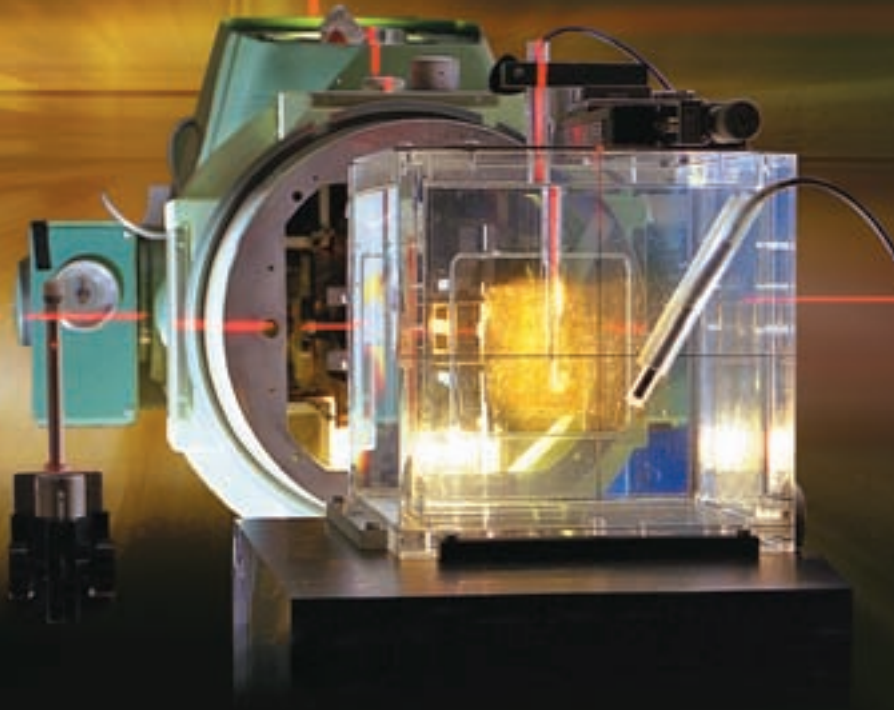


# Radiation Oncology Physics: A Handbook for Teachers and Students

E.B. Podgorsak  
Technical Editor



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**RADIATION ONCOLOGY PHYSICS:  
A HANDBOOK FOR TEACHERS AND STUDENTS**

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PHYSICS: A HANDBOOK FOR  
TEACHERS AND STUDENTS**

**INTERNATIONAL ATOMIC ENERGY AGENCY  
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## FOREWORD

In the late 1990s the IAEA initiated for its Member States a systematic and comprehensive plan to support the development of teaching programmes in medical radiation physics. Multiple projects were initiated at various levels that, together with the well known short term training courses and specialization fellowships funded by the IAEA Technical Cooperation programme, aimed at supporting countries to develop their own university based master of science programmes in medical radiation physics.

One of the early activities of the IAEA in this period was the development of a syllabus in radiotherapy physics, which had the goal of harmonizing the various levels of training that the IAEA provided. This was carried out during 1997–1998, and the result of this work was released as a report used for designing IAEA training courses. In 1999–2000 a more detailed teachers' guide was developed, in which the various topics in the syllabus were expanded to form a detailed 'bullet list' containing the basic guidelines of the material to be included in each topic so that lectures to students could be prepared accordingly. During the period 2001–2002 E.B. Podgorsak (Canada) was appointed editor of the project and redesigned the contents so that the book became a comprehensive handbook for teachers and students, with coverage deeper than a simple teachers' guide. The initial list of topics was expanded considerably by engaging an enhanced list of international contributors. The handbook was published as working material in 2003 and placed on the Internet in order to seek comments, corrections and feedback.

This handbook aims at providing the basis for the education of medical physicists initiating their university studies in the field. It includes the recent advances in radiotherapy techniques; however, it is not designed to replace the large number of textbooks available on radiotherapy physics, which will still be necessary to deepen knowledge in the specific topics reviewed here. It is expected that this handbook will successfully fill a gap in the teaching material for medical radiation physics, providing in a single manageable volume the largest possible coverage available today. Its wide dissemination by the IAEA will contribute to the harmonization of education in the field and will be of value to newcomers as well as to those preparing for their certification as medical physicists, radiation oncologists, medical dosimetrists and radiotherapy technologists.

Endorsement of this handbook has been granted by the following international organizations and professional bodies: the International Organization for Medical Physics (IOMP), the European Society for Therapeutic Radiology and Oncology (ESTRO), the European Federation of Organisations for Medical Physics (EFOMP), the World Health Organization

(WHO), the Pan American Health Organization (PAHO), the Canadian Organization of Medical Physicists (COMP) and the Canadian College of Physicists in Medicine (CCPM).

The following international experts are gratefully acknowledged for making major contributions to the development of an early version of the syllabus: B. Nilsson (Sweden), B. Planskoy (United Kingdom) and J.C. Rosenwald (France). The following made major contributions to this handbook: R. Alfonso (Cuba), G. Rajan (India), W. Strydom (South Africa) and N. Suntharalingam (United States of America). The IAEA scientific officers responsible for the project were (in chronological order) P. Andreo, J. Izewska and K.R. Shortt.

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## PREFACE

Radiotherapy, also referred to as radiation therapy, radiation oncology or therapeutic radiology, is one of the three principal modalities used in the treatment of malignant disease (cancer), the other two being surgery and chemotherapy. In contrast to other medical specialties that rely mainly on the clinical knowledge and experience of medical specialists, radiotherapy, with its use of ionizing radiation in the treatment of cancer, relies heavily on modern technology and the collaborative efforts of several professionals whose coordinated team approach greatly influences the outcome of the treatment.

The radiotherapy team consists of radiation oncologists, medical physicists, dosimetrists and radiation therapy technologists: all professionals characterized by widely differing educational backgrounds and one common link — the need to understand the basic elements of radiation physics, and the interaction of ionizing radiation with human tissue in particular. This specialized area of physics is referred to as radiation oncology physics, and proficiency in this branch of physics is an absolute necessity for anyone who aspires to achieve excellence in any of the four professions constituting the radiotherapy team. Current advances in radiation oncology are driven mainly by technological development of equipment for radiotherapy procedures and imaging; however, as in the past, these advances rely heavily on the underlying physics.

This book is dedicated to students and teachers involved in programmes that train professionals for work in radiation oncology. It provides a compilation of facts on the physics as applied to radiation oncology and as such will be useful to graduate students and residents in medical physics programmes, to residents in radiation oncology, and to students in dosimetry and radiotherapy technology programmes. The level of understanding of the material covered will, of course, be different for the various student groups; however, the basic language and knowledge for all student groups will be the same. The text will also be of use to candidates preparing for professional certification examinations, whether in radiation oncology, medical physics, dosimetry or radiotherapy technology.

The intent of the text is to serve as a factual supplement to the various textbooks on medical physics and to provide basic radiation oncology physics knowledge in the form of a syllabus covering all modern aspects of radiation oncology physics. While the text is mainly aimed at radiation oncology professionals, certain parts of it may also be of interest in other branches of medicine that use ionizing radiation not for the treatment of disease but for the diagnosis of disease (diagnostic radiology and nuclear medicine). The contents

may also be useful for physicists who are involved in studies of radiation hazards and radiation protection (health physics).

