Programme	BS Solid State Physics	Course Code	SSP-206	Credit Hours	3 (3-0)
Course Title	**Vector Calculus**				

Course Introduction

This course provides an introduction to the fundamental concepts of vector calculus, focusing on the differentiation and integration of vector fields. It covers a broad range of topics, including vector operations, vector functions of several arguments, space curves, surfaces, scalar and vector fields, and vector operators. The course also includes applications of these mathematical techniques in physics and engineering, preparing students for advanced studies in these fields.

Learning Outcomes

By the end of this course, students will:

1. Understand and apply the basic concepts of vector calculus, including vector functions, vector fields, and vector operators.
2. Learn how to compute and interpret the gradient, divergence, and curl of vector fields.
3. Study the line, surface, and volume integrals of vector fields.
4. Develop proficiency in working with cylindrical and spherical polar coordinates.
5. Apply vector calculus to solve problems in physics and engineering.

	Course Content	Assignments/Readings
Week 1	**Unit-I** 1.1 Introduction to Vectors and Vector Functions • Review of vectors in two and three dimensions • Vector operations: addition, scalar multiplication, dot product, cross product • Parametric equations of lines and curves • Space Curves: Tangent, normal, and binormal vectors; curvature and torsion	Brief introduction about vector analysis
Week 2	**Unit-II** 2.1 Differentiation of Vectors • Composite Vector Expressions: Differentiation of vector functions • Differential of a Vector: Derivatives of vector functions of a scalar variable • Applications to kinematics: velocity and acceleration as vector derivatives	What are vector functions?
Week 3	**Unit-III** 3.1 Integration of Vectors • Integration of vector functions with respect to a scalar variable • Applications in mechanics: displacement	What are the applications of vectors?

	and work done by a force	
Week 4	**Unit-IV** 4.1 Vector Functions of Several Arguments • Functions of multiple variables: partial derivatives and total derivatives • Chain rule for vector functions of several arguments • Applications in physics and engineering	
Week 5	**Unit-V** 5.1 Surfaces • Parameterization of Surfaces: Surface area calculation • Tangent planes and normal vectors to surfaces • Applications to surface integrals	Review related articles
Week 6	**Unit-VI** 6.1 Scalar and Vector Fields • Definition and Examples: Scalar and vector fields in physics • Gradient of a Scalar Field: Directional derivatives, level surfaces	What are scalar and vector field?
Week 7	**Unit-VII** 7.1 Divergence of a Vector Field: Physical interpretation in fluid flow and electromagnetism • Curl of a Vector Field: Rotation and circulation in vector fields	Quiz
Week 8	Mid Term Exams	
Week 9	**Unit-VIII** 8.1 Vector Operators • Vector Operator Formulae: Vector operators acting on sums and products • Combinations of grad, div, and curl: div(grad(f)), curl(grad(f)), and div(curl(F)) • The Laplacian operator and its applications	
Week 10	**Unit-IX** 9.1 Line and Surface Integrals • Line Integrals: Work done by a force field along a path	What is the physical significance of surface integral?
Week 11	**Unit-X** 10.1 Surface Integrals: Flux of a vector field across a surface	What is flux?

	• Applications to electromagnetism and fluid dynamics	
Week 12	**Unit-XI** 11.1 Vector Operator Theorems • Green's Theorem: Relation between line integrals and double integrals • Stokes' Theorem: Surface integrals and the curl of vector fields	Review
Week 13	**Unit-XII** 12.1 Gauss' (Divergence) Theorem: Volume integrals and the divergence of vector fields • Applications to physics and engineering problems	Quiz
Week 14	**Unit-XIII** 13.1 Cylindrical and Spherical Polar Coordinates • Cylindrical Polar Coordinates: Definitions, conversions, and applications • Spherical Polar Coordinates: Definitions, conversions, and applications • Use of cylindrical and spherical coordinates in integration and vector calculus problems	What are polar coordinates?
Week 15	**Unit-XIV** 14.1 Revision	Revision
Week 16	Final Term Exams	

Textbooks and Reading Material

1. "Vector Calculus" by Jerrold E. Marsden and Anthony J. Tromba
2. "Div, Grad, Curl, and All That: An Informal Text on Vector Calculus" by H. M. Schey
3. "Calculus: Early Transcendentals" by James Stewart
4. "Advanced Engineering Mathematics" by Erwin Kreyszig
5. "Vector Calculus" by Susan J. Colley
6. "Mathematical Methods for Physicists" by Arfken, Weber, and Harris

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assignments: Types and Number with Calendar

1.

2. 3. 4.
Assessment