DEPARTMENT OF MATHEMATICS
ANNA UNIVERSITY, CHENNAI

VISION
We, at the Department of Mathematics, Anna University, Chennai, shall strive constantly to
• Achieve excellence in Mathematics education by providing high quality teaching, research and training in Mathematics to all our students to significantly contribute in the fields of Mathematics, Computer Science and all related Engineering fields.
• Contribute to the quality Human Resource Development in Mathematics and Computer Science through our effective Masters and Research Programmes.

MISSION
• To provide strong Mathematical background to Engineering Students to cope up with the needs of emerging technologies both at National and International levels.
• To popularize and to project the proper perspective of Mathematics and Computer Science towards attracting young talents to take up teaching and research careers in Mathematical Sciences.
ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M. Phil. MATHEMATICS (FT)
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM

1. **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

   I. To provide training in advanced topics of Mathematics to professionally carry out Ph. D level research.
   II. To provide deeper knowledge for demonstrating the advanced principles of modern mathematics.
   III. To provide creative and critical thinking in specialized research topics.
   IV. To provide training in undertaking project work, so as to analyze and solve the problem independently.
   V. To provide training for making technical presentation and publishing results in any chosen topic related to the field of specialization.

2. **PROGRAMME OUTCOMES (POs):**

   After going through the one years of study, our M.Phil Students will exhibit ability to:

<table>
<thead>
<tr>
<th>PO#</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering knowledge</td>
<td>Apply knowledge of mathematics, basic science and engineering science.</td>
</tr>
<tr>
<td>2</td>
<td>Problem analysis</td>
<td>Identify, formulate and solve engineering problems.</td>
</tr>
<tr>
<td>3</td>
<td>Design/development of solutions</td>
<td>Design a system or process to improve its performance, satisfying its constraints.</td>
</tr>
<tr>
<td>4</td>
<td>Conduct investigations of complex problems</td>
<td>Conduct experiments &amp; collect, analyze and interpret the data.</td>
</tr>
<tr>
<td>5</td>
<td>Modern tool usage</td>
<td>Apply various tools and techniques to improve the efficiency of the system.</td>
</tr>
<tr>
<td>6</td>
<td>The Engineer and society</td>
<td>Conduct themselves to uphold the professional and social obligations.</td>
</tr>
<tr>
<td>7</td>
<td>Environment and sustainability</td>
<td>Design the system with environment consciousness and sustainable development.</td>
</tr>
<tr>
<td>8</td>
<td>Ethics</td>
<td>Interaction with industry, business and society in a professional and ethical manner.</td>
</tr>
<tr>
<td>9</td>
<td>Individual and team work</td>
<td>Function in a multi-disciplinary team.</td>
</tr>
<tr>
<td>10</td>
<td>Communication</td>
<td>Proficiency in oral and written Communication.</td>
</tr>
<tr>
<td>11</td>
<td>Project management and finance</td>
<td>Implement cost effective and improved system.</td>
</tr>
<tr>
<td>12</td>
<td>Life-long learning</td>
<td>Continue professional development and learning as a life-long activity.</td>
</tr>
</tbody>
</table>
3. **PROGRAMME SPECIFIC OUTCOMES (PSOs):**

By the completion of the M.Phil programme in Mathematics the student will have the following Programme specific outcomes.

1. To be able to demonstrate advanced principles of Mathematics.
2. To be able to identify the research level problems in the area of their research interest.
3. To be able to utilize appropriate mathematical tools for solving research level or real world problems.
4. To be able to critically analyse the possible solutions of the emerging mathematical research problems.

4. **PEO / PO Mapping:**

<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>I</td>
<td>✓</td>
</tr>
<tr>
<td>II</td>
<td>✓</td>
</tr>
<tr>
<td>III</td>
<td>✓</td>
</tr>
<tr>
<td>IV</td>
<td>✓</td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>
# Mapping of Course Outcome and Programme Outcome

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Semester</th>
<th>Course Name</th>
<th>PO01</th>
<th>PO02</th>
<th>PO03</th>
<th>PO04</th>
<th>PO05</th>
<th>PO06</th>
<th>PO07</th>
<th>PO08</th>
<th>PO09</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Algebra and Analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Advanced Differential Equations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Elective I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Elective II</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Project Work</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

---

*Attested*

**D. IYAPPAN**

Centre for Academic Courses
Anna University, Chennai-600 025
# CURRICULA AND SYLLABI

## M.Phil. MATHEMATICS (FT) REGULATIONS - 2019

### CHOICE BASED CREDIT SYSTEM

## SEMESTER I

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L   T  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td></td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1.</td>
<td>MX5101</td>
<td>Algebra and Analysis</td>
<td>PCC</td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>MX5102</td>
<td>Advanced Differential Equations</td>
<td>PCC</td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Program Elective I</td>
<td>PEC</td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td></td>
<td>12  0  0</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

## SEMESTER II

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L   T  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td></td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Program Elective II</td>
<td>PEC</td>
<td>4   0  0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>MX5211</td>
<td>Dissertation</td>
<td>EEC</td>
<td>0   0  32</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td></td>
<td>4   0  32</td>
<td>36</td>
<td>20</td>
</tr>
</tbody>
</table>

Total No. of Credits : 32

## PROGRAM CORE COURSES (PCC)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L   T  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>MX5101</td>
<td>Algebra and Analysis</td>
<td>4   0  0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>MX5102</td>
<td>Advanced Differential Equations</td>
<td>4   0  0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Credits</td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>S. No</td>
<td>COURSE CODE</td>
<td>COURSE TITLE</td>
<td>CATEGORY</td>
<td>CONTACT PERIODS</td>
<td>L</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>---------------------------------------------------</td>
<td>----------</td>
<td>----------------</td>
<td>---</td>
</tr>
<tr>
<td>1.</td>
<td>MX5001</td>
<td>Abstract Harmonic Analysis</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>MX5002</td>
<td>Advanced Analysis</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>MX5003</td>
<td>Advanced Number Theory and Cryptography</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>MX5004</td>
<td>Advances in Graph Theory</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>MX5005</td>
<td>Algebraic Theory of Semigroups</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>MX5006</td>
<td>Applied Combinatorics</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>MX5007</td>
<td>Approximation Theory</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>MX5008</td>
<td>Basic Hypergeometric Series</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>MX5009</td>
<td>Boundary Layer Flows</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>MX5010</td>
<td>Characteristic Classes</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>MX5011</td>
<td>Differential Topology</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>MX5012</td>
<td>Finite Element Method</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>MX5013</td>
<td>Finite Volume Method</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>MX5014</td>
<td>Fixed Point Theory and its Applications</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>15.</td>
<td>MX5015</td>
<td>Fluid Mechanics</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td>MX5016</td>
<td>Fractional Differential Equations</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>17.</td>
<td>MX5017</td>
<td>Functional Analysis and its Applications to Partial Differential Equations</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>18.</td>
<td>MX5018</td>
<td>Fundamentals of Chemical Graph Theory</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>19.</td>
<td>MX5019</td>
<td>Fuzzy Analysis, Uncertainty Modeling and Applications</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>20.</td>
<td>MX5020</td>
<td>Fuzzy Sets and Applications</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>21.</td>
<td>MX5021</td>
<td>Fuzzy Sets and Systems</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>22.</td>
<td>MX5022</td>
<td>Generalized Inverses</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>23.</td>
<td>MX5023</td>
<td>Harmonic Analysis</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>24.</td>
<td>MX5024</td>
<td>Heat and Mass Transfer</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>25.</td>
<td>MX5025</td>
<td>Homology and Cohomology</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>26.</td>
<td>MX5026</td>
<td>Introduction to Algebraic Topology</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>27.</td>
<td>MX5027</td>
<td>Introduction to Fibre Bundles</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>28.</td>
<td>MX5028</td>
<td>Introduction to Lie Algebras</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>29.</td>
<td>MX5029</td>
<td>Mathematical Aspects of Finite Element Method</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>30.</td>
<td>MX5030</td>
<td>Mathematical Finance</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>31.</td>
<td>MX5031</td>
<td>Mathematical Statistics</td>
<td>PEC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sl.No</td>
<td>COURSE CODE</td>
<td>COURSE TITLE</td>
<td>PERIODS PER WEEK</td>
<td>CREDITS</td>
<td>SEMESTER</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>--------------</td>
<td>------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1</td>
<td>MX5211</td>
<td>Dissertation</td>
<td>0</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUMMARY**

<table>
<thead>
<tr>
<th>M. Phil. Mathematics</th>
<th>Credits per Semester</th>
<th>Credits Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject Area</strong></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1. PCC</td>
<td>08</td>
<td>00</td>
</tr>
<tr>
<td>2. PEC</td>
<td>04</td>
<td>04</td>
</tr>
<tr>
<td>3. EEC</td>
<td>00</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total Credit</strong></td>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

Attested

[Signature]

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
OBJECTIVES:
- To introduce the advanced topics in algebra such as module.
- To study the classification and structure of module algebra.
- To learn about complex functions and complex integration on measurable space.
- To study about holomorphic functions and its properties over complex space.
- To know more about harmonic functions and Arzela-Ascoli theorem.

UNIT I  MODULES

UNIT II  STRUCTURE OF MODULES

UNIT III  ABSTRACT INTEGRATION
The concept of measurability – Simple functions – Elementary properties of measures – Integration of positive functions – Integration of complex functions – The role played by the sets of measure zero.

UNIT IV  ELEMENTARY PROPERTIES OF HOLOMORPHIC FUNCTIONS

UNIT V  HARMONIC FUNCTIONS
The Cauchy-Riemann Equations - The Poisson Integral - The mean value property - Arzela-Ascoli Theorem.

OUTCOMES:
- The students are capable of handling the advanced topics in algebra.
- Ability to understand and apply algebraic structures in other area of Mathematics.
- Students will be knowledgeable on abstract integration.
- Students will understand the properties of analytic functions and use it to evaluate the integrals.
- Students will get more idea about harmonic function and its applications.

REFERENCES
OBJECTIVES:

- To familiarize in various types of linear equations.
- To understand the method of solving equations with periodic coefficients.
- To understand the concept of stability analysis.
- To understand the concept of partial differential equations.
- To solve nonlinear partial differential equations.

UNIT I  
LINEAR EQUATIONS  
Uniqueness and existence theorem for a linear system - Homogeneous linear systems - Inhomogeneous linear systems - Second-order linear equations - Linear equations with constant coefficients problems.

UNIT II  
LINEAR EQUATIONS WITH PERIODIC COEFFICIENTS  
Floquet theory - Parametric resonance - Perturbation methods for the Mathieu equation - The Mathieu equations with damping problems.

UNIT III  
STABILITY  

UNIT IV  
PARTIAL DIFFERENTIAL EQUATIONS  

UNIT V  
NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS  

OUTCOMES:
After completing this course, the students will be able to

- Solve the linear differential equations with constant coefficients.
- Solve the linear differential equations with the periodic coefficients in Perturbation methods.
- Analysis the stability of the given ordinary differential equations.
- Solve Partial differential equations with given conditions.
- Solve nonlinear partial differential equations in application of real life problems.

REFERENCES:

TOTAL: 60 PERIODS
OBJECTIVES

- To give a comprehensive overview of harmonic analysis and its applications to all areas of mathematical sciences.
- To introduce compact and locally compact abelian groups.
- To introduce Haar measure and the invariant means.
- To introduce convolutions of functions and measures.
- To introduce duality theorem.

