# MARUDHAR KESARI JAIN COLLEGE FOR WOMEN (AUTONOMOUS)

## Vaniyambadi – 635 751

**PG & Research Department of Mathematics**

**for**

**Postgraduate Programme**

**Master of Science in Mathematics**

**From the Academic Year 2024 - 25**

| Semester–III | | | | | | | Semester-IV | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24PMAC31 | CC-8 Complex Analysis | 3 | 1 | 1 | 1 | 5 | 24PMAC41 | CC-12 Functional Analysis | 3 | 1 | 1 | 1 | 5 |
| 24PMAC32 | CC-9 Probability Theory | 3 | 1 | 1 | 1 | 4 | 24PMAC42 | CC-13 Differential Geometry | 3 | 1 | 1 | 1 | 5 |
| 24PMAC33 | CC-10 Topology | 3 | 1 | 0 | 1 | 4 | 24PMAC43 | CC-14 Project | 0 | 0 | 5 | 1 | 5 |
| 24PMAC34 | CC-11 Mechanics | 3 | 1 | 1 | 1 | 4 | 24PMAE41/ 24PMAE42 | EC-6 Resource Management Techniques / Financial Mathematics | 2 | 1 | 1 | 1 | 4 |
| 24PMAE31 / 24PMAE32 | EC-5 Fluid Dynamics/ Algebraic Number Theory | 2 | 0 | 1 | 1 | 3 | 24PMAP41 | PEC-1 Stochastic Process | 2 | 0 | 0 | 1 | 2 |
| 24PMAS31 | SEC–2 Research Tools and Techniques | 2 | 0 | 0 | 1 | 2 | 24PMAL41 | SLC-1Mathematical Modelling | 2 | 0 | 1 | 1 | 2 |
| 24PMAIN31 | Internship | 0 | 0 | 0 | 0 | 2 | | | | | | | |
| | | | | | **30** | **24** | | | | | | **30** | **23** |
| | | | | | | | | **Total Credits** | | | **90+2*** | | |

Students must complete at least one online course (MOOC) from plat forms like SWAYAM, NPTEL, or Nanmudalvan with in the fifth semester. Additionally, engaging in a specified Self-learning Course is mandatory To qualify for the degree, and successful participation will be acknowledged with an extra creditof2*.

| | | |
|---|---|---|
| CC | Core Course | 14 |
| EC | Elective Paper | 6 |
| SEC | Skill Enhancement Course | 2 |
| AEC | Ability Enhancement Compulsory Courses | 1 |
| VE | Value Educations | 1 |
| | Internship | 1 |
| PEC | Professional Enhancement Course | 1 |
| SLC | Self-Learning Course | 1 |

## II YEAR: THIRD SEMESTER

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th rowspan="2">Category</th><th rowspan="2">L</th><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">S</th><th rowspan="2">Credits</th><th rowspan="2">Hours</th><th colspan="3">Marks</th></tr>
<tr><th>CIA</th><th>External</th><th>Total</th></tr>
<tr><td>24PMAC31</td><td>Complex Analysis</td><td>Core Course-8</td><td>3</td><td>1</td><td>1</td><td>1</td><td>5</td><td>6</td><td>25</td><td>75</td><td>100</td></tr>
</table>

<table>
<tr><th colspan="2">Learning Objectives</th></tr>
<tr><td>LO1</td><td>To analyze and evaluate local properties of analytical functions and definite</td></tr>
<tr><td>LO2</td><td>To demonstrate the concept of the general form of Cauchy’s theorem.</td></tr>
<tr><td>LO3</td><td>To describe the concept of definite integral and harmonic functions.</td></tr>
<tr><td>LO4</td><td>To develop Taylor and Laurent series</td></tr>
<tr><td>LO5</td><td>To learn the infinite products, canonical products and Jensen’s formula.</td></tr>
</table>

| Unit | Content | Hours |
|---|---|---|
| 1 | **Cauchy’s Integral Formula**<br>The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions: Removable Singularities-Taylors’s Theorem – Zeros and poles – The local Mapping – The Maximum Principle.<br>**Chapter 4 : Section 2 : 2.1 to 2.3**<br>**Chapter 4 : Section 3 : 3.1 to 3.4** | 18 |
| 2 | **The General form of Cauchy’s Theorem**<br>Chains and cycles- Simple Connectivity - Homology - The General statement of Cauchy’s Theorem - Proof of Cauchy’s theorem - Locally exact differentials- Multiply connected regions - Residue theorem – The argument principle.<br>**Chapter 4 : Section 4 : 4.1 to 4.7**<br>**Chapter 4 : Section 5: 5.1 and 5.2** | 18 |
| 3 | **Evaluation of Definite Integrals and Harmonic Functions**<br>Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.<br>**Chapter 4 : Section 5 : 5.3**<br>**Chapter 4 : Sections 6 : 6.1 to 6.3** | 18 |
| 4 | **Harmonic Functions and Power Series Expansions**<br>Schwarz theorem - The reflection principle – Weierstras’s theorem –Taylor’s Series – Laurent series.<br>**Chapter 4 : Sections 6:6.4 and 6.5**<br>**Chapter 5 : Sections 1:1.1 to 1.3** | 18 |
| 5 | **Partial Fractions and Entire Functions**<br>Partial fractions -Infinite products – Canonical products – Gamma Function- Jensen’s formula – Hadamard’s Theorem.<br>**Chapter 5 : Sections 2: 2.1 to 2.4**<br>**Chapter 5 : Sections 3:3.1 and 3.2** | 18 |
|  | **Total** | 90 |
| **Theory 80% Problem- 20%** | | |

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Analyze and evaluate local properties of analytical functions and definite integrals |
| CO2 | Work out on general form of Cauchy's theorem and multiply connected regions |
| CO3 | Evaluate definite integral and harmonic functions. |
| CO4 | Apply Taylor and Laurent series. |
| CO5 | Examine the infinite products, canonical products and Jensen's formula. |
| **Textbooks:** | |
| 1 | Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979 |
| **Reference Books:** | |
| 1 | H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990 |
| 2 | J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Narosa Publishing Co.1978 |
| 3 | E.Hille, *Analytic function Theory* (2 vols.), Gonm and Co, 1959. |
| 4 | M.Heins, *Complex function Theory*, Academic Press, New York, 1968. |
| 5 | James Ward Brown, R.V. Churchil, *Complex Variables and Applications*, McGraw Hill Education Private Limited,8th Edition, 2014 |
| **Web resources:** | |
| 1 | http://mathforum.org |
| 2 | http://www.opensource.org |
| 3 | http://en.wikipedia.org |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| **Total** | 13 | 10 | 14 | 11 | 15 | 15 | 11 | 13 | 15 | 10 | 12 |
| **Average** | 2.6 | 2 | 2.8 | 2.5 | 3 | 3 | 2.5 | 2.6 | 3 | 2 | 2.4 |

