**RATHINAM COLLEGE OF ARTS AND SCIENCE**

**(AUTONOMOUS)**

**Rathinam Tech Zone, Eachanari, Coimbatore – 641021.**

**DEPARTMENT OF MATHEMATICS**


**Syllabus for**

**M.Sc.Mathematics**

**(I and II Semester)**

**2024 – 2025 Batch onwards**

**Vision and Mission of the Institution**

**Vision**

To emerge as a world-renowned Institution that is integrated with industry to impart Knowledge, Skills, Research Culture and Values in youngsters whocanaccelerate the overall development of India

**Mission**

To provide quality education at affordable cost, build academic and research excellence, maintain eco-friendly and robust infrastructure, and to create a team of well qualified faculty who can build global competency and employability among the youth of India

**Motto**

Transform the youth into National Asset

**Vision and Mission of the Department**

**Vision**

The Department aspires to the highest standards of excellence in teaching and service of humanity, through preparing students for learning Applied and Industrial Mathematics for the challenging growth of science and Technology.

**Mission**

The Mission of the Department is to provide an environment where students can learn and become competent users of Mathematics and Mathematical Application and also to provide quality Education, Research and Consultancy by providing highly skilled mathematical knowledge along with the industrial collaboration.

**Motto**

Empowering Minds through Mathematics

**Program Educational Objectives (PEO)**

| | | |
|---|---|---|
| **PEO1** | **:** | Pursue a career as a globally competent and universally employable professionalin core and related fields in diverse sectors who accelerates the overall development of India. |
| **PEO2** | **:** | Pursue lifelong learning opportunities including graduate degrees to improve and expand domain specific and professional skills. |
| **PEO3** | **:** | Advance personally and professionally by accepting professional and societal responsibilities, and pursuing leadership roles. |

**Mapping of Institute's Mission to PEO**

| Institute's Mission | PEO's |
|---|---|
| To provide quality education at affordable cost, build academic and research excellence maintain eco-friendly and robust infrastructure, and | PEO1, PEO2 |
| To create a team of well qualified faculty who can build global competency and employability among the youth of India. | PEO2, PEO3 |

**Mapping of Department Mission to PEO**

| Department Mission | PEO's |
|---|---|
| Impart Critical thinking ability to become more competency | PEO1, PEO3 |
| Analytical Knowledge with Industry Collabration | PEO1, PEO2 |
| Industry Collabration | PEO2, PEO3 |
| Research Culture | PEO1 PEO2 |

**Program Outcomes (PO):**

| | | |
|---|---|---|
| **PO1** | **:** | Demonstrate knowledge competency in core discipline |
| **PO2** | **:** | Apply the appropriate knowledge and suitable skills in solving the complex problems |
| **PO3** | **:** | Conduct investigations of complex problems through various scientific approaches |
| **PO4** | **:** | Design solutions for complex and open ended real-life or real-time problems |
| **PO5** | **:** | Use appropriate and advanced tools for wide range of practices with an understanding on its associated limitations |
| **PO6** | **:** | Work effectively and responsibly as a member or a leader in a team |
| **PO7** | **:** | Express complex concepts within the profession and with society at large |
| **PO8** | **:** | Understand the professional roles and responsibilities |
| **PO9** | **:** | Analyze social and environmental aspects of the professional practices |
| **PO10** | **:** | Practice higher moral and ethical standards during the discharge of professional duties |
| **PO11** | **:** | Incorporate finer finance and business practices in all professional engagements |
| **PO12** | **:** | Identify and address their professional development through lifelong learning |

**Program Specific Outcomes (PSO):**

| | | |
|---|---|---|
| **PSO1** | **:** | Solve complex problems by critical understanding, analysis and synthesis. |
| **PSO2** | **:** | Recognize the need to engage in lifelong learning through continuing education and research. |
| **PSO3** | **:** | Inculcate the capacity to transfer the mathematical knowledge for their industrial career. |
| **PSO 4** | **:** | Demonstrate engagement with current research and developments in the subject. |

**Correlation between the PO/PSO and the PEOs**

| Program Outcomes | | PEO 1 | PEO 2 | PEO 3 |
|---|---|---|---|---|
| **PO1** | : | 3 | 1 | 3 |
| **PO2** | : | 3 | 2 | 3 |
| **PO3** | : | 1 | 2 | 3 |
| **PO4** | : | 3 | 1 | 3 |
| **PO5** | : | 3 | 3 | 2 |
| **PO6** | : | 2 | 3 | 3 |
| **PO7** | : | 2 | 3 | 1 |
| **PO8** | : | 3 | 2 | 1 |
| **PO9** | : | 2 | 2 | 3 |
| **PO 10** | : | 3 | 2 | 1 |
| **PO 11** | : | 2 | 1 | 1 |
| **PO 12** | : | 3 | 2 | 2 |
| **PSO1** | : | 3 | 2 | 1 |
| **PSO2** | : | 2 | 2 | 1 |
| **PSO3** | : | 2 | 2 | 1 |
| **PSO4** | : | 3 | 3 | 2 |

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

**Components considered for Course Delivery is listed below:**

a. Class room Lecture
b. Laboratory class and demo
c. Assignments
d. Mini Project
e. Project
f. Online Course
g. External Participation
h. Seminar
i. Internship

**Mapping of POs with Course Delivery:**

| Program Outcome | Course Delivery | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** |
| PO1 | 3 | 3 | 1 | 1 | 2 | 1 | 3 | 3 | 1 |
| PO2 | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 2 | 3 |
| PO3 | 3 | 3 | 1 | 3 | 1 | 1 | 1 | 2 | 3 |
| PO4 | 2 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 1 |
| PO5 | 3 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 3 |
| PO6 | 2 | 3 | 1 | 3 | 3 | 1 | 2 | 3 | 3 |
| PO7 | 2 | 3 | 1 | 3 | 1 | 1 | 2 | 3 | 3 |
| PO8 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 |
| PO9 | 1 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| PO10 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| PO11 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| PO12 | 1 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| PSO1 | 2 | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 3 |
| PSO2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| PSO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 |
| PSO4 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 1 | 2 |

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

**RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)**

**B.SC. MATHEMATICS DEGREE PROGRAMME**

**M. Sc (MMA) Curriculum Structure - Regulation – 2024**

**(For students admitted from 2024-2025 and onwards)**

| Sem | Part | Type | Sub Code | Subject | Credit | Per Week | CIA | ESE | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.1 | 3 | C1 | | Core-I | 4 | 5 | 50 | 50 | 100 |
| 1.2 | 3 | C2 | | Core-II | 4 | 5 | 50 | 50 | 100 |
| 1.3 | 3 | C3 | | Core-III | 4 | 5 | 50 | 50 | 100 |
| 1.4 | 3 | C4 | | Core-IV | 4 | 5 | 50 | 50 | 100 |
| 1.5 | 3 | SEC 1 | | Skill - I (Practical / Training) | 4 | 5 | 50 | 50 | 100 |
| 1.6 | 3 | ELE 1 | | Elective-1 | 4 | 5 | 50 | 50 | 100 |
| | | | | | **24** | **30** | **350** | **350** | **700** |
| 2.1 | 3 | C5 | | Core-V | 4 | 5 | 50 | 50 | 100 |
| 2.2 | 3 | C6 | | Core-VI | 4 | 5 | 50 | 50 | 100 |
| 2.3 | 3 | C7 | | Core-VII | 4 | 5 | 50 | 50 | 100 |
| 2.4 | 3 | C8 | | Core-VIII | 4 | 5 | 50 | 50 | 100 |
| 2.5 | 3 | SEC 2 | | Skill - II (Practical / Training) | 4 | 5 | 50 | 50 | 100 |
| 2.6 | 3 | ELE 2 | | Elective-2 | 4 | 5 | 50 | 50 | 100 |
| | | | | | **24** | **30** | **250** | **250** | **500** |
| 3.1 | 3 | C9 | | Core-IX | 4 | 6 | 50 | 50 | 100 |
| 3.2 | 3 | C10 | | Core-X | 4 | 6 | 50 | 50 | 100 |
| 3.3 | 3 | C11 | | Core – XI | 4 | 6 | 50 | 50 | 100 |
| 3.4 | 3 | SEC 3 | | Skill - III (Practical / Training) | 4 | 6 | 50 | 50 | 100 |
| 3.5 | 3 | ELE 4 | | Elective-3 | 4 | 6 | 50 | 50 | 100 |
| 3.6 | 3 | ITR | | Internship / Industrial Training (Summer vacation at the end of II semester activity) | 2 | | 50 | 0 | 50 |
| | | | | | **22** | **30** | **300** | **250** | **550** |
| 4.1 | 3 | C12 | | Core-XII | 4 | 6 | 50 | 50 | 100 |
| 4.2 | 3 | SEC 4 | | Skill - IV (Practical / Training) | 4 | 6 | 50 | 50 | 100 |
| 4.3 | 3 | ELE 5 | | Elective-4 | 4 | 6 | 50 | 50 | 100 |
| 4.4 | 3 | PRJ | | Project with Viva-Voce | 8 | 12 | 100 | 100 | 200 |
| | | | | | **20** | **30** | **250** | **250** | **500** |
| **TOTAL** | | | | | **90** | **120** | **1150** | **1100** | **2250** |

| **Certificate on Minor Discipline** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Sem** | **Part** | **Sub Type** | **Sub Code** | **Subject** | **Credit** | **Hours** | **INT** | **EXT** | **Total** |
| 1 | 2 | 6 | MD | | Course - I | 5 | 2 | 0 | 100 | 100 |
| 2 | 3 | 6 | MD | | Course - II | 5 | 2 | 0 | 100 | 100 |
| 3 | 4 | 6 | MD | | Course - III | 5 | 2 | 0 | 100 | 100 |
| 4 | 5 | 6 | MD | | Course - IV | 5 | 2 | 0 | 100 | 100 |

**Core**

| S.No. | Sem | Pre-requesite | Course Code | Course Name | Offering Department | Type Theory / Practical |
|---|---|---|---|---|---|---|
| 1 | 1 | | | Abstract Algebra | Mathematics | Theory |
| 2 | 1 | | | Real Analysis | Mathematics | Theory |
| 3 | 1 | | | Ordinary Differential Equations | Mathematics | Theory |
| 4 | 1 | | | Graph Theory | Mathematics | Theory |
| 5 | 2 | | | Complex Analysis | Mathematics | Theory |
| 6 | 2 | | | Linear Algebra | Mathematics | Theory |
| 7 | 2 | | | Partial Differential Equations | Mathematics | Theory |
| 8 | 2 | | | Mathematical Statistics | Mathematics | Theory |
| 9 | 3 | | | Topology | Mathematics | Theory |
| 10 | 3 | | | Functional Analysis | Mathematics | Theory |
| 11 | 3 | | | Mechanics | Mathematics | Theory |
| 12 | 4 | | | Fluid Dynamics | Mathematics | Theory |

