MULTIVARIABLE CALCULUS
(Common to the branches CSE (AI&ML), CSE (DS))

Course Code: 22BM1102

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Course Outcomes: At the end of the Course, the student shall be able to:

CO1: test the convergence of an infinite series and express functions in terms of power series **(L5)**

CO2: apply the techniques of multivariable differential calculus to determine extrema and series expansions of functions of several variables **(L3)**

CO3: use the concept of integration of higher dimensions to solve the problems in engineering **(L3)**

CO4: summarize various concepts of vector differentiation **(L5)**

CO5: use calculus to vector functions and interpret vector integral theorems **(L3)**

UNIT-I   **10 Lectures**

Sequences, Series and Mean Value Theorems:

Sequence, infinite series, tests for convergence: comparison test, ratio test, root test, Rolle's Theorem, Lagrange's and Cauchy's mean value theorem (without proof); expansions of functions of one variable: Taylor's and Maclaurin's series (without proof). (Sections 4.3, 4.4, 9.1-9.6, 9.8, 9.9, 9.11 of the textbook)

Learning Outcomes:

At the end of the unit, the student will be able to

1. apply a mean value theorem to a continuous function (L3)
2. classify the Taylor's and Maclaurin's series expansions of a function (L4)
3. test the convergence of an infinite series (L5)

UNIT-II   **10 Lectures**

Partial Differentiation:

Introduction to partial derivatives, total derivatives, change of variables, Jacobians, Taylor's theorem for functions of two variables, maxima and minima of functions of two variables, Lagrange's method of undetermined multipliers. (Sections 5.5-5.7, 5.9, 5.11, 5.12 of the textbook)

Learning Outcomes:

At the end of the unit, the student will be able to

1. calculate the partial derivatives and use them to analyze a function (L3)
2. discuss the maxima and minima of a function of several variables (L2)
3. determine the Jacobian of an implicit function (L3)

UNIT-III   **10 Lectures**

Multiple Integrals: Double integrals, change of order of integration, double integration in polar coordinates, areas enclosed by plane curves, triple integrals and change of variables. (Sections 7.1 - 7.5, 7.7 of the textbook)

Learning Outcomes:

At the end of the unit, the student will be able to

1. use the concept of integration of higher dimensions to evaluate a multiple integral. (L3)
2. determine the area of a region using multiple integrals. (L3)
3. describe the concept of change of order of integration in double integrals. (L2)

UNIT-IV   **10 Lectures**

Vector Differential Calculus:

Scalar and vector point functions, vector operator del, gradient, directional derivative, divergence and curl, solenoidal and irrotational vector functions, vector identities: del applied twice to point functions, del applied to products of point functions (Sections 8.4-8.9 of the textbook).

Learning Outcomes:

At the end of the unit, the student will be able to

1. illustrate the concepts of gradient, divergence and curl (L4)
2. evaluate the directional derivative of a scalar point function (L5)
3. apply del operator to a vector point functions (L3)

UNIT-V   **10 Lectures**

Vector Integral Calculus:

line integral - circulation, work done, surface integral-flux, volume integral, Green's theorem in the plane, Stoke's theorem and the divergence theorem (without proof), irrotational fields (Sections 8.11- 8.16, 8.18 of the textbook)

Learning Outcomes:

At the end of the unit, the student will be able to

1. determine the work done in moving a particle along a path (L3)
2. interpret surface and volume integrals (L2)
3. apply vector integral theorems to multiple integrals (L3)

Text Books:

1. B. S. Grewal, *Higher Engineering Mathematics*, 44th edition, Khanna Publishers, 2017.

Reference Books:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th edition, John Wiley & Sons, 2011.
2. Greenberg M D, *Advanced Engineering Mathematics*, 2nd edition, Pearson Education, Singapore, Indian Print, 2003.
3. Peter V. O'Neil, *Advanced Engineering Mathematics*, 7th edition, Cengage Learning, 2011.

Web References:

1. https://nptel.ac.in/courses/111/106/111106051