**3 – Strong, 2- Medium, 1- Low**

# II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAC32 | Probability Theory | Core Course-9 | 3 | 1 | 1 | 1 | 4 | 6 | 25 | 75 | 100 |

| **Learning Objectives** | |
|---|---|
| LO1 | To understand Random Events, Random Variables, to describe Probability, to apply Baye's to define Distribution Function, to find Joint Distribution function, Marginal Distribution and Conditional Distribution function. |
| LO2 | To define Expectation, Moments and Chebyshev's Inequality, to solve Regression of the first and second types. |
| LO3 | To learn Characteristic functions, distribution function, to find probability generating functions |
| LO4 | To describe One point, two-point Binomial distributions, to solve problems of Hyper geometric and Poisson distributions, to define Uniform, normal, gamma, Beta distributions. |
| LO5 | To discuss Stochastic convergence, Bernaulli's law of large numbers, to elaborate Convergence of sequence of distribution functions, to prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, to explain Poisson, Chebyshev's, Khintchine Weak law of large numbers, to explain and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Random Events and Random Variables**<br>Random events –Probability axioms – Combinatorial formulae – conditional probability –Baye's Theorem – Independent events – Random Variables –Distribution Function – Joint Distribution – Marginal Distribution –Conditional Distribution – Independent random variables – Functions of random variables.<br>**Chapter 1: Sections 1.1 to 1.7**<br>**Chapter 2 : Sections 2.1 to 2.9** | 18 |
| 2 | **Parameters of the Distribution**<br>Expectation- Moments –The Chebyshev's Inequality – Absolute moments – Order parameters –Moments of random vectors – Regression of the first and second types.<br>**Chapter 3 : Sections 3.1 to 3.8** | 18 |
| 3 | **Characteristic functions**<br>Properties of characteristic functions – Characteristic functions and moments – semi invariants –characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function –Characteristic function of multidimensional random vectors –Probability generating functions.<br>**Chapter 4 : Sections 4.1 to 4.7** | 18 |
| 4 | **Some Probability distributions**<br>One point and two point distribution ,Binomial – Polya – Hypergeometric – Poisson (discrete) distributions –Uniform – normal- gamma – Beta – Cauchy and Laplace (continuous) distributions.<br>**Chapter 5 : Section 5.1 to 5.10** | 18 |

| | | |
|---|---|---|
| 5 | **Limit Theorems**<br>Stochastic convergence – Bernaulli's law of large numbers – Convergence of sequence of distribution functions –Levy-Cramer Theorems – De Moivre-Laplace Theorem – Poisson, Chebyshev's, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.<br>**Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12. (Omit Sections 6.5, 6.10)** | 18 |
| | **Total** | **90** |
| **Theory 80% Problem 20%** | | |

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Apply Random Events, Random Variables and distribution functions. |
| CO2 | Work on Expectation, Moments and Chebyshev's Inequality and Regression types. |
| CO3 | Determine Characteristic functions, distribution function and probability generating functions |
| CO4 | Solve problems on Binomial distributions, Hypergeometric and Poisson distributions. |
| CO5 | Evaluate Stochastic convergence, Bernaulli law of large numbers, Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. |
| **Textbooks:** | |
| 1 | M.Fisz, *Probability Theory and Mathematical Statistics*, John Wiley and Sons, New York,1963. |
| **Reference Books:** | |
| 1 | R.B. Ash, *Real Analysis and Probability*, Academic Press, New York, 1972 |
| 2 | K.L. Chung, *A course in Probability*, Academic Press, New York, 1974 |
| 3 | R.Durrett, *Probability: Theory and Examples*, (2nd Edition) Duxbury Press, New York, 1996. |
| 4 | V.K. Rohatgi, *An Introduction to Probability Theory and Mathematical Statistics*, WileyEastern Ltd., New Delhi, 1988(3rd Print). |
| 5 | S.I. Resnick, *A Probability Path*, Birhauser, Berlin, 1999. |
| **Web resources:** | |
| 1 | http://mathforum.org// |
| 2 | www.opensource.org// |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| **Total** | 13 | 10 | 14 | 11 | 15 | 15 | 11 | 13 | 15 | 10 | 12 |
| **Average** | 2.6 | 2 | 2.8 | 2.5 | 3 | 3 | 2.5 | 2.6 | 3 | 2 | 2.4 |

**3 – Strong, 2- Medium, 1- Low**

# II YEAR: THIRD SEMESTER

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th rowspan="2">Category</th><th rowspan="2">L</th><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">S</th><th rowspan="2">Credits</th><th rowspan="2">Hours</th><th colspan="3">Marks</th></tr>
<tr><th>CIA</th><th>External</th><th>Total</th></tr>
<tr><td>24PMAC33</td><td>Topology</td><td>Core Course-10</td><td>3</td><td>1</td><td>0</td><td>1</td><td>4</td><td>5</td><td>25</td><td>75</td><td>100</td></tr>
<tr><td colspan="12">Learning Objectives</td></tr>
<tr><td>LO1</td><td colspan="11">To define and illustrate the concept of topological spaces, open sets, neighbourhood, interior, exterior, closure and their axioms.</td></tr>
<tr><td>LO2</td><td colspan="11">To understand continuity, compactness, connectedness, homeomorphism and topological properties.</td></tr>
<tr><td>LO3</td><td colspan="11">To analyze and apply the topological concepts in Functional Analysis</td></tr>
<tr><td>LO4</td><td colspan="11">To determine a point in a topological space is either a limit point or not for a given subset of a topological space.</td></tr>
<tr><td>LO5</td><td colspan="11">To develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent (homeomorphic).</td></tr>
<tr><td>Unit</td><td colspan="10">Content</td><td>Hours</td></tr>
<tr><td>1</td><td colspan="10">Topological spaces<br>Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points.<br>Chapter 2 : Sections 12 to 17</td><td>15</td></tr>
<tr><td>2</td><td colspan="10">Continuous functions<br>Continuous functions – The product topology – The metric topology.<br>Chapter 2 : Sections 18 to 21</td><td>15</td></tr>
<tr><td>3</td><td colspan="10">Connectedness<br>Connected spaces- connected subspaces of the Real line – Components and local connectedness.<br>Chapter 3: Sections 23 to 25.</td><td>15</td></tr>
<tr><td>4</td><td colspan="10">Compactness<br>Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.<br>Chapter 3: Sections 26 to 29.</td><td>15</td></tr>
<tr><td>5</td><td colspan="10">Countability and Separation Axiom:<br>The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietze extension theorem.<br>Chapter 4 : Sections 30 to 35.</td><td>15</td></tr>
<tr><td></td><td colspan="10">Total</td><td>75</td></tr>
<tr><td colspan="12">Theory 100%</td></tr>
</table>