This book represents a collaborative effort by professionals from many different countries who share a common goal of disseminating their radiation oncology physics knowledge and experience to a broad international audience of teachers and students. Special thanks are due to J. Denton-MacLennan for critically reading and editing the text and improving its syntax.

E.B. Podgorsak

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# CONTENTS

CHAPTER 1. BASIC RADIATION PHYSICS .....	1
1.1. INTRODUCTION .....	1
1.1.1. Fundamental physical constants (rounded off to four significant figures) .....	1
1.1.2. Important derived physical constants and relationships ..	1
1.1.3. Physical quantities and units .....	3
1.1.4. Classification of forces in nature .....	4
1.1.5. Classification of fundamental particles .....	4
1.1.6. Classification of radiation .....	5
1.1.7. Classification of ionizing photon radiation .....	6
1.1.8. Einstein's relativistic mass, energy and momentum relationships .....	6
1.1.9. Radiation quantities and units .....	7
1.2. ATOMIC AND NUCLEAR STRUCTURE .....	7
1.2.1. Basic definitions for atomic structure .....	7
1.2.2. Rutherford's model of the atom .....	9
1.2.3. Bohr's model of the hydrogen atom .....	10
1.2.4. Multielectron atoms .....	12
1.2.5. Nuclear structure .....	14
1.2.6. Nuclear reactions .....	15
1.2.7. Radioactivity .....	16
1.2.8. Activation of nuclides .....	19
1.2.9. Modes of radioactive decay .....	20
1.3. ELECTRON INTERACTIONS .....	22
1.3.1. Electron-orbital electron interactions .....	23
1.3.2. Electron-nucleus interactions .....	23
1.3.3. Stopping power .....	24
1.3.4. Mass scattering power .....	25
1.4. PHOTON INTERACTIONS .....	26
1.4.1. Types of indirectly ionizing photon radiation .....	26
1.4.2. Photon beam attenuation .....	26
1.4.3. Types of photon interaction .....	28
1.4.4. Photoelectric effect .....	28
1.4.5. Coherent (Rayleigh) scattering .....	29

1.4.6.	Compton effect (incoherent scattering) .....	30
1.4.7.	Pair production .....	32
1.4.8.	Photonuclear reactions .....	34
1.4.9.	Contributions to attenuation coefficients .....	34
1.4.10.	Relative predominance of individual effects .....	36
1.4.11.	Effects following photon interactions .....	37
1.4.12.	Summary of photon interactions .....	38
1.4.13.	Example of photon attenuation .....	40
1.4.14.	Production of vacancies in atomic shells .....	41
	<b>BIBLIOGRAPHY</b> .....	43
 <b>CHAPTER 2. DOSIMETRIC PRINCIPLES, QUANTITIES AND UNITS</b> .....		45
2.1.	INTRODUCTION .....	45
2.2.	PHOTON FLUENCE AND ENERGY FLUENCE .....	45
2.3.	KERMA .....	48
2.4.	CEMA .....	48
2.5.	ABSORBED DOSE .....	49
2.6.	STOPPING POWER .....	49
2.7.	RELATIONSHIPS BETWEEN VARIOUS DOSIMETRIC QUANTITIES .....	54
2.7.1.	Energy fluence and kerma (photons) .....	54
2.7.2.	Fluence and dose (electrons) .....	56
2.7.3.	Kerma and dose (charged particle equilibrium) .....	57
2.7.4.	Collision kerma and exposure .....	60
2.8.	CAVITY THEORY .....	61
2.8.1.	Bragg–Gray cavity theory .....	61
2.8.2.	Spencer–Attix cavity theory .....	62
2.8.3.	Considerations in the application of cavity theory to ionization chamber calibration and dosimetry protocols .	64
2.8.4.	Large cavities in photon beams .....	66
2.8.5.	Burlin cavity theory for photon beams .....	66
2.8.6.	Stopping power ratios .....	68
	<b>BIBLIOGRAPHY</b> .....	70

CHAPTER 3. RADIATION DOSIMETERS .....	71
3.1. INTRODUCTION .....	71
3.2. PROPERTIES OF DOSIMETERS .....	72
3.2.1. Accuracy and precision .....	72
3.2.1.1. Type A standard uncertainties .....	72
3.2.1.2. Type B standard uncertainties .....	73
3.2.1.3. Combined and expanded uncertainties .....	73
3.2.2. Linearity .....	74
3.2.3. Dose rate dependence .....	74
3.2.4. Energy dependence .....	75
3.2.5. Directional dependence .....	76
3.2.6. Spatial resolution and physical size .....	76
3.2.7. Readout convenience .....	76
3.2.8. Convenience of use .....	76
3.3. IONIZATION CHAMBER DOSIMETRY SYSTEMS .....	77
3.3.1. Chambers and electrometers .....	77
3.3.2. Cylindrical (thimble type) ionization chambers .....	78
3.3.3. Parallel-plate (plane-parallel) ionization chambers .....	79
3.3.4. Brachytherapy chambers .....	79
3.3.5. Extrapolation chambers .....	79
3.4. FILM DOSIMETRY .....	81
3.4.1. Radiographic film .....	81
3.4.2. Radiochromic film .....	84
3.5. LUMINESCENCE DOSIMETRY .....	84
3.5.1. Thermoluminescence .....	85
3.5.2. Thermoluminescent dosimeter systems .....	86
3.5.3. Optically stimulated luminescence systems .....	88
3.6. SEMICONDUCTOR DOSIMETRY .....	89
3.6.1. Silicon diode dosimetry systems .....	89
3.6.2. MOSFET dosimetry systems .....	90
3.7. OTHER DOSIMETRY SYSTEMS .....	91
3.7.1. Alanine/electron paramagnetic resonance dosimetry system .....	91
3.7.2. Plastic scintillator dosimetry system .....	92
3.7.3. Diamond dosimeters .....	92

3.7.4.	Gel dosimetry systems .....	93
3.8.	PRIMARY STANDARDS .....	94
3.8.1.	Primary standard for air kerma in air .....	95
3.8.2.	Primary standards for absorbed dose to water .....	95
3.8.3.	Ionometric standard for absorbed dose to water .....	96
3.8.4.	Chemical dosimetry standard for absorbed dose to water .....	96
3.8.5.	Calorimetric standard for absorbed dose to water .....	97
3.9.	SUMMARY OF SOME COMMONLY USED DOSIMETRIC SYSTEMS .....	97
	BIBLIOGRAPHY.....	99
CHAPTER 4. RADIATION MONITORING INSTRUMENTS ....		101
4.1.	INTRODUCTION .....	101
4.2.	OPERATIONAL QUANTITIES FOR RADIATION MONITORING .....	102
4.3.	AREA SURVEY METERS .....	103
4.3.1.	Ionization chambers .....	105
4.3.2.	Proportional counters .....	105
4.3.3.	Neutron area survey meters .....	105
4.3.4.	Geiger–Müller counters .....	106
4.3.5.	Scintillator detectors .....	107
4.3.6.	Semiconductor detectors .....	107
4.3.7.	Commonly available features of area survey meters ....	108
4.3.8.	Calibration of survey meters .....	108
4.3.9.	Properties of survey meters .....	110
4.3.9.1.	Sensitivity .....	110
4.3.9.2.	Energy dependence .....	110
4.3.9.3.	Directional dependence .....	111
4.3.9.4.	Dose equivalent range .....	111
4.3.9.5.	Response time .....	111
4.3.9.6.	Overload characteristics .....	111
4.3.9.7.	Long term stability .....	112
4.3.9.8.	Discrimination between different types of radiation .....	112
4.3.9.9.	Uncertainties in area survey measurements ...	112
4.4.	INDIVIDUAL MONITORING .....	113
4.4.1.	Film badge .....	113



