|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)
SJB Institute of Technology
BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060
Approved by AICTE, New Delhi.
Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi
Accredited by NAAC with 'A+'grade, Certified by ISO 9001 - 2015
Recognized by UGC, New Delhi with 2(f) & 12 (B)

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|---|---|---|---|---|---|
| **Semester:** | I | **Course Type:** | ASC | | |
| **Course Title: Differential Equations & Linear Algebra** | | | | | |
| **Course Code:** | 25MAT11B | | | **Credits:** | 4 |
| **Teaching Hours/Week (L:T:P:S)** | | | 3:2:0:1 | **Total Hours:** | 50 (40L+10T) |
| **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. Develop the knowledge of Linear Algebra referring to matrices.
3. To interpret and visualize mathematical solutions through MATLAB

## 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: Differential Calculus** | 10 Hours |
|---|---|

Polar curves, angle between the radius vector and the tangent, angle between the polar curves, pedal equations. Curvature and radius of curvature in cartesian and pedal forms. Implementation using MATLAB

**Self- study:** Radius of curvature in Parametric and polar form

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

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

Statement and problems on Taylor's and Maclaurin's series expansion for one variable. Indeterminate forms $(0^0, 1^\infty, \infty^0)$- L'Hospital's rule. Partial Differentiation: Definition, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables. Implementation using MATLAB

**Self-Study:** Partial derivatives: Euler's Theorem and differentiation of Implicit functions

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

| **Module-3: Ordinary Differential Equations (ODE) of First Order and First Degree and Nonlinear ODE** | 10 Hours |
|---|---|

Bernoulli's differential equations. Exact and reducible to exact differential equations- Integrating factors on $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ and $\frac{-1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$. Orthogonal trajectories (Cartesian form). Non-linear differential equations: Introduction to general and singular solutions, solvable for p only, Clairaut's Equations. Implementation using MATLAB

**Self-Study:** Linear differential equations, L-R and C-R circuits.

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

| **Module-4: Ordinary Differential Equations of Higher Order** | 10 Hours |
|---|---|

Higher-order linear ODEs with constant coefficients, homogeneous differential equations, non-homogeneous equations ($2^{nd}$ order only) - $e^{ax}, sin(ax+b), cos(ax+b), x^n$ . Cauchy's and Legendre's homogeneous differential equations. L-C-R circuits. Implementation using MATLAB

**Self-study:** Method of variation of parameters

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

| **Module-5: Linear Algebra** | 10 Hours |
|---|---|

Rank of a matrix by echelon form. Consistency and Solution of system of linear equations. Approximate solution by Gauss-Seidel method. Determination of largest Eigen values and the corresponding Eigen vector by Rayleigh's power method. Traffic flow problems, Implementation using MATLAB

**Self-study:** Gauss Elimination and Gauss-Jordan method.

**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** | Apply methods to solve ordinary differential equations of first and higher 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., 2021 |
| **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 | Tata Mc Graw-Hill | 11th Ed., 2017 |
| 2 | Higher Engineering Mathematics | H. K. Dass and Er. Rajnish Verma | S. Chand Publication, | 3rd Ed., 2014. |
| 3 | Engineering Mathematics | Srimantha Pal & Subodh C Bhunia | Oxford Publication | 3rd Ed., 2016. |
| 4 | Linear Algebra and its Applications | David C Lay | Pearson Publishers | 4th Ed., 2018. |
| 5 | A Textbook of Engineering Mathematics | N. P. Bali and Manish Goyal | Laxmi Publications | 10th Ed., 2022 |

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

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

**VIII: Activity Based Learning**

Assignments, quiz and presentation.