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Study the concept of topological spaces, open sets, neighbourhood, interior, exterior, closure and their axioms. |
| CO2 | Understand continuity, compactness, connectedness, homeomorphism and topological properties |
| CO3 | Apply the topological concepts in Functional Analysis |
| CO4 | Evaluate whether a point in a topological space is either a limit point or not for a given subset of a topological space |
| CO5 | Review qualitative tools to characterize connectedness, compactness, second countable, Hausdorff. |
| **Textbooks:** | |
| 1 | James R. Munkres, *Topology* (2nd Edition) Pearson Education Private. Ltd., Delhi-2010 (Third Indian Reprint) |
| **Reference Books:** | |
| 1 | J.Dugundji, *Topology* , Prentice Hall of India, New Delhi, 1975. |
| 2 | George F.Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 |
| 3 | J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York. |
| 4 | L.Steen and J.Subhash, *Counter Examples in Topology*, Holt, Rinehart and Winston, New York,1970. |
| 5 | S.Willard, *General Topology*, Addison - Wesley, Mass., 1970 |
| **Web resources:** | |
| 1 | http://mathforum.org |
| 2 | http://www.opensource.org |
| 3 | http://en.wikipedia.org |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **Total** | 13 | 10 | 15 | 11 | 15 | 15 | 15 | 10 | 15 | 10 | 12 |
| **Average** | 2.6 | 2 | 3 | 2.2 | 3 | 3 | 3 | 2 | 3 | 2 | 2.4 |

**3 – Strong, 2- Medium, 1- Low**

# II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAC34 | Mechanics | Core Course-11 | 3 | 1 | 1 | 1 | 4 | 6 | 25 | 75 | 100 |

| Learning Objectives | |
|---|---|
| LO1 | To understand mechanical systems under generalized coordinate systems |
| LO2 | To apply mechanics techniques in virtual work-Lagrange Equations |
| LO3 | To develop students ability to deal with Energy and momentum |
| LO4 | To learn the concept of Hamilton -Jacobi Theory. |
| LO5 | To discuss the Canonical Transformation. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Mechanical Systems**<br>The Mechanical system-Generalized coordinates- Constraints-Virtual work–Energy and Momentum.<br>**Chapter1: Sections 1.1 to 1.5** | 18 |
| 2 | **Lagrange's Equations**<br>Derivation of Lagrange's equations- Examples - Integrals of motion.<br>**Chapter 2: Sections 2.1 to 2.3** | 18 |
| 3 | **Hamilton's Equations**<br>Hamilton's Principle - Hamilton's Equation - Other variational principles.<br>**Chapter4: Sections 4.1 to 4.3** | 18 |
| 4 | **Hamilton-Jacobi Theory**<br>Hamilton's Principle function-Hamilton-Jacobi Equation-Separability.<br>**Chapter5: Sections 5.1 to 5.3** | 18 |
| 5 | **Canonical Transformation**<br>Differential forms and generating functions - Lagrange and Poisson brackets.<br>**Chapter 6: Sections 6.1 , 6.3 (Omit 6.2)** | 18 |
| | **Total** | 90 |

**Theory 80% Problem 20%**

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Understand mechanical systems under generalized coordinate systems |
| CO2 | Apply mechanical techniques in virtual work by Lagrange |
| CO3 | Evaluate energy and momentum in Hamilton's Equations |
| CO4 | Understand Hamilton-Jacobi theory |
| CO5 | Work on Canonical Transformation. |
| **Textbooks:** | |
| 1 | D.T. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985. |
| **Reference Books:** | |
| 1 | H.Goldstein, *Classical Mechanics*,(2nd Edition) Narosa Publishing House, New Delhi,1950. |
| 2 | N.C.Raneand P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991. |
| 3 | J.L.Synge and B.A. Griffth, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co.,New York, 1970. |
| 4 | French and Ebison, *Introduction to Classical Mechanics*, Kluwer Academic Publishers |
| 5 | George Hrabovsky, *Classical Mechanics*, Penguin Books |
| **Web resources:** | |
| 1 | https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/ |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 |
| **Total** | 13 | 13 | 11 | 13 | 12 | 10 | 12 | 13 | 12 | 14 | 12 |
| **Average** | 2.6 | 2.6 | 2.2 | 2.6 | 2.4 | 2 | 2.4 | 2.6 | 2.4 | 2.8 | 2 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAE31 | Fluid Dynamics | Elective Course-V | 2 | 0 | 1 | 1 | 3 | 4 | 25 | 75 | 100 |

**Learning Objectives**

| | |
|---|---|
| LO1 | To understand the concepts of kinematics of fluids in motions |
| LO2 | To find the pressure at a point in a moving fluid |
| LO3 | To discuss Stokes stream function. |
| LO4 | To analyze complex velocity potential for two dimensional flows |
| LO5 | To derive the Navier – Stokes equations of motion of a Viscous fluid |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Kinematics of Fluids in Motion**<br>Real fluids and ideal fluids – Velocity of a fluid at a point, Stream lines, path lines, steady and unsteady flows –The Velocity potential –The vorticity vector – Local and particle rates of changes –Equations of continuity – Worked examples.<br>**Chapter 2: Sections 2.1 to 2.8** | 12 |
| 2 | **Equations of Motion of a Fluid**<br>Pressure at a point in a fluid at rest – Pressure at a point in a moving fluid – Conditions at a boundary of two inviscid immiscible fluids – Euler's equation of motion –Discussion of the case of steady motion under conservative body forces.<br>**Chapter 3: Sections 3.1 to 3.4 and 3.7** | 12 |
| 3 | **Some Three Dimensional Flows**<br>Introduction – Sources, sinks and doublets – Images in a rigid infinite plane –Axis symmetric flows – Stokes stream function.<br>**Chapter 4: Sections 4.1- 4.3, 4.5** | 12 |
| 4 | **Some Two Dimensional Flows**<br>The stream function – The complex potential for two dimensional, irrational incompressible flow –Complex velocity potentials for standard two dimensional flows – Some worked examples – Two dimensional image systems –The Milne Thompson circle Theorem.<br>**Chapter 5: Sections 5.3 to 5.8** | 12 |
| 5 | **Viscous Flows**<br>Stress components in a real fluid – Relations between Cartesian components of stress – Translational motion of fluid element –The co-efficient of viscosity and Laminar flow – The Navier –Stokes equations of motion of a Viscous fluid.<br>**Chapter 8: Sections 8.1 to 8.3, 8.8 and 8.9** | 12 |
| | **Total** | 60 |