4.4.2.	Thermoluminescence dosimetry badge .....	115
4.4.3.	Radiophotoluminescent glass dosimetry systems .....	116
4.4.4.	Optically stimulated luminescence systems .....	116
4.4.5.	Direct reading personal monitors .....	117
4.4.6.	Calibration of personal dosimeters .....	118
4.4.7.	Properties of personal monitors .....	118
4.4.7.1.	Sensitivity .....	118
4.4.7.2.	Energy dependence .....	119
4.4.7.3.	Uncertainties in personal monitoring measurements .....	119
4.4.7.4.	Equivalent dose range .....	119
4.4.7.5.	Directional dependence .....	120
4.4.7.6.	Discrimination between different types of radiation .....	120
	<b>BIBLIOGRAPHY.....</b>	<b>120</b>
	<b>CHAPTER 5. TREATMENT MACHINES FOR EXTERNAL BEAM RADIOTHERAPY .....</b>	<b>123</b>
5.1.	INTRODUCTION .....	123
5.2.	X RAY BEAMS AND X RAY UNITS .....	124
5.2.1.	Characteristic X rays .....	124
5.2.2.	Bremsstrahlung (continuous) X rays .....	124
5.2.3.	X ray targets .....	125
5.2.4.	Clinical X ray beams .....	126
5.2.5.	X ray beam quality specifiers .....	127
5.2.6.	X ray machines for radiotherapy .....	127
5.3.	GAMMA RAY BEAMS AND GAMMA RAY UNITS .....	129
5.3.1.	Basic properties of gamma rays .....	129
5.3.2.	Teletherapy machines .....	130
5.3.3.	Teletherapy sources .....	130
5.3.4.	Teletherapy source housing .....	131
5.3.5.	Dose delivery with teletherapy machines .....	132
5.3.6.	Collimator and penumbra .....	132
5.4.	PARTICLE ACCELERATORS .....	132
5.4.1.	Betatron .....	134
5.4.2.	Cyclotron .....	134
5.4.3.	Microtron .....	135

5.5.	LINACS .....	136
5.5.1.	Linac generations .....	137
5.5.2.	Safety of linac installations .....	137
5.5.3.	Components of modern linacs .....	138
5.5.4.	Configuration of modern linacs .....	138
5.5.5.	Injection system .....	140
5.5.6.	Radiofrequency power generation system .....	143
5.5.7.	Accelerating waveguide .....	143
5.5.8.	Microwave power transmission .....	144
5.5.9.	Auxiliary system .....	145
5.5.10.	Electron beam transport .....	146
5.5.11.	Linac treatment head .....	146
5.5.12.	Production of clinical photon beams in a linac .....	147
5.5.13.	Beam collimation .....	148
5.5.14.	Production of clinical electron beams in a linac .....	149
5.5.15.	Dose monitoring system .....	149
5.6.	RADIOTHERAPY WITH PROTONS, NEUTRONS AND HEAVY IONS .....	151
5.7.	SHIELDING CONSIDERATIONS .....	152
5.8.	COBALT-60 TELETHERAPY UNITS VERSUS LINACS .....	153
5.9.	SIMULATORS AND COMPUTED TOMOGRAPHY SIMULATORS .....	156
5.9.1.	Radiotherapy simulator .....	157
5.9.2.	Computed tomography simulator .....	158
5.10.	TRAINING REQUIREMENTS .....	159
	BIBLIOGRAPHY.....	160
CHAPTER 6.	EXTERNAL PHOTON BEAMS: PHYSICAL ASPECTS .....	161
6.1.	INTRODUCTION .....	161
6.2.	QUANTITIES USED IN DESCRIBING A PHOTON BEAM ..	161
6.2.1.	Photon fluence and photon fluence rate .....	162
6.2.2.	Energy fluence and energy fluence rate .....	162
6.2.3.	Air kerma in air .....	163
6.2.4.	Exposure in air .....	164
6.2.5.	Dose to small mass of medium in air .....	164
6.3.	PHOTON BEAM SOURCES .....	166

6.4.	INVERSE SQUARE LAW .....	167
6.5.	PENETRATION OF PHOTON BEAMS INTO A PHANTOM OR PATIENT .....	169
6.5.1.	Surface dose .....	171
6.5.2.	Buildup region .....	171
6.5.3.	Depth of dose maximum $z_{\max}$ .....	172
6.5.4.	Exit dose .....	172
6.6.	RADIATION TREATMENT PARAMETERS .....	172
6.6.1.	Radiation beam field size .....	173
6.6.2.	Collimator factor .....	174
6.6.3.	Peak scatter factor .....	175
6.6.4.	Relative dose factor .....	177
6.7.	CENTRAL AXIS DEPTH DOSES IN WATER: SOURCE TO SURFACE DISTANCE SET-UP .....	179
6.7.1.	Percentage depth dose .....	179
6.7.2.	Scatter function .....	181
6.8.	CENTRAL AXIS DEPTH DOSES IN WATER: SOURCE TO AXIS DISTANCE SET-UP .....	183
6.8.1.	Tissue-air ratio .....	184
6.8.2.	Relationship between $TAR(d, A_Q, h\nu)$ and $PDD(d, A, f, h\nu)$ .....	185
6.8.3.	Scatter-air ratio .....	189
6.8.4.	Relationship between $SAR(d, A_Q, h\nu)$ and $S(z, A, f, h\nu)$ .	190
6.8.5.	Tissue-phantom ratio and tissue-maximum ratio .....	190
6.8.6.	Relationship between $TMR(z, A_Q, h\nu)$ and $PDD(z, A, f, h\nu)$ .....	192
6.8.7.	Scatter-maximum ratio .....	193
6.9.	OFF-AXIS RATIOS AND BEAM PROFILES .....	194
6.9.1.	Beam flatness .....	196
6.9.2.	Beam symmetry .....	197
6.10.	ISODOSE DISTRIBUTIONS IN WATER PHANTOMS .....	197
6.11.	SINGLE FIELD ISODOSE DISTRIBUTIONS IN PATIENTS ..	199
6.11.1.	Corrections for irregular contours and oblique beam incidence .....	200
6.11.1.1.	Effective source to surface distance method ...	201
6.11.1.2.	Tissue-air ratio or tissue-maximum ratio method .....	202