**Skill Enhancement Course**

| S.No. | Sem | Pre-requesite | Course Code | Course Name | Offering Department | Type Practical / Training |
|---|---|---|---|---|---|---|
| 1 | 1 | | | Latex | Mathematics | Practical |
| 2 | 2 | | | Matlab | Mathematics | Practical |
| 3 | 3 | | | Neural Networks | Mathematics | Training |
| 4 | 4 | | | Object Oriented Programming and Python | Mathematics | Practical |

**Elective**

| S.No. | Sem | Pre-requesite | Course Code | Course Name | Offering Department | Type Practical / Training |
|---|---|---|---|---|---|---|
| 1 | 1 | | | Optimization Techniques | Mathematics | Theory |
| 2 | 1 | | | Mathematical Modelling | Mathematics | Theory |
| 3 | 1 | | | Fuzzy Logics and System | Mathematics | Theory |
| 4 | 2 | | | Astronomy | Mathematics | Theory |
| 5 | 2 | | | Numerical Analysis | Mathematics | Theory |
| 6 | 2 | | | Number Theory and Cryptography | Mathematics | Theory |
| 7 | 3 | | | Control Theory | Mathematics | Theory |
| 8 | 3 | | | Differential Geometry | Mathematics | Theory |
| 9 | 3 | | | Stochastic Process | Mathematics | Theory |
| 10 | 4 | | | Mathematical Methods | Mathematics | Theory |
| 11 | 4 | | | Machine Learning | Mathematics | Theory |
| 12 | 4 | | | Finite Elements Method | Mathematics | Theory |

**Semester I**

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Abstract Algebra** | 4 | 5 | - | - | **Core** |

**Course Introduction**

This course enables to provide foundation in group and to enhance the power of ideas for solving the problems in Algebra

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To familiarize and apply Sylow's theorem and Direct products |
| **CO 2:** | To understand the concepts of rings, Euclidean and polynomial rings |
| **CO 3:** | To apply the concept of fields in roots of a polynomial |
| **CO 4:** | To analyze Galois Theory and Radicals using Field concept |
| **CO 5:** | To evaluate the algebra of Linear Transformations and elementary canonical forms |

| | | |
|---|---|---|
| **Unit I:** | **Group Theory** | **[12 Periods]** |

Another counting principle – Sylow's theorem – Direct products.

| | | |
|---|---|---|
| **Unit II:** | **Ring Theory** | **[12 Periods]** |

Euclidean rings – A particular Euclidean ring – Polynomial rings – Polynomials over the rational field.

| | | |
|---|---|---|
| **Unit III:** | **Fields** | **[12 Periods]** |

Extension Fields – Roots of polynomials – More about roots.

| | | |
|---|---|---|
| **Unit IV:** | **Galios Theory and Radicals** | **[12 Periods]** |

Elements of Galois theory – Solvability by Radicals.

| | | |
|---|---|---|
| **Unit V:** | **Sterilization and Disinfection** | **[12 Periods]** |

Canonical forms: Triangular form – Trace and Transpose – Hermitian, unitary and normal Transformations.

**Text Books:**

1. I.N.Herstein, "Topics in Algebra" (II Edition), published by Wiley, 2015.

**Contents :**

Unit I : Chapter 2 -Sections 2.11 to 2.13.
Unit II : Chapter 3 -Sections 3.7 to 3.10.
Unit III : Chapter 5 -Sections 5.1,5.3 and 5.5.
Unit IV : Chapter 5 -Section 5.6, 5.7.
Unit V : Chapter 6 -Sections: 6.4,6.8 and 6.10.

**Reference Books:**

1. J.B.Fraleigh, "A First Course in Abstract Algebra", Narosa Publishing House, New Delhi, 1988
2. M.Artin, "Algebra", Prentice-Hall, Englewood Cliff, 1991.

**Web Resources:**

1. https://faculty.etsu.edu/gardnerr/4127/notes-Herstein.htm
2. https://archive.nptel.ac.in/courses/111/106/111106113/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 |
| **CO4** | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Real Analysis** | 4 | 5 | - | - | **Core** |

**Course Introduction**

This course provides basic knowledge on measure theory, properties of integrals and the functions of several variables.

**Course Focus on:**kill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To construct rigorous mathematical proofs of basic results in real analysis. |
| **CO 2:** | Torecognize the difference between pointwise and uniform convergence of a sequence of functions. |
| **CO 3:** | To apply the concept of Functions of Several Variables and prove theorems. |
| **CO 4:** | Tounderstand the concept of Lebesgue Measure and its properties. |
| **CO 5:** | To discuss about theory of Lebesgue integration, Riemann Integration and its properties. |

| **Unit I:** | **Riemann Stieltjes Integral** | **[12 Periods]** |
|---|---|---|

Definition and Existence of the Integral-properties of the integral-Integration and Differentiation-Integration of vector function-rectifiable curves.

| **Unit II:** | **Sequences and Series of Functions** | **[12 Periods]** |
|---|---|---|

Uniform convergence and continuity-uniform convergence and integration-uniform convergence and differentiation-equi continuous families of functions- The Stone Weierstrass theorem

| **Unit III:** | **Functions of Several variables** | **[12 Periods]** |
|---|---|---|

Linear transformation-contraction principle-Inverse function theorem-Implicit function theorem.

| **Unit IV:** | **Lebsegue Measure** | **[12 Periods]** |
|---|---|---|

Outer measure-Measurable sets and Lebesgue Measure-Measurable functions-Littlewood's Theorem

| **Unit V:** | **Lebsegue Integral** | **[12 Periods]** |
|---|---|---|

The Lebsegue integral of bounded functions over a set of finite measure-integral of a non-negative function-General Lebsegue Integral.

**Text Books:**

1. W.Rudin, "Principles of Mathematical Analysis" McGraw –Hill, New York, 1976.
2. H.L.Roydon, "Real Analysis" Third Edition, Macmillan, New York, 1988.

**Content**

Unit I : Textbook 1: Chapter 6: Page No. 120 – 137.
Unit II: Textbook 1: Chapter 7: Page No. 143 – 165.
Unit III: Textbook 1: Chapter 9: Page No. 204 – 223.
Unit IV: Textbook 2: Chapter 3: Page No. 54 – 72.
Unit V: Textbook 2: Chapter 4: Page No. 75 – 89.

**Reference Books:**

1. R.G.Bartle, " Elements of Real Analysis" , 2nd Edition, John Wily and Sons, New York, 1976.
2. W.Rudin, "Real and Complex Analysis" , 3rd Edition , McGraw Hill, New York, 1986.

**Web Resources:**

1. https://www.youtube.com/watch?v=kmbhu3DIUkw
2. https://www.mathcity.org/notes/real-analysis-hand-written-kaushef

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 3 |
| **CO2** | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| **CO5** | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Ordinary Differential Equations** | 4 | 5 | - | - | **Core** |

**Course Introduction**

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

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | Toestablish the qualitative behaviour of solutions of systems of differential equations |
| **CO 2:** | To recognize the physical phenomena modelled by differential equations and dynamical systems. |
| **CO 3:** | To analyze solutions using appropriate methods and give examples. |
| **CO 4:** | To formulate Green's function for boundary value problems |
| **CO 5:** | To understand and use various theoretical ideas and results that underlie the mathematics in this course |

| **Unit I:** | **Linear equations with constant coefficients** | **[12 Periods]** |
|---|---|---|

Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.

| **Unit II:** | **Linear equations with constant coefficients** | **[12 Periods]** |
|---|---|---|

Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation- Algebra of constant coefficient operators.

| **Unit III:** | **Linear equation with variable coefficients** | **[12 Periods]** |
|---|---|---|

Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.

| **Unit IV:** | **Linear equation with regular singular points** | **[12 Periods]** |
|---|---|---|

Euler equation – Second order equations with regular singular points –Exceptional cases – Bessel Function.

| **Unit V:** | **Existence and uniqueness of solutions** | **[12 Periods]** |
|---|---|---|

Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.

**Text Books:**

1. E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

**Contents :**

Unit I :Chapter 2: Sections 1 to 6.
Unit II :Chapter 2: Sections 7 to 12.
Unit III :Chapter 3: Sections 1 to 8 ( Omit section 9)
Unit IV :Chapter 4: Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9
Unit V :Chapter 5: Sections 1 to 6 ( Omit Sections 7 to 9) .

**Reference Books:**

1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and sons, New York, 1967.
2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill,

New Delhi, 1974.
3. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, Advanced Differential Equations, S.Chand& Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.

**Web Resources:**

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

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | 4 | 1 | 1 | 3 | 1 | 2 | 2 |
| CO2 | 3 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 2 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 |
| CO5 | 1 | 1 | 3 | 1 | 3 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Graph Theory** | 4 | 5 | - | - | **Core** |

**Course Introduction**

This course provides knowledge about the concept of graphs, sub graphs, trees, connectivity, Euler tours, Hamilton cycles, matching, and coloring of graphs.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the basic concepts involved in a graph. |
| **CO 2:** | To understand the concept of trees and its applications. |
| **CO 3:** | To apply the concept of Connectivity and Traversability. |
| **CO 4:** | To analyze the concept of Matching and coloring. |
| **CO 5:** | To evaluate the concept of planarity of graph. |

| **Unit I:** | **Graphs** | **[12 Periods]** |
|---|---|---|

Vertices of graphs, Walks and connectedness, Degrees, Operations on graphs, Blocks, Cut-points, bridges and blocks, Block graphs and cut- point graphs.

| **Unit II:** | **Trees** | **[12 Periods]** |
|---|---|---|

Elementary properties of trees, Centers and Centroids, Block-cut point trees, Independent cycles.

| **Unit III:** | **Connectivity and Traversability** | **[12 Periods]** |
|---|---|---|

Connectivity and line connectivity, Eulerian graph, Hamiltonian graphs.

| **Unit IV:** | **Matchings and Colouring** | **[12 Periods]** |
|---|---|---|

Matchings: Matchings coverings in Bipartite Graphs – Perfect Matchings- Edge colourings: Edge chromatic number – Vizing'stheorem-Vertex Colourings: Chromatic Number – Brook's Theorem

| **Unit V:** | **Planarity** | **[12 Periods]** |
|---|---|---|

Planar graphs, outer planar graphs, Kuratowski's theorem

**Text Books:**

1. F. Harary, Graph theory, Narosa Publishing House, New Delhi, 1988.

**Contents :**

Unit I: Chapter 2,3: Sections 1,2.2,2.3,2.7,3.1,3.2,3.3
Unit II: Chapter 4: Sections 4.1,4.2,4.3,4.4
Unit III: Chapter 5,7: Sections 5.1,7.1,7.2
Unit IV: Chapter 10: Sections 10.1,10.2,10.3
Unit V: Chapter11: Sections 11.1,11.2,11.3.

