

Differential Calculus & Linear Algebra		Semester	1
Course Code	1BMATE101	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	04	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 and higher-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 electrical engineering and allied engineering science using modern ICT tools.			
Module-1: Differential Calculus		(8 Hours Theory + 4 Hours Tutorial)	
Polar curves, angle between the radius vector and the tangent, angle between the polar curves, pedal equations. Curvature and radius of curvature in cartesian, polar, parametric and pedal forms.			
Module-2: Power Series Expansions, Indeterminate Forms and Multivariable Calculus		(8 Hours Theory + 4 Hours Tutorial)	
Statement and problems on Taylor’s and Maclaurin’s series expansion for one variable. Indeterminate forms - L’Hospital’s rule. Partial Differentiation: Partial differentiation, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables.			
Module-3: Ordinary Differential Equations (ODE) of First Order and First Degree and Nonlinear ODE		(8 Hours Theory + 4 Hours Tutorial)	
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 $\frac{-1}{M}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right)$ only. Linear and Bernoulli’s differential equations. Orthogonal trajectories, L-R and C-R circuits. Non-linear differential equations: Introduction to general and singular solutions, solvable for p only, Clairaut’s equations, reducible to Clairaut’s equations.			
Module-4: Ordinary Differential Equations of Higher Order		(8 Hours Theory + 4 Hours Tutorial)	
Higher-order linear ODEs 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. L-C-R circuits.			
Module-5: Linear Algebra		(8 Hours Theory + 4 Hours Tutorial)	
Elementary transformations on a matrix, Echelon form, rank of a matrix, consistency of system of linear equations. Gauss elimination, Gauss –Seidel method to solve system of linear equations. Eigen values and eigen vectors of a matrix, Rayleigh power method to determine the dominant eigen value of a matrix.			

Suggested Learning Resources: (Textbook/Reference Book):**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. Gilbert Strang, Linear Algebra and its Applications, Cengage Publications, 4th Ed., 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, 3rd Ed., 2016.
3. N. P. Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, 10th Ed., 2022.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.
5. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4th Ed., 2018.

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 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)

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 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):

	Superior	Good	Fair	Needs Improvement	Unacceptable
Performance Indicator- 1 (CO/PO Mapping)					
Performance Indicator-2 (CO/PO Mapping)					
...					
Performance Indicator-n (CO/PO Mapping)					

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