6.11.1.3.	Isodose shift method .....	202
6.11.2.	Missing tissue compensation .....	202
6.11.2.1.	Wedge filters .....	203
6.11.2.2.	Bolus .....	203
6.11.2.3.	Compensators .....	203
6.11.3.	Corrections for tissue inhomogeneities .....	204
6.11.4.	Model based algorithms .....	205
6.12.	CLARKSON SEGMENTAL INTEGRATION .....	206
6.13.	RELATIVE DOSE MEASUREMENTS WITH IONIZATION CHAMBERS .....	209
6.14.	DELIVERY OF DOSE WITH A SINGLE EXTERNAL BEAM .....	212
6.15.	EXAMPLE OF DOSE CALCULATION .....	213
6.16.	SHUTTER CORRECTION TIME .....	215
	BIBLIOGRAPHY.....	216
CHAPTER 7.	CLINICAL TREATMENT PLANNING IN EXTERNAL PHOTON BEAM RADIOTHERAPY .....	219
7.1.	INTRODUCTION .....	219
7.2.	VOLUME DEFINITION .....	219
7.2.1.	Gross tumour volume .....	220
7.2.2.	Clinical target volume .....	220
7.2.3.	Internal target volume .....	221
7.2.4.	Planning target volume .....	221
7.2.5.	Organ at risk .....	222
7.3.	DOSE SPECIFICATION .....	222
7.4.	PATIENT DATA ACQUISITION AND SIMULATION .....	223
7.4.1.	Need for patient data .....	223
7.4.2.	Nature of patient data .....	223
7.4.2.1.	Two dimensional treatment planning .....	223
7.4.2.2.	Three dimensional treatment planning .....	224
7.4.3.	Treatment simulation .....	225
7.4.4.	Patient treatment position and immobilization devices ..	226
7.4.5.	Patient data requirements .....	228
7.4.6.	Conventional treatment simulation .....	229
7.4.6.1.	Simulators .....	229

7.4.6.2.	Localization of the target volume and organs at risk .....	230
7.4.6.3.	Determination of the treatment beam geometry	230
7.4.6.4.	Acquisition of patient data .....	230
7.4.7.	Computed tomography based conventional treatment simulation .....	230
7.4.7.1.	Computed tomography based patient data acquisition .....	230
7.4.7.2.	Determination of the treatment beam geometry .....	232
7.4.8.	Computed tomography based virtual simulation .....	233
7.4.8.1.	Computed tomography simulator .....	233
7.4.8.2.	Virtual simulation .....	233
7.4.8.3.	Digitally reconstructed radiographs .....	234
7.4.8.4.	Beam's eye view .....	234
7.4.8.5.	Virtual simulation procedure .....	235
7.4.9.	Conventional simulator versus computed tomography simulator .....	237
7.4.10.	Magnetic resonance imaging for treatment planning ....	238
7.4.11.	Summary of simulation procedures .....	240
7.5.	CLINICAL CONSIDERATIONS FOR PHOTON BEAMS ....	241
7.5.1.	Isodose curves .....	241
7.5.2.	Wedge filters .....	241
7.5.3.	Bolus .....	244
7.5.4.	Compensating filters .....	245
7.5.5.	Corrections for contour irregularities .....	246
7.5.5.1.	Isodose shift method .....	246
7.5.5.2.	Effective attenuation coefficient method ....	248
7.5.5.3.	Tissue-air ratio method .....	248
7.5.6.	Corrections for tissue inhomogeneities .....	248
7.5.6.1.	Tissue-air ratio method .....	249
7.5.6.2.	Batho power law method .....	250
7.5.6.3.	Equivalent tissue-air ratio method .....	250
7.5.6.4.	Isodose shift method .....	250
7.5.7.	Beam combinations and clinical application .....	251
7.5.7.1.	Weighting and normalization .....	251
7.5.7.2.	Fixed source to surface distance versus isocentric techniques .....	251
7.5.7.3.	Parallel opposed beams .....	252
7.5.7.4.	Multiple coplanar beams .....	253

7.5.7.5.	Rotational techniques .....	254
7.5.7.6.	Multiple non-coplanar beams .....	255
7.5.7.7.	Field matching .....	255
7.6.	TREATMENT PLAN EVALUATION .....	256
7.6.1.	Isodose curves .....	257
7.6.2.	Orthogonal planes and isodose surfaces .....	257
7.6.3.	Dose statistics .....	257
7.6.4.	Dose–volume histograms .....	258
7.6.4.1.	Direct dose–volume histogram .....	259
7.6.4.2.	Cumulative dose–volume histogram .....	259
7.6.5.	Treatment evaluation .....	260
7.6.5.1.	Port films .....	261
7.6.5.2.	On-line portal imaging .....	262
7.7.	TREATMENT TIME AND MONITOR UNIT CALCULATIONS .....	264
7.7.1.	Treatment time and monitor unit calculations for a fixed source to surface distance set-up .....	265
7.7.2.	Monitor unit and treatment time calculations for isocentric set-ups .....	267
7.7.3.	Normalization of dose distributions .....	270
7.7.4.	Inclusion of output parameters in the dose distribution .....	270
7.7.5.	Treatment time calculation for orthovoltage and cobalt-60 units .....	271
	BIBLIOGRAPHY.....	271
CHAPTER 8.	ELECTRON BEAMS: PHYSICAL AND CLINICAL ASPECTS .....	273
8.1.	CENTRAL AXIS DEPTH DOSE DISTRIBUTIONS IN WATER	273
8.1.1.	General shape of the depth dose curve .....	273
8.1.2.	Electron interactions with an absorbing medium .....	274
8.1.3.	Inverse square law (virtual source position) .....	276
8.1.4.	Range concept .....	277
8.1.5.	Buildup region (depths between the surface and $z_{\max}$ (i.e. $0 \leq z \leq z_{\max}$ )) .....	279
8.1.6.	Dose distribution beyond $z_{\max}$ ( $z > z_{\max}$ ) .....	279

8.2.	DOSIMETRIC PARAMETERS OF ELECTRON BEAMS . . . .	281
8.2.1.	Electron beam energy specification . . . . .	281
8.2.2.	Typical depth dose parameters as a function of energy . .	281
8.2.3.	Percentage depth dose . . . . .	282
8.2.3.1.	Percentage depth doses for small electron field sizes . . . . .	282
8.2.3.2.	Percentage depth doses for oblique beam incidence . . . . .	283
8.2.4.	Output factors . . . . .	284
8.2.5.	Therapeutic range $R_{90}$ . . . . .	285
8.2.6.	Profiles and off-axis ratios . . . . .	285
8.2.7.	Flatness and symmetry . . . . .	285
8.3.	CLINICAL CONSIDERATIONS IN ELECTRON BEAM THERAPY . . . . .	286
8.3.1.	Dose specification and reporting . . . . .	286
8.3.2.	Small field sizes . . . . .	287
8.3.3.	Isodose curves . . . . .	287
8.3.4.	Field shaping . . . . .	289
8.3.4.1.	Electron applicators . . . . .	289
8.3.4.2.	Shielding and cut-outs . . . . .	289
8.3.4.3.	Internal shielding . . . . .	290
8.3.4.4.	Extended source to surface distance treatments . . . . .	290
8.3.5.	Irregular surface correction . . . . .	291
8.3.6.	Bolus . . . . .	291
8.3.7.	Inhomogeneity corrections . . . . .	292
8.3.7.1.	Coefficient of equivalent thickness . . . . .	292
8.3.7.2.	Scatter perturbation (edge) effects . . . . .	293
8.3.8.	Electron beam combinations . . . . .	295
8.3.8.1.	Matched (abutted) electron fields . . . . .	295
8.3.8.2.	Matched photon and electron fields . . . . .	295
8.3.9.	Electron arc therapy . . . . .	295
8.3.10.	Electron therapy treatment planning . . . . .	298
	BIBLIOGRAPHY . . . . .	299
	CHAPTER 9. CALIBRATION OF PHOTON AND ELECTRON BEAMS . . . . .	301
9.1.	INTRODUCTION . . . . .	301

