Contents

1. ELECTROSTATICS I

1.1.	The electrical nature of matter	1
1.2.	Coulomb's law and fundamental definitions	2
1.3.	Gauss's theorem	6
1.4.	Electric dipoles	11
1.5.	The theory of isotropic dielectrics	14
1.6.	Capacitors and systems of conductors	20
1.7.	Stress in the electrostatic field	26
	References	29
	Problems	29

2. ELECTROSTATICS II

2.1.	The equations of Poisson and Laplace	32
2.2.	Solutions of Laplace's equation in spherical coordinates	34
2.3.	The multipole expansion	38
2.4.	Some electrostatic problems	43
2.5.	Electrical images	48
2.6.	Line charges	51
2.7.	Images in dielectrics	55
	References	56
	Problems	56

3. CURRENT AND VOLTAGE

3.1.	Introduction	60
3.2.	Flow of current in conductors	62
3.3	The voltaic circuit	67
3.4.	Resistance networks	70
3.5.	The potential divider and resistance bridge	73
3.6.	Electron optics	74
3.7.	Space charge and Child's law	79
3.8.	Conduction of electricity through gases	81
3.9.	Conduction of electricity through liquids	90
3.10.	Voltaic cells	92
3.11.	Metallic conduction: classical theory	94
	References	95
	Problems	96

4. THE MAGNETIC EFFECTS OF CURRENTS AND MOVING CHARGES, AND MAGNETOSTATICS

4.1.	Forces between currents	98
4.2.	Magnetic dipole moment and magnetic shell	101
4.3.	Magnetostatics and magnetic media	107
4.4.	Solution of magnetostatic problems	111
4.5.	Steady currents in uniform magnetic media	114
4.6.	Calculation of the magnetic field strengths of simple circuits	122

4.7. Moving charges in electric and magnetic fields 125
References 129
Problems 129

5. ELECTROMAGNETIC INDUCTION AND VARYING CURRENTS
5.1. Faraday's laws of electromagnetic induction 132
5.2. Self-inductance and mutual inductance 135
5.3. Transient currents in circuits containing inductance, resistance, and capacitance 140
5.4. Magnetic energy and mechanical forces in inductive circuits 145
5.5. Magnetic energy in magnetic media 149
5.6 Galvanometers and galvanometer damping 150
5.7. The ballistic galvanometer and fluxmeter 153
5.8. Absolute measurements 157
Reference 160
Problems 160

6. MAGNETIC MATERIALS AND MAGNETIC MEASUREMENTS
6.1. Origins of magnetism 163
6.2. Diamagnetism 166
6.3. Paramagnetism 169
6.4. Ferromagnetism 171
6.5. Production of magnetic fields 174
6.6. Measurement of magnetic fields 183
6.7. Measurement of magnetic moment and susceptibility 184
6.8. Experimental investigation of the hysteresis curve 188
6.9. Terrestrial magnetism 190
References 190
Problems 191

7. ALTERNATING CURRENT THEORY
7.1. Forced oscillations 193
7.2. Use of vectors and complex numbers 196
7.3. Tuned circuits 201
7.4. Coupled resonant circuits 207
7.5 Low-frequency transformers 212
7.6. Linear circuit analysis 215
Problems 222

8. ELECTROMAGNETIC WAVES
8.1. Maxwell's equations of the electromagnetic field 225
8.2. Plane waves in isotropic dielectrics 229
8.3. The Poynting vector of energy flow 232
8.4. Plane waves in conducting media 234
8.5. The skin effect 236
8.6. Reflections and refraction of plane waves at the boundary of two dielectrics 239
8.7. Reflection from the surface of a metal 246
8.8. The pressure due to radiation 247

8.9. Radiation from an oscillating dipole 248
References 255
Problems 255

9. FILTERS, TRANSMISSION LINES, AND WAVEGUIDES
9.1. Elements of filter theory 258
9.2. Some simple types of filter 263
9.3. Travelling waves on loss-free transmission lines 267
9.4. Terminated loss-free lines 271
9.5. Lossy lines and resonant lines 277
9.6. Guided waves—propagation between two parallel conducting planes 281
9.7. Waveguides 287
References 291
Problems 292

APPENDIX A. VECTORS
A.1. Definition of scalar and vector quantities A1
A.2. Vector addition and subtraction A1
A.3. Multiplication of vectors A1
A.4. Differentiation and integration of vectors A4
A.5. The divergence of a vector A5
A.6. The curl of a vector A6
A.7. The divergence theorem A8
A.8. Stokes's theorem A8
A.9. Some useful vector relations A9
A.10. Transformation from a rotating coordinate system A10
A.11. Larmor's theorem A11

APPENDIX B. DEPOLARIZING AND DEMAGNETIZING FACTORS A13

APPENDIX C. NUMERICAL VALUES OF THE FUNDAMENTAL CONSTANTS A15

APPENDIX D. SOME USEFUL UNIT CONVERSIONS A16

INDEX A17