**Theory- 60%, Problem-40%**

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Understand the concepts of kinematics of fluids in motions. |
| CO2 | Evaluate the pressure at a point in a moving fluid |
| CO3 | Work on Stokes stream function intrinsic |
| CO4 | Analyze complex velocity potential for two dimensional flows |
| CO5 | Solve the Navier – Stokes equations of motion of a Viscous fluid |
| **Textbooks:** | |
| 1 | F.Chorlton, *Text Book of Fluid Dynamics*, CBS Publications. Delhi, 1985 |
| **Reference Books:** | |
| 1 | R.W.Fox and A.T.McDonald. *Introduction to Fluid Mechanics*, Wiley, 1985. |
| 2 | E.Krause, *Fluid Mechanics with Problems and Solutions*, Springer, 2005. |
| 3 | B.S.Massey, J.W.Smith and A.J.W.Smith, *Mechanics of Fluids*, Taylor and Francis, New York, 2005 . |
| 4 | P.Orlandi, *Fluid Flow Phenomena*, Kluwer, New Yor, 2002. |
| 5 | T.Petrila, *Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics*, Springer,Berlin, 2004. |
| **Web resources:** | |
| 1 | http://web.mit.edu/1.63/www/lecnote.html |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | 15 | 15 | 14 | 12 | 14 | 12 | 13 | 13 | 13 | 13 | 14 |
| **Average** | 3 | 3 | 2.8 | 2.4 | 2.8 | 2.4 | 2.6 | 2.6 | 2.6 | 2.6 | 2.8 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAE32 | Algebraic Number Theory | Elective Course-V | 2 | 0 | 1 | 1 | 3 | 4 | 25 | 75 | 100 |

**Learning Objectives**

| | |
|---|---|
| LO1 | To learn about rings, fields and factorization of polynomials. |
| LO2 | To know about norms and traces over ring of integers |
| LO3 | To understand factorization to irreducible polynomials. |
| LO4 | To study on Euclidean Quadratic fields |
| LO5 | To analysis concepts of ideals. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Algebraic Background**<br>Rings and Fields- Factorization of Polynomials - Field Extensions - Symmetric Polynomials - Modules - Free Abelian Groups.<br>**Chapter 1: Sec. 1.1 to 1.6** | 12 |
| 2 | **Algebraic Numbers**<br>Algebraic numbers - Conjugates and Discriminants - Algebraic Integers - Integral Bases - Norms and Traces - Rings of Integers.<br>**Chapters 2: Sec. 2.1 to 2.6** | 12 |
| 3 | **Quadratic and Cyclotomic Fields**<br>Quadratics and cyclotomatic fields : Factorization into irreducibles: Trivial factorization - Factroization into irreducibles - Examples of nonunique factorization into irreducibles.<br>**Chapter 3: Sec. 3.1 and 3.2 ; Chapter 4: Sec. 4.2 to 4.4** | 12 |
| 4 | Prime Factroization - Euclidean Domains - Euclidean Quadratic fields - Consequences of unique factorization - The Ramanujan –Nagell Theorem.<br>**Chapter 4: Sec. 4.5 to 4.9** | 12 |
| 5 | **Ideals**<br>Prime Factorization of Ideals - The norms of an Ideal - Non-unique Factorization in Cyclotomic Fields..<br>**Chapter 5 : Sec. 5.2 to 5.4** | 12 |
| | **Total** | 60 |

**Theory-90% Problem-10%**

| CO | Course Outcomes<br>**The Students will be able to** |
|---|---|
| CO1 | Study about rings, fields and factorization of polynomials. |
| CO2 | Recall on norms and traces over ring of integers. |
| CO3 | Solve factorization to irreducible polynomials. |
| CO4 | Understand Euclidean Quadratic fields |
| CO5 | Work on concepts of ideals. |
| **Textbooks:** | |
| 1 | Steward and D.Tall. *Algebraic Number Theory and Fermat's Last Theorem* (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002.. |
| **Reference Books:** | |
| 1 | Z.I.Bosevic and I.R.Safarevic, *Number Theory*, Academic Press, New York, 1966 |
| 2 | J.W.S.Cassels and A.Frohlich, *Algebraic Number Theory*, Academic Press, New York, 1967 |
| 3 | R J.W.S.Cassels and A.Frohlich, *Algebraic Number Theory*, Academic Press, New York, 1967 |
| 4 | P.Samuel, *Algebraic Theory of Numbers*, Houghton Mifflin Company, Boston, 1970. |
| 5 | A.Weil. *Basic Number Theory*, Springer, New York, 1967. |
| **Web resources:** | |
| 1 | http://mathforum.org// |
| 2 | http://www.opensource.org// |
| 3 | www.mathpages.com// |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 12 | 14 | 14 | 14 | 15 | 14 | 13 | 15 | 13 | 15 |
| **Average** | 3 | 2.4 | 2.8 | 2.8 | 2.8 | 3 | 2.8 | 2.6 | 3 | 2.6 | 5 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAS31 | Research Tools And Techniques | SEC-II | 2 | 0 | 1 | 1 | 2 | 3 | 25 | 75 | 100 |

| **Learning Objectives** | |
|---|---|
| LO1 | To demonstrate the knowledge of Research methodology and research problem |
| LO2 | To create the knowledge on Research Design |
| LO3 | To learn the concept of measurement and scaling |
| LO4 | To analyze the data. |
| LO5 | To formulate the hypothesis and to learn the concept of critical value |

| Unit | Content | Hours |
|---|---|---|
| 1 | Research Methodology- Meaning-Objectives- Types- Methods. Research Problem-Definition-Techniques.<br>**Chapter 1: Section:1.1 to 1.8**<br>**Chapter 2: Section:2.1 to 2.4** | 9 |
| 2 | Research Design-Meaning,-Features- Concepts- types- principles- Different Research Design- Principles and experimental design<br>**Chapter 3: Section:3.1 to 3.7** | 9 |
| 3 | Measurement and Scaling-Qualitative and quantitative data- Classification, Techniques, Scaling-Classification.<br>**Chapter 5: Section:5.1 to 5.7** | 9 |
| 4 | Data Collection-Introduction-Experiments and survey -Primary and Secondary data<br>**Chapter 6: Section:6.1 to 6.4** | 9 |
| 5 | Testing of Hypothesis-Basic concepts-Critical region and critical value – Procedure.<br>**Chapter 10: Section:10.1 to 10.6** | 9 |
| | **Total** | 45 |
| | **Theory-100%** | |

| CO | **Course Outcomes**<br>**The Students will be able to** |
|---|---|
| CO1 | Understand the knowledge of Research methodology and research problem. |
| CO2 | Frame the Research Designs. |
| CO3 | Work on measurement and scaling. |
| CO4 | Able to collect and classify the data |
| CO5 | Formulate the hypothesis and learnt the concept of critical value. |

**Textbooks:**

| | |
|---|---|
| 1 | C.R.Kothari, Gaurav Garg, *Research Methodology Methods and Techniques*, New AgeInternational Publishers, 2019. |

| Reference Books: | |
|---|---|
| 1 | Dr. Prabhat Pandey Dr. Meenu Mishra Pandey ,*Research Methodology: Tools and Techniques*, Bridge Center, 2015 |
| 2 | Ackoff, Russell L. *The Design of Social Research*, University of Chicago Press: Chicago, 1961 |
| 3 | Allen, T. Harrell, *New Methods in Social Research*, Praeger Publication: New York, 197 |
| 4 | Baker, R.P. and Howell, A.C. *The Preparation of Reports*, Ronald Press: New York, 1958. |
| 5 | Barzun, Jacques and Graff. F. *The Modern Researcher*, Harcourt, Brace Publication: New York, 1990 |
| **Web resources:** | |
| 1 | http://mathforum.org// |
| 2 | http://www.opensource.org// |
| 3 | www.mathpages.com// |


