Calculus, Laplace Transforms and Numerical Techniques		Semester	2
Course Code	**1BMATE201**	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 outcome (Course Skill Set)

CO1: Apply the concepts of integral calculus and vector calculus to model and solve problems in engineering applications such as area, volume.

CO2: 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.

CO3: Apply Laplace transform techniques for time domain, wave forms, periodic functions and solving differential equations.

CO4: Demonstrate the applications of electrical engineering and allied engineering science using modern ICT tools.

Module-1: Integral Calculus and its applications (8 Hours Theory + 4 Hours Tutorial)

Multiple Integrals: Evaluation of double and triple integrals, change of order of integration, changing to polar coordinates. Areas and volume using double integration.
Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions.
Textbook-1: Chapter-7.1,-7.16.

Module-2: Vector calculus and its applications (8 Hours Theory + 4 Hours Tutorial)

Vector differentiation: Scalar and vector fields, gradient of a scalar field, directional derivatives, divergence of a vector field, solenoidal vector, curl of a vector field, irrotational vector, physical interpretation of gradient, divergence and curl and scalar potential.
Vector Integration**:** Line integrals, Statement of Green's and Stokes' theorem without verification problems.
TextBook-1: Chapter-8.4- 8.14.

Module-3: Numerical Methods-1 (8 Hours Theory + 4 Hours Tutorial)

Solution of algebraic and transcendental equations: Regula-Falsi method, and Newton-Raphson method.
Finite Differences and Interpolation: Forward and backward differences, Interpolation, Newton forward and backward interpolation formulae, Newton's divided difference interpolation formula and Lagrange's interpolation formula.
Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule.
Textbook-1: Chapter-28.1, 28.2(2,3), 29.1-29.12, 30.4, 30.6, 30.7, 30.8.

Module-4: Numerical Methods-2 (8 Hours Theory + 4 Hours Tutorial)

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 method and Adam-Bashforth predictor-corrector method.

Textbook -1: Chapter-32.1-32.10

Module-5: Laplace transforms (8 Hours Theory + 4 Hours Tutorial)

Laplace transforms: Definition and Formulae of Laplace Transforms, Laplace Transforms of elementary functions. Properties–Linearity, Scaling, shifting property, differentiation in the s domain, division by t. Laplace Transforms of periodic functions, square wave, saw-tooth wave, triangular wave, full and half wave rectifier, Heaviside Unit step function.

Inverse Laplace Transforms: Definition, properties, evaluation of Inverse Laplace Transforms using different methods, and applications to solve ordinary differential equations.

Textbook -1: Chapter-21.1- 21.17

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, JohnWiley & 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, 8th Ed., 2022.

Reference books:

1. B. V. Ramana, Higher Engineering Mathematics, McGraw-HillEducation,11thEd., 2017
2. Srimanta Pal & Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 3rd Ed., 2016.
3. N. P. Bali and Manish Goyal, A Text book 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. Steven V. Chapra and Raymond P. Canale, Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw-Hill, 3rdEd., 2011.
6. Richard L. Burden, Douglas J. Faires and A. M. Burden, Numerical Analysis, 10th Ed., 2010, Cengage Publishers.
7. S.S. Sastry," Introductory Methods of Numerical Analysis", PHI Learning Private Limited, 5thEd.,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-spring-2012/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 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.

- 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) Evaluate double integration and compute area and volume,
2) Evaluate triple integration and compute volume,
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, Fourth order Runge -Kutta method of fourth order,
9) Laplace transform,
10) Inverse Laplace transforms.

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, CO-3 /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