**Reference Books:**

1. R. Balakrishnan and K. Renganathan, A textbook of Graph theory, Springer, 2000
2. Bela Bollobas, Modern Graph Theory Springer, 2002
3. G. Chartrand, L. Lesniak, Graphs & digraphs. Fourth edition. Chap- man & Hall/CRC, 2005.
4. J.A.Bondy and U.S.R. Murthy, Graph Theory and Applications, Macmillan, London, 1976.

**Web Resources:**

1. https://onlinecourses.nptel.ac.in/noc20_ma05/preview
2. https://www.coursera.org/learn/graphs
3. https://www.cip.ifi.lmu.de/~grinberg/t/22s/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 3 | | 2 | | | | 3 | 2 | | 1 | | 1 | 2 | | 1 | 3 |
| **CO2** | 1 | 1 | 2 | | | | | 3 | | 1 | 1 | 1 | 2 | 1 | | |
| **CO3** | | 1 | | 2 | | 2 | 3 | | | 1 | | 1 | | | 2 | 3 |
| **CO4** | | 2 | | 1 | | 3 | 2 | | 3 | | 2 | | 1 | | 3 | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO5** | 1 | | 2 | | 2 | | | 3 | | 1 | 2 | 1 | | 2 | | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Latex** | 4 | 5 | - | - | **Skill Enhancement Course** |

**Course Introduction**

This course provides knowledge about basics of Latex that is used to produce high quality scientific documents, like articles, books, dissertations and technical reports.

**Course Focus on: Skill Development**/ Entrepreneurship / Employability / Research

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the Mathematical formulas and Drawing tools of Latex. |
| **CO 2:** | To analyze the need of Latex software. |
| **CO 3:** | To apply the advanced mathematics with Latex tools. |
| **CO 4:** | To discuss the coding Series, symbols and limits. |
| **CO 5:** | To develop the knowledge of investigating and learning new LATEX package on own. |

**List of Topics Covered**

Introduction- Text, Symbols and Commands- Document Layout and Organization- Display Text and Mathematical formulas

**Program List**

1. To illustrate different font sizes in Latex.
2. To prepare a title page in Latex document.
3. To create the section hierarchy of book environment in Latex.
4. To prepare a list using itemize environment in Latex.
5. To prepare a table in Latex.
6. To prepare a table in Latex with multiple title row.
7. To split the equations in Latex.
8. To type an equation using left cases and right cases in Latex.
9. To type a system of equations in Latex.
10. To type given Binomial equations in Latex.

**Text Books:**

1. H. Kopka and P.W. Daly, "A Guide to LATEX "3rd Edition, Addison – Wesley, UK, 1999.

**Reference Books:**

1. L. Lamport. LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994.
2. Stefan Kottwitz, "LaTeX Beginner's Guide: Create High-quality and Professional-looking Texts, Articles, and Books for Business and Science Using LaTeX" Packt Publishing, 2011.

**Web Resources:**

1. https://www.overleaf.com/learn/latex/Free_online_introduction_to_LaTeX_(part_1)
2. https://onlinecourses.swayam2.ac.in/aic20_sp17/preview
3. https://www.geo.university/courses/introduction-to-latex

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 1 | | 3 | 2 | | | 2 | | | 1 | 1 | 1 | 3 | 2 | | 1 |
| CO2 | | 1 | | 3 | | 3 | 3 | | | 1 | 1 | | | 1 | 2 | |
| CO3 | 2 | | | 2 | | | 2 | 2 | 3 | | 2 | 1 | 1 | | 3 | |
| CO4 | 1 | | 2 | | | 3 | | 3 | | 2 | | 2 | | 2 | | 3 |
| CO5 | | 2 | | 3 | | 2 | | | 2 | | 2 | | 1 | | 1 | |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Optimization Techniques** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

This course provides knowledge on concepts of Operations Research with specific applications in Linear, Non Linear and Dynamic Programming.

**Course Focus on:** Skill Development/ Entrepreneurship / **Employability** / Research

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the concept of Advanced Linear Programming. |
| **CO 2:** | To examine the concept of Integer L.P. in a suitable way. |
| **CO 3:** | To construct the problems based on Classical optimization Theory. |
| **CO 4:** | To evaluate the problems on Non - linear programming. |
| **CO 5:** | To develop the problem-solving techniques using operations research. |

| **Unit I:** | **Linear Programming** | **[12 Periods]** |
|---|---|---|

Introduction to L.P. –Graphical L.P. Solution – Sensitivity analysis Simplex Method – L.P. solution space in equation form –Transition from graphical to algebra solution – The simplex method – artificial starting solution – Special cases in simplex method applications. Duality – Primal and Dual – relationships - additional simplex algorithm for L.P.

| **Unit II:** | **Advanced Linear Programming** | **[12 Periods]** |
|---|---|---|

Advanced Linear Programming – Generalized simplex tableau in matrix form – Decomposition algorithm – Matrix definition of dual problem –optimal dual solution.

| **Unit III:** | **Integer Linear Programming & Dynamic Programming** | **[12 Periods]** |
|---|---|---|

Integer L.P. and Dynamic Programming – Integer Programming – Gomory cutting plane algorithm – Branch and Bound algorithm – Deterministic Dynamic programming – Recursive nature of computation in D.P. – Forward and Backward recursion..

| **Unit IV:** | **Numerical Application** | **[12 Periods]** |
|---|---|---|

Classical optimization Theory – unconstraint – Necessary and sufficient Conditions –The Newton - Raphson method –constrained problems – Equality constraints (Jacobi method and Lagrangian method).

| **Unit V:** | **Non-Linear Programming** | **[12 Periods]** |
|---|---|---|

Non - linear programming - Direct search method –Gradient method–Separable programming – Quadratic programming.

**Text Books:**

1. Hamdy A Taha, Operations Research-Seventh Edition-Prentice Hall of India Private Ltd, New Delhi(2004)

   **Contents:**

   Unit-I: Chapter 2: 2.2, 2.3, (excluding 2.2.3 and 2.3.3).
   Chapter 3: 3.1 –3.5 (excluding 3.3.3).
   Chapter:4: 4.2 and 4.4
   Unit-II: Chapter 7: 7.1.2, 7.4 and 7.5
   Unit-III: Chapter 9: 9.2 and 9.3(excluding 9.2.2 and 9.2.4).
   Chapter 10: 10.1 and 10.2
   Unit-IV: Chapter 20: 20.1, 20.12, 20.2.1.
   Unit-V: Chapter 21: 21.1, 21.2.1, 21.2.2

**Reference Books:**

1. G.Dantzig, Linear Programming and Extension, Princeton University Press, Princeton, 1963.
2. S.Ross, A Course in Simulation , Macmillian, New York, 1990.

**Web Resources:**

1. https://nptel.ac.in/courses/111/105/111105100/
2. https://nptel.ac.in/courses/111/104/111104071/
3. http://apmonitor.com/me575/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PS01 | PS02 | PS03 | PS04 |
| **CO1** | 3 | | 2 | | | 3 | | | 3 | | 1 | 1 | | 2 | | 1 |
| **CO2** | | 3 | | 1 | | 2 | 2 | | | 1 | 1 | 1 | 2 | 3 | | 1 |
| **CO3** | 3 | | | 3 | 1 | 1 | | 3 | | 1 | | 1 | 1 | | 2 | |
| **CO4** | | 3 | | 2 | | | 2 | 3 | | 2 | 2 | 2 | 3 | 1 | | 3 |
| **CO5** | 3 | | 2 | | 3 | | | | 1 | | 2 | | | | 2 | |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Mathematical Modelling** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

This course provides knowledge to build mathematical models of real-world systems, analyze them and make predictions about behavior of these systems.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To use mathematical equations to model real-life problems. |
| **CO 2:** | To interpret numerical results given by program in order to predict the behavior of the system. |
| **CO 3:** | To apply computational methods and concepts from prerequisite mathematical content to analyze scientific problems. |
| **CO 4:** | To make predictions of the behavior of a given physical system based on the analysis of its mathematical model. |
| **CO 5:** | To construct a mathematical model of a given physical system and analyze it. |

| **Unit I:** | **Need and Techniques of Mathematical Modelling** | **[12 Periods]** |
|---|---|---|

Simple situations requiring Mathematical Modelling – The techniques of Mathematical Modelling – Classification of Mathematical Models – Some characteristics of Mathematical Models – Mathematical Modelling through Geometry , Algebra, Trigonometry and Claculus – Limitations of Mathematical Modelling.

| **Unit II:** | **Mathematical Modelling through Partial Differential Equations** | **[12 Periods]** |
|---|---|---|

Situations giving rise to Partial differential equations models – Mass Balance Equations – Momentum Balance Equations – Variational Principles – Probability generation function – Model for a traffic flow in a highway – Nature of Partial differential equations – Initial and boundary conditions.

| **Unit III:** | **Mathematical Modelling through Functional integral and Differential-Difference equations** | **[12 Periods]** |
|---|---|---|

Mathematical Modelling through Functional equations – Mathematical Modelling through integral equations – Mathematical Modelling through Delay-Differential and Differential-Difference equations.

| **Unit IV:** | **Mathematical Modelling through Calculus of Variations and Dynamic Programming** | **[12 Periods]** |
|---|---|---|

Mathematical Modelling through Calculus of Variations and Dynamic Programming :
Optimization principles and Techniques – Mathematical Modelling through Calculus of Variations – Mathematical Modelling through Dynamic Programming.

| **Unit V:** | **Mathematical Modelling Mathematical Programming, Maximum and Maximum-Entropy Principle** | **[12 Periods]** |
|---|---|---|

Mathematical Modelling through Linear Programming – Mathematical Modeling through Non-linear Programming – Mathematical Modelling through Maximum Principle – Mathematical Modelling through the use of principle of Maximum Entropy.

**Text Books:**

1. J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, New Delhi, 1988.

**Contents :**

Unit I: Chapter 1 : Sections 1.1-1.9
Unit II: Chapter 6 : Sections 6.1-6.8
Unit III: Chapter 8 : Sections 8.1-8.3
Unit IV: Chapter 9 : Sections 9.1-9.3
Unit V: Chapter 10 : Sections 10.1-10.4

**Reference Books:**

1. J. N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East –West Press Pvt Limited, New Delhi, 19.
2. Singh – Mathematical Modelling, International Book house – 2003.

3. Frank R. Giordano, Maurice D.Weir and William P. Fox, - A first course in mathematical modelling, Thomson Learning, London and New York, 2003.

