Differential Calculus and Numerical Methods		Semester	2
Course Code	**1BMATC201**	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 outcome (Course Skill Set)

CO1: Apply the concepts of integral calculus, partial differential equations, and vector calculus to model and solve problems in engineering applications such as area, volume, heat conduction, and field analysis.

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

Module-1: Integral Calculus **(8 Hours Theory + 4 Hours Tutorial)**

Multiple Integrals: Evaluation of double and triple integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates. Applications to find Area and Volume by double integral.

Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions.

Textbook -1. Chapter -7.1-7.16

Module-2: Partial Differential Equations (PDE) **(8 Hours Theory + 4 Hours Tutorial)**

Formation of PDEs by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives with respect to one independent variable only. Method of Separation of variables. Application of PDE: Derivation of one-dimensional heat equation and wave equation.

Module-3: Vector Calculus **(8 Hours Theory + 4 Hours Tutorial)**

Scalar and vector fields. Gradient, directional derivative, divergence and curl - physical interpretation, solenoidal vector fields, irrotational vector fields and scalar potential.

Vector Integration: Line integrals, work done by a force and flux, Statements of Green's theorem and Stoke's theorem, problems without verification.

Textbook -1. Chapter -8.4-8.14

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

Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson methods, problems.

Interpolation: Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula.

Numerical integration: Trapezoidal, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules.

Text Book -1. Chapter -28.1-28.2, 29.1-30.8

Module-5: 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 Adams-Bashforth predictor-corrector method.

Textbook -1. Chapter -28.1-30.8

Suggested Learning Resources: (Textbook/Reference Book):

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44thEd., 2021.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10thEd., 2018.
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 8thEd., 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. Steven V. Chapra and Raymond P. Canale, Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw-Hill, 3rd Ed., 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, 5th Ed., 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.

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) 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,
9) Fourth order Runge -Kutta method,
10) Milne's method.

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

- 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