B.Sc. (Mathematics) (Part II) (Semester – IV)
Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2020)

Course code	**:**	DSE – D5
Title of course	**:**	Vector Calculus
Theory	**:**	32 Hrs. (40 lecturers of 48 min.)
Marks	**:**	50 (Credit: 02)

Course Learning Outcomes: This course will enable the students to:

CO1**:** understand and evaluate the concepts of gradient, divergence and curl of point functions in terms of cartesian co-ordinate system.

CO2**:** understand and evaluate different types of line, surface & volume integrals and the two integral transformation theorems of Gauss and Stokes.

Unit 1 Differential Operators **(16 Hrs.)**

1.1 Scalar and Vector valued Point functions

1.2 Limit and continuity of a scalar and vector point functions

1.3 Directional Derivatives of scalar and vector Point Functions & examples

1.4 The Operator ∇

1.5 Gradient of a Scalar Point Function & examples

1.6 Geometrical Interpretation of grad $\emptyset$, where $\emptyset$ is a scalar point function

1.7 Divergence and Curl of vector point function

- 1.7.1 Definition of $div\ f$ and $curl\ f$, where f is a vector point function
- 1.7.2 Expressions of $div\ f$ and $curl\ f$ in terms of components of f
- 1.7.3 Characters of div f and curl f as point functions
- 1.7.4 Problems based on 1.7

1.8 Gradient, Divergence and Curl of Sums

- 1.8.1 $grad\ (\emptyset \pm \varphi) = grad\ \emptyset \pm grad\ \varphi$
- 1.8.2 $div\ (f \pm g) = div\ f \pm div\ g$
- 1.8.3 $curl\ (f \pm g) = curl\ f \pm curl\ g$

1.9 Gradient, Divergence and Curl of Products

- 1.9.1 $grad\ (\emptyset\varphi),\ grad\ (f \cdot g)$
- 1.9.2 $div\ (\emptyset f),\ div\ (f \times g)$
- 1.9.3 $curl\ (\emptyset f),\ curl\ (f \times g)$

1.10 Second Order Differential Operators

- 1.10.1 $div\ grad\ \emptyset = \nabla \cdot \nabla\emptyset = \frac{\partial^2 \emptyset}{\partial x^2} + \frac{\partial^2 \emptyset}{\partial y^2} + \frac{\partial^2 \emptyset}{\partial z^2}$
- 1.10.2 $curl\ grad\ \emptyset = \nabla \times \nabla\emptyset = 0$
- 1.10.3 $div\ curl\ f = \nabla \cdot \nabla \times f = 0$
- 1.10.4 $grad\ div\ f = curl\ curl\ f + \sum \frac{\partial^2 f}{\partial x^2}$

1.11 The Laplacian Operator, ∇^2 and examples

Unit 2 Integral Transformations **(16 Hrs.)**

2.1 Some preliminary concepts: Oriented curve, Smooth curve, Smooth surface, classification of regions

2.2 Line integrals

2.3 Circulation, work done by a force

2.4 Surface integrals, flux

2.5 Volume integrals

2.6 Problems based on 2.2 to 2.5

2.7 Green's theorem in the plane

2.8 Green's theorem in the plane in vector notation

2.9 Problems based on 2.7 and 2.8

2.10 The Divergence theorem of Gauss (statement only)

2.11 Stoke's theorem (statement only)

2.12 Line integrals independent of path

2.13 Physical interpretation of div. and curl

Recommended Book:

1. Shanti Narayan & P. K. Mittal: Vector Calculus, S. CHAND & CO (Pvt) LTD, RAM NAGAR, NEW DELHI-110055.

Scope: [**Chapter -6:** 6.1 to 6.17]

2. J. N. Sharma & A. R. Vasishtha: Vector Calculus, KRISHNA Prakashan Media (P) Ltd., Meerut.

Scope: [Chapter- 3]

Reference Books:

1. M. L. Khanna: Vector Calculus, Jai Prakash Nath & Co. Meerut
2. P. N. Wartikar and J. N. Wartikar: A text book of Applied Mathematics (Vol-II), Vidhyarthi Griha Prakashan, Pune.
3. B. S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi-110002.
4. R. K. Jain & S. R. K. Iyengar: Advanced Engineering Mathematics, fourth edition, Narosa Publishing House New Delhi.