BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(An Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi)

Avalahalli, Doddaballapur Main Road, Bengaluru – 560119

DEPARTMENT OF MATHEMATICS

Choice Based Credit System (CBCS)

SEMESTER-I

MULTIVARIATE CALCULUS AND LINEAR ALGEBRA

(Common to CSE, AI&ML and CSBS Branches)

(Effective from the academic year 2024-25)

Course Code	**BMATCS11**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Credit distribution (L:T:P:S)	3:0.5:0.5:0	Credits	04
Total Hours of Pedagogy	40 hours Theory + 10 hours Lab	Exam Hours	03

Course objectives:

The goal of the course Multivariate Calculus and Linear Algebra (24MATCS11) is to

- **Know** the importance of partial derivatives in computer science and engineering.
- **Apply** the knowledge of integral calculus for the analysis of wave propagation in various media.
- **Get familiarized** with the concepts of linear algebra, vector space and linear transformation which have applications in the field of engineering and computer graphics.

Teaching-Learning Process

Pedagogy (General Instructions):

These are sample strategies which teachers can use to accelerate the attainment of the various courseoutcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop student's 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 for group learning to improve their creative and analytical skills.
6. Show short video lectures in the following ways as:
   - An introduction to new topics (pre-lecture activity).
   - a revision of topics (post-lecture activity).
   - additional examples (post-lecture activity).
   - additional material of challenging topics (pre-and post-lecture activity).

Module-1: Partial Derivates (8 hours)
Introduction, Partial differentiation-problems, Homogeneous functions, Euler's theorem for homogeneous functions-derivation and problems (only first order), total derivatives, differentiation of composite functions, Jacobian-problems, Maxima and minima for a function of two variables-problems. **Applications:** Computing errors and approximation. **(RBT Levels: L1, L2 and L3)**
Module-2: Multiple Integrals (8 hours)
Introduction**,** Evaluation of double and triple integrals, Evaluation of double integrals by changing the order of integration, Evaluation of double integrals by changing into polar coordinates, Applications to find area by double integral and volume by triple integral, Problems. Beta and Gamma functions, Definitions, properties, Relation between Beta and Gamma functions, Problems. **Applications:** Evaluating mass, moments and center of mass of an object. **(RBT Levels: L1, L2 and L3)**
Module-3: Linear Algebra-I (8 hours)
Introduction, Elementary row transformation of a matrix, Rank of a matrix, Consistency and Solution of system of homogeneous & non-homogeneous linear equations - Gauss-elimination method, Gauss-Jordan method, LU decomposition method and Gauss-Seidel iterative method. Problems. **Applications:** Traffic Network and Network Analysis **(RBT Levels: L1, L2 and L3)**
Module-4: Linear Algebra-II (8 hours)
Introduction, Eigenvalues and Eigenvectors of a matrix, Cayley-Hamilton theorem (Statement only)-problems, Rayleigh's power method-problems, Diagonalization of matrices of order 2, Quadratic forms, Reduction to canonical form, Nature, Rank, Index and Signature of quadratic forms, Problems. Principal Component Analysis & problems to find the principal components. **Applications:** Data processing. Cryptography **(RBT Levels: L1, L2 and L3)**
Module-5: Linear Algebra-III (8 hours)
Introduction**,** Definition and examples, Subspace and examples, Linear combinations, Linear span, linearly independent and dependent sets, Basis and dimension, Problems. Linear transformations, Definition and examples, Matrix of a linear transformation, Rank-Nullity theorem (Statement only), Problems. Inner product space, orthogonal and orthonormal sets, Problems. **Applications:** Image processing. Computer graphics **(RBT Levels: L1, L2 and L3)**

List of Laboratory experiments (1 hours/week): 10 lab sessions + 1 Lab Assessment

1	Finding partial derivatives and plotting solution graphs.
2	Finding Jacobian of a vector functions.
3	Evaluation of double and triple integrals.
4	Computation of area and volume.
5	Solution of system of linear equations.
6	Solution of system of linear equations using Gauss-Seidel iteration method.
7	Compute eigen values and eigen vectors, finding the largest eigen value by Rayleigh power method.
8	Diagonalization of square matrix.
9	Computation of basis and dimension of a vector space.
10	Computing inner product and orthogonality.

Suggested Software: MATLAB

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)

Text Books:

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. **Srimanta Pal & Subodh C.Bhunia**: "Engineering Mathematics", Oxford University Press,3rd Ed., 2016.
2. **N.P Bali and Manish Goyal**: "A Textbook of Engineering Mathematics", Laxmi Publications, 10th Ed., 2022.
3. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics", McGraw Hill Book Co., New York, 6th Ed., 2017.
4. **James Stewart: "**Calculus", Cengage Publications, 7thEd., 2019.
5. **David C Lay:** "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.

Web links and Video Lectures (e-Resources):

- http://nptel.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- VTU e-Shikshana Program
- VTU EDUSAT Program

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar