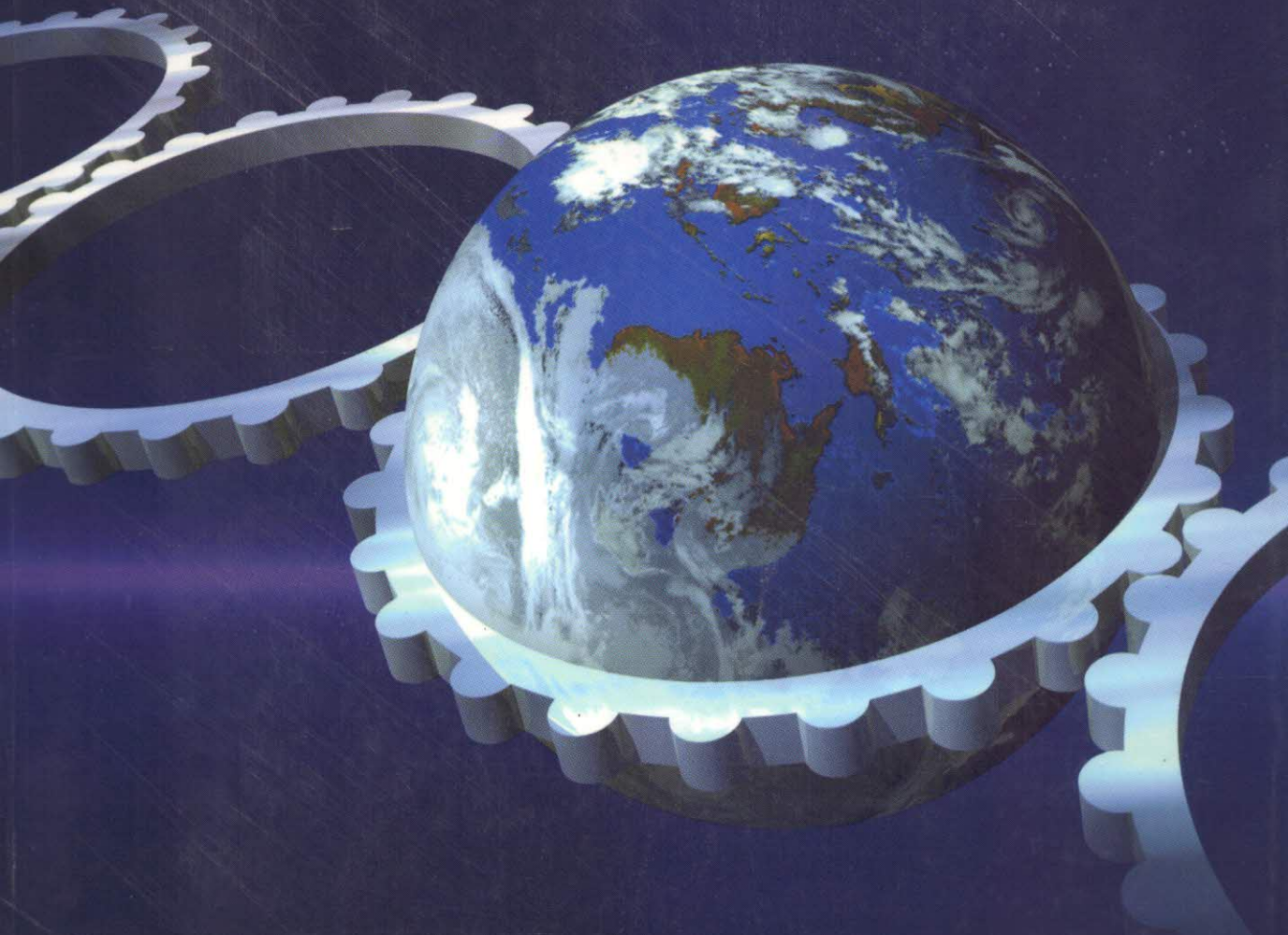


W. BOLTON

Engineering Science

FOURTH EDITION



Contents

	<i>Preface</i>		xi
1	Basics		
	1.1	Introduction	1
	1.2	Measuring and collecting data	1
	1.3	Random errors	3
	1.4	Significant figures	4
	1.5	Graphs	5
	1.6	Units	6
	1.7	Basic terms	8
		Problems	9
2	Energy		
	2.1	Introduction	10
	2.2	Energy transformations	10
	2.3	Work	13
	2.4	Potential energy	15
	2.5	Kinetic energy	16
	2.6	Conservation of mechanical energy	16
	2.7	Power	18
	2.8	Machines	19
		Activities	22
		Problems	22
3	Heat		
	3.1	Introduction	25
	3.2	Heat capacity	26
	3.3	Expansion	27
	3.4	Gas laws	30
		Activities	34
		Problems	35
4	Light and sound		
	4.1	Introduction	37
	4.2	Light waves	37
	4.3	Sound waves	42
		Activities	44
		Problems	45
5	Statics		
	5.1	Introduction	46
	5.2	Forces in equilibrium	47
	5.3	Resultant forces	48
	5.4	Resolving forces	50
	5.5	Moment of a force	51

	5.6	Centre of gravity	52
	5.7	Static equilibrium	54
	5.8	Measurement of force	55
		Activities	56
		Problems	56
6	Stress and strain		
	6.1	Introduction	59
	6.2	Direct stress and strain	59
	6.3	Stress–strain graphs	61
	6.4	Factor of safety	65
	6.5	Poisson’s ratio	65
	6.6	Strain energy	66
		Activities	66
		Problems	67
7	Linear motion		
	7.1	Introduction	69
	7.2	Straight line motion	70
	7.3	Velocity and acceleration as vectors	73
	7.4	Motion under the action of gravity	74
	7.5	Graphs of motion	75
		Activities	78
		Problems	78
8	Angular motion		
	8.1	Introduction	81
	8.2	Equations of motion	82
	8.3	Relationship between linear and angular motion	84
	8.4	Torque	85
		Activities	86
		Problems	86
9	Dynamics		
	9.1	Introduction	88
	9.2	Newton’s laws	88
	9.3	Friction	93
	9.4	Linear motion and energy	95
		Activities	96
		Problems	96
10	D.c. circuits		
	10.1	Introduction	98
	10.2	Resistors	101
	10.3	Resistors in series	105
	10.4	Resistors in parallel	106
	10.5	Series–parallel circuits	107
	10.6	Kirchhoff’s laws	108
	10.7	Resistivity	110
	10.8	Basic measurements	111
		Activities	114
		Problems	115
11	Magnetism		
	11.1	Introduction	117
	11.2	Electromagnetic induction	119

	11.3	Generators	121
	11.4	Induced e.m.f. with two coils	122
	11.5	Force on a current-carrying conductor	124
		Activities	127
		Problems	127
12	Circuit analysis		
	12.1	Introduction	129
	12.2	Series and parallel resistors	129
	12.3	Kirchhoff's laws	134
	12.4	Superposition theorem	138
	12.5	E.M.F. and internal resistance	141
	12.6	Thévenin's theorem	142
	12.7	Norton's theorem	145
	12.8	Non-linear circuits	148
		Problems	149
13	Capacitance		
	13.1	Introduction	153
	13.2	Capacitor	153
	13.3	Capacitors in series and parallel	154
	13.4	Capacitance of a parallel plate capacitor	156
	13.5	Forms of capacitors	158
	13.6	Capacitors in circuits	160
	13.7	Energy stored in a charged capacitor	161
		Activities	162
		Problems	162
14	Semiconductors		
	14.1	Introduction	164
	14.2	Current flow	164
	14.3	Junction diodes	167
	14.4	Transistors	170
		Activities	178
		Problems	178
15	Magnetic circuits		
	15.1	Introduction	180
	15.2	The magnetic circuit	180
	15.3	Reluctance	183
	15.4	Magnetisation curves	188
	15.5	Hysteresis	189
		Activities	191
		Problems	192
16	Inductance		
	16.1	Introduction	194
	16.2	Inductance	194
	16.3	Mutual inductance	196
		Problems	198
17	Alternating current		
	17.1	Introduction	199
	17.2	Sinusoidal waveform	199
	17.3	Average value	201
	17.4	Root-mean-square values	203

