

Contents

	<i>Preface</i>	<i>page xi</i>
1	Introduction	1
	Exercises	7
2	General Relativity	8
	2.1 Gravity and the Equivalence Principle	8
	2.2 Special Relativity and the Metric	13
	2.3 Einstein's Equation	16
	2.4 The Schwarzschild Metric	19
	2.5 Energy-Momentum Tensor	22
	2.6 The Full Einstein Equation with Matter	28
	2.7 Tolman–Oppenheimer–Volkoff Equation	29
	2.8 The Schwarzschild Solution for a Sphere of Fluid	34
	Exercises	36
3	Dense Matter	38
	3.1 Thermodynamic Potentials	38
	3.2 Chemical Equilibrium	42
	3.3 Matter in β -Equilibrium	45
	3.4 Equation of State	49
	3.5 Properties of Free Fermi Gases	50
	3.6 Polytropes	55
	Exercises	58
4	Compact Stars	60
	4.1 Spheres in Hydrostatic Equilibrium	60
	4.2 Maximum Masses of Compact Stars	66
	4.3 Scaling Solutions for Compact Stars	71

viii	<i>Contents</i>	
4.4	Interacting Fermions	81
4.5	Boson Stars	85
	Exercises	90
5	White Dwarfs	92
5.1	A Brief History of White Dwarfs	92
5.2	Mass–Radius Relation for Polytropes	93
5.3	Lane–Emden Equation	95
5.4	Chandrasekhar Mass	98
5.5	Coulomb Corrections	101
5.6	Structure of White Dwarfs	103
5.7	Thermal Effects for White Dwarfs	106
5.8	Observation of White Dwarfs	110
	Exercises	115
6	Pulsars	117
6.1	The Discovery of Pulsars	117
6.2	Pulsars Are Rotation-Powered Neutron Stars	117
6.3	Properties of Pulsars	120
6.4	The Zoo of Neutron Stars	121
6.5	The Dipole Model of Pulsars	123
6.6	The Pulsar Diagram ($P - \dot{P}$ Diagram)	129
6.7	Pulsar Glitches	131
6.8	The Aligned Rotator	132
6.9	Dispersion Measure	136
6.10	Neutron Star Masses	137
6.11	The Double Pulsar	144
	Exercises	146
7	Neutron Stars	147
7.1	Brief History of Neutron Stars	147
7.2	Neutron Star Crust	149
7.3	Neutron Matter: The Outer Core	172
7.4	Hyperon Matter: The Inner Core	193
7.5	Structure of Neutron Stars	206
	Exercises	208
8	Quark Stars	209
8.1	Quantum Chromodynamics	209
8.2	Free Strange Quark Matter	220
8.3	Selfbound Stars	224

<i>Contents</i>		ix
8.4	Interacting Quark Matter	229
8.5	Mass–Radius Relations for Quark Stars	233
	Exercises	235
9	Hybrid Stars	237
9.1	Combining Neutron and Quark Matter	237
9.2	Phase Transitions in Dense Matter	243
9.3	A Third Family of Compact Stars	252
9.4	Mass–Radius Relation with a Phase Transition	259
	Exercises	262
10	Gravitational Waves	264
10.1	Linearized Gravity	266
10.2	Production of Gravitational Waves	270
10.3	Ellipticity of Neutron Stars	275
10.4	Neutron Star Mergers	279
	Exercises	293
	<i>References</i>	295
	<i>Index</i>	306