**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **Total** | 12 | 12 | 13 | 15 | 13 | 14 | 14 | 12 | 13 | 13 | 14 |
| **Average** | 2.4 | 2.4 | 2.6 | 3 | 2.6 | 2.8 | 2.8 | 2.4 | 2.6 | 2.6 | 2. 8 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAIN31 | **Internship** | | **0** | **0** | **0** | **0** | **2** | **25** | **25** | **75** | **100** |
| **Learning Objectives** | | | | | | | | | | | |
| LO1 | Engage in a professional working environment to gain hands-on experience and understand the practical applications of theoretical knowledge. | | | | | | | | | | |
| LO2 | Analyze various aspects of developing computer-based solutions while fostering teamwork and collaboration. | | | | | | | | | | |
| LO3 | Demonstrate proficiency in problem-solving, soft skills, and other essential abilities required for professional growth and development. | | | | | | | | | | |
| LO4 | Develop additional competencies and specialized skills relevant to a chosen occupation or profession. | | | | | | | | | | |
| LO5 | Enhance interpersonal, social, and communication skills to promote effective workplace interaction. | | | | | | | | | | |
| | **REGULATIONS** | | | | | | | | | | |
| 1 | Every student must complete an internship program in a relevant firm, industry, or organization during the course of study to gain practical exposure. | | | | | | | | | | |
| 2 | After completing the second semester, the student should identify and analyze a suitable project to be undertaken during the third semester. | | | | | | | | | | |
| 3 | During the internship, students are expected to actively participate in assigned tasks and document the work performed throughout the training period. | | | | | | | | | | |
| 4 | A detailed internship report must be prepared and submitted by the student in the format prescribed by the institution. | | | | | | | | | | |
| 5 | The report submission will take place at the end of the third semester, followed by presentation and viva voce evaluation during the semester examination. | | | | | | | | | | |
| 6 | The evaluation of the internship/project work will be for 100 marks, comprising 50 internal (25 for report and 25 for viva) and 50 externals (25 for report and 25 for viva), assessed jointly by internal and external examiners. The external examiner shall be appointed from affiliated colleges or, if necessary, from within the college. | | | | | | | | | | |
| 7 | Students must secure at least 50% of the total marks to pass. Those who fail to meet this requirement must improve their performance and resubmit their report in the next available attempt. The final report must include all prescribed sections and be submitted to the Controller of Examinations within the specified date. | | | | | | | | | | |

| CO | COURSE OUTCOMES |
|---|---|
| CO1 | Identify specific areas of interest and enhance relevant skills and competencies |
| CO2 | Cultivate greater self-awareness while fostering respect and appreciation for others. |
| CO3 | Develop professional work habits and attitudes essential for success in the workplace. |
| CO4 | Recognize the significance of effective communication, interpersonal skills, and teamwork. |
| CO5 | Promote proactive preparation to transition internship experiences and creativity into full-time employment immediately upon graduation. |

**Internal Marks Awarded for the Internship – 25 Marks**

| Component | Marks |
|---|---|
| Internship Review I (During the Beginning of The Semester) | 5 Marks |
| Internship Review II (During the End of The Semester) | 15 Marks |
| Progress of The Internship by the Student Participated | 5 Marks |

**External Marks Awarded for the Internship – 75 Marks**

| Component | Marks |
|---|---|
| Evaluation of the Internship Report | 25 Marks |
| Presentation | 25 Marks |
| Viva Voce Examination | 25 Marks |

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAC41 | Functional Analysis | Core | 3 | 1 | 1 | 1 | 5 | 6 | 25 | 75 | 100 |

| Learning Objectives | |
|---|---|
| LO1 | To study Banach spaces and continuous linear transformations. |
| LO2 | To understand the concepts of Open mapping theorem and properties of Orthogonal complements. |
| LO3 | To learn conjugate space $H^*$, adjoint, self-adjoint, normal and Unitary operators. |
| LO4 | To understand the preliminaries of Banach Algebra. |
| LO5 | To study on commutative Banach Algebras. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Banach Spaces**: Definition and some examples – Continuous linear transformations – The Hahn-Banach theorem- The natural imbedding of $N$ in $N^{**}$. Chapter9: Sections 46-49 | 18 |
| 2 | **Banach Spaces and Hilbert Spaces:** The open mapping theorem – The conjugate of an Operator-The definition and some simple properties–Orthogonal complements–Orthonormal sets. Chapter9: Sections 50-51 Chapter10: Sections 52-54 | 18 |
| 3 | **Hilbert Spaces:** The conjugate space $H^*$-The adjoint of an operator–self- adjoint operators-Normal and unitary operators – Projections. Chapter10: Sections 55-59 | 18 |
| 4 | **General Preliminaries on Banach Algebras:** The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi- simplicity. Chapter12: Sections 64-69 | 18 |
| 5 | **The Structure of Commutative Banach Algebras:** The Gelfand mapping – Applications of the formula $r(x) = \lim \|x^n\|^{1/n}$ – Involutions in Banach algebras-The Gelfand-Neumark theorem. Chapter13: Sections 70-73 | 18 |
| | **Total** | **90** |
| | **Theory 80% problem 20%** | |

| CO | Course Outcomes<br>The students will be able to |
|---|---|
| CO1 | Understand Banach spaces and Transformations on Banach Spaces. |
| CO2 | Apply conjugate operator and Open mapping theorem. |
| CO3 | Work on the Hilbert spaces. |
| CO4 | Classify on Banach algebra and spectral radius. |
| CO5 | Construct the concept of Gelfand- Neumark theorem and its applications. |
| **Text books** | |
| 1 | G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1963. |
| **Reference Books** | |
| 1 | W. Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973. |
| 2 | B.V. Limaye, Functional Analysis, New Age International,1996. |
| 3 | C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi,1987. |
| 4 | E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978. |
| 5 | M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002. |
| **Website and e-Learning Source** | |
| 1 | http://mathforum.org, |
| 2 | http://www.opensource.org// |
| 3 | http://en.wikiepedia.org |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | 13 | 10 | 14 | 11 | 15 | 15 | 15 | 10 | 14 | 12 | 14 |
| **Average** | 2.6 | 2 | 2.8 | 2.2 | 3 | 3 | 3 | 2 | 2.8 | 2.4 | 2.8 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: FOURTH SEMESTER