	17.5	Basic measurements	206
		Activities	209
		Problems	210
18	Series a.c. circuits		
	18.1	Introduction	212
	18.2	Sine waves and phasors	212
	18.3	R, L, C in a.c. circuits	215
	18.4	Components in series	218
	18.5	Series resonance	223
	18.6	Subtracting phasors	225
	18.7	Power in a.c. circuits	226
	18.8	Power factor	229
	18.9	Rectification	232
		Activities	233
		Problems	234
19	Parallel a.c. circuits		
	19.1	Introduction	236
	19.2	Parallel circuits	236
	19.3	Parallel resonance	240
	19.4	Power in a parallel circuit	242
		Activities	243
		Problems	243
20	Transients		
	20.1	Introduction	245
	20.2	Purely resistive circuit	245
	20.3	RC circuit: charging	246
	20.4	RC circuit: discharging	250
	20.5	Rectangular waveforms and RC circuits	254
	20.6	RL circuit: current growth	255
	20.7	RL circuit: current decay	259
	20.8	Rectangular waveforms and RL circuits	262
		Activities	263
		Problems	263
21	Three-phase a.c.		
	21.1	Introduction	265
	21.2	The three phases	265
	21.3	Connection of phases	266
	21.4	Power in a balanced system	271
		Problems	274
22	Transformers		
	22.1	Introduction	276
	22.2	Transformer construction	277
	22.3	Auto-transformers	279
	22.4	Three-phase transformers	281
	22.5	Uses of transformers	282
		Activities	283
		Problems	283
23	Motors		
	23.1	Introduction	285
	23.2	D.c. motors	285

	23.3	Three-phase induction motor	289
	23.4	Single-phase induction motor	292
	23.5	Synchronous motors	294
	23.6	Speed control with a.c. motors	294
		Problems	294
24 Direct stress	24.1	Introduction	296
	24.2	Composite members	296
	24.3	Thermal strain	298
		Problems	301
25 Shear stress	25.1	Introduction	303
	25.2	Shear stress and strain	303
	25.3	Torsion	306
		Problems	311
26 Structures	26.1	Introduction	314
	26.2	Pin-jointed frameworks	315
	26.3	Bow's notation	316
	26.4	Method of joints	317
	26.5	Method of sections	319
	26.6	Redundancy	321
		Problems	322
27 Beams	27.1	Introduction	324
	27.2	Bending	324
	27.3	Bending stress	328
		Activities	335
		Problems	335
28 Circular motion	28.1	Introduction	337
	28.2	Centripetal force	337
	28.3	Cornering	339
	28.4	Centrifugal clutch	340
		Problems	341
29 Angular dynamics	29.1	Introduction	342
	29.2	Torque and angular acceleration	342
	29.3	Angular momentum	347
	29.4	Angular kinetic energy	348
		Problems	349
30 Mechanical power transmission	30.1	Introduction	350
	30.2	Machines	350
	30.3	Gears	352
	30.4	Belt drives	356
		Activities	357
		Problems	357

31	Oscillations	31.1	Introduction	359
		31.2	Simple harmonic motion	359
		31.3	Mass on a spring	362
		31.4	Simple pendulum	363
		31.5	Energy of SHM	363
			Activities	364
			Problems	365
32	Heat transfer	32.1	Introduction	366
		32.2	Heat transfer processes	366
		32.3	Conduction	367
			Activities	370
			Problems	370
33	Fluid mechanics	33.1	Introduction	371
		33.2	Pressure	371
		33.3	Measurement of pressure	372
		33.4	Archimedes' principle	374
		33.5	Thrust on an immersed surface	375
		33.6	Fluid flow	377
			Activities	382
			Problems	382
34	Engineering systems	34.1	Introduction	384
		34.2	Block diagrams	384
		34.3	Measurement systems	385
		34.4	Control systems	388
			Problems	394
			Answers	395
			Index	400