## Table of Contents

Pre	eface		v	
1.	Introduction			
	1.1	The first century of X-rays	1	
	1.2	From plasma sources to X-UV lasers	9	
	1.3	From synchrotron radiation to free-electron-lasers	21	
	1.4	The novel radiation sources	31	
2.	Radiation by Relativistic Electrons			
	2.1	Classification of the emission mechanisms	37	
	2.2	Basic formalism	40	
	2.3	Characteristic parameters	46	
	2.4	Quantum effects	49	
	2.5	Resonance phenomena in periodic structures	51	
	2.6	The Weizsäcker-Williams method of quasireal photons	55	
	2.7	Classical sum rules	63	
	App	endix	65	
3.	Synchrotron Radiation, Undulators, Free-Electron Lasers			
	3.1	Synchrotron radiation	71	
	3.2	Wigglers and undulators	73	
	3.3	Free-electron lasers	81	
4.	Compton Scattering of Laser Light			
	4.1	Introduction	89	
	4.2	Relativistic kinematics	90	
	4.3	Back-scattering of laser light	94	
	4.4	Compton scattering at 90°	95	
5.	. Coherent Bremsstrahlung			
	5.1	Introduction	99	
	5.2		101	
	5.3	Validity of the Born approximation	110	

viii Contents

6.	Channeling Radiation			
	6.1	Introduction	113	
	6.2	Planar channeling	114	
	6.3	Band structure calculations	121	
	6.4	Axial channeling	122	
	6.5	Summary	125	
7.	Transition Radiation			
	7.1	Introduction	127	
	7.2	Transition radiation at a boundary	128	
	7.3	X-ray transition radiation from a thin foil	131	
	7.4	X-ray transition radiation from a stack of foils	134	
	7.5	Optical transition radiation	136	
	7.6	Summary	140	
8.	Parametric X-Rays			
	8.1	Introduction	143	
	8.2	Bragg diffraction of virtual photons	143	
	8.3	Kinematical approach	147	
	8.4	Dynamical theory	154	
	8.5	Corrections to the spectral-angular distribution	157	
9.	Smith-Purcell Effect			
	9.1	Introduction	161	
	9.2	General formalism	162	
	9.3	Solutions of the grating problem	166	
	9.4	Spectral-angular distributions	169	
	9.5	The Smith–Purcell free-electron-laser and the inverse Smith–Purcell effect	175	
10.	Photon beam characteristics			
	10.1	Generalities	179	
	10.2	Qualitative properties of the novel X-ray sources	186	
	10.3	Quantitative comparison of radiation sources	192	
	10.4	Conclusion	197	
Ind	le <del>v</del>		199	