**Web Resources:**

1. https://nptel.ac.in/courses/111107113
2. https://www.openlearning.com/usmmooc/courses/math-modeling-de/?cl=1
3. https://archive.nptel.ac.in/courses/111/106/111106131/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 1 |
| CO2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 2 | 1 | 1 | 2 | 3 | 2 |
| CO4 | 2 | 3 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Fuzzy Logics and Systems** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

This course enables the students to understand the concept of fuzzy logic, fuzzy sets and its operations, relations and measures. An highlight on uncertainty and information their applications is explored

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the basic concepts of Crisp Sets and fuzzy set and its Operations |
| **CO 2:** | To analyze the concept of Fuzzy relations. |
| **CO 3:** | To apply the concept of Fuzzy Measures. |
| **CO 4:** | To examine the concept of Uncertainty and Information |
| **CO 5:** | To apply the concept of fuzzy theory in Real world. |

| **Unit I:** | **Crisp Sets and Fuzzy Sets and its Operations** | **[12 Periods]** |
|---|---|---|

Introduction-Crisp sets: The Notion of Fuzzy Sets-basic concepts of Fuzzy sets–Classical Logic: complement-Fuzzy Union-Fuzzy interaction–Combination of operations–General aggregation of operations.

| **Unit II:** | **Fuzzy Relations** | **[12 Periods]** |
|---|---|---|

Crisp and Fuzzy relations–Binary relations– Binary relations on a single set–Equivalence and similarity relations –Compatibility on Tolerance Relations-Orderings –Morphism –Fuzzy relations Equations.

| **Unit III:** | **Fuzzy Measures** | **[12 Periods]** |
|---|---|---|

General discussion– Belief and PlausibilityMeasures–Probabilitymeasures–Possibility and Necessitymeasures–RelationshipamongClassesofFuzzyMeasures.

| **Unit IV:** | **Uncertainty and Information** | **[12 Periods]** |
|---|---|---|

Types of uncertainty–Measures of Fuzziness-Classical Measures of Uncertainty– Measures of Dissonance-Measures of Confusion–Measures of Non-Specificity–Uncertainty and Information– Information and Complexity –Principles of Uncertainty and information.

| **Unit V:** | **Applications** | **[12 Periods]** |
|---|---|---|

Natural, life and Social Sciences-Engineering-Medicine-Management and decision making –Computer Sciences-System Science-Other Applications.

**Text Books:**

1. George J. Klir, Tina A. Folger -"Fuzzy Sets, Uncertainty, and Information", Prentice- Hall of India Private Limited-Fourth printing-June 1995.

**Contents :**

Unit:1 Chapter 1 Section 1.3,1.4,
Chapter 2 Section 2.2-2.6
Unit:2 Chapter 3 Section 3.1-3.8
Unit:3 Chapter 4 Section 4.2-4.5
Unit:4 Chapter 5 Section 5.1-5.4, 5.6
Unit:5 Chapter 6 Section 6.2-6.5 .

**Reference Books:**

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, Ltd.,
2. D. DuBois and H.M. Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, 1994.

**Web Resources:**

1. https://www.techtarget.com/searchenterpriseai/definition/fuzzy-logic
2. https://elearn.nptel.ac.in/shop/nptel/fuzzy-sets-logic-and-systems-applications/
3. https://nptel.ac.in/courses/108104157

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 1 | 2 | 2 |
| **CO4** | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 3 |

**Semester II**

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Complex Analysis** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

This course provides knowledge about functions of complex variable, analytic functions, harmonic functions and complex integration.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the concept of analytic functions. |
| **CO 2:** | To understand the concept of complex integration. |
| **CO 3:** | To apply the concept of calculus of Residues and its corresponding theorems. |
| **CO 4:** | To examine the series and product developments. |
| **CO 5:** | To prove the Riemann Mapping theorem. |

**Unit I:** **Introduction to the concept of analytic function** **[12 Periods]**

Limits and continuity – Analytic functions – Polynomials – Rational functions.

**Conformality:** Arcs and closed curves – Analytic functions in regions – Conformal Mapping – Length and Area – Linear Transformations: The Linear group –The Cross ratio – Elementary Riemann Surfaces.

**Unit II:** **Complex Integration** **[12 Periods]**

Line Integrals Rectifiable Arcs – Line Integrals as Functions of Arcs –Cauchy's theorem for a rectangle - Cauchy's theorem in a disk, Cauchy's Integral formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives Removable singularities, Taylor's Theorem – Zeros and Poles – The Local Mapping – The maximum principle – Chains and cycles.

**Unit III:** **The Calculus of Residues** **[12 Periods]**

The Residue theorem –The Argument principle – Evaluation of definite integrals. Harmonic functions: The Definitions and basic Properties – Mean value property –Poisson's Formula.

**Unit IV:** **Series and Product Developments** **[12 Periods]**

Weierstrass Theorem –The Taylor Series –The Laurent Series – Partial fractions and Factorization: Partial Fractions – Infinite Products – Canonical Products.

**Unit V:** **The Riemann Mapping Theorem** **[12 Periods]**

Statement and Proof –Boundary Behavior –Use of the reflection principle –Analytic arcs.

**Conformal mapping of Polygons**: The Behavior at an angle –The Schwarz –Christoffel Formula –Mapping on a rectangle.

**Text Books:**

L.V. Ahlfors, " Complex Analysis", Mc Graw Hill, New York,1979.

**Contents :**

Unit I: Chapter – 2: Sections 1.1 – 1.4
Chapter – 2,3: Sections 2.1 – 2.4, 3.1, 3.2 and 3.4
Unit II: Chapter – 4 : Sections 1.1 – 1.5, 2.1 – 2.3, 3.1 - 3.4 and 4.1
Unit III: Chapter – 4: Sections 5.1 – 5.3, 6.1 – 6.3
Unit IV: Chapter – 5: Sections 1.1 – 1.3, 2.1 – 2.3
Unit V: Chapter – 6: Sections 1.1 – 1.4, 2.1 – 2.3.

**Reference Books:**

1. W. Rudin, "Real and Complex Analysis " McGraw-Hill Book Co., 1966.
2.R.V. Churchill & J. W. Brown , "Complex Variables & Applications", Mc.Graw Hill, 1990

**Web Resources:**

1. https://www.mathcity.org/_media/msc/notes/complex-analysis-iqra-liaqat.pdf
2. https://youtu.be/_mv0q7-WF4E?si=3FAwT48Bxy9PEJM6
3. https://youtu.be/dEu5ie25U0Y?si=ALSny70Jy3Wq2xrQ

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Linear Algebra** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about the concept of matrices, vectors, dual spaces and linear transformation.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the basic concepts of Vector spaces. |
| **CO 2:** | To understand the concept of algebra of linear transformations. |
| **CO 3:** | To construct the algebra of polynomials . |
| **CO 4:** | To classify the concept of Annihilating polynomials and Invariant subspaces . |
| **CO 5:** | To discuss the concept of Decomposition . |

| **Unit I:** | **Matrices and Vector spaces** | **[12 Periods]** |
|---|---|---|

Systems of linear Equations – Matrices and Elementary Row operations – Row - Reduced echelon Matrices – Matrix Multiplication – Invertible Matrices – Vector spaces – Subspaces – Bases and Dimension – Computations concerning Subspaces.

| **Unit II:** | **The algebra of linear transformations** | **[12 Periods]** |
|---|---|---|

The algebra of linear transformations – Isomorphism of Vector Spaces – Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual – The Transpose of a Linear Transformation.

| **Unit III:** | **The algebra of polynomials** | **[12 Periods]** |
|---|---|---|

The algebra of polynomials – Lagrange Interpolation – Polynomial Ideals – The prime factorization of a polynomial, Commutative rings – Determinant functions – Permutations and the uniqueness of determinants – Classical Adjoint of a (Square) matrix – Inverse of an invertible matrix using determinants.

| **Unit IV:** | | **[12 Periods]** |
|---|---|---|

Characteristic values – Annihilating polynomials, Invariant subspaces – Simultaneous triangulation and simultaneous Diagonalization – Direct-sum Decompositions.

| **Unit V:** | | **[12 Periods]** |
|---|---|---|

Invariant Direct sums – The Primary Decomposition Theorem – Cyclic subspaces – Cyclic Decompositions and the Rational Form.

**Text Books:**

1.Kenneth Hoffman and Ray Kunze, Linear Algebra, Second Edition, Prentice – Hall of India Private Limited, New Delhi , 1975.

**Contents:**
Unit – I - Chapters 1 and 2
Unit – II - Chapter 3
Unit – III - Chapter 4 and Chapter 5: Sections 5.1 to 5.4
Unit – IV - Chapter 6: Sections 6.1 to 6.6
Unit – V - Sections 6.7 and 6.8 and Chapter 7: Sections 7.1 to 7.4

**Reference Books:**

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, New Delhi, 1975.
2. I.S. Luther and I.B.S. Passi, Algebra, Vol.I – Groups, Vol.II- Rings, Narosa Publishing House (Vol.I – 1996, Vol.II- 1999)
3 N. Jacobson, Basic Algebra, Vols. I & II, Freeman, 1980 (also published by Hisdustan Publishing Company)

**Web Resources:**

1. https://physicaeducator.wordpress.com/wp-content/uploads/2018/10/csir-net-gate-mathematical-sciences-linear-algebra-handwritten-notes.pdf
2. https://physicaeducator.wordpress.com/wp-content/uploads/2018/10/csir-net-gate-mathematical-sciences-linear-algebra-handwritten-notes-2.pdf
3. https://youtu.be/91XecwO0YYI?si=VG7KXVMKxF0W1tWj

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Partial Differential Equations** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about the second order and non linear partial differential equations, Laplace equation and wave equation.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the basic concept of Non Linear partial differential equation of first order. |
| **CO 2:** | To illustrate the non Linear partial differential equation of second order. |
| **CO 3:** | To apply the solution of linear hyperbolic equations and its operations. |
| **CO 4:** | To examine the concept of Laplace equation with related problems. |
| **CO 5:** | To evaluate the concept of wave equations. |

| **Unit I:** | **Nonlinear partial differential equations of the first order:** | **[12 Periods]** |
|---|---|---|

Cauchy's method of characteristics–Compatible systems of first order equations – Charpit's method- Special types of first order equations – Jacobi's method.

| **Unit II:** | **Partial differential equations of second order**: | **[12 Periods]** |
|---|---|---|

The origin of second-order equations – Linear partial differential equations with constant coefficients – Equations with variable coefficients–Characteristic curves of second–order equations- Characteristics of equations in three variables.

| **Unit III:** | | **[12 Periods]** |
|---|---|---|

The solution of linear hyperbolic equations – Separation of variables – The method of integral transforms – Nonlinear equations of the second order.

| **Unit IV:** | **Laplace's Equation** | **[12 Periods]** |
|---|---|---|

The occurrence of Laplace's equation in physics- elementary solution of Laplace's equation – Families of equipotential surfaces - boundary value problems – Separation of variables- Problems with axial symmetry.

| **Unit V:** | **The wave equation:** | **[12 Periods]** |
|---|---|---|

The occurrence of wave equation in physics – Elementary solutions of the one-dimensional wave equation – vibrating membranes: Applications of the calculus of variations – Three dimensional problems.