UNIT I  TOPOLOGICAL GROUPS  12
Topological group and its basic properties - Subgroups and quotient groups - Product groups and projective limits - Properties of topological groups involving connectedness - Invariant pseudo-metrics and separation axioms.

UNIT II  STRUCTURE THEOREMS  12
Structure theory for compact and locally compact Abelian groups - Some special locally compact Abelian groups.

UNIT III  HAAR MEASURE  12
The Haar integral - Haar measure - Invariant means defined for all bounded functions - Invariant means on almost periodic functions.

UNIT IV  UNITARY REPRESENTATIONS  12
Convolutions - Convolutions of functions and measures - Elements of representation theory. Unitary representations of locally compact groups.

UNIT V  DUALS  12
The character group of a locally compact Abelian group and the duality theorem.

TOTAL: 60 PERIODS

OUTCOMES

- To familiarize the students with topological groups, Haar, measures and convolutions in the harmonic analysis.
- The student will gain understanding of structure theorems.
- The student will get to know about Haar measure and the invariant means on almost periodic functions.
- The student will be able to understand about the elements of representation theory.
- The student will learn about the duality in locally compact Abelian groups.

REFERENCES

OBJECTIVES
- Real Analysis is the fundamental course behind almost all other branches of Mathematics.
- The aim of the course is to make the students understand the basic and advanced concepts of Real analysis.
- To introduce Lebesgue measure and the Fundamental Theorem of Calculus.
- To introduce the Fourier Transforms.
- To introduce the Holomorphic Fourier Transforms.

UNIT I  L^P SPACES  12

UNIT II  COMPLEX MEASURES  12
Total variation - Positive and negative variation - Absolute Continuity - Radon Nikodym theorem - Bounded linear functional in L^p - Riesz representation theorem.

UNIT III  DIFFERENTIATION  12
Derivatives of measures Lebesgue points - Metric density - Fundamental theorem of calculus - Differentiable transformations.

UNIT IV  FOURIER TRANSFORMS  12

UNIT V  HOLOMORPHIC FOURIER TRANSFORM  12
Two theorems of Paley and Wiener - Quasi Analytic classes - Denjoy-Carleman Theorem.

OUTCOMES
- The students get introduced to the classical Banach spaces.
- The students will get good understanding of methods of decomposing signed measures which has applications in probability theory and Functional Analysis.
- The students will be able to use measure theory for differentiation.
- The students will get good understanding of Fourier Transform and its Holomorphic extensions.
- The students will be able to analyze Holomorphic Fourier Transforms.

REFERENCES
OBJECTIVES:
- To introduce congruences and solving congruences
- To introduce quadratic residues, Jacobi symbol and different important functions in number theory
- To introduce diophantine equations and Waring’s problem
- To introduce traditional symmetric key ciphers
- To introduce asymmetric key cryptography

UNIT I CONGRUENCES
Congruences, Solutions of congruences, congruences of deg 1, The function \(0(n)\) - Congruences of higher degree, Prime power moduli, Prime modulus, congruences of degree 2, Prime modulus, Power residues.

UNIT II QUADRATIC RESIDUES
Quadratic residues, Quadratic reciprocity, The Jacobi symbol, greatest integer function, arithmetic function, The Mobius Inversion formula, The multiplication of arithmetic functions.

UNIT III DIOPHANTINE EQUATIONS
Diophantine equations, The equation \(ax + by = c\), Positive solutions, Other linear Equations, Sums of four and five squares, Waring’s problem, sum of fourth powers, sum of two Squares.

UNIT IV TRADITIONAL SYMMETRIC – KEY CIPHERS
Substitution Ciphers – Transportation Ciphers – Stream and Block Ciphers – Modern Block Ciphers – Modern Stream Ciphers – DES – AES.

UNIT V ASYMMETRIC KEY CRYPTOGRAPHY

OUTCOMES:
- Students would have learnt to solve congruences and compute power residues
- Students will be able to apply quadratic reciprocity law and the Mobius inversion formula in cryptography
- The student will be able to solve diophantine equations and Waring’s problem
- The student would have learnt about traditional and modern stream and Block ciphers
- The student will be equipped to deal with advanced crypto systems like elliptic curve cryptosystem

REFERENCES
MX5004 ADVANCES IN GRAPH THEORY

Prerequisite: Graph Theory

OBJECTIVE
- To introduce advanced topics in Graph Theory.
- To study Graph Theory based tools in solving practical problems.
- To understand the concepts of connectivity and colorings in Graphs.
- To understand the connection between Graph Theory and Geometry.
- To relate properties of Graphs with the spectral properties of associated matrices.

UNIT I CONNECTIVITY IN GRAPHS
Vertex connectivity – Edge connectivity – Blocks – k-connected and k-edge connected graphs – Network flow problems.

UNIT II COLORING OF GRAPHS
Vertex colorings and upper bounds – Brooks’ theorem – Graphs with large chromatic number – Turan’s theorem – Counting proper colorings – Edge colouring – Characterization of line graphs.

UNIT III PLANAR GRAPHS
Embeddings and Euler’s formula – Dual graphs – Kuratowski’s theorem – 5 colour theorem – Crossing number – Surface of higher genus.

UNIT IV MATCHINGS AND COVERS IN GRAPH
Maximum Matchings, Hall’s Matching Condition, Min-Max Theorems, Independent Sets and Covers, Dominating Sets.

UNIT V EIGENVALUES OF GRAPHS
The characteristic polynomial – Linear algebra of real symmetric matrices – Eigenvalues and graph parameters – Eigenvalues of regular graphs – Strongly regular graphs.

TOTAL: 60 PERIODS

OUTCOME
After successful completion of the course, students will be able to:
- investigate research problems in Graph Theory.
- write research papers on Graph Theory in a technical manner.
- apply Graph Theory based tools in solving practical problems.
- verify whether a given graph is planar.
- relate properties of Graphs with the spectral properties of associated matrices.

REFERENCES
MX5005  ALGEBRAIC THEORY OF SEMIGROUPS  L T P C
4 0 0 4

Prerequisite: An introductory course in Algebra

OBJECTIVES:
- To introduce the branch of Algebraic concepts developed on Semi groups
- To know about more classes of Semigroups,
- To introduce the concept of bands and variety of bands.
- To learn about inverse semigroup and inverse semigroup.
- To study more about auto uniform semi lattices.

UNIT I  SEMIGROUPS  12
Monogenic semigroups – Ordered sets, semi lattices and lattices Binary relations, equivalences
The structure of D classes – Regular D-classes – Regular semi groups.

UNIT II  SIMPLE SEMIGROUPS  12
Certain classes of semigroups – O-Simple semigroups – Principal factors – Primitive Idempotents –
Congruences on completely simple O – semigroups.

UNIT III  BANDS  12

UNIT IV  INVERSE SEMIGROUPS AND SIMPLE INVERSE SEMIGROUPS  12
Inverse semigroups – Natural order relation on an inverse semi group – Congruence in Inverse
semigroup – Bisimple inverse semigroups – Simple inverse semigroups.

UNIT V  SEMI LATTICES  12
Fundamental inverse semigroups – auto uniform semi lattices.

TOTAL: 60 PERIODS

OUTCOMES:
- Students would have learnt the basics of semi group theory
- Students would have got the the idea of congruences on semi group.
- Students will understand the relation of groups and lattices,
- Students will be knowledgeable about inverse semigroups.
- Students would have learnt about some important applications of semilattices.

REFERENCES

MX5006  APPLIED COMBINATORICS  L T P C
4 0 0 4

OBJECTIVE
- To introduce combinatorial techniques such as generating functions.
- To introduce Polya’s Theorem to enumerate discrete combinatorial objects of a given type.
- To arrange elements of a finite set into patterns according to specified rules.
- To introduce codes and its applications in communication.
- To introduce combinatorial techniques to solve discrete optimization problems
UNIT I  TOOLS OF COMBINATORICS 12

UNIT II  POLYA THEORY OF COUNTING 12

UNIT III  COMBINATORIAL DESIGNS 12
Balanced incomplete block designs – Necessary condition for existence of \((b, r, k, \lambda)\) designs. Resolvable designs – Steiner triple systems – Symmetric balanced incomplete block designs.

UNIT IV  CODING THEORY 12
Encoding and decoding – Error correcting codes – Linear codes – Use of block designs to find error correcting codes.

UNIT V  COMBINATORIAL OPTIMIZATION 12

OUTCOME
After successful completion of the course, students will be able to:
- apply combinatorial techniques in design theory, coding theory and optimization problems.
- use generating functions to solve a variety of combinatorial problems.
- apply Polya’s Theorem to enumerate discrete combinatorial objects of a given type.
- use codes in communication problems.
- solve discrete optimization problems.

REFERENCES

MX5007 APPROXIMATION THEORY L T P C 4 0 0 4
Prerequisite: A basic course in Analysis

OBJECTIVES
- To introduce the basic concepts of approximation theory and its applications.
- To introduce the concept of Chebyshev polynomials.
- To introduce various interpolation methods.
- To introduce Characterization and Duality.
- To introduce projection and its various properties.
UNIT I  APPROXIMATION IN NORMED LINEAR SPACES  12

UNIT II  CHEBYSHEV POLYNOMIALS  12

UNIT III  INTERPOLATION  12

UNIT IV  BEST APPROXIMATION IN NORMED LINEAR SPACES  12
Introduction - Approximative properties of sets - Characterization and Duality.

UNIT V  PROJECTION  12
Continuity of metric projections - Convexity, Solarity and Chebyshevy of sets - Best simultaneous approximation.

TOTAL: 60 PERIODS

OUTCOMES
- The course enables the students to gain better knowledge on topics like interpolation, best approximation and projection.
- The students gain knowledge in Chebyshev polynomials and its properties.
- The students will be able to approximate using different interpolation techniques.
- The students will get to know about approximating in normed linear spaces.
- The students will be able to know about projections and simultaneous approximation.

REFERENCES

MX5008 BASIC HYPERGEOMETRIC SERIES L T P C  4 0 0 4

Prerequisite: Complex Analysis

OBJECTIVES
- To introduce an extension of Beta, Gamma functions.
- To introduce Hypergeometric series and its properties.
- To introduce summation formula and also transformation formula.
- To introduce bilateral hypergeometric series.
- To develop the above on q-analogue and their applications on theta and elliptic functions.
UNIT I  INTRODUCTION TO Q-SERIES
A q-Analogue of Differentiation and Integration – Simple q-Differentiation and q-Integration Formulae – The q-Binomial Theorem – q-Exponential Functions – q-Analogue of Circular Functions – q-Gamma and q-Beta Functions.

UNIT II  BASIC HYPERGEOMETRIC SERIES

UNIT III  SUMMATION AND TRANSFORMATION FORMULAS

UNIT IV  BILATERAL BASIC HYPERGEOMETRIC SERIES

UNIT V  THETA AND ELLIPTIC FUNCTIONS

TOTAL: 60 PERIODS

OUTCOMES
- The students have learnt the q-analogue along with an extension of Concepts of Beta, Gamma function and its application on elliptic and theta functions.
- The students will gain an understanding about hypergeometric and Q-hypergeometric series.
- The students will get to know summation and transformation formulae.
- The students will get introduced to bilateral hypergeometric series.
- The students will be able to apply the above for theta and elliptic functions.

