

Contents

1. Fundamental Concepts	1
• Units and Measurements	1
• Mechanics	3
• Temperature and Heat	7
• Atomic Structure	9
• Nucleus	13
• Electromagnetic Wave	14
• Semiconductor Physics	20
• Semiconductor Properties	21
2. Electromagnetic Induction	29
• Electric Charge	29
• Electrostatic Potential	31
• Electrostatic Induction	31
• Electric Current	35
• Magnetism	38
• Magnetic Effect on Electric Current	42
• Electromagnetic Induction	46
• Methods of Producing Induced EMF	49
• Alternating Current	52
• Transformer	53
3. Medical X-rays	60
• Production of X-rays	60
• X-ray Tubes	62
• X-ray Spectrum	69
• Quality and Intensity of X-rays	72
• Diagnostic X-rays	76
• Therapeutic X-rays	91
4. Radioactivity and Gamma Rays	95
• Radioactivity	95
• Radioactive Disintegration	96
• Radioactive Series	100
• Radioactive Equilibrium	100
• Nuclear Transformation	102
• Nuclear Reactions	109
• Production of Radioisotopes	110
• Radioisotope Therapy Machines	117
• Tele-Cobalt Therapy Machines	118
• Gamma Knife	124

5. Interactions of Radiation with Matter	127
• Photon Interaction 127	
– Coherent or Rayleigh Scattering 128	
– Photoelectric Effect 128	
– Compton Scattering 130	
– Pair Production 131	
• Attenuation 132	
• Radiation Units 141	
6. Radiation Dosimetry	151
• Principles of Radiation Detection 151	
• Types of Detectors 152	
• Gas-filled Chamber Detectors 153	
• Solid State Detectors 157	
• Chemical Dosimeter 169	
• Biodosimetry 171	
• Practical Dosimeters 173	
• Calibration of High-energy Beams, TG-51 Protocol 183	
• Calibration of High-energy Beams; TRS-398 Protocol 186	
• Radiation Survey Meter 189	
• Calibration and Maintenance of Radiation Monitoring Instruments 191	
7. Linear Accelerators	192
• Historical Background 192	
• Medical Linear Accelerator 195	
• Physical Design of a Linear Accelerator 197	
• Ancillary Devices 213	
• Tomotherapy 217	
• Cyber Knife 220	
8. External Beam Characteristics	223
• Phantoms 223	
• Radiation Field Size 226	
• Dosimetry Parameters 229	
• Isodose Curves 236	
• Beam Profile with Flattening Filter 239	
• Flattening Filter Free Beam Profile 240	
• Beam Modifiers 244	
9. Basics of Treatment Planning	256
• Immobilization 256	
• Simulation 264	
• Radiotherapy Treatment Planning 272	

- Manual Dose Calculations 279
- Missing Tissue Correction 283
- Body Inhomogeneity Correction 285
- Radiotherapy Treatment Planning System 287
- Dose Prescribing, Recording, and Reporting 292
- Dose-Volume Histogram 296

10. Clinical Treatment Planning..... 299

- Three-dimensional Treatment Planning 299
- Treatment Planning Process 299
- Three-dimensional Conformal Radiation Therapy 307
- Intensity-modulated Radiation Therapy 310
- Image-guided Radiation Therapy 321
- Stereotactic Radiosurgery and Radiotherapy 328

11. Particle Radiotherapy 338

- Common Characteristics of Particle Interactions 338
- Heavy-charged Particle Interactions 340
- Light-charged Particle Interactions 341
- Electron Therapy 344
- Proton Therapy 362
- Neutron Interaction 367
- Heavy Ion Therapy 367

12. Brachytherapy 371

- Classification of Brachytherapy 371
- Physical Characteristics of Brachytherapy Sources 372
- Dose Calculations 382
- Remote Afterloading Systems 386
- Brachytherapy Clinical Applications 395
- Special Brachytherapy Techniques 406

13. Quality Assurance 411

- Quality Assurance for Linear Accelerator 412
- Patient-specific Quality Assurance 425
- Quality Assurance for CT Simulator 428
- High-dose Rate Brachytherapy Quality Assurance 433
- Quality Assurance for Tele-Cobalt Therapy Machine 441

14. Radiation Protection 445

- Equivalent Dose 445
- Sources of Radiation 447
- Biological Effects of Radiation 449
- Radiation Hazards Evaluation and Control 456

- Planning a Radiation Therapy Installation 465
- Radiation Regulation in India 476
- Radiation Emergency Preparedness 481

15. Oncology Imaging 484

- Computed Tomography 484
- Positron Emission Tomography 500
- Magnetic Resonance Imaging 507
- Ultrasound Imaging 519
- Image Quality, Artifacts, and Bioeffects 531

Appendices 533

Index 553