**Text Books:**

1. I. N. Sneddon, "Elements of Partial Differential Equations" McGraw-Hill Book Company, Singapore,1957.

**Contents :**

Unit I: Chapter – 2 Sections 2.8 – 2.11, 2.13
Unit II: Chapter – 3 Sections 3.1, 3.4 – 3.7
Unit III: Chapter – 3 Sections 3.8 – 3.11
Unit IV: Chapter – 4 Sections 4.1 – 4.6
Unit V: Chapter – 5 Sections5.1, 5.2, 5.4

**Reference Books:**

1. Tyn Myint, U LokenathDebnath, Partial Differential Equations for Scientists and Engineers, 3rd Edition. 2007

2. L.C.Evans, Partial Differential Equations AMS, Providence, R I, 2003.

**Web Resources:**

1. https://physicaeducator.wordpress.com/wp-content/uploads/2018/10/csir-net-gate-mathematical-sciences-partial-differential-equation-handwritten-notes.pdf
2. https://youtu.be/U51lQtlzvA0?si=rMJqzO-gfYJjRvH4

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 |
| CO3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Mathematical Statistics** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about the fundamental concepts of Statistics and its applications.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the fundamental concept of Random Variables. |
| **CO 2:** | To understand the concept of Discrete and continuous probability distribution function. |
| **CO 3:** | To apply the concept of Unbiasedness and Cramer-Rao inequality. |
| **CO 4:** | To evaluate the fitting of curves with related problems. |
| **CO 5:** | To classify the Analysis of Variance. |

**Unit I:** **[12 Periods]**

Random Variables - Discrete and continuous random variables - Distribution function properties-Probability Mass Function-Probability Density Function-Mathematical Expectation - Theorems on Expectations.

**Unit II:** **[12 Periods]**

Discrete and continuous probability distribution function and its Moment generating function - binomial and Poisson and normal distribution and their properties, simple problem.

**Unit III:** **[12 Periods]**

Unbiasedness, Consistency, efficiency and sufficiency of estimators, factorization theorem and Rao-Blackwell theorem, Cramer- Rao inequality.

**Unit IV:** **[12 Periods]**

Curve fitting and principles of least squares -fitting of curves- straight line-second degree parabola and power curve-correlation and regression analysis.(simple problems).

**Unit V:** **[12 Periods]**

Student t-test, F-test, Chi-Square test for independence of Attributes, Analysis of Variance-One-way, Two-way Classification.

**Text Books:**

1.S.C.Gupta&V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan chand& sons Educational publishers, New Delhi(2007).
2.S.P.Gupta, "Statistical Methods", Sultan Chand & sons Educational publishers, New Delhi(2015).

**Contents:**

Unit-I: Text Book-1(Chapter-5)
Unit-II: Text Book-1(Chapter-8, 9)
Unit-III: Text Book-1(Chapter-17)
Unit-IV: Text Book-1(Chapter-10, 11)
Unit-V: Text Book-2 (Chapter- 5,6,7)

**Reference Books:**

1. S.C.Gupta&V.K.Kapoor, "Fundamentals of Applied Statistics", Sultan chand& sons, Educational publishers, New Delhi(2012).
2. R.S.N. Pillai and V. Bagavathi, "Statistics", Sultan chand& sons Educational publishers, New Delhi(2007).
3. G.V. Shenoy, U.K. Srivastava, S.C. Sharma, "Business Statistics", New Age International Pvt Ltd Publishers, New Delhi(2014).

4. R.S. Bhardwaj, "Business Statistics", Anurag Jain For Excel books Publishers, Second Edition, New Delhi(2008).
5. D.N. Elhance, "Fundamentals of Statistics", Kitab Mahal Publishers, New Delhi(2002).

**Web Resources:**

1.http://spartan.ac.brocku.ca/~jvrbik/MATH2P82/Statistics.PDF
2.https://www.dcpehvpm.org/EContent/Stat/FUNDAMENTAL%20OF%20MATHEMATICAL%20STATISTICS-S%20C%20GUPTA%20&%20V%20K%20KAPOOR.pdf
3.https://youtu.be/I0u1cecfXQ4?si=X2kzYt93gvGSJMqu

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO5 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Matlab** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about the use of Matlab in modern computing environments for the purpose of symbolic and numerical problem solving and visualization.

**Course Focus on:** Skill Development/ Entrepreneurship / **Employability** / Research

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the basic comments of Matlab. |
| **CO 2:** | To recall the concept of Matrices and Vectors. |
| **CO 3:** | To explain the concept of Scripts and Functions in files. |
| **CO 4:** | To classify the concept of Two and Three dimensional plots. |
| **CO 5:** | To apply the concept of Linear Algebra, Finding Eigen Values and Vectors. |

| | | |
|---|---|---|
| **Unit I:** | Introduction | **[12 Periods]** |

Basics of MATLAB, Input – Output, File types – Platform dependence – General commands. Interactive Computation: Matrices and Vectors – Matrix and Array operations

| | | |
|---|---|---|
| **Unit II:** | Programming in MATLAB | **[12 Periods]** |

Scripts and Functions – Script files – Functions files-Language specific features – Advanced Data objects.

| | | |
|---|---|---|
| **Unit III:** | Plotting | **[12 Periods]** |

Two-dimensional plots - Three-dimensional plots.

| | | |
|---|---|---|
| **Unit IV:** | Applications | **[12 Periods]** |

Linear Algebra - Solving a linear system – Finding Eigen values and Eigen vectors – Matrix Factorizations.

## List of Programs

1. Program to solve geometry and trigonometryproblem.
2. Program to illustrate the row and column vector operations in a givenmatrix.
3. Program to illustrate the creation of sub matrix form a givenmatrix.
4. Program for frictionexperiment.
5. Program to create vertical bar, horizontal bar, stairs, stem plots of afunction.
6. Program to create mesh and surface plots for a givenfunction.
7. Program to create various views of 3Dplots.
8. Program to plot a function and curve corresponds to the interpolationmethod.
9. Program to calculate value and finding roots of apolynomial.
10. Program to determine a function that best fits the givendata.

**Text Books:**

Rudra Pratap, Getting Started with MATLAB-A Quick Introduction for Scientists and Engineers, Oxford University Press, 2003.

**Contents:**

Unit I: Chapter 1,3: Sections 1.6.3-1.6.6, 3.1, 3.2

Unit II: Chapter 4: Sections 4.1-4.4.
Unit III: Chapter 6: Sections 6.1, 6.2.
Unit IV: Chapter 5: Sections 5.1,5.2.

**Reference Books:**

1. William John Palm, "Introduction to Matlab 7 for Engineers " McGraw-Hill Professional, 2005.

2.Dolores M. Etter, David C. Kuncicky, "Introduction to MATLAB 7 " Prentice Hall, 2004

**Web Resources:**

1. https://kanchiuniv.ac.in/coursematerials/MATLAB%20Programming_Lecture%20Notes.pdf
2. https://youtu.be/1XiIZczRyAQ?si=GMBxohpQragoCXiC

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 1 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| CO5 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Astronomy** | 4 | 5 | - | - | **Elective** |

**Course Introduction:** This course provides knowledge about the Solar system, Celestial sphere, Dip-Twilight & Keplar's laws.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the General description of Solar system. |
| **CO 2:** | To understand the concept of Celestial sphere and Diurnal motion also length of the day. |
| **CO 3:** | To apply the knowledge of Twilight. |
| **CO 4:** | To analyze refraction with respect to tangent formula. |
| **CO 5:** | To explain the concept of Kepler's Law. |

| | | |
|---|---|---|
| **Unit I:** | | **[12 Periods]** |

General description of the Solar system -Comets and meteorites – Spherical trigonometry.

| | | |
|---|---|---|
| **Unit II:** | | **[12 Periods]** |

Celestial sphere – Celestial co – ordinates – Diurnal motion – Variation in length of the day.

| | | |
|---|---|---|
| **Unit III:** | | **[12 Periods]** |

Dip – Twilight – Geocentric parallax.

| | | |
|---|---|---|
| **Unit IV:** | | **[12 Periods]** |

Refraction – Tangent formula – Cassini's formula.

| | | |
|---|---|---|
| **Unit V:** | | **[12 Periods]** |

Kepler's laws – Relation between true eccentric and mean anamolies.

**Text Books:**

S.Kumaravelu and Susheela Kumaravelu "Astronomy" (Unit I to V).

**Reference Books:**

1.W.M.Smart. "Text book of Spherical Astronomy ".
2. Ramachandran .G.V – "Astonomy".

**Web Resources:**

1. https://crossfield.ku.edu/A391_2020A/notes_halfway.pdf
2. https://www.youtube.com/live/0nZnvE-Dljg?si=dzaowAj5WfDYa_bW
3. https://youtu.be/0rHUDWjR5gg?si=66RihIWKAN_Ba-gq

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 2 | 1 | 3 |
| **CO5** | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 1 | 1 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Numerical Analysis** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the concept of numerical differentiation and integration and its applications. |
| **CO 2:** | To understand the concept of solving system of equations through various methods. |
| **CO 3:** | To apply various methods for obtaining a better solution for ODE. |
| **CO 4:** | To analyze the concept of boundary value problems and characteristic equations. |
| **CO 5:** | To evaluate the numerical solution of Partial differential equations. |

| **Unit I:** | **Solution of system of equations** | **[12 Periods]** |
|---|---|---|

he Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method – Matrix inversion by Gauss-Jordan method – Methods of Iteration – Jacobi and Gauss Seidal Iteration – Relaxation method – Systems of Nonlinear equations.

| **Unit II:** | **Solution of nonlinear equations** | **[12 Periods]** |
|---|---|---|

Newton's method – Convergence of Newton's method – Bairstow's Method for quadratic factors.
**Numerical differentiation and integration:** Derivatives from Differences tables – Higher order derivatives – Divided difference, Central-Difference formulas – Composite formula of Trapezoidal rule – Romberg integration – Simpson's rules.

| **Unit III:** | **Solution of ordinary differential equations** | **[12 Periods]** |
|---|---|---|

Taylor series method – Euler and Modified Euler methods – Rungekutta methods – Multistep methods – Milne's method – Adams Moulton method.

| **Unit IV:** | **Boundary value problems and characteristic value problems** | **[12 Periods]** |
|---|---|---|

The shooting method – solution through a set of equations – Derivative boundary conditions – Characteristic value problems – Eigen values of a matrix by Iteration – The power method.

| **Unit V:** | **Numerical solution of partial differential equations:** | **[12 Periods]** |
|---|---|---|

(Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations) Representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method – solving the wave equation by Finite Differences.

