MANGALORE UNIVERSITY

MSc Medical Physics

MPS 504: Clinical Aspects of Radiation Therapy

Teaching hours: Each Unit – 12 h

Objective:

To familiarize the students with theoretical models for fractionated radiotherapy and brachytherapy treatment. To familiarise the students with the various radiation sources such as linear accelerators, generation of charged particle beams, brachytherapy techniques such as LDR,HDR, pulsed brachytherapy, permanent implants, manual and remote after-loading techniques. Familiarization with algorithms associated with treatment planning

Outcomes:

- Students will familiarise with physical and biological factors affecting cell survival, tumour growth and regroth.
- They will learn about time and dose fractionation in radiotherapy.
- They will learn about kinds of accelerators used in production of radioisotopes and used in diagnosis and therapy.
- They will understand all aspects of X-ray production and their applications.
- They learn about brachytherapy techniques including high dose, low dose and pulsed dose techniques, their quality assurance and dosimetry.
- They will understand different kinds of algorithms used for treatment planning computations including Monte Carlo based algorithms.

Unit I: Biological Basis of Radiotherapy and Time Dose Fractionation

Physical and biological factors affecting cell survival, tumour regrowth and normal tissue response -Non-conventional fractionation scheme and their effect of reoxygenation, repair, redistribution in the cell cycle - High LET radiation therapy. Effects on Cancer Cells: Direct, Indirect Effects of Radiation: Introduction, Pathogenesis of Early and Late Radiation Effects, Single and double strand brake.

Time dose fractionation - Basis for dose fractionation in beam therapy - Concepts for Nominal Standard Dose (NSD), Roentgen equivalent therapy (RET) - Time dose fractionation (TDF) factors and cumulative radiation effects (CRE) - Gap correction, Linear and Linear Quadratic models.

Unit II: Particle Accelerators

Particle accelerators for industrial, medical and research applications - The Resonant transformer - Cascade generator - Van De Graff Generator - Pelletron - Cyclotron – Betatron

- Synchro-Cyclotron-Linear Accelerator - Klystron and magnetron - Travelling and Standing Wave Acceleration - Microtron - Electron Synchrotron-Proton synchrotron. Details of

accelerator facilities in India.

Unit III: X-ray Generators

Discovery - Production - Properties of X-rays - Characteristics and continuous spectra - Design of hot cathode X-ray tube - Basic requirements of medical diagnostic, therapeutic and industrial radiographic tubes - Rotating anode tubes - Hooded anode tubes - Industrial X-ray tubes - X-ray tubes for crystallography - Rating of tubes - Safety devices in X-ray tubes - Rayproof and shockproof tubes - Insulation and cooling of X-ray tubes - Mobile and dental units - Faults in X-ray tubes - Limitations on loading.

Electric Accessories for X-ray tubes - Filament and high voltage transformers - High voltage circuits - Half-wave and full-wave rectifiers - Condenser discharge apparatus - Three phase apparatus - Voltage doubling circuits - Current and voltage stabilisers - Automatic exposure control - Automatic Brightness Control- Measuring instruments - Measurement of kV and mA - timers - Control Panels - Complete X-ray circuit - Image intensifiers and closed circuit TV systems - Modern Trends.

Unit IV: Brachytherapy

Definition and classification of brachytherapy techniques – surface mould, intracavitary, interstitial and intraluminal techniques. Requirement for brachytherapy sources – Description of radium and radium substitutes – 137 Cs, 60Co, 192 Ir, 125I and other commonly used brachytherapy sources. Dose rate considerations and classification of brachytherapy techniques – Low dose rate (LDR), High dose rate (HDR) and pulsed dose rate (PDR) Paterson Parker and Manchester Dosage systems.ICRU 38 and 58 protocols.Specification and calibration of brachytherapy sources – RAKR and AKR – IAEA TECDOC 1274 and ICRU 72 recommendations. Point and line sources Dosimetry formalisms – Sievert integral AAPM TG-43/43U1 and other Dosimetry formalisms.

High dose rate brachytherapy (HDR):High dose rate unit – remote afterloader – applicators – facility design - HDR dosimetry procedures - quality assurance protocol, procedures and program – HDR source calibration

Afterloading technique: Advantages and disadvantages of manual and remote afterloading techniques. AAPM and IEC requirements for remote afterloading brachytherapy

equipment.Acceptance, commissioning and quality assurance of remote after loading brachytherapy equipment.ISO requirements and AQ of brachytherapy sources.Integrated brachytherapy unit.

Brachytherapy treatment planning: CT/MR based brachytherapy planning – forward and inverse planning – DICOM image import/export from OT – Record & verification.Brachytherapy treatment for Prostate cancer.Ocular Brachytherapy using photon and beta sources.Intravascular Brachytherapy – classification – sources – dosimetry procedures – AAPM TG 60 protocol – Electronic Brachytherapy (Axxent, Mammosite etc.)

Unit V: Treatment Planning

Scope of computers in radiation treatment planning – Review of algorithms used for treatment planning computations – pencil beam, double pencil beam, Clarkson method, convolution superposition, lung interface algorithm, fast Fourier transform, Inverse planning algorithm, Monte Carlo based algorithms. Treatment planning calculations for photon beam, electron beam and brachytherapy – Factors to be incorporated in computational algorithms. Plan optimization – direct aperture optimization – beamlet optimization – simulated annealing – dose volume histograms (DVH) – Indices used for plan comparisons – Hardware and software requirements – beam & source library generation. Networking, DICOM and PACS.Acceptance, commissioning and quality assurance of radiotherapy treatment planning systems using IAEA TRS 430 and other protocols.

Reference Books:

1. Devita, Cancer Principle and Practice of oncology, 7th Edition, 2000.
2. Choa K. S., Clifford, Radiation oncology – management decisions, 1998.
3. Perez et.al., Principles of radiation oncology.
4. J.Dobbset.al., Practical Radiotherapy Planning. 3rd, 1999.
5. Rath GK et.al. Text book of radiation oncology, 1st, 2000.
6. R.F.Mould, ―Radiotherapy Treatment Planning Medical Physics Hand book series No.7, Adam Hilger Ltd, Bristol, 1981.
7. S.C.Klevenhagen ―Physics of Electron Beam Therapy‖ Medical Physics Hand Book Series No.6 Adam Hilger Ltd, Bristol, 1981.
8. F.A.Attix ―Radiation Dosimetry‖ Vol IIII, Academic press New York, 1985.
9. FahizM.Khan, Treatment Planning in Radiation Oncology, LWW publication, Second Edition.
10. Ann Barrett, Jane Dobbs, Stephen Morris and Tom Roques. ―Practical Radiotherapy Planning‖ Fourth Edition 2009.

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