

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)			
<p>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.</p> <p>CO2: Apply the principles of linear algebra to solve systems of linear equations, determine eigen values and eigenvectors, and analyze real-world problems such as traffic flow.</p> <p>CO3: Demonstrate the applications of Electrical engineering and Allied Engineering Science using modern ICT tools.</p>			
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.			
Textbook-1: Chapter- 4.7- 4.11			
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 derivatives, total derivative, differentiation of composite functions, Jacobians. Maxima and minima for functions of two variables.			
Textbook-1: Chapter- 4.4(1,2,3),4.5(1,2,3), 5.1- 5.11.			
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.			

Textbook-1: Chapter-11.9-11.14- 12.3,12.5.	
Module-4: Ordinary differential equations of higher Order	
(8 Hours Theory + 4 Hours Tutorial)	
Higher-order linear 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, L-C-R circuits.	
Textbook-1: Chapter-13.1-13.9, 14.5.	
Module-5: Linear Algebra	(8 Hours Theory + 4 Hours Tutorial)
Elementary transformations of a matrix, Echelon form, rank of a matrix, consistency of system of linear equations. Gauss elimination and Gauss –Seidel method to solve system of linear equations. Eigen values and eigen vectors of a matrix, Rayleigh's power method to determine the dominant eigen value and corresponding eigen vector of a matrix. Applications: Traffic flow.	
Textbook-1: Chapter-2.7-2.13, 28.5,28.6(1),28.7(2),28.9.	
Textbook-2: Chapter-7	
Suggested Learning Resources: (Textbook/ Reference Book):	
Textbooks:	
<ol style="list-style-type: none"> 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,4thEd.,2022. 	
Reference books / Manuals:	
<ol style="list-style-type: none"> 1. B. V. Ramana, HigherEngineeringMathematics, McGraw-HillEducation,11thEd., 2017 2. Srimanta Pal & Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 3rd Ed., 2016. 3. N. P. Baliand Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, 10thEd.,2022. 4. H.K. Das and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014. 5. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4thEd., 2018. 	
Web links and Video Lectures (e-Resources):	
<ul style="list-style-type: none"> • 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 (Average of two objective type assessments (GATE-based Aptitude Test) for 15 marks each)

Learning Activity-2: Choose either lab activity or seminar for 10 marks

Lab activity: Execute the following lab exercises with the aid of any modern technological tool (Matlab/ Mathematica/ Scilab/ Python/ Maxima, etc).

Seminars: The students has to present applications of mathematics related to syllabus as a group maximum of four 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 iteration
- 10) Determine Eigenvalues and Eigenvectors.

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

Learning 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
Learning 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
- 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