REFERENCES

MX5009  BOUNDARY LAYER FLOWS
L T P C
4 0 0 4

OBJECTIVES
- To give a comprehensive overview of the boundary layer theory.
- To demonstrate the application of the theory to all areas of fluid mechanics with emphasis on the laminar flow past bodies.
- To enable the students derive the boundary layer equations and study their properties.
- To show how to obtain exact and approximate solutions for specific boundary layer flows.
- To enable the students understand the turbulent boundary layer flows.
UNIT I DERIVATION AND PROPERTIES OF NAVIER-STOKES EQUATIONS 12

UNIT II EXACT SOLUTIONS 12
Hagen – Poiseuille theory – Flow between two concentric rotating cylinders – Couette Motion – Parallel flow – Other exact solutions.

UNIT III BOUNDARY LAYER EQUATIONS AND THEIR PROPERTIES 12
Derivation of boundary layer equations – Separation – Skin friction – Boundary layer along a flat plate – Characteristics of a boundary layer - Similar solutions – Transformation of the boundary layer equations – Momentum and integral equations.

UNIT IV EXACT AND APPROXIMATE METHODS 12
Exact solutions of boundary layer equations – Flow past a wedge - Flow past a cylinder – Approximate methods – Application of the momentum equation – Von Karman and Pohlhausen method – Comparison – Methods of boundary layer control.

UNIT V TURBULENT BOUNDARY LAYERS 12

TOTAL: 60 PERIODS

OUTCOMES
At the end of the course, the students will be able to
• derive the governing equations of any flow problem.
• determine the exact solutions for flows in specific geometries.
• formulate the boundary layer flows and analyze their properties.
• solve the boundary layer flows using exact and approximate methods.
• formulate the turbulent boundary layer flows and study their properties.

REFERENCES

MX5010 CHARACTERISTIC CLASSES L T P C
4 0 0 4

Pre-requisites: A basic course in Algebraic topology including homology and cohomology and basic knowledge of smooth manifolds

OBJECTIVES:
• To introduce the notion of a vector bundle
• To introduce the Stiefel-Whitney cohomology classes of a vector bundle through axiomatic definition and study their properties
• To prove the existence and uniqueness of Stiefel-Whitney classes
• To study about the Euler classes and the Chern classes
• To introduce Pontrjagin classes and the relations between Chern classes and Pontrjagin class and the Euler class
UNIT I VECTOR BUNDLES 12
Vector bundles, the tangent bundle and normal bundle of a smooth manifold, Euclidean vector spaces, Construction of new vector bundles from the old.

UNIT II STIEFEL WHITNEY CLASSES 12
Axiomatic definition of Stiefel Whitney classes, Whitney product theorem and Whitney duality theorem, parallelizability and immersion of projective spaces, Stiefel Whitney numbers and applications to cobordism.

UNIT III EXISTENCE AND UNIQUENESS OF STIEFEL WHITNEY CLASSES 12
Thom isomorphism and Stiefel Whitney classes, Grassmann manifolds and universal bundles, cell structure for Grassmann manifolds, mod 2 cohomology of infinite real Grassmann manifolds, uniqueness of Stiefel Whitney classes.

UNIT IV CHERN CLASSES 12
Euler classes, construction of Chern classes, the integral cohomology ring of an infinite complex Grassmannians, product theorem for Chern classes, dual bundles, total Chern class of the tangent bundle of complex projective space.

UNIT V PONTRJAGIN CLASSES 12
Complexification of a real vector bundle, Pontrjagin classes, Chern classes and Pontrjagin classes, Pontrjagin class and the Euler class, the cohomology of the oriented Grassmann manifold, Chern numbers, Pontrjagin numbers.

TOTAL: 60 PERIODS

OUTCOMES
- Students would have learnt about vector bundles in detail
- Students would have gained knowledge about Steifel-Whitney classes, Stiefel-Whitney numbers and their applications
- Students would have learnt how to prove the existence of Steifel-Whitney classes using Thom isomorphism and their uniqueness using the mod 2 cohomology ring of an infinite real Grassmannian
- Students would have learnt about the construction of Chern classes and their computations for some important bundles
- Students would have learnt about Pontrjagin classes, computation of the cohomology of oriented Grassmann manifolds and about Chern numbers and Pontrjagin numbers

REFERENCES

MX5011 DIFFERENTIAL TOPOLOGY L T P C
Prerequisite: Topology

OBJECTIVES
- To introduce smooth manifolds and to do calculus on manifolds.
- To introduce manifolds with boundary and intersection theory.
- To introduce the concept of orientation and oriented intersection theory.
- To introduce the Hopf degree theorem.
- To introduce the notion of smooth manifolds and classify compact one manifolds and smooth compact surfaces.
UNIT I  MANIFOLDS AND MAPS  12
Derivatives and tangents-inverse function theorem and immersions-submersions -homotopy and
stability-Sard’s theorem and Morse functions-embedding manifolds in Euclidean space.

UNIT II  TRANSVERSALITY AND INTERSECTION  12
Manifolds with boundary- one manifolds and some consequences – transversality -intersection theory
modulo 2-winding numbers and the Jordan – Brouwer separation theorem.

UNIT III  ORIENTED INTERSECTION THEORY  12
Orientation on manifolds – oriented intersection number-degrees of maps- fundamental theorem of
algebra -Euler characteristic as an intersection number.

UNIT IV  APPLICATIONS OF INTERSECTION THEORY  12
Lefschetz Fixed point theory –Borsuk Ulam theorem – vector fields- isotopy –Hopf degree
degree theorem.

UNIT V  COMPACT SMOOTH SURFACES  12
Morse functions, Morse Lemma, Connected sum, attaching handles, Handle decomposition theorem,
Application to smooth classification of compact smooth surfaces.

TOTAL: 60 PERIODS

OUTCOMES
• Differential manifolds occur in different fields like mathematics, physics, mechanics and
economics.
• A course in differential topology will equip the students with techniques and results required to
solve problems involving manifolds.
• The students will gain an understanding of manifolds with boundary.
• The students will get more knowledge on orientation intersection theory.
• The students will gain a thorough understanding of Hopf Degree theorem.
• The students will be able to gain knowledge about smooth surfaces and application of their
classification.

REFERENCES
2. Milnor J., “Topology from the differentiable view point, Princeton Landmarks in Mathematics”,

MX5012  FINITE ELEMENT METHOD  L T P C
4 0 0 4

Prerequisite: Numerical Analysis

OBJECTIVES
• To introduce the integral formulations and variational methods of solving boundary value
problems.
• To enable the students understand various steps in the finite element method of solution.
• To demonstrate finite element method to solve time-dependent problems in one-dimension.
• To discuss the finite element method to solve time-dependent problems in two-dimensions.
• To make the students analyze various measures of errors, convergence and accuracy of
solution.
UNIT I INTEGRAL FORMULATIONS AND VARIATIONAL METHODS 12
Weighted integral and weak formulations of boundary value problems - Rayleigh-Ritz method - Method of weighted residuals.

UNIT II FINITE ELEMENT ANALYSIS OF ONE-DIMENSIONAL PROBLEMS 12
Discretization of the domain - Derivation of element equations - Connectivity of elements - Imposition of boundary conditions - Solution of equations.

UNIT III EIGENVALUE AND TIME DEPENDENT PROBLEMS IN ONE DIMENSION 12
Formulation of eigenvalue problem - Finite element models - Applications of semi discrete finite element models for time-dependent problems - Applications to parabolic and hyperbolic equations.

UNIT IV FINITE ELEMENT ANALYSIS OF TWO-DIMENSIONAL PROBLEMS 12
Interpolation functions - Evaluation of element matrices - Assembly of element equations - Imposition of boundary conditions - Solution of equations - Applications to parabolic and hyperbolic equations.

UNIT V FINITE ELEMENT ERROR ANALYSIS 12
Interpolation Functions - Numerical Integration and Modeling Considerations - Various measures of errors - Convergence of solution - Accuracy of solution.

TOTAL: 60 PERIODS

OUTCOMES
At the end of the course, the students will be able to
- construct integral formulations of boundary value problems.
- implement Finite Element Method for one-dimensional problems.
- formulate and solve eigenvalue problems and time-dependent problems in one-dimension.
- apply finite element method and solve time dependent problems in two-dimensions.
- perform the finite element error analysis.

REFERENCES

MX5013 FINITE VOLUME METHOD L T P C 4 0 0 4

Prerequisite: Numerical Analysis

OBJECTIVES
- To introduce the ideas of conservation laws and governing equations of fluid flows.
- To demonstrate the finite volume method for diffusion and convection-diffusion problems.
- To present the solution algorithms for momentum equations.
- To exhibit the finite volume methods of solving unsteady flows.
- To extend the above ideas to problems in complex geometries.

UNIT I CONSERVATION LAWS AND BOUNDARY CONDITIONS 12
UNIT II  
FINITE VOLUME METHOD FOR DIFFUSION & CONVECTION-DIFFUSION PROBLEMS  

UNIT III  
SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY LINKED EQUATIONS  
Staggered grid - momentum equations - SIMPLE, SIMPLER, SIMPLEC algorithms - PISO algorithm - Solution of discretised equation: Multigrid techniques.

UNIT IV  
FINITE VOLUME METHOD FOR UNSTEADY FLOWS  
One-dimensional unsteady heat conduction: Explicit - Crank-Nicolson - fully implicit schemes - Implicit method for two and three dimensional problems - transient convection - Diffusion equation and QUICK differencing scheme - Solution procedures for unsteady flow calculations and implementation of boundary conditions.

UNIT V  
METHOD WITH COMPLEX GEOMETRIES  
Body-fitted co-ordinate grids for complex geometries - Cartesian Vs. Curvilinear grids -difficulties in Curvilinear grids - Block-structured grids - Unstructured grids and discretisation in unstructured grids - Discretisation of the diffusion term - Discretisation of convective term -Treatment of source terms - Assembly of discretised equations - Pressure-velocity coupling in unstructured meshes - Staggered Vs. co-located grid arrangements - Face velocity interpolation method to unstructured meshes.

OUTCOMES  
At the end of the course, the students will be able to  
• derive the conservation laws and governing equations of fluid flows.
• apply finite volume method for diffusion and convection-diffusion problems.
• solve momentum equations after discretizing.
• solve unsteady flow problems using the finite volume methods.
• apply finite volume methods to solve problems in complex geometries.

REFERENCES  

MX5014  
FIXED POINT THEORY AND ITS APPLICATIONS  
Prerequisite: Functional Analysis

OBJECTIVES  
• To identify all self maps in which at least one element is left invariant.
• To introduce Brouwer fixed point theorem.
• To introduce fixed points for multivalued functions.
• To introduce more fixed point theorems and few operators.
• To introduce fixed point theorem for perturbed operators and their applications to differential equations.
UNIT I  THE BANACH FIXED POINT THEOREM AND ITERATIVE METHODS 12
The Banach fixed point theorem – The significance of Banach fixed point theorem – Applications to nonlinear equations – The Picard – Lindelof theorem – The Main theorem for iterative methods for linear operator equation – Applications to systems of linear equations and to linear integral equations.

UNIT II  THE SCHAUDER FIXED POINT THEOREM AND COMPACTNESS 12

UNIT III  FIXED POINTS OF MULTIVALUED MAPS 12
Generalized Banach fixed point theorem – Upper and lower semi continuity of multi-valued maps – Generalized Schauder fixed point theorem – Variational inequalities and Browder fixed point theorem.