9.1.1.	Calorimetry .....	302
9.1.2.	Fricke dosimetry .....	303
9.1.3.	Ionization chamber dosimetry .....	304
9.1.4.	Mean energy expended in air per ion pair formed .....	304
9.1.5.	Reference dosimetry with ionization chambers .....	305
9.1.5.1.	Standard free air ionization chambers .....	305
9.1.5.2.	Cavity ionization chambers .....	306
9.1.5.3.	Phantom embedded extrapolation chambers ..	306
9.1.6.	Clinical beam calibration and measurement chain .....	307
9.1.7.	Dosimetry protocols .....	307
9.2.	IONIZATION CHAMBER BASED DOSIMETRY SYSTEMS .	308
9.2.1.	Ionization chambers .....	308
9.2.2.	Electrometer and power supply .....	309
9.2.3.	Phantoms .....	310
9.3.	CHAMBER SIGNAL CORRECTION FOR INFLUENCE QUANTITIES .....	312
9.3.1.	Air temperature, pressure and humidity effects: $k_{T,P}$ .....	312
9.3.2.	Chamber polarity effects: polarity correction factor $k_{pol}$ .....	313
9.3.3.	Chamber voltage effects: recombination correction factor $k_{sat}$ .....	314
9.3.4.	Chamber leakage currents .....	318
9.3.5.	Chamber stem effects .....	319
9.4.	DETERMINATION OF ABSORBED DOSE USING CALIBRATED IONIZATION CHAMBERS .....	319
9.4.1.	Air kerma based protocols .....	320
9.4.2.	Absorbed dose to water based protocols .....	323
9.5.	STOPPING POWER RATIOS .....	326
9.5.1.	Stopping power ratios for electron beams .....	326
9.5.2.	Stopping power ratios for photon beams .....	327
9.6.	MASS-ENERGY ABSORPTION COEFFICIENT RATIOS ...	328
9.7.	PERTURBATION CORRECTION FACTORS .....	329
9.7.1.	Displacement perturbation factor $p_{dis}$ and effective point of measurement .....	330
9.7.2.	Chamber wall perturbation factor $p_{wall}$ .....	331



9.7.3.	Central electrode perturbation $p_{\text{cel}}$ .....	333
9.7.4.	Cavity or fluence perturbation correction $p_{\text{cav}}$ .....	334
9.8.	BEAM QUALITY SPECIFICATION .....	335
9.8.1.	Beam quality specification for kilovoltage photon beams .....	336
9.8.2.	Beam quality specification for megavoltage photon beams .....	337
9.8.3.	Beam quality specification for megavoltage electron beams .....	339
9.9.	CALIBRATION OF MEGAVOLTAGE PHOTON AND ELECTRON BEAMS: PRACTICAL ASPECTS .....	342
9.9.1.	Calibration of megavoltage photon beams based on the air kerma in air calibration coefficient $N_{\text{K,Co}}$ .....	342
9.9.2.	Calibration of megavoltage photon beams based on the dose to water calibration coefficient $N_{\text{D,w,Co}}$ .....	343
9.9.3.	Calibration of megavoltage electron beams based on the air kerma in air calibration coefficient $N_{\text{K,Co}}$ .....	345
9.9.4.	Calibration of high energy electron beams based on the dose to water calibration coefficient $N_{\text{D,w,Co}}$ .....	346
9.10.	KILOVOLTAGE DOSIMETRY .....	347
9.10.1.	Specific features of kilovoltage beams .....	347
9.10.2.	Air kerma based in-phantom calibration method (medium energies) .....	348
9.10.3.	Air kerma based backscatter method (low and medium photon energies) .....	349
9.10.4.	Air kerma in air based calibration method for very low energies .....	351
9.10.5.	Absorbed dose to water based calibration method .....	351
9.11.	ERROR AND UNCERTAINTY ANALYSIS FOR IONIZATION CHAMBER MEASUREMENTS .....	352
9.11.1.	Errors and uncertainties .....	352
9.11.2.	Classification of uncertainties .....	352
9.11.3.	Uncertainties in the calibration chain .....	352
	BIBLIOGRAPHY.....	353

CHAPTER 10. ACCEPTANCE TESTS AND COMMISSIONING MEASUREMENTS .....	355
10.1. INTRODUCTION .....	355
10.2. MEASUREMENT EQUIPMENT .....	355
10.2.1. Radiation survey equipment .....	355
10.2.2. Ionometric dosimetry equipment .....	356
10.2.3. Film .....	356
10.2.4. Diodes .....	356
10.2.5. Phantoms .....	357
10.2.5.1. Radiation field analyser and water phantom ..	357
10.2.5.2. Plastic phantoms .....	357
10.3. ACCEPTANCE TESTS .....	358
10.3.1. Safety checks .....	359
10.3.1.1. Interlocks, warning lights and patient monitoring equipment .....	359
10.3.1.2. Radiation survey .....	359
10.3.1.3. Collimator and head leakage .....	360
10.3.2. Mechanical checks .....	361
10.3.2.1. Collimator axis of rotation .....	361
10.3.2.2. Photon collimator jaw motion .....	361
10.3.2.3. Congruence of light and radiation field .....	362
10.3.2.4. Gantry axis of rotation .....	363
10.3.2.5. Patient treatment table axis of rotation .....	363
10.3.2.6. Radiation isocentre .....	364
10.3.2.7. Optical distance indicator .....	364
10.3.2.8. Gantry angle indicators .....	365
10.3.2.9. Collimator field size indicators .....	365
10.3.2.10. Patient treatment table motions .....	365
10.3.3. Dosimetry measurements .....	365
10.3.3.1. Photon energy .....	366
10.3.3.2. Photon beam uniformity .....	366
10.3.3.3. Photon penumbra .....	366
10.3.3.4. Electron energy .....	367
10.3.3.5. Electron beam bremsstrahlung contamination ..	367
10.3.3.6. Electron beam uniformity .....	368
10.3.3.7. Electron penumbra .....	368
10.3.3.8. Monitor characteristics .....	368
10.3.3.9. Arc therapy .....	370