**Text Books:**

1. C.F.Gerald and P.O.Wheatley, Applied Numerical Analysis, 5th Edition, Addison Wesley, (1998).

**Contents:**

Unit I : Chapter 1: Sections: 1.4, 1.8, 1.11,
Chapter 5: Sections: 5.2, 5.3, 5.6, 5.7.
Unit II : Chapter 2: Sections: 2.3 - 2.5, 2.7, 2.10 - 2.12.
Unit III : Chapter 6: Sections: 6.2 - 6.7.
Unit IV : Chapter 7: Sections: 7.2 – 7.5.
Unit V : Chapter 7: Sections: 7.6,7.7
Chapter 8 : Sections: 8.1 -8.4**.**

**Reference Books:**

1. S.C. Chapra and P.C. Raymond, "Numerical Methods for Engineers" Numerical Methods for Engineers Tata McGraw Hill, New Delhi, (2000)

2. R.L. Burden and J. Douglas Faires, P.W.S.Kent "Numerical Analysis " Publishing Company, Boston (1989), Fourth Edition.

3. S.S. Sastry, "Introductory methods of Numerical Analysis " Prentice Hall of India, New Delhi, (1998).

4. P.Kandasamy et al., "Numerical Methods", S.Chand&Co.Ltd., New Delhi

**Web Resources:**

1. https://personal.math.vt.edu/embree/math5466/nanotes.pdf
2. https://youtu.be/JPSi-WCOhk4?si=f6DSNmFdju4WTbtv
3. https://youtu.be/M8HrMF1kh3c?si=zYP2LSU1Z0ZdAOsv

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Number Theory and Cryptography** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about the concept of divisibility, functions, groups and basic properties.

**Course Focus on: Skill Development/** Entrepreneurship / Employability / Research

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the basic concept of Numbers and need of Number theory. |
| **CO 2:** | To understand the concept of Finite fields and Jacobi symbol. |
| **CO 3:** | To gain knowledge about message authentication and hash functions. |
| **CO 4:** | To acquire skills on fundamentals of cryptography and its application to network security. |
| **CO 5:** | To acquire skills on maintaining the Confidentiality, Integrity and Availability of a data. |

| **Unit I:** | **[12 Periods]** |
|---|---|

Divisibility and Euclidean algorithm – Congruence, Euler's Theorem, Wilson's Theorem, Chinese Remainder Theorem, Primitive roots - Applications to Factoring.

| **Unit II:** | **[12 Periods]** |
|---|---|

Finite Fields – Quadratic Residues – Quadratic Reciprocity – The Jacobi symbol.

| **Unit III:** | **[12 Periods]** |
|---|---|

Cryptosystems – Enciphering Matrices – Public Key Cryptography – Concepts of Public Key Cryptography – Modular Arithmetic – RSA.

| **Unit IV:** | **[12 Periods]** |
|---|---|

Pseudo primes and Strong Pseudo primes – The rho method – Fermat factorization and factor bases and Algorithm – The Continued fraction method and Algorithm.

| **Unit V:** | **[12 Periods]** |
|---|---|

Elliptic Curves – Basic Facts, Elliptic curves Cryptosystems, Elliptic curve Factorization.

**Text Books:**

1."A Course in Number Theory and Cryptography" by Neal Koblitz, , Springer – Verlag, New York,

1987.

**Contents:**

Unit I: Chapter 1 : Sections 1.1-1.4
Unit II: Chapter 2 : Sections 2.1-2.2
Unit III: Chapters 3&4 : Sections 3.1-3.2, 4.1-4.2
Unit IV: Chapter 5 : Sections 5.1-5.4
Unit V: Chapter 6 : Sections 6.1-6.2,6.4

**Reference Books:**

1. "An Introduction to Theory of Numbers" by Ivan Nivan and HerbertsZucherman, Third Edition Wiley Eastern Limited, New Delhi, 1972 .
2. "Introduction to Analytic Number Theory" by Tom Apostol, Narosa Publications, New Delhi .
3. "Elementary Number Theory" by David M. Burton, Wm. C. Brown Publishers, Dubuque, Lowa, 1989.

4. "Cryptography and Network Security Principles and Practice" by William Stallings, Prentice Hall, Fifth Edition, New Delhi, 2011.

**Web Resources:**

1. https://youtu.be/VGE78ngNdQE?si=EanUo_g_PNJT7NTS
2. https://youtu.be/OjjgAmbhS9c?si=j4oPbksW8nQwfCf3
3. https://youtu.be/2aHkqB2-46k?si=zHGuoaoVnn0UlH9C

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 3 |

**Semester III**

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Topology** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about topological spaces and continuous functions, connectedness, compactness, separation axioms and further related topics.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To remember the basic terminologies of Topology. |
| **CO 2:** | To understand about Connectedness and Compactness with its limits. |
| **CO 3:** | To apply the idea of Countability and Separation Axioms. |
| **CO 4:** | To analyze the concept of regular spaces. |
| **CO 5:** | To prove the theorems on Complete Metric spaces. |

**Unit I:** **[12 Periods]**

Topological spaces – Basis for Topology – The order Topology – Product Topology – Closed sets and Limit Points – Continuous Functions – Metric Topology.

**Unit II:** **[12 Periods]**

Connectedness and Compactness: Connected Spaces – Connected sets in R – Components and path components – Local connectedness – Compact Spaces – Limit Point Compactness

**Unit III:** **[12 Periods]**

Countability and Separation Axioms: Countability Axioms – Separation Axioms Urysohn's Lemma – UrysohnMetrization Theorem.

**Unit IV:** **[12 Periods]**

The Tychonoff Theorem – Completely regular spaces – The stone-Cech Compactification.

**Unit V:** **[12 Periods]**

Complete Metric Spaces – Compactness in Metric Spaces – Pointwise and Compact Convergences – The Compact-Open Topology – Ascoil's Theorem – Baire Spaces – A Nowhere-Differentiable Function.

**Text Books:**

1.James R. Munkres, "Topology; A First Course" Prentice Hall of India Private Limited, New Delhi, 2000.

**Contents:**

Unit I- Chapter2- sections 12-20.
Unit II- Chapter 3- sections 23-28.
Unit III- Chapter 4- sections 30-34.
Unit IV- Chapter 5- sections 37,38.
Unit V- Chapter 7- sections 43-47
Chapter 8- sections 48,49.

**Reference Books:**

1. J. Dugundji, "Topology", Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Private Limited.).

2. George F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Company, 1963.

3. J.L. Kelley, "General Topology", Van Nostrand, Reinhold Co., New York, 1995.

4. L. Steen and J. Seebach, "Counter examples in Topology", Holt, Rinehart and Winston, New York, 1970.

**Web Resources:**

**1. https://youtu.be/XHKcrs8YaSo?si=U4so00nxYl5C84zh**
**2. https://youtu.be/vv3JNSPKeEU?si=FVjrN36B6EDsrMgd**
**3. https://youtu.be/SXHHvoaSctc?si=Z26aooPxPJPi0J5e**

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 1 | 3 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Functional Analysis** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge on the Banach space, Conjugate space and Banach algebra which is the fundamental concept for further research.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the concept Banach Spaces and Hahn Banach theorem. |
| **CO 2:** | To analyze the Conjugate of an operator and Orthogonal components. |
| **CO 3:** | To acquire knowledge on the different types of operators with respect to conjugate space. |
| **CO 4:** | To recall the knowledge of Matrices, Determinants of Operator. |
| **CO 5:** | To evaluate the formula for spectral radius. |

**Unit I:** **[12 Periods]**

Banach spaces – The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N** - The open mapping problem.

**Unit II:** **[12 Periods]**

The conjugate of an operator – Hilbert spaces – The definition and some simple properties – Orthogonal complements - Orthonormal sets.

**Unit III:** **[12 Periods]**

The Conjugate space H* - The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

**Unit IV:** **[12 Periods]**

Matrices – Determinants and the spectrum of an operator – The spectral theorem.

**Unit V:** **[12 Periods]**

The definition and some examples of Banach algebra – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius.

**Text Books:**

G.F. Simmons, "Introduction to Topology and Modern Analysis", McGraw –Hill Book Company, London, 1963.

**Contents:**

Unit I: Chapter 9: Sections: 46 – 50.

Unit II: Chapter 10: Sections: 51 – 54.

Unit III: Chapter 10: Sections: 55 – 59.

Unit IV: Chapter 11: Sections: 60 – 63.

Unit V: Chapter 12: Sections: 64 – 68.

**Reference Books:**

1. C. Goffman & G. Pedrick, "A First Course in Functional Analysis", Prentice Hall of India, Delhi, 1987.
2. G. Bachman and L. Narici, "Functional Analysis", Academic Press, New York, 1966.
3. L.A. Lusternik and V.J. Sobolev, "Elements of Functional Analysis", Hindustan Publishing Corporation, New Delhi, 1971.

4. A.E.Taylor,"Introduction to Functional analysis", John Wiley and Sons, Newyork,1958.

**Web Resources:**

1. https://youtu.be/nE67uQPfRbI?si=5Kc9rGpTNivoLlh3
2. https://youtu.be/OonaUALrKUk?si=EEuy4yZcfqE_7KBP
3. https://youtu.be/yDdxFBcvSGw?si=jMTA75YlvpF-9KVV

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Mechanics** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about basic concepts of Mechanics, which is one of the important aspects of advanced mathematics.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To recall the basic concepts of mechanical system. |
| **CO 2:** | To understand the concept of Lagrange's equation s and its derivations. |
| **CO 3:** | To evaluate the concept of Hamilton's equations. |
| **CO 4:** | To examine the concept of Jacobi theory and its equation. |
| **CO 5:** | To apply the concept of Canonical Transformations. |

| | | |
|---|---|---|
| **Unit I:** | **Introductory Concepts** | **[12 Periods]** |

Mechanical system – Generalized Coordinates – Constraints –Virtual Work – Energy and Momentum.

| | | |
|---|---|---|
| **Unit II:** | **Lagrange's Equations** | **[12 Periods]** |

Derivations of Lagrange's Equations – Examples –Integrals of Motion.

| | | |
|---|---|---|
| **Unit III:** | **Hamilton's Equations** | **[12 Periods]** |

Hamilton's Principle – Hamilton's Equations.

| | | |
|---|---|---|
| **Unit IV:** | **Hamilton – Jacobi Theory** | **[12 Periods]** |

Hamilton's Principle function – Hamilton – Jacobi Equation – Separability.

| | | |
|---|---|---|
| **Unit V:** | **Canonical Transformations** | **[12 Periods]** |

Differential forms and Generating Functions – Lagrange and Poisson Brackets.

**Text Books:**

D.T. Greenwood, "Classical Dynamics" Dover Publication, New York, 1997.