UNIT IV  NON EXPANSIVE OPERATORS AND ITERATIVE METHODS 12

UNIT V  CONDENSING MAPS 12
A non-compactness measure – Condensing maps – Operators with closed range and an approximation technique for constructing fixed points – Sadovskii’s fixed point theorem for condensing maps – Fixed point theorem for perturbed operators – Application to differential equations in Banach spaces.

TOTAL: 60 PERIODS

OUTCOMES
• The student will be able to apply fixed point theory in various branches of applied mathematics.
• The student will get to know about fixed point theorem and its application to systems of integral equations.
• The student will be able to gain an in-depth understanding of various fixed point theorems.
• The student will get to know about approximation methods and applications to periodic solutions.
• The student will get to know more about approximation techniques for constructing fixed points and their applications to differential equations in Banach spaces.

REFERENCES

MX5015 FLUID MECHANICS

OBJECTIVES:
• To give a comprehensive overview of basic concepts of fluid mechanics.
• To introduce the concepts of kinematics and kinetics in fluid flows.
• To enable the students understand the two-dimensional flows in various geometries.
• To introduce the hydrodynamical aspects of conformal transformation.
• To demonstrate various viscous fluid flows.
UNIT I  KINEMATICS OF FLUIDS IN MOTION  12

UNIT II  EQUATIONS OF MOTION OF A FLUID  12
Pressure at a point in a fluid – Boundary conditions of two inviscid immiscible fluids – Euler’s equations of motion – Bernoulli’s equation – Some potential theorems – Flows involving axial symmetry.

UNIT III  TWO DIMENSIONAL FLOWS  12
Two-Dimensional flows – Use of cylindrical polar co-ordinates – Stream function, complex potential for two-dimensional flows, irrotational, incompressible flow – Complex potential for standard two-dimensional flows – Two dimensional image systems – Milne-Thomson circle theorem – Theorem of Blasius.

UNIT IV  CONFORMAL TRANSFORMATION AND ITS APPLICATIONS  12
Use of conformal transformations – Hydrodynamical aspects of conformal mapping – Schwarz Christoffel transformation – Vortex rows.

UNIT V  VISCOUS FLOWS  12

TOTAL: 60 PERIODS

OUTCOMES
At the end of the course, the students will be able to
• understand the concepts of kinematics and kinetics of fluid flows.
• derive the governing equations of fluid flows.
• solve the fluid flows in two-dimensional and axisymmetric geometries.
• apply conformal transformation to fluid flows.
• solve the viscous fluid flow problems in different geometries.

REFERENCES

MX5016  FRACTIONAL DIFFERENTIAL EQUATIONS  L T P C
Prerequisite: Differential Calculus
4  0  0  4

OBJECTIVES
• To introduce functions of fractional calculus.
• To introduce fractional derivatives and fractional integrals.
• To propose new methods to approximate Fractional differential equations solution.
• To use the new method to approximate the solution of partial Fractional differential equations.
• To discuss the perturbation of the solution of Fractional differential equations.
UNIT I  SPECIAL FUNCTIONS OF FRACTIONAL CALCULUS  12

UNIT II  FRACTIONAL DERIVATIVES AND INTEGRALS  12

UNIT III  LINEAR FRACTIONAL DIFFERENTIAL EQUATIONS  12
Fractional Derivatives of a General Form – Existence and Uniqueness Theorems as Method of Solutions. Dependence of a solution on initial data.

UNIT IV  FRACTIONAL GREEN’S FUNCTIONS  12
Definition and some properties. One-Term Equation – Two –Term Equation – Three Term Equation Four Term Equation – General n-term Equation.

UNIT V  OTHER METHODS OF SOLUTIONS OF FRACTIONAL- ORDER EQUATIONS  12

TOTAL : 60 PERIODS

OUTCOMES
After the completion of this course students can able to
- Explain the basic concepts of Fractional order derivatives.
- Obtain and Explain the Fundamental Definitions, Concepts, Theorems, Stability and Applications of Fractional Dynamical Systems.
- Gain Experience on Fractional order Differential Equations.
- Generalize, Emphasize and Apply the concept of Theory of Ordinary Differential Equations to the Fractional order Differential Equations.
- Interpret the Stability results and Applications of Fractional Dynamical Systems.

REFERENCES

MX5017  FUNCTIONAL ANALYSIS AND ITS APPLICATIONS TO PARTIAL DIFFERENTIAL EQUATIONS  4 0 0 4
Prerequisite: Functional Analysis and Partial Differential Equations

OBJECTIVES
- The aim of the course is to make the students understand the functional analytic concepts and techniques used in Partial Differential Equations.
- To introduce Sobolev Spaces and their properties.
- To find weak solutions to elliptic boundary value problems.
- To introduce finite element method and the analysis of the method.
- To introduce semigroups in Hilbert spaces.
UNIT I DISTRIBUTION THEORY 12
Distributions - operations with distributions - support and singular support – convolutions - fundamental solutions - Fourier transform - tempered distributions.

UNIT II SOBOLEV SPACES 12
Basic properties - approximation by smooth functions and consequences - imbedding theorems - Rellich- Kondrasov compactness theorem - fractional order spaces - trace spaces - dual spaces – trace theory.

UNIT III WEAK SOLUTIONS OF ELLIPTIC EQUATIONS 12
Abstract variational results (Lax-Milgram lemma, Babuska- Brezzi theorem) - existence and uniqueness of weak solutions for elliptic boundary value problems (Dirichlet Neumann and mixed problems) - regularity results.

UNIT IV GALERKIN METHODS 12
Galerkin method - maximum principles - eigenvalue problems - introduction to the mathematical theory of the finite element method.

UNIT V EVOLUTION EQUATIONS 12
Unbounded operators - exponential map - C0-semigroups - Hille-Yosida theorem - contraction semigroups in Hilbert spaces - applications to the heat - wave and Schrodinger equations in homogeneous problems.

TOTAL : 60 PERIODS

OUTCOMES
• The course, apart from providing a thorough understanding of the functional analytic concepts and techniques used in partial differential equations, will enable them to solve the partial differential equations of various problems arising in Science and Engineering.
• The student will gain more understanding of Sobolev spaces, trace spaces etc.
• The student will be able to solve various elliptic boundary value problems.
• The student will be able to find solutions to partial differential equations through Galerkin’s finite element method.
• The student will be in a position to apply the technique to the heat wave problem.

REFERENCES

MX5018 FUNDAMENTALS OF CHEMICAL GRAPH THEORY L T P C
4 0 0 4
Prerequisite: Graph Theory

OBJECTIVES:
• To study the connection between Chemical structures and Topological indices.
• To represent chemical compounds as molecular graphs.
• To study the various type of polynomials of molecular graphs.
• To study a constructive algorithm for finding a structures and enumerating valence isomers.
• To study the elements of Graph Spectral Theory and Topological Resonance Theory.
UNIT I  THE ORIGINS OF CHEMICAL GRAPH THEORY  12
The first use of Chemical Graphs – The emergence of Structure Theory – The concept of valence – The growth of Chemical Graph Theory – The introduction to Topological Indices – Elementary Bonding Theory.

UNIT II  ELEMENTS OF GRAPH THEORY FOR CHEMIST  12

UNIT III  POLYNOMIALS IN GRAPH THEORY  12

UNIT IV  ENUMERATIONS OF ISOMERS  12

UNIT V  GRAPH THEORY AND MOLECULAR ORBITALS  12

TOTAL : 60 PERIODS

OUTCOMES
- Students will be able to connect chemical structures and Topological indices.
- A knowledge for interpreting molecular structure as a graph can be achieved.
- Students should be able to derive polynomials for respective chemical graphs.
- Students could successfully construct algorithms for generating isomerism and reaction graphs.
- One can understand the application of spectral graph theory.

REFERENCES

MX5019  FUZZY ANALYSIS, UNCERTAINTY MODELING AND APPLICATIONS  L T P C
4  0  0  4
Prerequisite: Fuzzy Set Theory

OBJECTIVES
- To impart knowledge in understanding the Applications of fuzzy relations.
- To give a clear picture about the Uncertainty Modeling.
- To get a clear understanding of the various applications of fuzzy sets both in Engineering and Management.
- To acquire knowledge in solving Scheduling, Inventory and Marketing.
- To obtain the most optimal solution for a problem with given constraints.
UNIT I  FUZZY RELATIONS, FUZZY GRAPHS AND FUZZY ANALYSIS  12
Fuzzy Relations on sets and Fuzzy Sets-compositions of Fuzzy Relations – Properties of the Min-Max composition- Fuzzy Graphs- Special Fuzzy Relations- Fuzzy functions on Fuzzy Sets- Extrema of fuzzy functions- Integration of fuzzy functions- Integration of a Fuzzy function over a crisp interval-Integration of a (crisp) Real-valued function over a Fuzzy interval- Fuzzy differentiation.

UNIT II  UNCERTAINTY MODELING  12
Application-Oriented Modeling of Uncertainty-Causes of Uncertainty- types of available information-Uncertainty theorems as transformers of information-Matching Uncertainty theory and Uncertain phenomena-Possibility theory-Fuzzy sets and Possibility Distribution-Possibility and necessity measures- Possibility of Fuzzy events-Probability of a Fuzzy event as a scalar-Probability of a Fuzzy event as a Fuzzy set -Possibility vs. Probability

UNIT III  APPLICATIONS OF FUZZY SETS IN ENGINEERING AND MANAGEMENT  12

UNIT IV  SCHEDULING, INVENTORY AND MARKETING  14

UNIT V  EMPIRICAL RESEARCH IN FUZZY SET THEORY  10

TOTAL : 60 PERIODS

OUTCOMES
- It helps the students to understand the applications of fuzzy relations.
- It gives the ability to perform the uncertainty modeling.
- It enables them to solve the real time engineering problems with uncertainty modeling.
- It sets up a base for techniques of solving scheduling, inventory and Marketing.
- It paves way to obtain the most optimal solution for a constrained problem.

REFERENCES

MX5020  FUZZY SETS AND APPLICATIONS  L T P C
4 0 0 4

OBJECTIVE
- To introduce the basic methods that are applicable to the construction of membership Functions of Fuzzy Sets and to the selection of appropriate operations on Fuzzy Sets.
- To cover fundamentals of reasoning based on approximate reasoning.
- To overview the applications of Fuzzy sets on varied topics such as fuzzy Neural Networks, fuzzy Automata and fuzzy dynamic systems.
• To get exposed to the ideas of fuzzy clustering, pattern recognition and image processing.
• It paves way to adopt the methods which gives most optimal solution for decision making, Ranking and Linear Programming.

UNIT I  CONSTRUCTING FUZZY SETS AND OPERATIONS ON APPROXIMATE REASONING 12
General Discussion – Methods of construction: An overview – Direct methods with one expert – Direct methods with multiple experts – Indirect methods with one expert - direct methods with multiple experts – Constructions from Sample Data

UNIT II  APPROXIMATE REASONING 12

UNIT III  FUZZY SYSTEMS 12
General Discussion – Fuzzy Controllers : An overview and an example-Fuzzy Systems and Neural Networks – Fuzzy Neural Networks – Fuzzy Automata – Fuzzy Dynamic Systems.

