Contents

Preface — IX

1	Introduction — 1	
1.1	Review of Set Theory — 1	
1.2	Review of Linear Algebra — 3	
1.3	Coordinate systems —— 13	
1.4	Functions and Mappings: including partial derivatives —— $f 1$	9
1.5	Parametric representation of curves — 27	
1.6	Quadrics —— 34	
2	Calculus of Vector Functions — 41	
2.1	Derivatives and Integrals —— 41	
2.2	Best Linear Approximation and Tangent Lines —— 49	
2.3	Reparametrizations and arc-length parameter —— 53	
3	Tangent Spaces and 1-forms — 58	
3.1	Tangent spaces — 58	
3.2	Differentials — 69	
3.3	1-forms —— 80	
4	Line Integrals — 84	
4.1	Integration of 1 forms —— 84	
4.2	Arc-length, Metrics and Applications — 95	
4.3	Line integrals of vector fields —— 111	
5	Differential Calculus of Mappings — 117	
5.1	Graphs and Level Sets —— 117	
5.2	Limits and Continuity —— 121	
5.3	Best Linear Approximation and Derivatives —— 129	
5.4	Tangent spaces —— 139	
5.5	The Chain Rule —— 142	
5.6	Higher Derivatives —— 145	
5.7	Taylor expansions —— 151	
6	Applications of Differential Calculus — 156	
6.1	Optimization —— 156	
6.2	Parametrizations — 166	
6.3	Differential Operators — 176	
6.4	Application of Clairault's theorem to 1-forms — 183	

Index — 301

7	Double and Triple Integrals — 188
7.1	Area and Volume Forms — 188
7.2	Double integrals — 194
7.3	Green's Theorem — 207
7.4	Three-dimensional domains —— 215
8	Wedge Products and Exterior Derivatives — 224
8.1	More on Wedge Products — 224
8.2	Differential Forms — 231
8.3	Exterior Derivative —— 234
9	Integration of Forms — 243
9.1	Pullbacks of <i>k</i> -forms: $k = 1, 2, 3$ — 243
9.2	Integrals of Forms: change of variables formula — 247
9.3	Integrals on a surface — 253
9.4	Orientation of Surfaces — 264
9.5	General Pullback Formula —— 270
10	Stokes' Theorem and Applications — 274
10.1	More on orientation of curves and surfaces — 274
10.2	Stokes' Theorem — 280
10.3	Stokes's Theorem for Vector Fields — 294
Biblio	graphy —— 299