

Vector Analysis

Second Edition

480 fully solved problems

- Complete review of all course fundamentals
- Theories, concepts, and definitions, with an introduction to tensor analysis

USE WITH THESE COURSES

Electromagnetics • Mechanics • Electromagnetic Theory Aerodynamics

Murray R. Spiegel, Ph.D. • Seymour Lipschutz, Ph.D. • Dennis Spellman, Ph.D.

Contents

VECTORS AND SCALARS	1
1.1 Introduction 1.2 Vector Algebra 1.3 Unit Vectors 1.4 Rectangular Unit Vectors i, j, k 1.5 Linear Dependence and Linear Independence 1.6 Scalar Field 1.7 Vector Field 1.8 Vector Space R ⁿ	-
	124
THE DOT AND CROSS PRODUCT	21
2.1 Introduction 2.2 Dot or Scalar Product 2.3 Cross Product 2.4 Triple Products 2.5 Reciprocal Sets of Vectors	
VECTOR DIFFERENTIATION	44
 3.1 Introduction 3.2 Ordinary Derivatives of Vector-Valued Functions 3.3 Continuity and Differentiability 3.4 Partial Derivative of Vectors 3.5 Differential Geometry 	
GRADIENT, DIVERGENCE, CURL	69
4.1 Introduction 4.2 Gradient 4.3 Divergence 4.4 Curl 4.5 Formulas Involving ∇ 4.6 Invariance	
VECTOR INTEGRATION	97
5.1 Introduction 5.2 Ordinary Integrals of Vector Valued Functions 5.3 Line Integrals 5.4 Surface Integrals 5.5 Volume Integrals	
DIVERGENCE THEOREM, STOKES' THEOREM, AND RELATED INTEGRAL THEOREMS	126
6.1 Introduction 6.2 Main Theorems 6.3 Related Integral Theorems	
CURVILINEAR COORDINATES	157
7.1 Introduction 7.2 Transformation of Coordinates 7.3 Orthogonal Curvilinear Coordinates 7.4 Unit Vectors in Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Coordinate Systems	
	1.1 Introduction 1.2 Vector Algebra 1.3 Unit Vectors 1.4 Rectangular Unit Vectors i, j, k 1.5 Linear Dependence and Linear Independence 1.6 Scalar Field 1.7 Vector Field 1.8 Vector Space R ⁿ THE DOT AND CROSS PRODUCT 2.1 Introduction 2.2 Dot or Scalar Product 2.3 Cross Product 2.4 Triple Products 2.5 Reciprocal Sets of Vectors VECTOR DIFFERENTIATION 3.1 Introduction 3.2 Ordinary Derivatives of Vector-Valued Functions 3.3 Continuity and Differentiability 3.4 Partial Derivative of Vectors 3.5 Differential Geometry GRADIENT, DIVERGENCE, CURL 4.1 Introduction 4.2 Gradient 4.3 Divergence 4.4 Curl 4.5 Formulas Involving ∇ 4.6 Invariance VECTOR INTEGRATION 5.1 Introduction 5.2 Ordinary Integrals of Vector Valued Functions 5.3 Line Integrals 5.4 Surface Integrals 5.5 Volume Integrals DIVERGENCE THEOREM, STOKES' THEOREM, AND RELATED INTEGRAL THEOREMS 6.1 Introduction 6.2 Main Theorems 6.3 Related Integral Theorems CURVILINEAR COORDINATES 7.1 Introduction 7.2 Transformation of Coordinates 7.3 Orthogonal Curvilinear Coordinates 7.4 Unit Vectors in Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Orthogonal Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradient, Divergence, Curl 7.7 Special Orthogonal Curvilinear Systems 7.5 Arc Length and Volume Elements 7.6 Gradie



CHAPTER 8 TENSOR ANALYSIS

189

8.1 Introduction 8.2 Spaces of N Dimensions 8.3 Coordinate Transformations 8.4 Contravariant and Covariant Vectors 8.5 Contravariant, Covariant, and Mixed Tensors 8.6 Tensors of Rank Greater Than Two, Tensor Fields 8.7 Fundamental Operations with Tensors 8.8 Matrices 8.9 Line Element and Metric Tensor 8.10 Associated Tensors 8.11 Christoffel's Symbols 8.12 Length of a Vector, Angle between Vectors, Geodesics 8.13 Covariant Derivative 8.14 Permutation Symbols and Tensors 8.15 Tensor Form of Gradient, Divergence, and Curl 8.16 Intrinsic or Absolute Derivative 8.17 Relative and Absolute Tensors

235

INDEX