**Contents:**

Unit-I: Chapter 1: Sections 1.1 – 1.5
Unit-II: Chapter 2: Sections 2.1 – 2.3
Unit-III: Chapter 4: Sections 4.1 – 4.2
Unit-IV: Chapter 5: Sections 5.1 – 5.3
Unit-V: Chapter 6: Sections 6.1, 6.3

**Reference Books**

1. F. Gantmacher, "Lectures in Analytic Mechanics" MIR Publishers, Moscow, 1975.

2. I.M. Gelfand and S.V. Fomin, "Calculus of Variations", Prentice Hall.

3. S.L. Loney, "An Elementary Treatise on Statics" Kalyani Publishers, New Delhi, 1979.

Web Resources:

1. https://archive.nptel.ac.in/courses/115/105/115105098/
2. https://theoreticalminimum.com/courses/classical-mechanics/2011/fall
3. https://www.damtp.cam.ac.uk/user/tong/dynamics.html
4. https://math.ucr.edu/home/baez/classical/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| **CO1** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 1 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 1 | 1 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 2 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Neural Networks** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications. Acquire in-depth knowledge in Nonlinear dynamics. Apply neural networks to classification and generalization problems

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To understand the fundamental of neuron models |
| **CO 2:** | To analyze the Perceptron Architecture |
| **CO 3:** | To apply the linear associator in Supervised Hebbian Learning |
| **CO 4:** | To understand the back propagation in neural networks |
| **CO 5:** | To examine the condition for performance optimality |

| | | |
|---|---|---|
| **Unit I:** | Neuron Model and Network Architectures: | **[12 Periods]** |

Mathematical Neural Model-Network Architectures-Perceptron- Hamming Network-Hopfield Network-Learning Rules.

| | | |
|---|---|---|
| **Unit II:** | Perceptron Architectures | **[12 Periods]** |

Perceptron Architectures and Learning Rules with proof of convergence.

| | | |
|---|---|---|
| **Unit III:** | Supervised Hebbian Learning | **[12 Periods]** |

Linear Associator-The Hebb Rule-Pseudo inverse rule-Variation of Hebbian Learning.

| | | |
|---|---|---|
| **Unit IV:** | Back Propagation | **[12 Periods]** |

Multilayer Perceptrons -Back Propagation algorithm-convergence and Generalization- Performances surfaces and optimum points-Taylor series.

| | | |
|---|---|---|
| **Unit V:** | Performance surface and performance optimizations | **[12 Periods]** |

Directional derivatives-Minima-Necessary conditions for optimality- Quadratic functions-Performance optimizations-Steepest Descent Newton's method-Conjugate Gradient.

**Text Books:**

1. Martin T. Hagan, Howard B/Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi, 2002.

Contents :

Unit-I: Chapter 2
Unit-II: Chapter 4
Unit-III: Chapter 7
Unit-IV: Chapter 11,8.1,8.2
Unit-V: Chapter 8.5-8.20& 9

**Reference Books**

1. James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
2. Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.

Web Resources:

1. https://www.ibm.com/topics/neural-networks
2. https://news.mit.edu/2017/explained-neural-networks-deep-learning-0414

3. https://www.udemy.com/course/deep-learning-neural-nets-with-math-derivations-part-1/

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 2 |
| CO2 | 3 | 1 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 |
| CO3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 2 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 3 | 1 | 3 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Control Theory** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will able |
|---|---|
| **CO 1:** | To recall the basic concept of Linear systems and Observability Grammian. |
| **CO 2:** | To understand about the reconstruction kernel with their Nonlinear Systems. |
| **CO 3:** | To build the Controllability Grammian Constant coefficient systems and Adjoint systems. |
| **CO 4:** | To apply the concept of steering function with Nonlinear systems. |
| **CO 5:** | To analyze the concept of Asymptotic Stability of Linear Systems with the help of uniform stability. |
| **CO 6:** | To develop the concept of Stabilization via linear feedback control, Controllable subspace and Stabilization with restricted feedback. |

| **Unit I:** | **Observability** | **[12 Periods]** |
|---|---|---|

Linear Systems – Observability Grammian – Constant coefficient systems –Reconstruction kernel – Nonlinear Systems

| **Unit II:** | **Controllability** | **[12 Periods]** |
|---|---|---|

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – steering function – Nonlinear systems

| **Unit III:** | **Stability** | **[12 Periods]** |
|---|---|---|

Stability – Uniform Stability – Asymptotic Stability of Linear Systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems

| **Unit IV:** | **Stabilizability** | **[12 Periods]** |
|---|---|---|

Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback

| **Unit V:** | **Optimal control:** | **[12 Periods]** |
|---|---|---|

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems

**Text Books:**

Elements of Control Theory by K.Balachandran and J.P.Dauer, Narosa, New Delhi, 1999.

**Contents:**

Unit -I : Chapter 2.

Unit -II : Chapter 3: Sections: (3.1 - 3.3)

Unit - III: Chapter 4.

Unit - IV: Chapter 5.

Unit - V : Chapter 6.

**Reference Books**

1. R.Conti, “Linear Differential Equations and Control “ Academic Press, London, 1976.

2. R.F.Curtain and A.J.Pritchard, “”Functional Analysis and Modern Applied Mathematics Academic Press, New

York, 1977.

3. J.Klamka, "Controllability of Dynamical Systems " Kluwer Academic Publisher, Dordrecht, 1991.

4. D.L.Russell, "Mathematics of Finite Dimensional Control Systems "Marcel Dekker, New York, 1979.

5. E.B. Lee and L. Markus, "Foundations of optimal Control Theory "John Wiley, New York, 1967

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 1 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 1 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 1 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Differential Geometry** | 4 | 5 | - | - | **Elective** |

**Course Introduction** This course provides knowledge about basic concepts of differential geometry, emphasizing calculation methods and illustrating their utility.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will able |
|---|---|
| **CO 1:** | To recall the concept of Analytic representation through curves. |
| **CO 2:** | To understand the concept of Curvature torsion. |
| **CO 3:** | To compare the concepts of Evolutes and Involutes. |
| **CO 4:** | To apply the First & Second Fundamental form of Normal, |
| **CO 5:** | To prove the theorems on Mesniers, Eulers of some surfaces. |
| | |

| | | |
|---|---|---|
| **Unit I:** | | **[12 Periods]** |
| Curves: Analytic representation - Arc Length – Osculation plane. | | |
| **Unit II:** | | **[12 Periods]** |
| Curvature torsion – Formulas of Ferret - Contact – Natural equations – Helices – General solutions of Natural equations. | | |
| **Unit III:** | | **[12 Periods]** |
| Evolutes and Involutes - Elementary theory of surface: Analytic representation. | | |
| **Unit IV:** | | **[12 Periods]** |
| First fundamental form – Normal, Tangent plane – Developable surfaces - Second fundamental form. | | |

| **Unit V:** | | **[12 Periods]** |
|---|---|---|

Meusnier's theorem – Euler's Theorem – Dupin's indicatrix –Some surfaces.

**Text Books:**

D. Struik, Lectures on Classical Differential Geometry, Addison Wesley Publishing Company, 1961.

**Contents:**

Unit I: Chapter 1: Sections:1.0-1.3.

Unit II: Chapter 1: Sections:1.4-1.10.

Unit III: Chapter 1,2: Sections:1.11, 2.0,2.1.

Unit IV: Chapter 2: Sections:2.2-2.5.

Unit V: Chapter 2: Sections:2.5-2.8.

**Reference Books**

1. M. Spivak, "A Comprehensive Introduction to Differential Geometry" Publish or Perish, 1979.

2. J. A. Thorpe, "Elementary Topics in Differential Geometry" Springer-Verlag, 1994

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Stochastic Processes** | 4 | 5 | - | - | **Elective** |

**Course Introduction**This course provides knowledge about stochastic processes and concepts pertaining to stochastic modelling.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will able |
|---|---|
| **CO 1:** | To remember the basic concepts of Stochastic processes. |
| **CO 2:** | To understand the concepts of Bernoulli trails. |
| **CO 3:** | To apply the concept of Poisson process and its extensions. |
| **CO 4:** | To classify the conditional expectations and conditional probabilities. |
| **CO 5:** | To prove the theorems on queuing model . |

**Unit I:** **[12 Periods]**

Stochastic processes: Some notions - Introduction-Specification of stochastic processes – stationary processes – Mortingales – Difference equation: Differentiable- Difference equations. Markov chain -Definition and examples – High transition probabilities.

**Unit II:** **[12 Periods]**

Generalization of independent Bernoulli trails: sequence of chain dependent trails – Classification of states and chain: Determination of higher transition probabilities – Stability of Markov system – Graph theoretic approach – Markov chain with denumerable number of states.

**Unit III:** **[12 Periods]**

Markov processes with discrete state space: Poisson process and its extensions - Poisson process – Poisson process and related distributions – Generalizations of Poisson process – Birth death process.

**Unit IV:** **[12 Periods]**

Markov processes with discrete state space (continuous time Markov chains)- Randomization Derived Markov chain – Erlang process. Markov process with continuous state space: Introduction: Brownian motion – Wiener process – Differential equations for a wiener process – Kolmogorov equation.

**Unit V:** **[12 Periods]**

Stochastic Processes in Queueing system: General concepts – The queuing model M/M/1 : Steady state behavior. Transient behavior of M/M/1 model – Birth and death processes - The model M/M/S.

**Text Books:**

1. J.Medhi, Stochastic Processes, Wiley Eastern Limited.

**Contents:**

Unit I :Chapter 2: Sections 2.1-2.4,
Chapter 3: Sections 3.1,3.2
Unit II :Chapter 3: Sections 3.3 - 3.8
Unit III :Chapter 4: Sections 4.1 - 4.4
Unit IV :Chapter 4: Sections 4.5 - 4.7
Chapter 5: Sections 5.1 - 5.4
Unit V :Chapter 10: Sections 10.1 - 10.3, 10.4 (only 10.4.1, 10.4.2, 10.4.2.1)

**Reference Books**

1., S.Karlin and M.Taylor, "A First course in Stochastic Process" Second Edition, Academic Press, Newyork (1975).

2.U, Narayan Bhat, "Elements of Applied Stochastic processes " 2nd edition, Wiley, New York (1968)

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 3 |

**Semester IV**

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Fluid Dynamics** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

This course provides knowledge about fluid flow, energy equation, conservative forces and its applications.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will able |
|---|---|
| **CO 1:** | To remember the basic concept of fluid flow. |
| **CO 2:** | To understand the energy equation of flow of a fluid. |
| **CO 3:** | To apply the concept of two dimensional motion of fluid and the lift forces. |
| **CO 4:** | To analyze viscous flow and the steady flow of fluids. |
| **CO 5:** | To explain the concept of boundary layer. |

**Unit I:** **[12 Periods]**

Introduction -Velocity -Stream line & path line Stream tubs - fluid body-density-pressure. Differentiation following the fluid -equation of continuous-boundary conditions -kinematical and physical -rate of change of linear momentum-equation of motion of an in viscid fluid.

**Unit II:** **[12 Periods]**

Introductory Euler's momentum theorem -conservative forces-Bernouli theorem -energy equation for in viscid fluid -circulation -Kelvin's theorem -vortex motion Helemholtz equation .

**Unit III:** **[12 Periods]**

Two dimensional motion -two dimensional function -complex potential basic singularties-sourse vortex-doublet circle theorem flow past a circular cylinder with circulation -conformal transformation -Blasius theorem-lift forces.

