K. S. INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU, Approved by AICTE

Department of Mathematics

SECOND SEMESTER SYLLABUS

Course: **Applied Mathematics-II for ME stream: Multivariable Calculus and Numerical Methods**		Semester	II
Course Code	**25BMAME201**	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-II for ME stream** is to

1. **Familiarize** the importance of Integral calculus and Vector calculus essential for Mechanical engineering.
2. **Analyze** Mechanical engineering problems by applying Ordinary Differential Equations of higher order.
3. **Develop** the knowledge of solving Mechanical engineering problems numerically.

Module-1: Ordinary Differential Equations of Higher Order

Higher-order ordinary differential equations with constant coefficients, homogeneous and non-homogeneous equations- $e^{ax}, sin(ax+b), cos(ax+b), x^n$ only, Method of variation of parameters, Cauchy's and Legendre's homogeneous differential equations. Applications: mass spring model.

(Text 1: Ch-13(13.4, 13.5, 13.6(1,2,3), 13.8(1), 13.9(1,2), 14.4)

(Text 2: Ch-4(4.1(Example 3 and Problem14)))

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

Module-2: Integral Calculus

Multiple Integrals: Definition, Evaluation of double and triple integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates. Applications to find Area and Volume by double integral. Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions.

(Text 1: Ch-7(7.1 to 7.5, 7.6(1), 7.7(1), 7.14 to 7.16)

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

Module-3: Vector Calculus

Scalar and vector fields. Gradient, directional derivative, divergence and curl - physical interpretation, solenoidal vector fields, irrotational vector fields and scalar potential. Vector Integration: Line integrals, surface integrals, work done by a force and flux. Statement of Green's theorem and Stoke's theorem and problems without verifications.

(Text 1: Ch-8(8.4 to 8.7, 8.11 to 8.14, 8.18))

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

Module-4: Numerical Methods - 1

Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson methods. Interpolation: Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula. Numerical integration: Trapezoidal, Simpson's 1/3rd and 3/8th rules, Weddle's rule.

(Text 1: Ch-28(28.2(2,3)), Ch-29(29.1(1,2),29.6(1,2), 29.9 to 29.12), Ch-30(30.4, 30.6, 30.7, 30.8, 30.10)

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

Module-5: Numerical Methods – 2

Numerical solution of ordinary differential equations of first order and first degree: Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's predictor-corrector formula and Adams-Bashforth predictor-corrector method.

(Text 1: Ch-32(32.1, 32.3, 32.5, 32.7, 32.9, 32.10))

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

Course outcome (Course Skill Set)

CO1: Apply the concepts of higher order differential equations to model and solve problems in engineering applications such as heat conduction

CO2: **Apply** the concepts of integral calculus to solve problems in engineering applications such as area, volume.

CO3: Apply the concepts of vector calculus to model and solve problems in engineering applications such as field analysis.

CO4: Apply appropriate numerical methods to find approximate solutions of algebraic, transcendental, and ordinary differential equations and to perform interpolation and numerical integration in engineering contexts.

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)

Textbooks:

1) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2021.
2) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2018.
3) M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 8thEd., 2022.

Reference books:

1) B.V.Ramana, Higher Engineering Mathematics, McGraw-Hill Education, 11th Ed., 2017
2) Srimanta Pal & Subodh C.Bhunia, Engineering Mathematics, Oxford University Press, 37 Ed., 2016.
3) N.P. Bali and Manish Goyal, ATextbook 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, 6th Ed., 2017.
6) Steven V. Chapra and Raymond P. Canale, Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw-Hill, 3rd Ed., 2011.

7) Richard L. Burden, Douglas J. Faires and A. M. Burden, Numerical Analysis, 10th Ed.,2010, Cengage Publishers.
8) S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI Learning Private Limited, 5th Ed., 2012.

Web links and Video Lectures (e-Resources):

- http://academicearth.org/
- VTU e-Shikshana Program
- VTU EDUSAT Program
- https://nptel.ac.in/courses/111105160
- https://nptel.ac.in/courses/127106019
- https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/
- https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring2012/pages/syllabus/

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) Evaluate double and triple integration and compute area and volume,
2) Solve higher order differential equations,
3) Finding gradient, divergence and curl,
4) Evaluate line integrals,
5) Regula Falsi and Newton Raphson method,
6) Interpolation,
7) Numerical integration,
8) Modified Euler's method,
9) Fourth order Runge -Kutta method,
10) Milne's method

Total CIE marks will be the sum of average of three tests (25 marks) and Continuous Comprehensive Assessments (25 marks) which will be scaled down to 50 marks.

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