

Contents

Part I : First Semester

1 Vectors	1
1.1 Direction and Magnitude	2
1.2 Scalar Product	9
1.3 Vector product	16
2 Kinematics	28
2.1 Space curves	28
2.2 Differentiation	33
3 Newton	39
3.1 Predicting the future	41
3.2 Momentum and angular momentum	45
3.3 Energy and potential	47
4 Tensors	55
4.1 Rotation matrix	55
4.2 Four second rank tensors	63
4.3 Principal axes	71
5 Functions	76
5.1 Scaling	77
5.2 The exponential function	81
5.3 Power series	87
5.4 Perturbation series	94

6 Integrals	99
6.1 Ordinary integrals	99
6.2 Physics with integrals	107
6.3 Integration methods	112
6.4 Line, surface and volume integrals	115
6.5 Curvilinear coordinates	125
6.6 Delta function	128
7 On solving equations of motion	136
7.1 Terminology	136
7.2 Ten case studies	138
<hr/>	
Part II : Second Semester	
8 Fields	149
8.1 Gradient and nabla	150
8.2 Curl	153
8.3 Divergence	157
8.4 Nabla times nabla	162
8.5 Three theorems	167
9 Integral Theorems	173
9.1 Gauss and Stokes	173
9.2 Typical applications	175
9.3 Paths in the Complex Plane	181
10 Diffusion and waves	186
10.1 The diffusion equation	186
10.2 The wave equation	190
11 Maxwell	194
11.1 First conclusions	195
11.2 Light	199
11.3 Field energy	204

12 Fourier transform	208
12.1 Fourier series	208
12.2 Fourier transform	215
12.3 Applications	221
13 Calculus of variation	236
13.1 Trial functions (path 1)	237
13.2 Variation set to zero (path 2)	238
13.3 The inverse problem (path 3)	244
14 Probabilities	248
14.1 Probability is measurable	248
14.2 Entropy	252

Part III : Breaking New Ground

15 First steps into Special Relativity	257
16 First steps into Quantum Theory	273

Part IV : Exercises

On getting practice	301
Exercises for week 1 to week 26	304
Two written tests with solutions	338
Descriptive geometry: a problem and its solution	342
Bibliography	343
Index	346
Some life data	354
,The nasty bits‘	355