

CONTENTS

Chapter 1. Periodic Structures

1.1	Translational symmetry	<i>page</i> 1
1.2	Periodic functions	6
1.3	Properties of the reciprocal lattice	9
1.4	Bloch's theorem	15
1.5	Reduction to a Brillouin zone	19
1.6	Boundary conditions: counting states	23

Chapter 2. Lattice Waves

2.1	Lattice dynamics	27
2.2	Properties of lattice waves	30
2.3	Lattice sums	37
2.4	Lattice specific heat	43
2.5	Lattice spectrum	47
2.6	Diffraction by an ideal crystal	51
2.7	Diffraction by crystal with lattice vibrations	55
2.8	Phonons	59
2.9	The Debye–Waller factor	62
2.10	Anharmonicity and thermal expansion	66
2.11	Phonon–phonon interaction	68
2.12	Vibrations of imperfect lattices	71

Chapter 3. Electron States

3.1	Free electrons	77
3.2	Diffraction of valence electrons	79
3.3	The nearly-free-electron model	83
3.4	The tight-binding method	91

x	CONTENTS	
3.5	Cellular methods	<i>page</i> 96
3.6	Orthogonalized plane waves	98
3.7	Augmented plane waves	103
3.8	The Green function method	106
3.9	Model pseudo-potentials	108
3.10	Resonance bands	113
3.11	Crystal symmetry and spin-orbit interaction	115
 Chapter 4. Static Properties of Solids		
4.1	Types of solid: band picture	119
4.2	Types of solid: bond picture	124
4.3	Cohesion	129
4.4	Rigid band model and density of states	133
4.5	Fermi statistics of electrons	136
4.6	Statistics of carriers in a semiconductor	139
4.7	Electronic specific heat	144
 Chapter 5. Electron-Electron Interaction		
5.1	Perturbation formulation	146
5.2	Static screening	149
5.3	Screened impurities and neutral pseudo-atoms	151
5.4	The singularity in the screening: Kohn effect	155
5.5	The Friedel sum rule	157
5.6	Dielectric constant of a semiconductor	161
5.7	Plasma oscillations	163
5.8	Quasi-particles and cohesive energy	166
5.9	The Mott transition	168
 Chapter 6. Dynamics of Electrons		
6.1	General principles	171
6.2	Wannier functions	172
6.3	Equations of motion in the Wannier representation	175

	CONTENTS	xi
6.4	The equivalent Hamiltonian: impurity levels	<i>page</i> 177
6.5	Quasi-classical dynamics	181
6.6	The mass tensor: electrons and holes	182
6.7	Excitons	187
6.8	Zener breakdown: tunnelling	190
6.9	Electrons at a surface	196
6.10	Scattering of electrons by impurities	199
6.11	Adiabatic principle	200
6.12	Renormalization of velocity of sound	203
6.13	The electron-phonon interaction	205
6.14	Deformation potentials	209
 Chapter 7. Transport Properties		
7.1	The Boltzmann equation	211
7.2	Electrical conductivity	215
7.3	Calculation of relaxation time	219
7.4	Impurity scattering	220
7.5	'Ideal' resistance	221
7.6	Carrier mobility	228
7.7	General transport coefficients	229
7.8	Thermal conductivity	231
7.9	Thermo-electric effects	235
7.10	Lattice conduction	239
7.11	Phonon drag	244
7.12	The Hall effect	246
7.13	The two-band model. magneto-resistance	250
 Chapter 8. Optical Properties		
8.1	Macroscopic theory	255
8.2	Dispersion and absorption	260

xii	CONTENTS	
8.3	Optical modes in ionic crystals	<i>page</i> 266
8.4	Photon-phonon transitions	269
8.5	Interband transitions	272
8.6	Interaction with conduction electrons	278
8.7	The anomalous skin effect	282
8.8	Ultrasonic attenuation	287

Chapter 9. The Fermi Surface

9.1	High magnetic fields	292
9.2	Cyclotron resonance	294
9.3	High-field magneto-resistance	301
9.4	Open orbits	306
9.5	Magneto-acoustic oscillations	309
9.6	Quantization of orbits	313
9.7	The de Haas-van Alphen effect	313
9.8	Magneto-optical absorption	324
9.9	Magnetic breakdown	326

Chapter 10. Magnetism

10.1	Orbital magnetic susceptibility	329
10.2	Spin paramagnetism	331
10.3	The Curie-Weiss Law and ferromagnetism	334
10.4	Exchange interaction	336
10.5	Band ferromagnetism	339
10.6	Magnetic impurities	341
10.7	Antiferromagnetism	348
10.8	The Ising model	353
10.9	Combinatorial method	356
10.10	Exact solutions of the Ising problem	362
10.11	Spin waves	366
10.12	The antiferromagnetic ground state	372

	CONTENTS	xiii
Chapter 11. Superconductivity		
11.1	The attraction between electrons	<i>page</i> 379
11.2	Cooper pairs	382
11.3	The superconducting ground state	386
11.4	Quasi-particles and the energy gap	390
11.5	Temperature dependence of the energy gap	392
11.6	Persistent currents	394
11.7	The London equation	396
11.8	The coherence length	399
11.9	Off-diagonal long range order	402
11.10	Superconducting junctions	405
11.11	Type II material	410
	<i>Bibliography</i>	415
	<i>Index</i>	425