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th rowspan="2">Category</th><th rowspan="2">L</th><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">S</th><th rowspan="2">Credits</th><th rowspan="2">Hours</th><th colspan="3">Marks</th></tr>
<tr><th>CIA</th><th>External</th><th>Total</th></tr>
<tr><td>24PMAC42</td><td>Differential Geometry</td><td>Core</td><td>3</td><td>1</td><td>1</td><td>1</td><td>5</td><td>6</td><td>25</td><td>75</td><td>100</td></tr>
<tr><td colspan="12">Learning Objectives</td></tr>
<tr><td>LO1</td><td colspan="11">To study on space curves, characterizations and Fundamental Existence theorem.</td></tr>
<tr><td>LO2</td><td colspan="11">To learn intrinsic properties and metrics of surface.</td></tr>
<tr><td>LO3</td><td colspan="11">To analysis Geodesics and Geodesic curvature problems.</td></tr>
<tr><td>LO4</td><td colspan="11">To study non- intrinsic properties of a surface and applicability.</td></tr>
<tr><td>LO5</td><td colspan="11">To gain knowledge on differential geometry of surface and Hilbert's lemma.</td></tr>
<tr><td>Unit</td><td colspan="9">Content</td><td colspan="2">Hours</td></tr>
<tr><td>1</td><td colspan="9">Space curves: Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion of a curve given as the intersection of two surfaces – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helices.<br>Chapter I: Sections 1 - 9.</td><td colspan="2">18</td></tr>
<tr><td>2</td><td colspan="9">Intrinsic properties of a surface: Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties.<br>Chapter II: Sections 1 - 9.</td><td colspan="2">18</td></tr>
<tr><td>3</td><td colspan="9">Geodesics: Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature.<br>Chapter II: Sections 10 - 18.</td><td colspan="2">18</td></tr>
<tr><td>4</td><td colspan="9">Local Non-intrinsic properties of a surface: The second fundamental form- Principal curvatures – Lines of curvature – Developable - Developable associated with space curves and with curves on surface - Minimal surfaces – Ruled surfaces.<br>Chapter III: Sections 1 - 8.</td><td colspan="2">18</td></tr>
<tr><td>5</td><td colspan="9">Local Non-intrinsic properties of a surface: Fundamental equations of surface theory-Fundamental existence theorem for surfaces.<br>Differential Geometry of Surfaces in the Large: Introduction-Compact surfaces whose points are umbilic- Hilbert's lemma– Compact surfaces of constant Gaussian or mean curvature – Complete surfaces.<br>Chapter III: Sections 9 - 11<br>Chapter IV: Sections 1 – 5</td><td colspan="2">18</td></tr>
<tr><td></td><td colspan="9">Total</td><td colspan="2">90</td></tr>
<tr><td></td><td colspan="9">Theory 80% problem 20%</td><td colspan="2"></td></tr>
</table>

| CO | Course Outcomes<br>The students will be able to |
|---|---|
| CO1 | Understand the concepts of a space curves and to compute curvature, torsion. |
| CO2 | Classify the curves on surface and its intrinsic properties. |
| CO3 | Compute problems on Geodesics. |
| CO4 | Work on developable and non-intrinsic properties of a surface. |
| CO5 | Express Hilbert's lemma and the fundamental existence theorem for surface theory. |
| **Text books:** | |
| 1 | T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press, (17th Impression) New Delhi 2002. (Indian Print) |
| **Reference Books:** | |
| 1 | D. Somasundaram, Differential Geometry A First Course, Alpha Science International Limited,2005 |
| 2 | Kobayashi. S. and Nomizu. K., Foundations of Differential Geometry, Inter science Publishers, 1963. |
| 3 | Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag, 1978. |
| 4 | J.A. Thorpe, Elementary topics in Differential Geometry, Undergraduate Texts in Mathematics, Springer - Verlag, 1979. |
| 5 | D.T. Struik, Lectures on Classical Differential Geometry, Addison – Wesley, Mass, 1950. |
| **Website and e-Learning Source** | |
| 1 | http://mathforum.org |
| 2 | http://www.opensource.org, www.physicsforum.com |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | 13 | 10 | 14 | 11 | 15 | 15 | 15 | 10 | 11 | 11 | 13 |
| **Average** | 2.6 | 2 | 2.8 | 2.2 | 3 | 3 | 3 | 2 | 2.2 | 2.2 | 2.6 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAC43 | Project | Core | 0 | 0 | 5 | 1 | 5 | 6 | 25 | 75 | 100 |

| Learning Objectives | |
|---|---|
| LO1 | Engage in a real-time project environment to apply theoretical knowledge for practical problem-solving. |
| LO2 | Analyze different stages of project development and implementation while demonstrating effective project and collaboration. |
| LO3 | Demonstrate technical proficiency, analytical skills, and professional ethics in executing the assigned project work. |
| LO4 | Develop research project and innovative approaches relevant to the chosen project domain. |
| LO5 | Strengthen communication, documentation, and presentation skills required for professional project execution. |

| | REGULATIONS | |
|---|---|---|
| 1 | Every student must undertake an individual project work in a relevant domain, preferably aligned with their area of specialization, during the course of study to gain practical and analytical exposure. | |
| 2 | After completing the third semester, the student should identify, propose, and obtain approval for a suitable project topic to be executed during the fourth semester. | |
| 3 | During the project period, students are expected to actively participate in all stages of the project, including analysis, design, implementation, and documentation. | |
| 4 | A comprehensive project report must be prepared and submitted by the student in the prescribed institutional format. Students have to submit the copies of the thesis in the book form (size: 21.0 cm ×13.5 cm). Dissertation text should be typed in double line spacing and Times New Roman font size 12 and number of pages should be restricted to be maximum of 100 pages. | |
| 5 | The project report submission will take place at the end of the fourth semester, followed by a presentation and viva voce evaluation during the semester examination. | |
| 6 | The evaluation of the project work will be for 100 marks, comprising 25 internal, 50 project evaluation and 25 for viva-voice, assessed jointly by internal and external examiners. The external examiner shall be appointed from affiliated colleges of Parent University, University Departments, or any other affiliated colleges. | |
| 7 | Students must secure at least 50% of the total marks to pass. Those who are absent/fail to meet this requirement must improve their performance and resubmit the project report in the next available attempt. The final report must include all prescribed sections and be submitted to the Controller of Examinations within the specified date. | |

| CO | COURSE OUTCOMES |
|---|---|
| CO1 | Identify and define a real-world problem, applying relevant concepts and methodologies to develop an effective project solution. |
| CO2 | Cultivate independent thinking, critical analysis and collaborative skills throughout the project. |
| CO3 | Demonstrate professional ethics, responsibility and effective project management abilities. |
| CO4 | Communicate research and technical findings through well-structured documentation and presentations. |
| CO5 | Enhance readiness for professional employment or further research by applying innovative and creative approaches to project development. |