UNIT IV  PATTERN RECOGNITION AND FUZZY DATABASES 12

UNIT V  FUZZY DECISION MAKING 12

TOTAL : 60 PERIODS

OUTCOMES
• It helps to acquire a strong foundations in the construction of Membership Functions of Fuzzy Sets.
• It helps the students to study the fundamentals of reasoning based on approximate reasoning.
• It gives a overview of the applications of Fuzzy sets on fuzzy Networks, fuzzy automata and fuzzy dynamic systems.
• It motivates the students to explore the concepts of fuzzy clustering, pattern recognition and image processing.
• It gives a better understanding of fuzzy decision making, Ranking and Linear Programming.

REFERENCES

MX5021  FUZZY SETS AND SYSTEMS    L T P C
4 0 0 4

OBJECTIVES
• To introduce the basic concepts of fuzzy sets and operations on fuzzy sets.
• To discuss the most successful application area of fuzzy systems such as the area of fuzzy control.
• To define Intuitionistic Fuzzy Sets and its properties.
• To extend the concept of Intuitionistic Fuzzy Sets to interval valued fuzzy sets.
• To explore some other extensions of Intuitionistic Fuzzy Sets.
UNIT I  CRISP SETS AND FUZZY SETS  

UNIT II  FUZZY SYSTEMS  

UNIT III  INTUITIONISTIC FUZZY SETS  

UNIT IV  INTERVAL VALUED INTUITIONISTIC FUZZY SETS  
Interval Valued Fuzzy Sets and Interval Valued Fuzzy Sets - Definition, Operations, and Relations on Interval Valued Intuitionistic Fuzzy Sets - Norms and Metrics on Interval Valued Intuitionistic Fuzzy Sets.

UNIT V  OTHER EXTENSIONS OF INTUITIONISTIC FUZZY SETS  

OUTCOMES
- It gives the ability to analyse the various operations on fuzzy sets.
- It helps to visualize the applications of fuzzy sets in various fields.
- It motivates to have a concrete idea about fuzzy relations and Intuitionistic Fuzzy Sets.
- It sets a base to study the extension of Intuitionistic Fuzzy Sets in terms of interval valued fuzzy sets.
- It paves way for further extensions of Intuitionistic Fuzzy Sets.

REFERENCES
OBJECTIVES

- To acquaint the students with various techniques of generalized inverses related with optimal and spectral theory.
- To introduce the concept of generalized inverses and their applications.
- To introduce extremal property of inverses.
- To introduce various spectral inverses.
- To develop generalized inverses of partitioned matrices.

UNIT I EXISTENCE AND CONSTRUCTION OF GENERALIZED INVERSES 12

UNIT II LINEAR SYSTEMS AND CHARACTERIZATION OF GENERALIZED INVERSES 12

UNIT III MINIMAL PROPERTIES OF GENERALIZED INVERSES 12

UNIT IV SPECTRAL GENERALIZED INVERSES 12

UNIT V GENERALIZED INVERSES OF PARTITIONED MATRICES 12

TOTAL: 60 PERIODS

OUTCOMES

- The students are expected to have good knowledge of generalized inverses which will be helpful for research in this field.
- The students will have a thorough understanding of generalized inverses and their applications in interval linear programming.
- The students will be able to apply extremal properties to electrical networks.
- The students will gain the knowledge about spectral inverses and their properties.
- The students will get to know about generalized inverses of partitioned matrices.

REFERENCES

OBJECTIVES

- The aim of the course is to make the students understand the basic concepts of Harmonic Analysis.
- To introduce Fourier series and Fourier integrals.
- To give an introduction to Hardy spaces.
- To introduce conjugated functions and the related theorems.
- To introduce convolution theorem.

UNIT I

FOURIER SERIES

Basic properties of topological groups, subgroups, quotient groups, and connected groups. Discussion of Haar Measure without proof on R, T, Z, and some simple matrix groups. $L^1(G)$ and convolution with special emphasis on $L^1(R)$, $L^1(T)$, $L^1(Z)$. Approximate identities. Fourier series. Fejer’s Theorem.

UNIT II

FOURIER INTEGRALS


UNIT III

HARDY SPACES


UNIT IV

MAXIMAL FUNCTIONS


UNIT V

WIENER TAUBERIAN THEOREM


OUTCOMES

- The students will have good understanding of Fourier series and intricacies of convergence.
- The students will be able to understand Fourier integrals and their properties.
- The students will gain knowledge of Hardy spaces and the inequalities of Hardy and Hilbert.
- The students will get to know about conjugate function as a singular integral.
- The student will be able to understand the intricacies of Wiener Tauberian Theorem and invariant subspace problem.

REFERENCES

OBJECTIVES
• To enable the students understand the concepts of heat and mass transfer and its applications.
• To demonstrate the properties of heat conduction in solving heat equations.
• To introduce the methods of solving flow along surfaces and in channels.
• To familiarize the students with the properties of free and forced convection in laminar flows
• To present the basic ideas of mass transfer in real life problems.

UNIT I HEAT CONDUCTION

UNIT II FLOW ALONG SURFACES AND IN CHANNELS
Boundary layers and turbulence – momentum equation- laminar flow boundary layer equation plane plate in longitudinal flow – pressure gradients along a surface – exact solutions for a flat plate.

UNIT III FREE CONVECTION
Laminar heat transfer on a vertical plate and horizontal tube – turbulent heat transfer on a vertical plate – free convection in a fluid enclosed between two plane walls – mixed free and forced convection.

UNIT IV FORCED CONVECTION IN LAMINAR FLOW

UNIT V MASS TRANSFER
Diffusion – flat plate with heat and mass transfer – integrated boundary layer equations of mass transfer – similarity relations for mass transfer – evaporation of water into air.

TOTAL: 60 PERIODS

OUTCOMES
At the end of the course, the students will be able to
• solve heat conduction problems and obtain numerical solutions.
• solve the problems of flow along surfaces and in channels.
• apply finite element method to solve complex problems in free and forced convection flows.
• solve the heat flow equations in various situations with different boundary conditions.
• analyze the mass transfer properties in various fluid flow problems.

REFERENCES
OBJECTIVES:
- To learn about different types of complexes, homology and its properties
- To exhibit computation of homology for certain spaces
- To introduce the notion of cohomology, a dual concept of homology
- To introduce a product operation on cohomology and make it a ring
- To explain the Poincare duality theorem

UNIT I SIMPLICIAL AND SINGULAR HOMOLOGY
- complexes, simplicial complexes, simplicial homology, singular homology, Homotopy invariance, exact sequences and excision, Equivalence of simplicial and singular homology

UNIT II COMPUTATIONS, APPLICATIONS, FORMAL VIEW POINT
Degree, cell complexes, cellular homology, Mayer-Vietoris sequences, homology with coefficients, Axioms for homology, homology and fundamental group, simplicial approximation, Lefschetz fixed point theorem

UNIT III COHOMOLOGY GROUPS
The Universal coefficient theorem, Cohomology of spaces, Axioms for cohomology, simplicial cohomology, cellular cohomology, Mayer-Vietoris sequences

UNIT IV CUP PRODUCT
Cup product, the cohomology ring, Kunneth formula, spaces with polynomial cohomology.

UNIT V POINCARÉ DUALITY
Orientations and homology, Poincaré duality theorem, connection with cup product, Lefschetz duality, Alexander duality.

TOTAL: 60 PERIODS

OUTCOMES:
- The students would have learnt about simplicial homology and singular homology theories
- Students would have obtained the skill to compute the homology for certain spaces and the connection between homology and the fundamental group of a topological space
- Students would have learnt how to compute the cohomology of spaces and the Universal coefficient theorem for cohomology
- Students would have learnt the Kunneth theorem and seen examples of important spaces whose cohomology rings are polynomial rings
- Students would have learnt about different duality theorems

REFERENCES:
INTRODUCTION TO ALGEBRAIC TOPOLOGY

Pre-requisites: A basic course in algebra, a basic course in topology

OBJECTIVES:
- To introduce the notion of homotopy and some geometric constructions
- To introduce the notion of the fundamental group of a space and to see some applications
- To introduce Van Kampen’s theorem and see some of its applications
- To introduce covering spaces and to understand the connection between covering spaces and the fundamental group of the base space of a covering space
- To learn about the classification of covering spaces

UNIT I  HOMOTOPY AND SOME GEOMETRIC CONCEPTS  12
Homotopy and Homotopy type, contractible spaces, retraction and deformation, cell complexes-operations on cell complexes-criteria for homotopy equivalence, Homotopy extension property.

UNIT II  THE FUNDAMENTAL GROUP  13
Fundamental groups, the Fundamental group of the circle, applications: fundamental theorem of algebra, Brouwer fixed point theorem in dimension 2, Borsuk-Ulam theorem in dimension 2, Fundamental group of a product, induced homomorphisms-applications.

UNIT III  VAN KAMPEN’S THEOREM  12
Free product of groups, Van Kampen theorem, simple applications, applications to cell complexes-construction of a K(G,1) space

UNIT IV  COVERING SPACES  11
Covering projections, relations with fundamental group, the homotopy lifting property, the lifting problem.

UNIT V  MORE ON COVERING SPACES  12
universal covering space, the classification of covering spaces, group actions, deck transformation groups

TOTAL: 60 PERIODS

OUTCOMES:
- The students would have learnt about homotopy between maps and homotopically equivalent spaces
- Students would have learnt some important applications of fundamental groups including the Brouwer fixed point theorem and Borsuk-Ulam theorem in dimension 2
- Students will be able to compute fundamental groups of spaces using Van Kampen’s theorem
- Students would have understood about the lifting problems for covering spaces
- The students will have an understanding of universal covering spaces, group actions and deck transformation groups

REFERENCES
OBJECTIVES:
- To introduce the notion of a bundle
- To introduce and study about vector bundles
- To learn what is a fibre bundle and fibre bundles with structure group
- To learn about the restriction and prolongation of structure group for fibre bundles
- Using fibres bundles to study about the homotopy groups and classifying spaces for the classical groups.

UNIT I THE GENERALITIES ON BUNDLES 12
Bundles and cross sections, morphisms of bundles, Products and fibre products, restrictions of bundles and induced bundles.

UNIT II VECTOR BUNDLES 12
Vector bundles, morphism of vector bundles, induced vector bundles, Homotopy properties of vector bundles, Gauss maps, Functorial description of the Homotopy classification of vector bundles.

UNIT III GENERAL FIBRE BUNDLES 12
Bundles defined by transformation groups, Principal bundles, induced bundles of principal bundles, Fibre bundles, Numerable principal bundles, Milnor construction, Homotopy classification of Principal G-bundles over CW-complexes.

UNIT IV CHANGE OF STRUCTURE GROUP IN FIBRE BUNDLES 12
Fibre bundles with homogeneous spaces as fibres, Prolongation and restriction of Principal Bundles, restriction and prolongation of structure group for fibre bundles, Classifying spaces and reduction of structure group.

UNIT V CALCULATION INVOLVING CLASSICAL GROUPS 12
Stiefel varieties, Grassmann manifolds, Stability of the Homotopy groups of the classical groups, Vanishing of lower Homotopy groups of Stiefel varieties, Universal bundles and classifying spaces for the classical groups.

