K. S. INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU, Approved by AICTE

Department of Mathematics

FIRST SEMESTER SYLLABUS

Course: Applied Mathematics-I for ME stream : Differential Calculus and Linear Algebra		Semester	I
Course Code	**25BMAME101**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory+20 Hours Tutorials	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	**Theory**		

Course Objectives (Course Skill Set):

The goal of the course **Applied Mathematics-I for ME stream** is to

1. **Familiarize** the importance of calculus associated with one variable and two variables for Mechanical engineering.
2. **Analyze** Mechanical engineering problems applying Ordinary Differential Equations.
3. **Develop** the knowledge of Linear Algebra referring to matrices.

Module-1: Polar Curves and Curvature

Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and radius of curvature - Cartesian, parametric, polar and pedal forms. Stress and Strain analysis.

(Text 1:.Ch-4(4.7(1),4.8, 4.10, 4.11 (1,2,4), Reference Book 8(Ch-2))

Number of Hours: (8 Hours Theory+4 Hours Tutorials)

Module-2: Series Expansion, Indeterminate Forms and Multivariable Calculus

Statement and problems on Taylor's and Maclaurin's series expansion for one variable. Indeterminate forms - L'Hospital's rule. Partial differentiation, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for the function of two variables.

(Text 1:.Ch-4(4.4(1,3), 4.5(3)), Ch-5(5.1, 5.2, 5.5(1), 5.11, 5.7(1))

Number of Hours: (8 Hours Theory+4 Hours Tutorials)

Module-3: Ordinary Differential Equations of First Order

Linear and Bernoulli's differential equations. Exact and reducible to exact differential equations with Integrating factor: $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ and $\frac{1}{M}\left(\frac{\partial N}{\partial x}-\frac{\partial M}{\partial y}\right)$. Orthogonal trajectories, Law of natural growth and decay.

(Text 1:.Ch-11(11.9, 11.10, 11.11 ,11.12(4)), Ch-12(12.3(1,2,3), 12.8, 12.9)

Number of Hours: (8 Hours Theory+4 Hours Tutorials)

Module-4: Linear Algebra -1

Elementary row transformation of a matrix, Row echelon form and Rank of a matrix. Inverse of matrix by Jordan method. Consistency and Solution of system of linear equations - Gauss-elimination method, LU decomposition method and approximate solution by Gauss-Seidel method. Application to traffic flow.

(Text 1:.Ch-2(2.7(1,2,6), 2.10), Ch-28(28.6(1, 2)and 28.7(2), Text 2: Ch-7(7.3 Problem No. 21))

Number of Hours: (8 Hours Theory+4 Hours Tutorials)

Module-5: Linear Algebra -2
Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant Eigenvalue and Eigenvector. Model matrix, pseudo random number generator, Diagonalization of the matrix, inverse of a matrix by Cayley-Hamilton theorem, Characteristic and minimal polynomials of block matrices, Moore-Penrose pseudoinverse. (Text 1:.Ch-2(2.13, 2.15, 2.16), Ch-28(28.9), Text 3: Appendix D, Ch-2(2.4), Ch-1(1.4), Text 2: Ch 8(8.1), Reference book 9(Ch-8(8.1))) **Number of Hours: (8 Hours Theory+4 Hours Tutorials)**
Course Outcomes (Course Skill Set) **CO1: Apply** foundational concepts of calculus to analyze geometric properties of curves **CO2: Apply** foundational concepts of differential equations to solve first order ordinary differential equations, and model physical phenomena in science and engineering. **CO3: Apply** the principles of linear algebra to solve systems of linear equations, **CO4: Apply** the principles of linear algebra to determine eigenvalues and eigenvectors and analyze real-world problems such as traffic flow. **CO5: Demonstrate** the applications of mechanical engineering and allied engineering science using modern ICT tools.
Suggested Learning Resources: **Books (Name of the author/Title of the Book/Name of the publisher/Edition and Year)** **Text Books:** 1) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44 Ed., 2021. 2) E.Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10 Ed., 2018. 3) Gilbert Strang, Linear Algebra and its Applications, Cengage Publications, 4th Ed., 2022, **Reference books:** 1) B.V.Ramana, Higher Engineering Mathematics, McGraw-Hill Education, 11% Ed., 2017 2) Srimanta Pal & Subodh C.Bhunia, Engineering Mathematics, Oxford University Press, 37 Ed., 2016. 3) N.P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, 10 Ed., 2022. 4) H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 31 Ed., 2014. 5) Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6™ Ed., 2017. 6) David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4th Ed., 2018. 7)Gareth Williams, Linear Algebra with Applications" Jones Bartlett Publishers Inc., 6t Ed., 2017. 8) Roark's Formulas for Stress and Strain, Warren C. Young, Richard G. Budynas, 7th Ed., McGraw Hill 9) Cryptography and Network Security, William Stallings, Pearson Publishers, 8th Ed.
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

Teaching-Learning Process (Innovative Delivery Methods)

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching learning process and facilitate the achievement of course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self-study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to group learning to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).

As a model solution of some exercises (post-lecture activity).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation(CIE):

- Three Tests each of 25 Marks.
- 1st, 2nd, and 3rd tests shall be conducted after completion of the syllabus of 30-35%, 70-75%, and 90-100% of the course/s respectively. Average of three tests will be scaled down to 25 marks.
- Continuous Comprehensive Assessments will be conducted with a total of 25 marks. It is recommended to include a maximum of two learning activities aimed at enhancing the holistic development of students. These activities should align with course objectives and promote higher-order thinking and application-based learning.

  Learning Activity-1: Practicing problems (Lab Activities/Surprise Test/ Seminar for 15 Marks) Execute the following lab exercises with the aid of any modern technological tool (Matlab/ Mathematica/ Scilab/ Python/ Maxima, etc).

Learning Activity-2: Assignments (Marks-10).

List of Lab activities:

1) 2D plots for Cartesian and polar curves,
2) Finding angle between polar curves,
3) Finding Radius of curvature,
4) Expansion of Taylor's and Maclaurin's series,
5) Finding partial derivatives and Jacobian,
6) Solution of first order ordinary differential equations,
7) Plotting solutions of ODE,
8) Finding rank, reduced echelon form, solving system of linear equations using Gauss elimination method,
9) Solving system of linear equations using Gauss-Seidel method,
10) Determine Eigenvalues and Eigenvectors.

Semester End Examination(SEE):

Theory SEE will be conducted by KSIT as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper shall be set for 100 marks. The medium of the question paper shall be English). The duration of SEE is 03 hours.
- The question paper will have 10 questions. Two questions per module. Each question is set for 20 marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to): -

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching - Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play