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24PMAE41** | **Resource Management Techniques** | **Elective** | **2** | **1** | **1** | **1** | **4** | **5** | **25** | **75** | **100** |

| Learning Objectives | |
|---|---|
| LO1 | To solve integer linear Programming problems. |
| LO2 | To learn Decision making under different types and Decision Making with Utilities. |
| LO3 | To understand CPM and PERT techniques in scheduling problems. |
| LO4 | To classify various types of replacement problems and maintenance techniques. |
| LO5 | To use differential calculus-based methods to obtain the optimal solutions. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Integer linear Programming**<br>Cutting plane algorithm – Gomory's all and mixed integer cutting plane method.<br>Chapter: 7 Sections 7.1-7.5 | 15 |
| 2 | **Decision Theory**<br>Steps in Decision theory Approach-Types of Decision-Making Environments-Decision making Under Uncertainty-Decision Making under Risk-Decision Tree Analysis.<br>Chapter:11 Sections 11.1-11.5,11.7 | 15 |
| 3 | **Object Scheduling**<br>Network diagram representation – Critical path method – PERT-Project Time-Cost Trade off.<br>Chapter:13 Sections 13.1-13.7 | 15 |
| 4 | **Replacement and Maintenance Models**<br>Mechanism of items-Replacement of items Deteriorates with time-Replacement of items that fail completely- Other Replacement Problems.<br>Chapter: 17 Sections 17.1-17.5 | 15 |
| 5 | **Classical Optimization Theory**<br>Unconstrained Optimization-Constrained Optimization – Equality constraints — Lagrangian method – Kuhn– Tucker Necessary and Sufficient conditions.<br>Chapter: 23 Sections 23.1-23.4 | 15 |
| | **Total** | **75** |
| | **Theory 40% Problem 60%** | |

| CO | **Course Outcomes**<br>The students will be able to |
|---|---|
| CO1 | Formulate and analyze optimization problems. |
| CO2 | Make efficient decisions and applying various decision-making criteria. |
| CO3 | Effectively manage construction, project and to calculate CPM. |
| CO4 | Solve replacement problems and maintenance models. |
| CO5 | Classify optimization problems and work on Kuhn– Tucker problems. |

**Textbooks:**

| | |
|---|---|
| 1 | J.K. Sharma, Operations Research Theory and Applications ($6^{th}$ Edition), Trinity Press, Laxmi Publications Pvt. Ltd., New Delhi, Reprint 2017. |

**Reference Books:**

| | |
|---|---|
| 1 | R. Panneerselvam, Operations Research, Prentice Hall of India, New Delhi,2008. |
| 2 | Anderson, Quantitative Methods for Business ‘, 8th Edition,Thomson Learning, 2002. |
| 3 | Winston, Operations Research, Thomson Learning, 2003. |
| 4 | Vohra, Quantitative Techniques in Management, Tata Mc Graw Hill, 2002. |
| 5 | Anand Sarma, Operations Research, Himalaya Publishing House, 2003. |

**Website and e-Learning Source**

| | |
|---|---|
| 1 | http://mathforum.org// |
| 2 | http://ocw.mit.edu/ocwweb/Mathematics// |
| 3 | www.mathpages.com// |
| 4 | http://www.opensource.org// |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 12 | 14 | 13 | 14 | 13 | 14 | 14 | 14 | 13 | 13 |
| **Average** | 3 | 2.4 | 2.8 | 2.6 | 2.8 | 2.6 | 2.8 | 2.8 | 2.8 | 2.6 | 2.6 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAE42 | Financial Mathematics | Elective | 2 | 1 | 1 | 1 | 4 | 5 | 25 | 75 | 100 |

| Learning Objectives | |
|---|---|
| LO1 | To understand models and Neutral Probability Measure. |
| LO2 | To learn stochastic and deterministic models. |
| LO3 | To study Brownian Motion. |
| LO4 | To understand the Stochastic Calculus. |
| LO5 | To classify the Block-Scholes Model. |

| Unit | Content | Hours |
|---|---|---|
| 1 | Single Period Models: Definitions from Finance - Pricing a forward - One-step Binary Model - a ternary Model - Characterization of no arbitrage - Risk-Neutral Probability Measure. | 15 |
| 2 | Binomial Trees and Discrete Parameter Martingales: Multi-period Binary model - American Options - Discrete parameter martingales and Markov processes - Martingale Theorems - Binomial Representation Theorem –Overture to Continuous models. | 15 |
| 3 | Brownian Motion: Definition of the process - Levy's Construction of Brownian Motion - The Reflection Principle and Scaling - Martingales in Continuous time. | 15 |
| 4 | Stochastic Calculus: Non-differentiability of Stock prices - Stochastic Integration - Ito's formula - Integration by parts and Stochastic Fubini Theorem – Girsanov Theorem - Brownian Martingale Representation Theorem – Geometric Brownian Motion - The Feynman - Kac Representation. | 15 |
| 5 | Block-Scholes Model: Basic Block-Scholes Model - Block-Scholes price and hedge for European Options - Foreign Exchange - Dividends - Bonds– Market price of risk. | 15 |
| | **Total** | **75** |
| | **Theory 80% problem 20%** | |

| CO | Course Outcomes<br>The students will be able to |
|---|---|
| CO1 | Use discrete and continuous processes in financial modeling. |
| CO2 | Gain knowledge in the relationship between stochastic and deterministic models. |
| CO3 | Understand the roles of Put and Call options in risk reduction. |
| CO4 | Understand hedging strategies to reduce risk. |
| CO5 | Understand the role of the Black-Scholes partial differential equation and its boundary and final conditions in option pricing. |
| **Text books:** | |
| 1 | Alison Etheridge, A Course in Financial Calculus, Cambridge University Press, Cambridge, 2002. |
| **Reference Books:** | |
| 1 | Martin Boxter and Andrew Rennie, Financial Calculus: An Introduction to Derivatives Pricing, Cambridge University Press, Cambridge, 1996. |
| 2 | Chapman and Hall, Introduction to Stochastic Calculus Applied to Finance, 1996. |
| 3 | Marek Musiela and Marek Rutkowski, Martingale Methods in Financial Modeling, Springer Verlag, New York, 1988. |
| 4 | Robert J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Springer Verlag, New York, 2001 (3rd Printing) |
| **Website and e-Learning Source** | |
| 1 | https://archive.org/details/financialmathema032436mbp |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | 13 | 10 | 14 | 11 | 15 | 15 | 15 | 10 | 11 | 11 | 13 |
| **Average** | 2.6 | 2 | 2.8 | 2.2 | 3 | 3 | 3 | 2 | 2.2 | 2.2 | 2.6 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24PMAP41** | **Stochastic Processes** | **PEC** | **2** | **0** | **0** | **1** | **2** | **3** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | To understand the fundamentals of stochastic processes, classify Markov chains and their states. |
| LO2 | To analyze the stability, structure of Markov chains using graph theory and statistical inference. |
| LO3 | To know the model real-world systems using Poisson processes and their generalizations. |
| LO4 | To apply birth-death processes and continuous-time Markov models to dynamic systems. |
| LO5 | To solve Kolmogorov equations and first passage time problems by using Brownian motion, Wiener processes. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Stochastic Processes**<br>Stochastic processes – Specification of Stochastic processes.<br>Markov Chains: Definitions and Examples – Higher transition probabilities – Generalization of independent Bernoulli trials - Classification of States and Chains.<br>Chapter1 :1.5; Chapter2 :2.1- 2.4 | 9 |
| 2 | **Markov Chains**<br>Stability of Markov system – Graph theoretic approach –Markov chain with denumerable number of states-Markov Chains with Continuous State Space<br>Chapter2:2.6 -2.8 and 2.11. | 9 |
| 3 | **Markov Processes with Discrete State Space**<br>Poisson process: Poisson process and Related distributions - Generalizations of Poisson process.<br>Chapter3 :3.1 - 3.3 | 9 |
| 4 | **Markov Processes with Discrete State Space (Cont…..)**<br>Birth and death process – Markov processes with discrete state space (Continuous time Markov chain) - Erlang Process.<br>Chapter3 :3.4-3.5 and 3.7 | 9 |
| 5 | **Markov Processes with Continuous State Space**<br>Introduction-Brownian motion – Weiner process – Differential equations for Weiner Process – Kolmogorov equations – First passage time distribution for Weiner process.<br>Chapter4 :4.1 - 4.5 | 9 |
| | **Total** | **45** |
| | **Theory 60% problem 40%** | |

