MANGALORE UNIVERSITY

MSc Medical Physics

Semester – IV: Theory

MPH 551: Physics of Radiotherapy (Radiotherapy – I)

Teaching hours: Each Unit – 12 h

Objectives:

Students will be familiarised basics, working principlesand operating protocols of instruments used in radiation diagnosis and therapy; also to design, install and calibrate all the instruments including dose monitoring instruments.Acquaint students with the science of phantom and their application in dosimetric studies.

Outcomes:

- Students will acquaint basics and working principles of Low energy and high energy X-ray units, teletherapy cobalt units, medical electron accelerator and medical proton accelerator and associated instruments and components.
- The students will acquire knowledge in source designing, beam collimation, calibration of diagnosis and therapy units, simulation, dose monitoring &dose protocols related to the operation of therapy units.
- Students acquaint with the various phantoms and their application in dosimetry and dosimetric data generation as well as on various scatter factors.
- The students will understand techniques and devices for beam modification and shaping such as wedge fitter, shielding block etc. for appropriate dose delivery as well as better patient dosimetry.
- The students will know the method of electron energy selection, depth dose characterization, homogeneity correction, field shaping etc. and also carrying out the quality assurance in electron therapy beam.

Unit I: Beam Therapy Generators

Description of low kV therapy X-ray Units -Grenz ray therapy-contact therapy, superficial therapy, ortho-voltage, deep therapy– spectral distribution of kV X-rays and effect of filtration – thoraeus filter – output calibration procedure. Mega voltage therapy units: Construction and working of telecobalt units - source design – beam collimation and penumbra – trimmers and breast cones -Beam shutter mechanisms:-Mercury shutter – pneumatic pressure system – Isocentric gantry - Design and working of medical electron linear accelerators – beam collimation – asymmetric collimator – multileaf collimator – dose monitoring – electron contamination. Basic aspects of proton accelerators - Output calibration of Cobalt-60 gamma rays, high energy x-rays, electron and proton beams using IAEA TRS 398, AAPM TG 51 and other dosimetry protocols. Relative merits and demerits of kV x-rays, gamma rays, MV x-rays and electron beams. Radiotherapy simulator and its applications.CT and virtual simulations.

Unit II: Central axis Dosimetry parameters and Beam Modifying Devices

Phantoms - Tissue equivalent phantoms - Percentage depth doses (PDD), Tissue air ratio (TAR), Back scatter factor/Peak scatter factor (BSF/PSF)– Tissue phantom ratio (TPR) – Tissue maximum ratio (TMR) – Collimator scatter factor, Phantom scatter factor and total scatter factors. Relationship between TAR and PDD and its applications – relationship between TMR and PDD and its applications. SAR, SMR, off axis ratio and Field factor. Build-up region and surface dose. Use of Radiation field analyzer (RFA) in generation of Dosimetric data.

Beam modifying and shaping devices: Wedge filters – design of wedge filters –wedge isodose angle –wedge transmission factor – wedge system- universal, motorized and dynamic wedges –wedge field techniques - shielding blocks - custom blocking – independent jaws –– Tissue compensation – Bolus, design of compensators - skin dose and factors influencing – methods of field separation – field matching.

Unit III: Beamtherapy techniques and patient dosimetry

Treatment planning in beamtherapy –SSD and SAD set ups – two and three dimensional localization techniques – contouring – simulation of treatment techniques – field arrangements – single, parallel opposed and multiple fields – corrections for tissue in homogeneity, correction for contour irregularities and beam obliquity –- integral dose. Arc/rotation therapy and Clarkson technique for irregular fields – mantle and inverted Y fields.Conventional radiotherapy.Treatment time and Monitor unit calculations.

Unit IV: Clinical Electron Beams

Energy specification – electron energy selection for patient treatment – depth dose characteristics (Ds, Dx, R100, R90, Rp, etc.) – beam flatness and symmetry – penumbra – isodose plots – monitor unit calculations – output factor formalisms – effect of air gap and obliquity on beam dosimetry – effective SSD – X-ray contamination – tissue in homogeneities correction – use of bolus and absorbers – adjacent fields separation – field shaping.

Unit V: Quality Assurance of Beam Therapy

Relative merits of electron, neutron, X-ray and gamma ray beams – Neutron capture therapy heavy ion therapy. Quality assurance in radiation therapy: precision and accuracy in clinical dosimetry – quality assurance protocols for telecobalt, Medical Linear Accelerator and radiotherapy simulators – IEC requirements – acceptance, commissioning and quality control of telecobalt. Portal and in-vivo dosimetry.Electronic portal imaging devices (EPID).

Reference Books:

1. H.E. Johns and Cunningham, The Physics of radiology
2. FaizM.Khan, Roger A. Potish, treatment Planning in radiation Oncology
3. Walter and Miller‘s Textbook of Radiotherapy by C.K.Bomford, I.H.kunkler
4. F.A.Attix –Radiation Dosimetry‖ Vol IIII,
5. Academic press New York, 1985.
6. F.M. Khan — Physics of Radiation Therapy‖ 2010 Fourth edition.
7. H.E.Jones, J.R.Cunnigham, –The Physics of Radiology‖ Charles C.Thomas, NY, 1980.
8. W.R.Hendee, –Medical Radiation Physics‖, Year Book – Medical Publishers Inc London, 1981.
9. R.F.Mould, –Radiotherapy Treatment Planning Medical Physics Hand book series No.7, Adam Hilger Ltd, Bristol, 1981.
10. S.C.Klevenhagen –Physics of Electron Beam Therapy‖ Medical Physics Hand Book Series No.6 Adam Hilger Ltd, Bristol, 1981.
11. J.R.Greening –Fundamentals of Radiation Dosimetry‖, Medical Physics Hand Book, ADAM Hildre, 1981.

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