TOTAL: 60 PERIODS

OUTCOMES:
- Students would have gained knowledge about the generalities of bundles
- Students will be able to apply homotopy classification of vector bundles
- Students would have learnt about the Milnor construction of a Universal principal bundle
- Students would have learnt about classifying spaces and reduction of structure group for a fibre bundle
- Students would have learnt, using fibre bundles, how to get certain results about the classical groups

REFERENCES:
INTRODUCTION TO LIE ALGEBRAS

Pre-requisites: A basic course in abstract algebra and linear algebra

OBJECTIVES:
- To introduce the notion of a Lie algebra with suitable examples
- To introduce the notion of a subalgebra, ideal of a Lie algebra and homomorphism between Lie algebras
- To introduce some special types of Lie algebras like solvable and nilpotent Lie algebras
- To learn about semi-simple Lie algebras
- To understand the maximal toral subalgebras and root system for a semisimple Lie algebra

UNIT I LIE ALGEBRAS 12
The notion of a Lie algebra, Linear Lie algebras, Lie algebras of derivations, abstract Lie algebras

UNIT II IDEALS AND HOMOMORPHISMS 12
Ideals, homomorphisms and representations, adjoint representation, automorphisms, inner automorphisms

UNIT III SOLVABLE AND NILPOTENT LIE ALGEBRAS 12
Solvability, nilpotency, Engel’s theorem, Lie’s theorem, Jordan Chevalley decomposition, Cartan’s criterion.

UNIT IV SEMI-SIMPLE LIE ALGEBRAS 12
semi-simple Lie algebras, Killing form, complete reducibility of representations, representations of sl(2,F).

UNIT V ROOT SPACE DECOMPOSITION OF A SEMI-SIMPLE LIE ALGEBRA 12
Maximal toral subalgebras and roots, root space decomposition, orthogonality properties, integrality properties and rationality properties.

TOTAL: 60 PERIODS

OUTCOMES:
- Students would have learnt the basic axioms defining a Lie algebra
- Students will be knowledgeable about the representations of a Lie algebra
- Students would have learnt important results like Lie’s theorem and Engel’s theorem
- They would have a thorough understanding of basic properties of semi-simple Lie algebras
- Students will have a good understanding of the root space decomposition of a semi-simple Lie algebra

REFERENCES
OBJECTIVES

- The aim of the course is to make the students understand the mathematical aspects of finite element method required for solving partial differential equations.
- To introduce Sobolev Spaces and their properties.
- To introduce the concept of variational formulation of elliptic and parabolic boundary value problems.
- To introduce various element and approximation property.
- To introduce higher dimensional variational problems.

UNIT I  BASIC CONCEPTS  12

UNIT II  SOBOLEV SPACES  12
Review of Lebesgue integration theory - Weak derivatives - Sobolev norms and associated spaces - Inclusion relations and Sobolev's inequality - Trace Theorems - Negative norms and duality.

UNIT III  VARIATIONAL FORMULATIONS  12

UNIT IV  CONSTRUCTION OF FINITE ELEMENT SPACE AND APPROXIMATION THEORY IN SOBOLEV SPACES  12

UNIT V  HIGHER DIMENSIONAL VARIATIONAL PROBLEMS  12

TOTAL : 60 PERIODS

OUTCOMES

- The students will be in position to tackle complex problems involving partial differential equations arising in the mathematical models of various problems in Science and Engineering by finite element techniques.
- The student will gain more understanding of Sobolev spaces.
- The student will have more knowledge about variational formulations of elliptic and parabolic boundary value problems.
- The student will get to know about different finite elements and be able to find error estimates for different methods.
- The student will be able to extend the knowledge to higher dimensional variational problems.

REFERENCES


MX5030 MATHEMATICAL FINANCE L T P C

4 0 0 4

OBJECTIVES:
- To understand the basic probability concepts in association with random variables and significance of the Central Limit theorem with respect to the Brownian motion.
- To understand the basic concepts of present value and accumulated value and apply these concepts toward solving more complicated financial problems and complex annuity problems.
- To appreciate the Arbitrage theorem in the context of the Black – Scholes formula.
- To obtain a practical knowledge on the Portfolio selection problem
- To understand option pricing with respect to various options via multi-period binomial models.

UNIT I PROBABILITY AND RANDOM VARIABLES

UNIT II PRESENT VALUE ANALYSIS AND ARBITRAGE
Interest rates - Present value analysis - Rate of return - Continuously varying interest rates - Pricing contracts via Arbitrage - An example in options pricing.

UNIT III ARBITRAGE THEOREM AND BLACK-SCHOLES FORMULA

UNIT IV EXPECTED UTILITY
Limitations of arbitrage pricing - Valuing investments by expected utility - The portfolio section problem - Capital assets pricing model - Rates of return - Single period and geometric Brownian motion.

UNIT V EXOTIC OPTIONS

TOTAL: 60 PERIODS

OUTCOME
- To demonstrate a comprehensive understanding of the probability concepts
- To locate and use information to solve problems in interest theory and financial engineering
- To know the main features of models commonly drawn from industry and financial firms in order to explore arbitrage strategy
- To understand and appraise utility and effectiveness in option pricing
- To simulate appropriate models treating Exotic options

REFERENCES
OBJECTIVES:
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/large sample tests through Tests of hypothesis.
- To understand the correlation and regression concepts in empirical statistics.
- To understand the concept of analysis of variance and use them to investigate factorial dependence.
- To appreciate the classical multivariate methods and computational techniques.

UNIT I   SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY   12
Sampling distributions - Characteristics of good estimators - Method of Moments - Maximum Likelihood Estimation - Interval estimates for mean, variance and proportions.

UNIT II   TESTING OF HYPOTHESIS   12
Type I and Type II errors - Tests based on Normal, $t$, $\chi^2$ and F distributions for testing of mean, variance and proportions - Tests for Independence of attributes and Goodness of fit.

UNIT III   CORRELATION AND REGRESSION   12
Method of Least Squares - Linear Regression - Normal Regression Analysis - Normal Correlation Analysis - Partial and Multiple Correlation - Multiple Linear Regression.

UNIT IV   DESIGN OF EXPERIMENTS   12
Analysis of Variance - One-way and two-way Classifications - Completely Randomized Design - Randomized Block Design - Latin Square Design.

UNIT V   MULTIVARIATE ANALYSIS   12
Mean Vector and Covariance Matrices - Partitioning of Covariance Matrices - Combination of Random Variables for Mean Vector and Covariance Matrix - Multivariate, Normal Density and its Properties - Principal Components: Population principal components - Principal components from standardized variables.

OUTCOMES:
On successful completion of this course students will be able to:
- Demonstrate knowledge of, and properties of, statistical models in common use.
- Apply the basic principles underlying statistical inference (estimation and hypothesis testing).
- Be able to construct tests and estimators, and derive their properties.
- Demonstrate knowledge of applicable large sample theory of estimators and tests.
- Recognize the importance of Multivariate analysis in various practical application.

REFERENCES
OBJECTIVES

- To gain understanding of the abstract measure theory and definition and main properties of the integral. To construct Lebesgue’s measure on the real line and in $n$-dimensional Euclidean space.
- To explain the basic advanced directions of the theory.
- To introduce the completeness and convergence in measures.
- To introduce the concept of signed measures.
- To introduce the product measures.

UNIT I MEASURES ON THE REAL LINE 12
Lebesgue Outer Measure- Measurable sets – Regularity – Measurable functions-Borel and Lebesgue measurability-Hausdorff measures

UNIT II ABSTRACT MEASURES SPACES 12
Measures and outer measures-Extension of a measure-Uniqueness of the extension- Completion of a measure- Integration with respect to a measure.

UNIT III CONVERGENCE 12
$L^p$ spaces-completeness-Convergence in measure-Almost Uniform convergence

UNIT IV SIGNED MEASURES 12
Hahn-Jordan Decompositions-Radon-Nikodym theorem- Applications.

UNIT V MEASURES IN PRODUCT SPACES 12
Measurability in a product space- Product measures-Fubini’s Theorem-Lebesgue measure in Euclidean space-Laplace and Fourier Transforms.

TOTAL : 60 PERIODS

OUTCOMES

- The student learns the concepts of measure and integral with respect to a measure, to show their basic properties, and to provide a basis for further studies in Analysis, Probability, and Dynamical Systems.
- The student will be able to perform integration with respect to measure.
- The student will gain knowledge on convergence in measures.
- The student will get to know about signed measures and their properties.
- The student will be able to learn about measurability in product spaces.

REFERENCES
OBJECTIVES:

- To understand the basics of simulation and its types.
- To understand how to generate random numbers using various methods and test them for different standard probability distributions.
- To analyze models and simulate experiments to meet real world system specifications and evaluate the performance using logical flowchart.
- To appreciate the comparison of available simulation languages and study any one such language in detail.
- To build a simulation model for any of the industrial systems using the simulation models that are studied.

UNIT I  INTRODUCTION 12

UNIT II  RANDOM NUMBERS 12

UNIT III  DESIGN OF SIMULATION EXPERIMENTS 12

UNIT IV  SIMULATION LANGUAGES 12
Comparison and selection of simulation languages – study of any one simulation language.

UNIT V  CASE STUDY 12

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course students will be able to:

- Develop simulation in software
- Apply the experimental process to acquire desired simulation results
- Apply visualization techniques to support the simulation process
- Use appropriate techniques to verify and validate models and simulation
- Analyze simulation results to reach an appropriate conclusion

REFERENCES:
MX5034 MOLECULAR COMPUTING

OBJECTIVES:
- To study the structure of DNA.
- To study the methods of Molecular computing.
- To represent Languages
- To introduce Sticker system and Splicing system
- To highlight recent application of Molecular Computing.

UNIT I BIOLOGICAL INTRODUCTION (DNA STRUCTURE AND PROCESSING) 12
Structure of DNA – Operations on DNA molecules – Reading out the sequence.

UNIT II BEGINNINGS OF MOLECULAR COMPUTING 12
Adleman’s experiment – SAT problem – Breaking DES code.

UNIT III REPRESENTATION OF LANGUAGES 12
Representations of Regular and Linear Languages – Characterizations of Recursively Enumerable Languages.

UNIT IV STICKER SYSTEM AND SPICING SYSTEM 12
Operations of Sticking – Sticker systems classifications – Generative capacity of Sticker System
Operations of Splicing – Non-Iterated Splicing as an operation with Languages – Iterated Splicing as an operation with Languages.

UNIT V APPLICATIONS OF MOLECULAR COMPUTING 12
Recent applications of Molecular Computing to various problems of Mathematics and Theoretical Computer Science.

TOTAL : 60 PERIODS

OUTCOMES:
- Students will be able to understand DNA structures and their operations.
- Students get familiarity in Molecular Computing.
- Students successfully understand the characterization of Languages.
- Students able to iterate splicing is an operation with Languages.
- Students gain the knowledge of applications of Molecular Computation in Mathematics and Theoretical Computer Science.

REFERENCES

MX5035 NETWORKS, GAMES AND DECISIONS

OBJECTIVES:
- To introduce the certain algorithms for solving the network models
- To expose them to different project management techniques like PERT and CPM
- To familiarize with the various aspects of game theory which involves decision situation in which two intelligent opponents with conflicting objectives are vying to outdo one another
- To introduce the students to the idea of making decision for problems involving various alternatives
- To get an idea of certain topics on random processes such as Weiner process and OU process.
UNIT I  NETWORK MODELS 12
Scope and definition of network models - Minimal spanning tree algorithm - Shortest - route problem - 
Maximal-flow Model.

UNIT II  CPM AND PERT 12
Network representation - Critical path (CPM) computations - Construction of the time schedule - 
Linear programming formulation of CPM - PERT calculations.

