| | | | | | |
|---|---|---|---|---|---|
| **Semester:** | I | **Course Type:** | ASC | | |
| **Course Title: Differential Calculus and Linear Algebra** | | | | | |
| **Course Code:** | 25MAT11D | | | **Credits:** | 4 |
| **Teaching Hours/Week (L:T:P:S)** | | | 3:2:0:1 | **Total Hours:** | 50 |
| **CIE Marks:** | 50 | **SEE Marks:** | 50 | **Total Marks:** | 100 |
| **SEE Type:** | Theory | | | **Exam Hours:** | 3 |

## I. Course Objectives

1. To facilitate the students with a foundation of differential calculus.
2. Apply differential equations to model and solve real-world problems in science and engineering
3. Develop the knowledge of Linear Algebra referring to matrices.

## II. Teaching-Learning Process (General Instructions)

1. In addition to the traditional lecture method, innovative teaching methods shall be adopted.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Grading assignments, presentations, practical implementation of the problem, quizzes and documenting students' progress.
4. Encourage the students for group learning to improve their creative and analytical skills.

**Pre-requisites**

1. Trigonometric formulae.
2. Differentiation, Integration and properties.

## III. COURSE CONTENT

| **Module-1: Polar Curves and Curvature** | 10 Hours |
|---|---|

Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and radius of curvature - Cartesian, and pedal forms. Implementation using MAT LAB.

**Self study:** Radius of curvature in polar form and parametric form.

**RBT Levels:** L1, L2 and L3

| **Module-2: Series Expansion, Indeterminate Forms and Multivariable Calculus** | 10 Hours |
|---|---|

Statement and problems on Maclaurin's series expansion for one variable. Indeterminate forms (- $1^{\infty}$, $0^0$ *and* $\infty^0$) L'Hospital's rule.

**Partial differentiation:** Definition, total derivative - differentiation of composite functions, Jacobian, Maxima and minima for the function of two variables. Implementation using MAT LAB.

**Self-Study:** Statement and problems on Taylor's series expansion for one variable.

**RBT Levels:** L1, L2 and L3

| **Module-3: Ordinary Differential Equations of First Order** | 10 Hours |
|---|---|
| Bernoulli's differential equation. Exact and reducible to exact differential equations with integrating factors $1/N\left(\partial M/\partial y - \partial N/\partial x\right)$ *and* $1/M\left(\partial N/\partial x - \partial M/\partial y\right)$.Orthogonal trajectories (cartesian form). Study of Law of natural growth and decay. Implementation using MAT LAB. | |
| **Self-study:** Linear Differential Equation, Orthogonal trajectories in polar form. | |
| **RBT Levels:** L1, L2 and L3 | |
| **Module-4: Linear Algebra -1** | 10 Hours |
| Elementary row transformation of a matrix, Row echelon form and Rank of a matrix. Consistency and Solution of system of linear equations - Gauss-elimination method, Gauss Jordon method and approximate solution by Gauss-Seidel method. Application to traffic flow. Implementation using MAT LAB. | |
| **Self-study:** LU decomposition method (2 x 2 matrix) | |
| **RBT Levels:** L1, L2 and L3 | |
| **Module-5: Linear Algebra - 2** | 10 Hours |
| Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant Eigenvalue and Eigenvector. Model matrix, Diagonalization of the matrix (2 x 2 matrix), inverse of a matrix by Cayley-Hamilton theorem, Moore-Penrose pseudoinverse. Implementation using MAT LAB. | |
| **Self-study:** Characteristic and minimal polynomials of block matrices, | |
| **RBT Levels:** L1, L2 and L3 | |

## IV. COURSE OUTCOMES

| | |
|---|---|
| **CO1** | Apply the knowledge of single and multivariable calculus to evaluate the problems arising in engineering discipline |
| **CO2** | Solve ordinary differential equations of first order arising in engineering problems. |
| **CO3** | Apply the principles of linear algebra to solve systems of linear equations, eigenvalues and eigenvectors, real-world problems such as traffic flow. |
| **CO4** | Employ MATLAB techniques for analytical solutions, and graphical visualization of differential calculus and linear algebra concepts in engineering. |

## V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

| PO/PSO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | 1 | | | | 1 | | 1 | | | | |
| CO2 | 3 | 2 | | | 1 | | | | 1 | | 1 | | | | |
| CO3 | 3 | 2 | | | 1 | | | | 1 | | 1 | | | | |
| CO4 | 3 | 2 | | | 1 | | | | 1 | | 1 | | | | |

## VI. Assessment Details (CIE & SEE)

**General Rules:** Refer Annexure section 1

**Continuous Internal Evaluation (CIE):** Refer Annexure section 1

**Semester End Examination (SEE):** Refer Annexure section 1

## VII. Learning Resources

**VII(a): Textbooks:**

| Sl. No. | Title of the Book | Name of the author | Name of the publisher | Edition and Year |
|---|---|---|---|---|
| **1** | Higher Engineering Mathematics | B.S. Grewal | Khanna Publishers | 44th Ed., 2018. |
| **2** | Advanced Engineering Mathematics | E. Kreyszig | John Wiley & Sons | 10th Ed., 2018 |
| **3** | Linear Algebra and its Applications | Gilbert Strang | Cengage Publications | 4th Ed., 2022 |
| **VII(b): Reference Books:** | | | | |
| 1 | Higher Engineering Mathematics | B.V. Ramana | McGraw-Hill Education | 11th Ed., 2017 |
| 2 | Engineering Mathematics | Srimanta Pal & Subodh C.Bhunia | Oxford University | 3rd Ed., 2016 |
| 3 | A Textbook of Engineering Mathematics | N. P. Bali and Manish Goyal | Laxmi Publications | 10th Ed., 2022. |
| 4 | Higher Engineering Mathematics | H. K. Dass and Er. Rajnish Verma | S. Chand Publication | 3rd Ed., 2014 |
| 5 | Linear Algebra and its Applications | David C Lay | Pearson Publishers | 4th Ed., 2018 |

**VII(c): Web links and Video Lectures (e-Resources):**

- http://academicearth.org/
- VTU e-Shikshana Program
- VTU EDUSAT Program
- https://nptel.ac.in/courses/111106135
- https://nptel.ac.in/courses/111105160
- https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/
- https://ocw.mit.edu/courses/18-02sc-multivariable-calculus-fall-2010/

**VIII: Activity Based Learning**

Assignments, quiz and presentation.