Differential Calculus and Linear Algebra		Semester	1
Course Code	**1BMATM101**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40Hours Theory + 20Hours Tutorials	Total Marks	100
Credits	4 Credits	Exam Hours	3 Hours
Examination type (SEE)			**Theory**

Course Outcomes (Course Skill Set)

CO1: Apply foundational concepts of calculus and differential equations to analyze geometric properties of curves, solve first order ordinary differential equations, and model physical phenomena in science and engineering.

CO2: Apply the principles of linear algebra to solve systems of linear equations, determine eigenvalues and eigenvectors, and analyze real-world problems such as traffic flow.

CO3: Demonstrate the applications of mechanical engineering and allied engineering science using modern ICT tools.

Module-1: Polar Curves and Curvature (8 Hours Theory + 4 Hours Tutorial)

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.

Textbook 1: Chapter 4 :4.7-4.11

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

(8Hours Theory) + (4Hours Tutorial)

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.

Textbook 1: Chapter 4 :4.4,4.5, Chapter 5 :5.1-5.7

Module-3: Ordinary Differential Equations of First Order (8Hours Theory) + (4Hours Tutorial)

Linear and Bernoulli's differential equation. 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**.**

Textbook 1: Chapter 11:11.9-,11.12(4), Chapter 12:12.3-12.8, Textbook 2: Chapter 8: 8.17, 8.18

Module-4: Linear Algebra -1(8Hours Theory) + (4Hours Tutorial)

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.

Textbook 1: Chapter 2 :2.7,2.10, Chapter 28 :28.6(1,2,3), 28.7(2)
Textbook 3: Chapter 7

Module-5: Linear Algebra -2 (8Hours Theory) + (4Hours Tutorial)

Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant Eigenvalue and Eigenvector. Model matrix, Diagonalization of the matrix, inverse of a matrix by Cayley-Hamilton theorem, Characteristic and minimal polynomials of block matrices, Moore-Penrose pseudoinverse.

Textbook 3: Chapter 4: 4.0, Chapter 8 :8.1, Chapter 20: 20.8,
Textbook 1: Chapter 2:2.16(1),2.15, Chapter 28 :28.7(1)
Textbook 2:

Suggested Learning Resources: (Textbook/Reference Book):

Textbooks:
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers,44nd Ed., 2021.
2. Seymour Lipschutz and Marc Lipson, Linear Algebra, Schaum's outlines series, 4th Ed., 2008.
3. E.Kreyszig, Advanced Engineering Mathematics, JohnWiley & Sons,10th Ed.,2018.
4. Gilbert Strang, Linear Algebra and its Applications, Cengage Publications,4thEd.,2022.

Reference books:
1. Srimanta Pal & Subodh C.Bhunia, Engineering Mathematics, Oxford University Press, 3rd Ed., 2016.
2. N. P.Bali and Manish Goyal, AText book of Engineering Mathematics, Laxmi Publications,10thEd.,2022.
3. H.K.Dass and Er.RajnishVerma, Higher Engineering Mathematics,S.Chand Publication, 3rd Ed., 2014.
4. Ray Wylie,Louis C.Barrett, Advanced Engineering Mathematics, McGrawHill Book Co., New York, 6th Ed., 2017.
5. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4thEd., 2018.

7. Gareth Williams, Linear Algebra with Applications"Jones Bartlett Publishers Inc.,6th Ed., 2017.

Web links and Video Lectures (e-Resources):
- http://academicearth.org/
- VTUe-ShikshanaProgram
- VTUEDUSATProgram
- 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 Structure:
The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.
The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.
- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA):

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

Learning Activity-2: The students have to present applications of mathematics related to syllabus as a group maximum of five members.

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 and higher 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.

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

Activity-1	Superior (13-15)	Good (10-12)	Fair (7-9)	Needs Improvement (4-6)	Unacceptable (0-3)
Performance Indicator- 1 (CO-1/PO -1, PO-12, Mapping)	Demonstrates complete understanding of the topic	Shows good understanding with minor errors	some key points are missing	Shows little understanding	Very poor performance
Performance Indicator-2 (CO-2/PO-1/ PO-12, Mapping)	creatively to solve problems	Participates regularly but may need occasional prompting	Demonstrates partial understanding	major misconceptions present	Inadequate performance
Activity-2	9-10	7-8	5-6	3-4	1-2
Performance Indicator-3 (CO-3/PO-5 PO-12, Mapping)	perform tasks independently	Applies knowledge correctly	limited creativity.	Unable to apply knowledge appropriately.	Identical performance

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

- Course Project

- Case Study Presentation

- Programming Assignment

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- 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

- Open Book Test (preferably at RBL4 and RBL5 levels)

- GATE-based Aptitude Test

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