UNIT III  GAME THEORY 12
Optimal solution of two-person zero-sum games - Mixed strategies - Graphical solution of (2 x n) and 
(m x 2) games - Solution of m x n games by linear programming.

UNIT IV  DECISION ANALYSIS 12
Decision making under certainty: analytic hierarchy process (AHP) - Decision making under risk - 
Decision under uncertainty.

UNIT V  MARKOVIAN DECISION PROCESS 12
Scope of the Markovian decision problem - Finite stage dynamic programming model - Infinite stage 
model - Linear programming solution.

OUTCOMES:
- It helps in formulating many practical problems in the framework of Networks.
- It helps the students understand that CPM is a deterministic method whereas PERT uses a 
probabilistic model which deals with unpredictable activities.
- It enables the students to identify competitive situations which can be modeled and solved by 
game theoretic formulations.
- It molds the students to make decisions for various real-time problems subject to uncertainty and 
risk.
- It offers interesting techniques to quantify and effectively obtain the solution of various decision 
making situations.

REFERENCES:
2017.

MX5036  NONLINEAR DYNAMICS  L T P C 4 0 0 4

OBJECTIVES
- To introduce the method of solving nonlinear differential equations using Jacobi elliptic functions.
- To demonstrate the linear stability analysis for autonomous and non-autonomous systems.
- To give the Lagrangian and Hamiltonian formulation of Mechanics.
- To introduce the classical perturbation theory.
- To establish the properties of nonlinear evolution equations with emphasis on solving Kdv 
equation.
UNIT I  DYNAMICS OF DIFFERENTIAL EQUATIONS
Integration of linear second order equations – Integration of nonlinear second order equations - Jacobi elliptic functions – Periodic Structure of Elliptic functions - Dynamics in the phase plane.

UNIT II  LINEAR STABILITY ANALYSIS
Stability Matrix - Classification of Fixed points - Examples of fixed point analysis - Limit Cycles - Non-Autonomous Systems.

UNIT III  HAMILTONIAN DYNAMICS

UNIT IV  CLASSICAL PERTURBATION THEORY
Elementary perturbation theory – Canonical perturbation theory – Many degrees of Freedom and the problem of small divisors - The Kolmogorov-Arnold-Moser theorem.

UNIT V  NONLINEAR EVOLUTION EQUATIONS AND SOLITONS
Basic properties of the Kdv equation – The inverse Scattering transforms: Basic principles, Kdv equation – Other soliton systems.

OUTCOMES
At the end of the course, the students will be able to
- solve nonlinear differential equations using Jacobi elliptic functions.
- perform the linear stability analysis for autonomous and non-autonomous systems.
- obtain the Lagrangian and Hamiltonian formulation of Mechanics.
- investigate problems using perturbation theory.
- analyze the Kdv equation and its properties.

REFERENCES

MX5037  NUMBER THEORY  L T P C
4  0  0  4

OBJECTIVES:
- To introduce the concepts of divisibility and congruences.
- To know about application of congruences.
- To study some functions of number theory like greatest integer function, arithmetic functions and mobius inversion formula
- To introduce diophantine equations.
- To introduce Farey Fractions and simple continued Fractions.
UNIT I  DIVISIBILITY AND CONGRUENCES  12

UNIT II  APPLICATION OF CONGRUENCE AND QUADRATIC RECIPROCITY  12
Public - Key cryptography - Prime power moduli - Prime modulus - Primitive roots and power residues - Quadratic residues - The Gaussian reciprocity law.

UNIT III  FUNCTIONS OF NUMBER THEORY  12
Greatest integer function - Arithmetic functions - Mobius inversion formula - Recurrence functions - Combinational number theory.

UNIT IV  DIOPHANTINE EQUATIONS  12
The equations ax + by = c Pythagorean triangle - Shortest examples.

UNIT V  FAREY FRACTIONS AND SIMPLE CONTINUED FRACTIONS  12
Farey sequences - Rational approximations-The Euclidean Algorithm-Infinite continued fractions.

TOTAL: 60 PERIODS

OUTCOMES:
• The student would have learnt to solve divisibility problems some techniques of numerical calculations using congruences
• Students would have learnt application of congruences.
• Students will be able to apply the Gaussian reciprocity law in public-key cryptography
• The students will be able to solve some diophantine equations.
• Students will have a good foundation in Farey Fractions and simple continued Fractions

REFERENCES

MX5038  NUMBER THEORY AND CRYPTOGRAPHY  L T P C
4 0 0 4

OBJECTIVES:
• To study divisibility.
• To study congruences and solving congruences.
• To introduce quadratic residues, Jacobi symbol and different important functions in number theory
• To introduce diophantine equations and Waring’s problem
• To introduce traditional symmetric key ciphers

UNIT I  DIVISIBILITY  12
Introduction - Divisibility - Primes - The binomial theorem.

UNIT II  CONGRUENCES  12
Congruences, Solutions of congruences, congruences of deg 1, The function 0(n) - Congruences of higher degree, Prime power moduli, Prime modulus, congruences of degree 2, Prime modulus, Power residues.
UNIT III QUADRATIC RESIDUES 12
Quadratic residues, Quadratic reciprocity, The Jacobi symbol, greatest integer function, arithmetic function, The Moebius Inversion formula, The multiplication of arithmetic functions.

UNIT IV DIOPHANTINE EQUATIONS 12
Diophantine equations, The equation \( ax + by = c \), Positive solutions, Other linear Equations, Sums of four and five squares, warings problem, sum of fourth powers, sum of two Squares.

UNIT V TRADITION SYMMETRIC – KEY CIPHERS 12
Substitution Ciphers – Transportation Ciphers – Steam and Block Ciphers – Modern Block Ciphers – Modern Steam Ciphers – DES – AES.

TOTAL : 60 PERIODS

OUTCOMES:
- The student would have learnt to solve divisibility problems using binomial theorem
- Students would have learnt to solve congruences and compute power residues
- Students will be able to apply quadratic reciprocity law and the Mobius inversion formula in cryptography
- The student will be able to solve diophantine equations and Waring’s problem
- The student would have learnt about traditional and modern stream and Block ciphers

REFERENCES

MX5039 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 12

OBJECTIVES:
- To make the students understand the numerical methods of solving partial differential equations.
- To introduce the methods of solving one-dimensional parabolic equations.
- To demonstrate the methods of solving two-dimensional parabolic equations.
- To display the methods of solving hyperbolic equations.
- To reveal the ideas of solving elliptic equations.

UNIT I LINEAR SYSTEMS OF EQUATIONS 12

UNIT II ONE DIMENSIONAL PARABOLIC EQUATIONS 12
Explicit and Crank-Nicolson Schemes for \( u_t = u_{xx} \) - Weighted average approximation - Derivative boundary conditions - Truncation errors - Consistency, Stability and convergence - Lax Equivalence theorem.
UNIT III  MATRIX NORMS & TWO DIMENSIONAL PARABOLIC EQUATION  12

UNIT IV  HYPERBOLIC EQUATIONS  12
First order quasi-linear equations and characteristics - Numerical integration along a characteristic - Lax-Wendroff explicit method - Second order quasi-linear hyperbolic equation - Characteristics - Solution by the method of characteristics.

UNIT V  ELLIPTIC EQUATIONS  12
Solution of Laplace and Poisson equations in a rectangular region - Finite difference in Polar coordinate Formulas for derivatives near a curved boundary when using a square mesh -discretisation error - Mixed Boundary value problems.

TOTAL: 60 PERIODS

OUTCOMES
At the end of the course, the students will be able to
- learn various numerical methods of solving partial differential equations.
- solve one-dimensional parabolic equations using explicit and implicit schemes.
- solve two-dimensional parabolic equations and analyze the stability of the schemes.
- understand the methods of solving hyperbolic equations.
- solve elliptic equations in Cartesian and Polar coordinates.

REFERENCES

MX5040  OPERATOR THEORY  L T P C
4 0 0 4

OBJECTIVES
- The interplay between the ideas and methods from operator theory and functional analysis with methods and ideas from function theory, commutative algebra and algebraic, analytic and complex geometry gives the field a strong interdisciplinary character.
- To introduce generalized Kato decomposition.
- To introduce the concept of local spectrum and its related theorem.
- To introduce Algebraic spectral spaces.
- To introduce the spectra of some operators.

UNIT I  KATO DECOMPOSITION PROPERTY  12

UNIT II  GENERALIZED KATO DECOMPOSITION PROPERTY  12
UNIT III  SINGLE-VALUED EXTENSION PROPERTY (SVEP)  12
Local spectrum and SVEP- The SVEP at a point- A Local spectral mapping theorem.

UNIT IV  SVEP AND FREDHOLM THEORY  12
The Single-valued Extension Property (SVEP): Algebraic spectral subspaces. The SVEP and Fredholm Theory: Ascent, descent the SVEP- The SVEP for operators of Katotype.

UNIT V  SPECTRA OF SOME SPECIAL OPERATORS  12
The SVEP on the components of The Fredholm, Weyl and Browder spectra-Compressions.

OUTCOMES
- Operator Theory provides an introduction to functional analysis with an emphasis on the theory of linear operators and its application to differential and integral equations, approximation theory, and numerical analysis.
- The student will gain the knowledge on two-spectral mapping theorems.
- The student will be introduced to Single Valued Extension Property.
- The student will get to know about Fredholm theory.
- The student will be able to know the spectra of Fredholm, Weyl and Browder.

REFERENCES

MX5041  OPTIMIZATION TECHNIQUES  L T P C
4 0 0 4

OBJECTIVE
- To introduce Advanced Linear Programming Algorithms
- To introduce the Non Linear Programming Algorithms
- To introduce the Basic Inventory Models
- To introduce the Basic Queueing Models
- To introduce the Network Models.

UNIT I  ADVANCED LINEAR PROGRAMMING ALGORITHMS  12
Revised Simplex Method –Bounded Variables Algorithm – Dual Simplex Method and Parametric Linear Programming.

UNIT II  NON LINEAR PROGRAMMING ALGORITHMS  12
Direct Search Method-Gradient Method-Constraint Algorithm –Separable Programming and Quadratic Programming.

UNIT III  INVENTORY MODELS  12
UNIT IV  QUEUEING MODELS  12
General Poisson Queueing model- Single server models – Multiple server models- Self service models- Queueing networks.

UNIT V  NETWORK MODELS  12

OUTCOME
- Helps in formulating many Decision Making Problems as a Linear Programming Model
- Students will be capable of using advanced techniques in solving various decision making Problems
- Students should be able to formulate organization problems into Inventory models for seeking optimal solutions.
- Students should be able to formulate organization problems into Queueing models for optimizing the cost.
- Helps in formulating many practical Problems in the frame work of Networks.

REFERENCES
UNIT IV  SYSTEM RELIABILITY  12
Reliability and hazard functions - Exponential, normal, weibull and Gamma failure distributions - Time-dependent hazard models, Reliability of series and parallel systems.

UNIT V  MAINTAINABILITY AND AVAILABILITY  12
Maintainability and Availability functions - Frequency of failures - Two unit parallel system with repair - Two unit series system with repair - k out of m systems.

TOTAL: 60 PERIODS

OUTCOME
- Students can evaluate the various system performance measures of the Markovian queueing systems.
- Acquaint with various mathematical techniques of advanced Markovian queues.
- Students will able to formulate the various kinds of Non-Markovian queueing models.
- Aware of various models of reliability of the systems for different probability distributions.
- Understanding of system availability multi units series and parallel systems with repairs.