10.4. COMMISSIONING .....	370
10.4.1. Photon beam measurements .....	370
10.4.1.1. Central axis percentage depth doses .....	370
10.4.1.2. Output factors .....	371
10.4.1.3. Blocking tray factors .....	373
10.4.1.4. Multileaf collimators .....	373
10.4.1.5. Central axis wedge transmission factors .....	374
10.4.1.6. Dynamic wedge .....	375
10.4.1.7. Transverse beam profiles/off-axis energy changes .....	376
10.4.1.8. Entrance dose and interface dosimetry .....	376
10.4.1.9. Virtual source position .....	377
10.4.2. Electron beam measurements .....	378
10.4.2.1. Central axis percentage depth dose .....	378
10.4.2.2. Output factors .....	380
10.4.2.3. Transverse beam profiles .....	383
10.4.2.4. Virtual source position .....	383
10.5. TIME REQUIRED FOR COMMISSIONING .....	384
BIBLIOGRAPHY.....	385

CHAPTER 11. COMPUTERIZED TREATMENT PLANNING  
SYSTEMS FOR EXTERNAL PHOTON BEAM  
RADIOTHERAPY ..... 387

11.1. INTRODUCTION .....	387
11.2. SYSTEM HARDWARE .....	388
11.2.1. Treatment planning system hardware .....	388
11.2.2. Treatment planning system configurations .....	389
11.3. SYSTEM SOFTWARE AND CALCULATION ALGORITHMS	390
11.3.1. Calculation algorithms .....	390
11.3.2. Beam modifiers .....	393
11.3.2.1. Photon beam modifiers .....	393
11.3.2.2. Electron beam modifiers .....	394
11.3.3. Heterogeneity corrections .....	395
11.3.4. Image display and dose-volume histograms .....	395
11.3.5. Optimization and monitor unit calculations .....	396
11.3.6. Record and verify systems .....	396
11.3.7. Biological modelling .....	397

11.4.	DATA ACQUISITION AND ENTRY .....	397
11.4.1.	Machine data .....	397
11.4.2.	Beam data acquisition and entry .....	398
11.4.3.	Patient data .....	399
11.5.	COMMISSIONING AND QUALITY ASSURANCE .....	400
11.5.1.	Errors .....	400
11.5.2.	Verification .....	401
11.5.3.	Spot checks .....	402
11.5.4.	Normalization and beam weighting .....	402
11.5.5.	Dose–volume histograms and optimization .....	403
11.5.6.	Training and documentation .....	403
11.5.7.	Scheduled quality assurance .....	403
11.6.	SPECIAL CONSIDERATIONS .....	404
	BIBLIOGRAPHY.....	405
CHAPTER 12. QUALITY ASSURANCE OF EXTERNAL BEAM RADIOTHERAPY .....		407
12.1.	INTRODUCTION .....	407
12.1.1.	Definitions .....	407
12.1.1.1.	Quality assurance .....	407
12.1.1.2.	Quality assurance in radiotherapy .....	407
12.1.1.3.	Quality control .....	408
12.1.1.4.	Quality standards .....	408
12.1.2.	Need for quality assurance in radiotherapy .....	408
12.1.3.	Requirements on accuracy in radiotherapy .....	409
12.1.4.	Accidents in radiotherapy .....	411
12.2.	MANAGING A QUALITY ASSURANCE PROGRAMME ...	414
12.2.1.	Multidisciplinary radiotherapy team .....	414
12.2.2.	Quality system/comprehensive quality assurance programme .....	416
12.3.	QUALITY ASSURANCE PROGRAMME FOR EQUIPMENT .....	418
12.3.1.	Structure of an equipment quality assurance programme .....	418
12.3.1.1.	Equipment specification .....	419
12.3.1.2.	Acceptance .....	419

12.3.1.3.	Commissioning .....	420
12.3.1.4.	Quality control .....	420
12.3.2.	Uncertainties, tolerances and action levels .....	421
12.3.3.	Quality assurance programme for cobalt-60 teletherapy machines .....	423
12.3.4.	Quality assurance programme for linacs .....	425
12.3.5.	Quality assurance programme for treatment simulators .....	425
12.3.6.	Quality assurance programme for computed tomography scanners and computed tomography simulation .....	429
12.3.7.	Quality assurance programme for treatment planning systems .....	430
12.3.8.	Quality assurance programme for test equipment .....	431
12.4.	TREATMENT DELIVERY .....	433
12.4.1.	Patient charts .....	433
12.4.2.	Portal imaging .....	434
12.4.2.1.	Portal imaging techniques .....	436
12.4.2.2.	Future developments in portal imaging .....	439
12.4.3.	In vivo dose measurements .....	439
12.4.3.1.	In vivo dose measurement techniques .....	440
12.4.3.2.	Use of electronic portal imaging systems for in vivo dosimetry .....	443
12.4.4.	Record and verify systems .....	443
12.5.	QUALITY AUDIT .....	445
12.5.1.	Definition .....	445
12.5.2.	Practical quality audit modalities .....	446
12.5.2.1.	Postal audit with mailed dosimeters .....	446
12.5.2.2.	Quality audit visits .....	446
12.5.3.	What should be reviewed in a quality audit visit? .....	447
	BIBLIOGRAPHY.....	448
CHAPTER 13. BRACHYTHERAPY:		
	PHYSICAL AND CLINICAL ASPECTS .....	451
13.1.	INTRODUCTION .....	451
13.2.	PHOTON SOURCE CHARACTERISTICS .....	455
13.2.1.	Practical considerations .....	455

13.2.2.	Physical characteristics of some photon emitting brachytherapy sources . . . . .	456
13.2.3.	Mechanical source characteristics . . . . .	456
13.2.4.	Source specification . . . . .	457
13.2.4.1.	Specification of $\gamma$ ray sources . . . . .	457
13.2.4.2.	Specification of $\beta$ ray sources . . . . .	459
13.3.	CLINICAL USE AND DOSIMETRY SYSTEMS . . . . .	460
13.3.1.	Gynaecology . . . . .	460
13.3.1.1.	Types of source . . . . .	460
13.3.1.2.	Dose specification . . . . .	460
13.3.1.3.	Source arrangement . . . . .	460
13.3.1.4.	Applicators . . . . .	461
13.3.1.5.	Rectal and bladder dose monitoring . . . . .	461
13.3.2.	Interstitial brachytherapy . . . . .	461
13.3.2.1.	Patterson–Parker system . . . . .	461
13.3.2.2.	Quimby system . . . . .	462
13.3.2.3.	Paris system . . . . .	462
13.3.3.	Remote afterloading systems . . . . .	463
13.3.4.	Permanent prostate implants . . . . .	464
13.3.4.1.	Choice of radionuclide for prostate implants . . . . .	465
13.3.4.2.	Planning technique: ultrasound or computed tomography . . . . .	465
13.3.4.3.	Preplanning, seed placement and dose distributions . . . . .	465
13.3.4.4.	Post-implant dose distributions and evaluation . . . . .	465
13.3.5.	Eye plaques . . . . .	466
13.3.6.	Intravascular brachytherapy . . . . .	466
13.4.	DOSE SPECIFICATION AND REPORTING . . . . .	467
13.4.1.	Intracavitary treatments . . . . .	467
13.4.2.	Interstitial treatments . . . . .	467
13.5.	DOSE DISTRIBUTIONS AROUND SOURCES . . . . .	468
13.5.1.	AAPM TG 43 algorithm . . . . .	468
13.5.2.	Other calculation methods for point sources . . . . .	471
13.5.3.	Linear sources . . . . .	473
13.5.3.1.	Unfiltered line source in air . . . . .	473