| CO | Course Outcomes<br>The students will be able to |
|---|---|
| CO1 | Know the classification of stochastic processes. |
| CO2 | Know Markov chains and the stability condition. |
| CO3 | Understand Poisson process and its properties. |
| CO4 | Discuss on Poisson process and birth and death process. |
| CO5 | Understand Brownian process and Weiner process. |

**Textbooks:**

| | |
|---|---|
| 1 | J. Medhi, Stochastic Processes ($5^{th}$ Edition), New Academic Science Limited, New Delhi, 2022. |

**Reference Books:**

| | |
|---|---|
| 1 | S. Karlin, A first course in Stochastic Processes, ($2^{nd}$Edition), Academic Press,1958. |
| 2 | U.N. Bhat, Elements of Applied Stochastic Processes, John Wiley Sons, 1972. |
| 3 | E. Cinlar, Introduction to Stochastic Processes, PHI, 1975. |
| 4 | S.K. Srinivasan and A. Vijayakumar, Stochastic Processes, Narosa Publishing House, 2003. |

**Website and e-Learning Source**

| | |
|---|---|
| 1 | http://mathforum.org. |
| 2 | http://ocw.mit.edu/ocwweb/Mathematics, |
| 3 | www.mathpages.com. |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 12 | 14 | 13 | 14 | 14 | 15 | 13 | 15 | 13 | 15 |
| **Average** | 3 | 2.4 | 2.8 | 2.6 | 2.8 | 2.8 | 3 | 2.6 | 3 | 2.6 | 3 |

**3 – Strong, 2- Medium, 1- Low**

## II YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| 24PMAL41 | **Mathematical Modelling** | SLC | 2 | 0 | 1 | 1 | 2 | 4 | 25 | 75 | 100 |

| Learning Objectives | |
|---|---|
| LO1 | To understand the fundamentals and significance of mathematical modelling in real-world situations. |
| LO2 | To classify different types of mathematical models, identify their key characteristics and applications. |
| LO3 | To develop and analyze differential equations including linear, non-linear and compartmental types. |
| LO4 | To construct and interpret system models such as prey–predator, competition, and epidemic models using ordinary differential equations. |
| LO5 | To explore the use of graph theory in mathematical modelling such as directed and signed graphs, to represent network-based systems. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Mathematical Modelling**<br>Simple situations requiring mathematical modelling -Classification of Mathematical Models - Characteristics of mathematical models.<br>Chapter1 :1.1, 1.3 -1.4. | 12 |
| 2 | **Mathematical Modelling through ordinary differential equations of first order:**<br>Linear Growth and Decay Models. Non-Linear growth and decay models, Compartment models.<br>Chapter2: 2.2 - 2.4. | 12 |
| 3 | **Mathematical Modelling through system of Ordinary differential equations of first order:**<br>Mathematical Modelling in population dynamics- Mathematical Modelling of epidemics through systems of ordinary differential equations of first order.<br>Chapter3 :3.1 - 3.2. | 12 |
| 4 | **Mathematical Modelling through difference equations:**<br>The need for Mathematical modelling through difference equations: some simple models -Basic theory of linear difference equations with constant coefficients -Mathematical modelling through difference equations in economics and finance.<br>Chapter 5: 5.1 - 5.3. | 12 |
| 5 | **Mathematical modelling through Graphs**<br>Situations that can be modelled through graphs - Mathematical models in terms of directed graphs - Mathematical models in terms of signed graphs<br>Chapter 7: 7.1 -7.3 | 12 |
| | **Total** | **60** |
| | **Theory 70% problem 30%** | |

| CO | Course outcomes<br>The students will be able to |
|---|---|
| CO1 | Explain simple situations requiring mathematical modelling and determine the characteristics and classifications of such models. |
| CO2 | Develop models using differential equations to represent linear and non-linear growth and decay processes, including compartmental systems. |
| CO3 | Construct and analyze models using systems of first-order ordinary differential equations, including prey–predator, competition, and epidemic models. |
| CO4 | Explain and apply the concept of difference equations in developing discrete-time mathematical models for various real-world scenarios. |
| CO5 | Apply graph theory concepts to construct and analyze mathematical models using directed and signed graphs. |

| **Text books:** | |
|---|---|
| 1 | J N Kapur, Mathematical Modelling, New Age International, Publishers (2009). |
| **Reference Books:** | |
| 1 | D. N. Burghes, Modelling with Difference Equations, Ellis Harwood and John Wiley. |
| 2 | D. J. G. James and J. J. Macdonald, Case studies in Mathematical Modelling, Stanly Thames, Cheltonham. |
| 3 | M. Cross and A. O. Moscrcadini, The art of Mathematical Modelling, Ellis Harwood and John Wiley. |
| 4 | C. Dyson, Elvery, Principles of Mathematical Modelling, Academic Press, NewYork. |
| **Website and e-Learning Source** | |
| 1 | http://www.mathfoundation.com |
| 2 | https://nptel.ac.in |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |
| **Total** | 11 | 14 | 14 | 14 | 10 | 10 | 15 | 13 | 10 | 15 | 10 |
| **Average** | 2.2 | 2.8 | 2.8 | 2.8 | 2 | 2 | 3 | 2.6 | 2 | 3 | 2 |

**3 – Strong, 2- Medium, 1- Low**