REFERENCES

MX5043  REPRESENTATIONS OF LIE ALGEBRAS  14

Prerequisite: Lie algebra

OBJECTIVES:
- To understand what is a semi-simple Lie algebra and some of its properties
- To understand about the root system of a semi-simple Lie algebra
- To gain knowledge about the finite dimensional representations of a semisimple Lie algebra
- To learn the Harish-Chandra’s theorem on characters associated with an infinite dimensional module
- To understand how to obtain some remarkable formulas for characters and multiplicities of finite dimensional modules using Harish-Chandra’s theorem

UNIT I  SEMI SIMPLE LIE ALGEBRAS  14
UNIT II  ROOT SYSTEM
Cartan subalgebra, root system, Weyl group, weights, dominant weights, saturated set of weights.

UNIT III  FINITE DIMENSIONAL MODULES
universal enveloping algebra, Poincaré–Birkhoff-Witt theorem, Weight spaces, standard cyclic modules, existence and uniqueness theorems, necessary and sufficient conditions for finite dimension, weight strings and weight diagrams, generators and relations for V(\lambda).

UNIT IV  MULTIPLICITY FORMULA, CHARACTERS
A universal casimir element, traces on weight spaces, Freudenthal’s formula, examples, formal characters, invariant polynomial functions, standard cyclic modules and characters, Harish-Chandra’s theorem.

UNIT V  FORMULAS OF WEYL, KONSTANT, STEINBERG
Some functions on H*, Konstant’s multiplicity formula, Weyl’s formulas, Steinberg’s formula.

TOTAL: 60 PERIODS

OUTCOMES:
• Students would have learnt about basic properties of a semi-simple Lie algebra and representations of sl(2,F)
• They would have understood clearly the structure of a semi-simple Lie algebra in terms of its root system
• Students would have a detailed understanding of finite dimensional representations
• Students would have a good understanding of the theorem of Harish-Chandra and some of its remarkable applications
• The students will have a thorough understanding of the theory of semi-simple Lie algebras over an algebraically closed field of characteristic 0 and their representations.

REFERENCES:

MX5044  REPRESENTATION THEORY OF FINITE GROUPS
Prerequisite: Algebra

OBJECTIVES:
• Familiarize the concept of modules and its techniques
• To impart knowledge on representation theory on finite groups and relation between modules and representation theory
• To enable the students to analyze the irreducible representations of finite group through character theory.
• To make the students to construct all possible irreducible representation of symmetric group.
• To describe some the ideas of the representation theory in purely combinatorial terms.

UNIT I  MODULES
Modules – Simple and Semisimple Modules- Tensor product- Restricted and induced modules- Group algebra.

UNIT II  GROUP REPRESENTATION
Linear and Matrix representations- Reducibility – Complete reducibility and Maschke’s theorem – Schur’s lemma – Commutant and Endomorphism algebras.
UNIT III  CHARACTERS AND TENSOR PRODUCTS  12

UNIT IV  REPRESENTATION OF SYMMETRIC GROUPS  12
Representation of symmetric groups- Young subgroups, tableaux and tabloids – Specht modules – Standard tableaux- branching rule.

UNIT V  APPLICATIONS IN COMBINATORICS  12
The Robinson-Schensted algorithm – increasing and decreasing subsequences – the hook formula – the determinant formula.

TOTAL: 60 PERIODS

OUTCOMES
- Understanding the concept of module theory’
- Fluency in representation theory on finite groups.
- The students will acquire on the sound knowledge on the technical tools to construct a irreducible representations of finite groups
- Able to construct all possible irreducible representations of symmetric groups explicitly.
- Understanding combinatorial ideas which involves in representation of symmetric groups.

REFERENCES

SPECIAL FUNCTIONS  

OBJECTIVES
- To give an expertise treatment in various special function and orthogonal polynomial.
- To introduce hypergeometric functions and their properties.
- To introduce generalized hypergeometric functions and their properties.
- To introduce orthogonal polynomials with some spectral analysis.
- To introduce a few particular orthogonal polynomials.

UNIT I  SPECIAL FUNCTIONS  12

UNIT II  HYPERGEOMETRIC FUNCTIONS  12
UNIT III  GENERALIZED HYPERGEOMETRIC FUNCTIONS  12

UNIT IV  ORTHOGONAL POLYNOMIALS  12

UNIT V  SPECIFIC ORTHOGONAL POLYNOMIALS  12

TOTAL : 60 PERIODS

OUTCOMES

• Students are exposed to various special functions and orthogonal polynomials.
• The student will gain insight into hypergeometric functions and hypergeometric differential equations.
• The student will get to know about integral representation of generalized hypergeometric functions.
• The student will be able to know the properties of orthogonal polynomials.
• The student will get introduced to some particular orthogonal polynomials.

REFERENCES


MX5046  STOCHASTIC PROCESSES  L T P C
4 0 0 4

OBJECTIVE

• To understand the basic concepts of stochastic processes and be able to develop and analyse the stochastic models that capture the significant features of the probability models in order to predict the short and long term effects in the system.
• To Learn and model the renewal processes and study its theorems and their behavior.
• To study about the combination of renewal processes and Markov process.
• To understand the concept of branching processes and its nature. Also, to learn the variety of models in branching process.
• To find the nature of Wiener process and study its properties.

UNIT I  MARKOV AND STATIONARY PROCESSES  12
UNIT II RENEWAL PROCESSES 12
Renewal processes in discrete and continuous time - Renewal equation - Stopping time - Wald’s equation - Renewal theorems - Delayed and Equilibrium renewal processes - Residual and excess life times - Renewal reward process - Alternating renewal process - Regenerative stochastic process.

UNIT III MARKOV RENEWAL AND SEMI – MARKOV PROCESSES 12
Definition and preliminary results - Markov renewal equation - Limiting behaviour – First passage time.

UNIT IV BRANCHING PROCESSES 12
Generating functions of branching processes - Probability of extinction - Distribution of the total number of progeny - Generalization of classical Galton - Watson process - Continuous time Markov branching process - Age dependent branching process.

UNIT V MARKOV PROCESSES WITH CONTINUOUS STATE SPACE 12

TOTAL : 60 PERIODS

OUTCOME
After the completion of the course, the students will be able to
- Understand and characterize the random phenomena and model a stochastic system.
- Connect the real life situation and renewal processes.
- Obtain the knowledge about the advanced studies of renewal processes.
- Understand stochastic population models through branching processes.
- Obtain the knowledge about Wiener processes.

REFERENCES

MX5047 UNIVALENT FUNCTIONS L T P C
4 0 0 4

OBJECTIVES
- To introduce theory and advanced techniques in Univalent functions (advanced Complex Analysis)
- To introduce primitive variational method.
- To introduce the concept of subordination.
- To introduce extremal problems and properties.
- To introduce the integral transforms.

UNIT I ELEMENTARY THEORY OF UNIVALENT FUNCTIONS 12
The Area theorem-Growth and Distortion Theorems-Coefficient Estimates-Convex and Star like functions-Close to Convex functions-Spiral like functions-Typically Real functions.
UNIT II VARIATIONAL METHODS

UNIT III SUB ORDINATION
Basic Principles - Coefficient Inequalities - Sharpened Forms of the Schwartz Lemma–Majorization - Univalent Sub ordinate Functions.

UNIT IV GENERAL EXTREMAL PROBLEMS
Functionals of Linear Spaces - Representation of Linear Functionals - Extreme Points and Support Points- Properties of extremal Functions - Extreme Points.

UNIT V INTEGRALTRANSFORMS
Linear Operators – Nonlinear operators – Conclusion operators - Alexander Transforms – Libera Transforms – Bernardi Transforms.

TOTAL: 60 PERIODS

OUTCOMES
- Students will gain in-depth knowledge in Univalent functions theory to pursue research.
- The students will have a thorough understanding of univalent functions.
- The students will gain knowledge in subordination and univalent subordinate functions.
- The students will get an understanding in solving extremal problems.
- The students will get introduced to the integral transforms.

REFERENCES

MX5048 DOMINATION IN GRAPHS
Prerequisite: Graph Theory

OBJECTIVES:
- To introduce Domination concepts in graphs.
- To introduce various type of Dominate concepts.
- To study bonds and conditions of dominating set.
- To study Paired Domination Sets.
- Various types of Dominations are introduced.

UNIT I DOMINATING SETS
Dominating sets in graphs – Minimal dominating sets – Hereditary and superhereditary properties – Minimal and Maximal P-sets – Independent sets – Every maximal independent set is a minimal dominating set – Irredundant sets– Domination chain – Bounds involving domination, independence and irredundance numbers.

UNIT II CHANGING AND UNCHANGING DOMINATION
UNIT III  CONDITION ON DOMINATING SET  
Condition on the dominating set – Independent dominating sets – Total dominating sets – Connected dominating sets – Bound for connected domination number – External graphs attaining the bounds.

UNIT IV  DOMINATING CLIQUES  
Dominating cliques – Sufficient condition for existence of a dominating clique – Bound for the clique domination number – Paired dominating sets – Paired domination number – Bound for paired domination number – Inequalities connecting paired domination number and other domination parameters.

UNIT V  VARIETIES OF DOMINATION  
Varieties of domination – Multiple domination – Bound for the multiple domination number – k dependence number – Inequality connected k-domination number and k-dependence number – Locating domination – Locating domination number – Bound – Strong and weak domination – Strong and weak domination number – Bound.

OUTCOMES: 
- Students understand the Domination Theory in graphs. 
- Students get familiar with variations of Domination. 
- Students gain the fundamental knowledge on Domination Theory. 
- Students understand the bonds for Paired Domination number. 
- Students are able to construct various type of dominating sets.

TEXT BOOK: 

MX5049  GENETIC ALGORITHMS  
L T P C  
4 0 0 4

OBJECTIVES: 
- To familiarize with the fundamental concepts of genetic algorithm. 
- To study the usage of genetic algorithms in problem encoding. 
- To understand and analyze the genetic based techniques for problem solving through cellular automata and neural networks. 
- To understand the concepts of evolutionary computing paradigm and to design an appropriate evolutionary algorithm. 
- To appreciate construction of mathematical models using genetic algorithm.

UNIT I  OVERVIEW OF GENETIC ALGORITHMS  

UNIT II  IMPLEMENTING A GENETIC ALGORITHM  

UNIT III  GENETIC ALGORITHMS IN PROBLEM SOLVING  
Evolving cellular automata - Data analysis and prediction - Evolving Neural Networks.
UNIT IV GENETIC ALGORITHMS IN SCIENTIFIC MODELS
Modeling interactions between learning and evolution - Modeling Ecosystems - Measuring Evolutionary activity.

UNIT V THEORETICAL FOUNDATIONS OF GENETIC ALGORITHMS
Schemes and the two-armed Bandit problem - Exact mathematical models of simple genetic algorithms - Statistical mechanics approaches

TOTAL: 60 PERIODS

OUTCOME
- To appreciate and identify real life problems to be solved using Genetic algorithms
- To apply the encoding selection method to the formulated models.
- To obtain knowledge of the Data analysis and prediction and to evolve Cellular automata and Neural Networks
- To bridge the gap between modeling and application of genetic algorithms
- To demonstrate the application of Genetic algorithms for a few selected problems

REFERENCES