13.5.3.2.	Filtered line source in air .....	474
13.5.3.3.	Filtered line source in water .....	475
13.6.	DOSE CALCULATION PROCEDURES .....	475
13.6.1.	Manual dose calculations .....	475
13.6.1.1.	Manual summation of doses .....	475
13.6.1.2.	Precalculated dose distributions (atlases) .....	475
13.6.2.	Computerized treatment planning .....	476
13.6.2.1.	Source localization .....	476
13.6.2.2.	Dose calculation .....	476
13.6.2.3.	Dose distribution display .....	476
13.6.2.4.	Optimization of dose distribution .....	477
13.6.3.	Calculation of treatment time .....	477
13.6.3.1.	Use of Patterson–Parker tables .....	477
13.6.3.2.	Choice of reference points .....	478
13.6.3.3.	Decay corrections .....	478
13.7.	COMMISSIONING OF BRACHYTHERAPY COMPUTER TREATMENT PLANNING SYSTEMS .....	479
13.7.1.	Check of the reconstruction procedure .....	479
13.7.2.	Check of consistency between quantities and units .....	479
13.7.3.	Computer versus manual dose calculation for a single source .....	479
13.7.4.	Check of decay corrections .....	479
13.8.	SOURCE COMMISSIONING .....	480
13.8.1.	Wipe tests .....	480
13.8.2.	Autoradiography and uniformity checks of activity .....	480
13.8.3.	Calibration chain .....	480
13.9.	QUALITY ASSURANCE .....	481
13.9.1.	Constancy check of a calibrated dosimeter .....	481
13.9.2.	Regular checks of sources and applicators .....	481
13.9.2.1.	Mechanical properties .....	481
13.9.2.2.	Source strength .....	481
13.9.2.3.	Wipe tests .....	482
13.9.3.	Checks of source positioning with afterloading devices ..	482
13.9.4.	Radiation monitoring around patients .....	482
13.9.5.	Quality management programme .....	482

13.10. BRACHYTHERAPY VERSUS EXTERNAL BEAM	
RADIOTHERAPY .....	483
BIBLIOGRAPHY.....	483
CHAPTER 14. BASIC RADIOBIOLOGY .....	485
14.1. INTRODUCTION .....	485
14.2. CLASSIFICATION OF RADIATIONS IN RADIOBIOLOGY .	486
14.3. CELL CYCLE AND CELL DEATH .....	487
14.4. IRRADIATION OF CELLS .....	488
14.4.1. Direct action in cell damage by radiation .....	488
14.4.2. Indirect action in cell damage by radiation .....	488
14.4.3. Fate of irradiated cells .....	489
14.5. TYPE OF RADIATION DAMAGE .....	489
14.5.1. Timescale .....	489
14.5.2. Classification of radiation damage .....	490
14.5.3. Somatic and genetic effects .....	490
14.5.4. Stochastic and deterministic (non-stochastic) effects ....	491
14.5.5. Acute versus late tissue or organ effects .....	491
14.5.6. Total body radiation response .....	491
14.5.7. Foetal irradiation .....	492
14.6. CELL SURVIVAL CURVES .....	492
14.7. DOSE RESPONSE CURVES .....	494
14.8. MEASUREMENT OF RADIATION DAMAGE IN TISSUE ...	496
14.9. NORMAL AND TUMOUR CELLS:	
THERAPEUTIC RATIO .....	497
14.10. OXYGEN EFFECT .....	498
14.11. RELATIVE BIOLOGICAL EFFECTIVENESS .....	500
14.12. DOSE RATE AND FRACTIONATION .....	501
14.13. RADIOPROTECTORS AND RADIOSENSITIZERS .....	503
BIBLIOGRAPHY.....	504
CHAPTER 15. SPECIAL PROCEDURES AND TECHNIQUES	
IN RADIOTHERAPY .....	505
15.1. INTRODUCTION .....	505
15.2. STEREOTACTIC IRRADIATION .....	506
15.2.1. Physical and clinical requirements for radiosurgery ....	506
15.2.2. Diseases treated with stereotactic irradiation .....	507



15.2.3.	Equipment used for stereotactic radiosurgery	507
15.2.4.	Historical development	508
15.2.5.	Radiosurgical techniques	509
15.2.5.1.	Gamma Knife	509
15.2.5.2.	Linac based radiosurgery	509
15.2.5.3.	Miniature linac on robotic arm	511
15.2.6.	Uncertainty in radiosurgical dose delivery	512
15.2.7.	Dose prescription and dose fractionation	513
15.2.8.	Commissioning of radiosurgical equipment	514
15.2.9.	Quality assurance in radiosurgery	514
15.2.10.	Gamma Knife versus linac based radiosurgery	515
15.2.11.	Frameless stereotaxy	516
15.3.	<b>TOTAL BODY IRRADIATION</b>	516
15.3.1.	Clinical total body irradiation categories	516
15.3.2.	Diseases treated with total body irradiation	517
15.3.3.	Technical aspects of total body irradiation	517
15.3.4.	Total body irradiation techniques	518
15.3.5.	Dose prescription point	519
15.3.6.	Commissioning of total body irradiation procedure	519
15.3.7.	Test of total body irradiation dosimetry protocol	521
15.3.8.	Quality assurance in total body irradiation	521
15.4.	<b>TOTAL SKIN ELECTRON IRRADIATION</b>	522
15.4.1.	Physical and clinical requirements for total skin electron irradiation	523
15.4.2.	Current total skin electron irradiation techniques	523
15.4.3.	Selection of total skin electron irradiation technique	524
15.4.4.	Dose calibration point	525
15.4.5.	Skin dose rate at the dose prescription point	525
15.4.6.	Commissioning of the total skin electron irradiation procedure	525
15.4.7.	Measurement of clinical total skin electron irradiation dose distributions	526
15.4.8.	Quality assurance in total skin electron irradiation	526
15.5.	<b>INTRAOPERATIVE RADIOTHERAPY</b>	527
15.5.1.	Physical and clinical requirements for intraoperative radiotherapy	527
15.5.2.	Intraoperative radiotherapy radiation modalities and techniques	527