**Unit IV:** **[12 Periods]**

Viscous flows- Navier stokes equations-verticity and circulation in viscous fluid -steady flow through an arbitrary cylinder under pressure-steady couette flow between cylinder in relative motion -steady flow between parallel planes.

**Unit V:** **[12 Periods]**

Laminar boundary layer in incompressible flow -boundary layer concept-boundary layer equation-displacement thickness-momentum thickness-kinetic energy thickness-integral equation of boundary layer-flow parallel to semi infinite plate- Blasius equation and its solution in series.

**Text Books:**

1.L.M. Milne Thomson, "Theoretical Hydro Dynamics" McMillan Company, 5th Edition, 1968 (Units I and II).

2.N. Curle aand H.J. Davies, D Van Nostrand "Modern Fluid Dynamics – (Volume I) "
Company Limited., London ,1968. (Units III, IV and V).

**Contents:**

Unit I: Chapter I: Sections 1.0 – 1.3.
Unit II: Chapter III: Sections 3.10 – 3.53 (omit 3.32, 3.44)

Unit III: Chapter III: Sections 3.1 – 3.7.5
Unit IV: Chapter V: Sections 5.1 – 5.5.5
Unit V: Chapter VI: Sections 6.1 – 6.3.1 (omit 6.2.2.)

**Reference Books**

1. F.D Shanthi Swarup, "Fluid dynamics ", Krishna Prakashan private limit ,2000
2. M.DRaisinghania, "Fluid dynamics with hydro dynamics " S.Chand&co 2003 edition

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Object Oriented Programming and Python** | 4 | 5 | - | - | **Practical** |

## Course Introduction

Python was designed for readability, and has some similarities to the English language with influence from mathematics.

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / Research

| Course Outcomes | On completion of this course, students will able |
|---|---|
| CO 1: | Apply the concept of Decision making statements, looping constructs ,functions for Solving basic programs |
| CO 2: | To apply python code for Adding Two Numbers.. |
| CO 3: | To apply the concept of addition of two matrix. |
| CO 4: | To analyze recursive functions. |
| CO 5: | To explain the concept of Fibonacci sequence |

**List of Programming**

1. Write the Python code for Adding Two Numbers.
2. Write the Python code to find the Area of Triangle.
3. Write the Python code to check whether the given number is Odd or Even.
4. Write the Python code to Addition of Two Matrix.
5. Write the Python code to make simple Calculators.

6. Write the Python code to check whether the given number is Palindrome number or Not.
7. Write a python program that asks the user to enter a series of positive numbers (The user should enter a negative number to signal the end of the series)and the program should display the numbers in order And their sum.
8. Write recursive functions for GCD of two integers.
9. Write recursive functions for Fibonacci Sequence up to given number n.
10. Write recursive functions to display prime number from 2 to n

**Text Books:**

1. MarkSummerfield.—ProgramminginPython3:ACompleteintroductiontothePython Language,Addison-WesleyProfessional,2009.
2. MartinC.Brown,—PYTHON:TheCompleteReference‖,McGraw-Hill,2001

**Reference Books**

1.AllenB.Downey,``ThinkPython:HowtoThinkLikeaComputerScientist 2ndedition, UpdatedforPython3,Shroff/O„ReillyPublishers,2016

2.GuidovanRossumandFredL.DrakeJr,—AnIntroductiontoPython–Revisedandupdated For Python 3.2,NetworkTheoryLtd., 2011

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Mathematical Methods** | 4 | 5 | - | - | **Elective** |

**Course Introduction**
This course provides knowledge about integral equations, transforms, Fourier series and its applications.
**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will be able |
|---|---|
| **CO 1:** | To remember the basic concept of integral equations. |
| **CO 2:** | To understand about the boundary value problems. |
| **CO 3:** | To apply the concept of two dimensional motion of fluid and the lift forces. |
| **CO 4:** | To analyze viscous flow and the steady flow of fluids. |
| **CO 5:** | To explain the concept of boundary layer. |

**Unit I:** **[12 Periods]**

Integral equations: Types of Integral equations – Integral Fredholm Alternative - Approximate method – Equation with separable Kernel - Volterra integral equations – Fredholm's theory.

**Unit II:** **[12 Periods]**

Application of integral equations to ordinary integral equations and singular integral equations:
Initial value problems - Boundary value problems – singular integral equations – Abel Integral equation.

**Unit III:** **[12 Periods]**

Fourier Transforms: Fourier Transforms, Fourier sine and cosine transforms – Fourier transforms of derivatives - convolution integral – Parseval's Theorem - Solution of Laplace Equations by Fourier transform.

**Unit IV:** **[12 Periods]**

Hankel transforms: Properties of Hankel Transforms – Hankel transformation of derivatives of functions - The Parseval's relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space – Axisymmetric Dirichlet problem for a thick plate.

**Unit V:** **[12 Periods]**

Calculus of variations: Variation and its properties – Euler's(Euler Lagranges) equation – functionals dependent on the functions of several independent variables – variational problems in parametric form
–applications.

**Text Books:**

1. Linear Integral Equations Theory and Technique, R.P.Kanwal, Academic Press, New York, 1971.
2. The Use of Integral Transforms, I.N.Sneddon, McGraw-Hill, NewYork, 1972.
3. Differential Equations and Calculus of Variations, L.Elsgolts, Mir Publishers, Moscow, 1970.

**Contents:**
Unit I :Chapter 2: 2.3 - 2.7, 2.9 – 2.10, 2.16. (Book 1)
Unit II :Chapter 5: 5.2– 5.4, 5.6 – 5.7, 5.10 – 5.12. (Book 1)
Unit III :Chapter 2: 2.3- 2.5, Chapter 3: 3.3- 3.4. (Book 2)
Unit IV :Chapter 5: 5.1– 5.2, Chapter 8: 8.1– 8.2. (Book 2)
Unit V :Chapter 6: 6.1-6.3,6.4-6.7 (Book 3)

**Reference Books**

1. H.T. Davis – Introduction to nonlinear differential and integral equations, Dover Publications, 1962.
2. A.H. Nayfeh – Perturbation Methods, John Wiley & sons New York, 1973
3. Don Hong, J. Wang and R. Gardner. Real analysis with introduction to wavelets and applications, Academic Press Elsevier (2006)

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Machine Learning** | 4 | 5 | - | - | **Elective** |

**Course Introduction**
To explain about the basics of machine learning
Course Focus on**:** Skill Development/ Entrepreneurship / Employability / **Research**

| **Course Outcomes** | On completion of this course, students will be able |
|---|---|
| **CO 1:** | Understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc. |
| **CO 2:** | Understanding of the strengths and weaknesses of many popular machine learning approaches. |
| **CO 3:** | Explain about the concepts of computational learning theory and dimensionality reduction |
| **CO 4:** | Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning. |
| **CO 5:** | Explain about the applications in data mining, automated knowledge acquisition |

**Unit I:** **[12 Periods]**

Algorithmic models of learning, Learning classifiers, functions, relations, grammars, probabilistic models, value functions, behaviors and programs for experience. Bayesian, maximum some posterior, and minimum description length frameworks.

**Unit II:** **[12 Periods]**

Parameter Estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers.

**Unit III:** **[12 Periods]**

Computational Learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting, Dimensionality reduction: Principal component Analysis, feature selection and visualization..

**Unit IV:** **[12 Periods]**

Unsupervised Learning: Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering, Reinforcement learning; Learning from heterogeneous, distributed, data and knowledge.

**Unit V:** **[12 Periods]**

Selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, human computer interaction, semantic web, and Bio informatics and computational biology.

**Text Books:**

1 Bishop,C.(2006).PatternRecognitionandMachineLearning.Berlin:Springer-Verlag.

**Reference Books**

1 Russel,S.AndNorving,P.(2003).ArtificialIntelligence:AModernApproach.2ndEdition, NewYork:Prentice-Hall.
2. Baldi,P.,Frasconi,P.,Smyth,P.(2002).Bioinformatics:AMachineLearningApproach. Cambridge,MA:MITPress**.**

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |

| Course Code | Course Title | Credit | Lecture | Tutorial | Practical | Type |
|---|---|---|---|---|---|---|
| | **Finite Elements Method** | 4 | 5 | - | - | **Elective** |

**Course Introduction**

**Course Focus on:** Skill Development/ Entrepreneurship / Employability / **Research**

| Course Outcomes | On completion of this course, students will |
|---|---|
| **CO 1:** | Summarize the basics of finite element formulation |
| **CO 2:** | Apply finite element formulations to solve one dimensional Problems |
| **CO 3:** | Apply finite element formulations to solve two dimensional scalar Problems. |
| **CO 4:** | Apply finite element method to solve two dimensional Vector problems. |
| **CO 5:** | Apply finite element method to solve problems on iso parametric element and dynamic Problems. |

| **Unit I:** | INTRODUCTION | **[12 Periods]** |
|---|---|---|

Historical Background — Mathematical Modeling of field problems in Engineering — Governing Equations — Discrete and continuous models — Boundary, Initial and Eigen Value problems– Weighted Residual Methods — Variational Formulation of Boundary Value Problems — Ritz Technique — Basic concepts of the Finite Element Method.

| **Unit II:** | ONE-DIMENSIONAL PROBLEMS | **[12 Periods]** |
|---|---|---|

One Dimensional Second Order Equations — Discretization — Element types- Linear and Higher order Elements — Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices — Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

| **Unit III:** | TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS | **[12 Periods]** |
|---|---|---|

Second Order 2D Equations involving Scalar Variable Functions — Variational formulation –Finite Element formulation — Triangular elements — Shape functions and element matrices and vectors. Application to Field Problems — Thermal problems — Torsion of Non circular shafts –Quadrilateral elements — Higher Order Elements.

| **Unit IV:** | TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS | **[12 Periods]** |
|---|---|---|

Equations of elasticity — Plane stress, plane strain and axisymmetric problems — Body forces and temperature effects — Stress calculations — Plate and shell elements.

| **Unit V:** | ISOPARAMETRIC FORMULATION | **[12 Periods]** |
|---|---|---|

Natural co-ordinate systems — Isoparametric elements — Shape functions for iso parametric elements — One and two dimensions — Serendipity elements — Numerical integration and application to plane stress problems — Matrix solution techniques — Solutions Techniques to Dynamic problems — Introduction to Analysis Software. ME8692 Finite Element Analysis

**Text Books:**

Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill,

2005

2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi,

2007.

**Reference Books**

Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,

2005 (Indian Reprint 2013)*

2. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition,

Prentice Hall College Div, 1990

3. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002

4. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann,

2004

5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and

Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

ME8694

**Mapping of Course Outcome with Programme Outcome and Programme Specific Outcome:**

| Course Outcome | Programme Outcomes | | | | | | | | | | | | Programme Specific Outcome | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |