boxter and Andrew Rennie, Financial Calculus : *An Introduction to Derivatives Pricing*, Cambridge University Press, Cambridge, 1996.
2. Damien Lamberton and Bernard Lapeyre, (Translated by Nicolas Rabeau and Farancois Mantion),*Introduction to Stochastic Calculus Applied to Finance*, Chapman and Hall, 1996.

OUTCOME OF LEARNING: Students acquire knowledge in financial mathematics and stochastic calculus.

BHARATHI WOMEN'S COLLEGE(AUTONOMOUS),CHENNAI-600 108.
M.Sc. – MATHEMATICS
CORE ELECTIVE PAPER – V MATHEMATICAL MODELLING
(For the students admitted from the year 2019-2020)

HOURS/WEEK : 6
CREDITS : 5
SEMESTER :IV
SU BJECT CODE:19EA15

OBJECTIVES

This course aims to introduce mathematical modelling through, systems of ordinary differential equations, difference equations, graphs, calculus of variations and dynamical programming.

UNIT – I: MODELLING THROUGH SYSTEMS OFFIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS

Mathematical modelling in Population Dynamics – Mathematical Modelling of Epidemics 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 3:3.1, 3.2, 3.5, 3.6

UNIT – II: MODELLING THROUGH DIFFERENCE EQUATIONS

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: 5.1 – 5.3

UNIT – III: MODELLING THROUGH DIFFERENCE EQUATIONS

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: 5.4 – 5.6

UNIT – IV: GRAPHS AS MODELS

Situations that can be Modelled Through Graphs – Mathematical Models in Terms of Directed Graphs – Mathematical Models in Terms of Signed Graphs – Mathematical Modelling in Terms of Weighted Digraphs. Chapter 7: 7.1 – 7.4

UNIT – V: MODELLING THROUGH CALCULUS OF VARIATIONS AND DYNAMIC PROGRAMMING

Optimization Principles and Techniques – Mathematical Modelling Through Calculus of Variations – Mathematical Modelling Through Dynamic Programming. Chapter 9: 9.1 – 9.3

BOOK FOR STUDY:

J.N. Kapur, *Mathematical Modelling*, Wiley Eastern Limited, Reprint 2000.

BOOK FORREFERENCE :

1. D.J. G. James and J.J. Macdonald, *Case studies in Mathematical modelling*, Stanly Thames, Cheltonham.
2. J.N. Kapur, *Maximum entropy models*.

OUTCOME OF LEARNING: Students will able to develop their skills to solve different mathematical modeling.