15.5.3.	Commissioning of an intraoperative radiotherapy programme .....	528
15.5.4.	Quality assurance in intraoperative radiotherapy .....	528
15.6.	ENDOCAVITARY RECTAL IRRADIATION .....	529
15.6.1.	Physical and clinical requirements for endorectal irradiation .....	529
15.6.2.	Endorectal treatment technique .....	530
15.6.3.	Quality assurance in endorectal treatments .....	531
15.7.	CONFORMAL RADIOTHERAPY .....	531
15.7.1.	Basic aspects of conformal radiotherapy .....	531
15.7.2.	Multileaf collimators .....	532
15.7.3.	Acceptance testing of multileaf collimators .....	533
15.7.4.	Commissioning of multileaf collimators .....	534
15.7.5.	Quality assurance programme for multileaf collimators .	534
15.7.6.	Intensity modulated radiotherapy .....	534
15.7.7.	Commissioning of intensity modulated radiotherapy systems .....	535
15.7.8.	Quality assurance for intensity modulated radiotherapy systems .....	537
15.7.9.	Dose verification for intensity modulated radiotherapy treatment plans .....	537
15.8.	IMAGE GUIDED RADIOTHERAPY .....	538
15.8.1.	Cone beam computed tomography .....	539
15.8.2.	Computed tomography Primatom .....	540
15.8.3.	Tomotherapy .....	541
15.8.4.	BAT system .....	542
15.8.5.	ExacTrac ultrasonic module .....	542
15.8.6.	CyberKnife .....	543
15.9.	ADAPTIVE RADIOTHERAPY .....	544
15.10.	RESPIRATORY GATED RADIOTHERAPY .....	544
15.11.	POSITRON EMISSION TOMOGRAPHY/COMPUTED TOMOGRAPHY SCANNERS AND POSITRON EMISSION TOMOGRAPHY/COMPUTED TOMOGRAPHY IMAGE FUSION .....	545
	BIBLIOGRAPHY.....	548

CHAPTER 16. RADIATION PROTECTION AND SAFETY IN RADIOTHERAPY .....	549
16.1. INTRODUCTION .....	549
16.2. RADIATION EFFECTS .....	550
16.2.1. Deterministic effects .....	550
16.2.2. Stochastic effects .....	550
16.2.3. Effects on the embryo and foetus .....	551
16.3. INTERNATIONAL CONSENSUS AND RADIATION SAFETY STANDARDS .....	551
16.4. TYPES OF RADIATION EXPOSURE .....	552
16.5. QUANTITIES AND UNITS USED IN RADIATION PROTECTION .....	554
16.5.1. Physical quantities .....	554
16.5.2. Radiation protection quantities .....	554
16.5.2.1. Organ dose .....	555
16.5.2.2. Equivalent dose .....	555
16.5.2.3. Effective dose .....	556
16.5.2.4. Committed dose .....	557
16.5.2.5. Collective dose .....	558
16.5.3. Operational quantities .....	558
16.5.3.1. Ambient dose equivalent .....	558
16.5.3.2. Directional dose equivalent .....	558
16.5.3.3. Personal dose equivalent .....	559
16.6. BASIC FRAMEWORK OF RADIATION PROTECTION .....	559
16.7. GOVERNMENTAL REGULATION AND NATIONAL INFRASTRUCTURE .....	560
16.8. SCOPE OF THE BASIC SAFETY STANDARDS .....	561
16.9. RESPONSIBILITIES FOR IMPLEMENTATION OF BASIC SAFETY STANDARDS REQUIREMENTS .....	562
16.10. SAFETY IN THE DESIGN OF RADIATION SOURCES AND EQUIPMENT .....	562
16.10.1. Equipment .....	563
16.10.2. Sealed sources .....	565
16.10.3. Safety in the design of facilities and ancillary equipment .....	567
16.10.3.1. Manual brachytherapy .....	567
16.10.3.2. Remote control brachytherapy and external beam radiotherapy .....	569

16.11. SAFETY ASSOCIATED WITH ACCEPTANCE TESTS, COMMISSIONING AND OPERATION .....	570
16.11.1. Safe operation of external beam radiotherapy .....	572
16.11.2. Safe operation of brachytherapy .....	572
16.11.2.1. Safe operation of manual brachytherapy .....	574
16.11.2.2. Safe operation of remote control afterloading brachytherapy .....	575
16.12. SECURITY OF SOURCES .....	575
16.13. OCCUPATIONAL EXPOSURE .....	577
16.13.1. Responsibilities and conditions of service .....	577
16.13.2. Use of dose constraints in radiotherapy .....	577
16.13.3. Investigation levels for staff exposure in radiotherapy ...	578
16.13.4. Pregnant workers .....	578
16.13.5. Classification of areas .....	579
16.13.6. Local rules and supervision .....	579
16.13.7. Protective equipment and tools .....	580
16.13.8. Individual monitoring and exposure assessment .....	580
16.13.9. Monitoring of the workplace .....	581
16.13.10. Health surveillance .....	581
16.13.11. Records .....	582
16.14. MEDICAL EXPOSURE .....	583
16.14.1. Responsibilities for medical exposure .....	583
16.14.2. Justification of medical exposure .....	584
16.14.3. Optimization of exposure and protection .....	584
16.14.4. Calibration of radiotherapy sources and machines .....	585
16.14.5. Clinical dosimetry .....	587
16.14.6. Quality assurance for medical exposure .....	587
16.14.7. Constraints for comforters and visitors .....	589
16.14.8. Discharge of patients .....	589
16.14.9. Investigation of accidental medical exposure .....	590
16.15. PUBLIC EXPOSURE .....	591
16.15.1. Responsibilities .....	591
16.15.2. Access control for visitors .....	591
16.15.3. Radioactive waste and sources no longer in use .....	591
16.15.4. Monitoring of public exposure .....	592
16.16. POTENTIAL EXPOSURE AND EMERGENCY PLANS .....	592
16.16.1. Potential exposure and safety assessment .....	592

16.16.2.	Mitigation of consequences: emergency plans .....	593
16.16.2.1.	Lost source .....	593
16.16.2.2.	Stuck source .....	594
16.16.2.3.	Contamination .....	595
16.16.2.4.	Off-site accidents .....	595
16.16.2.5.	Patient accidental exposure .....	595
16.17.	GENERAL SHIELDING CALCULATIONS .....	596
16.17.1.	Step one: Design dose in occupied areas (annual dose and weekly dose) .....	597
16.17.2.	Step two: Calculation of the radiation field (air kerma in air) in the occupied area without shielding .	598
16.17.3.	Step three: Attenuation by shielding barriers .....	599
16.18.	TYPICAL LINAC INSTALLATION .....	600
16.18.1.	Workload .....	600
16.18.2.	Calculation of the primary barrier transmission factor ...	602
16.18.3.	Calculation of the scatter barrier transmission factor ...	603
16.18.4.	Calculation of the leakage barrier transmission factor ...	603
16.18.5.	Determination of barrier thickness .....	604
16.18.6.	Consideration of neutron production in a high energy linac .....	605
16.18.7.	Door of a linac room .....	605
16.18.8.	Other considerations .....	606
16.19.	SHIELDING DESIGN FOR BRACHYTHERAPY FACILITIES .....	606
	BIBLIOGRAPHY.....	607
	INTERNATIONAL ORGANIZATIONS.....	611
	ABBREVIATIONS .....	613
	SYMBOLS .....	619
	BIBLIOGRAPHY .....	627
	INDEX .....	639