K. S. INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU, Approved by AICTE

Department of Mathematics

SECOND SEMESTER SYLLABUS

Course : **Applied Mathematics-II for CSE Stream: Numerical Methods**		Semester	II
Course Code	**25BMACS201**	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 CSE Stream** is to

1. **Develop** the knowledge of numerical methods and apply them to solve transcendental and differential equations.
2. **Solve** the systems of linear equations and compute eigenvalues and eigenvectors using iterative and decomposition methods.
3. **Solve** first and higher-order differential equations using analytical methods and inverse differential operators for standard functional forms.

Module-1: Introduction to Numerical Methods

Errors and their computation: Round off error, Truncation error, Absolute error, Relative error and Percentage error. Solution of algebraic and transcendental equations: Bisection, Regula-Falsi, Secant and Newton-Raphson methods.

(Text 1: Ch-1(1.1, 1.3), Ch-2(2.1, 2.2, 2.3))

Text3: Ch 28(28.2(2))

Number of Hours: 8 Hours Theory+4 Hours Tutorials

Module-2: Numerical solutions for system of linear equations

Norms: Vector norms and Matrix norms-L1, L2 and L∞, Ill conditioned linear system, condition number. Solution of system of linear equations: Gauss Seidel method and LU-decomposition method.

Eigenvalues and Eigen vectors: Rayleigh power method, Jacobi's method.

(Text1: Ch-3(3.2, 3.3)

Text 3: Ch-28(28.7(1,2), 28.9))

Number of Hours: 8 Hours Theory+4 Hours Tutorials

Module-3: Interpolation

Finite differences, interpolation using Newton Gregory forward and Newton Gregory backward difference formulae, Newton's divided difference.

Lagrange interpolation formulae, Lagrange's inverse interpolation formula, piecewise interpolation-linear and quadratic.

(Text 3: Ch-29(29.1(1,2), 29.6, 29.9 to 29.13)

Text 1: Ch-4(4.6))

Number of Hours: 8 Hours Theory+4 Hours Tutorials

Module-4: Differential Equations of First and Higher Order

Linear and Bernoulli`s differential equations. Exact and reducible to exact differential equations with integrating factors on $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$and $\frac{1}{M}\left(\frac{\partial N}{\partial x}-\frac{\partial M}{\partial y}\right)$. Homogeneous and non-homogeneous Differential equations of higher order with constant coefficients. Inverse differential operators $e^{ax}, sin(ax+b), cos(ax+b)$ and x^n.
(Text 3:Ch-11(11.9, 11.10, 11.11, 11.12(4)), Ch-13(13.1, 13.2, 13.3, 13.4,13.5, 13.6(Case I, II and III))

Number of Hours: 8 Hours Theory+4 Hours Tutorials

Module-5: Numerical Integration and Numerical Solution of Differential Equations

Numerical integration: Trapezoidal, Simpson's 1/3rd, Simpson's 3/8th rule and Weddle's rule.
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 and Milne's predictor-corrector method, Adam-Bashforth predictor-corrector method.
(Text 3: Ch-30(30.4, 30.6, 30.7, 30.8, 30.10), 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)

At the end of the course, the student will be able to:

CO1: **Apply** numerical methods to solve transcendental equations.

CO2: **Solve** the system of linear equations using the numerical methods.

CO3: **Apply** finite difference and interpolation techniques to estimate function values from discrete data using polynomial and piecewise approaches.

CO4: **Solve** first and higher-order differential equations using analytical methods and apply them to mathematical models.

CO5: **Demonstrate** the applications of computer science 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. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 8th Ed., 2022.
2. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 5th Ed., 2023.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2021.

Reference books:

1. V. Ramana, Higher Engineering Mathematics, McGraw-Hill Education, 11th Ed., 2017
2. N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, 10th Ed., 2022.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited, 5th Ed. 2012.
4. Steven V. Chapra and Raymond P. Canale, Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw-Hill, 3rd Ed., 2011.
5. Richard L. Burden, Douglas J. Faires, A. M. Burden, Numerical Analysis, 10th Edition.,2010, Cengage Publishers.

Web links and Video Lectures(e-Resources):

- https://nptel.ac.in/courses/111105134
- https://nptel.ac.in/courses/111107105
- https://nptel.ac.in/courses/111107107
- https://nptel.ac.in/courses/111104030
- https://nptel.ac.in/courses/111107063
- https://nptel.ac.in/courses/111106100
- 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) Errors and approximation,
2) Root finding methods,
3) Norms, Condition number,
4) Gauss Seidel method and Rayleigh power's method,
5) Forward and Backward interpolation,
6) Lagrange's interpolation,
7) Solving differential equations of first and higher order,
8) Numerical integration,
9) Taylor's method, Modified Euler's method,
10) Runge-Kutta method of fourth order.

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