STATE MEDICAL FACULTY OF WEST BENGAL

DRT (Tech)
REVISED (2012) SYLLABUS OF THE COURSE

PRELIMINARY (1ST YEAR)

PAPER - I

Radiotherapy Physics – Part – I

Introduction : The subject should be taught at an elementary level. The treatment should be descriptive and qualitative rather than quantitative. Principles and practical applications should be emphasized throughout.

CHAPTER – I : REVISION OF MATHEMATICS

1. Calculations of percentages. Proportion, Surds, Indices, Logarithm. Inverse square law. Geometry of triangles. Properties of similar triangles. Graphical representation of exponential and inverse exponential functions. Linear and semilog graphs.

CHAPTER – II : ELECTROSTATICS, MAGNETISM & CURRENT ELECTRICITY

1. Coulomb's Law, Electric Field and potential, Potential energy, Capacitance, Ohm's law, Heating effect of current, Biot-Severt law, Definition of Tesla and Gauss, Magnetic field due to circular coil and long solenoid, the left hand rule. Elementary Principles of – magnetization of materials by electric current, electromagnets. Force on conductor in magnetic field (Lorentz force), Magnetic flux. Electromagnetic induction, Mutual and self inductance, the right hand rule. Transformer, Eddy current. Instruments – ammeter, voltmeter. Units used in Electrostatics, Magnetism and current Electricity. RMS and average current and voltage in AC. Variation of voltage and current in AC circuit consisting only resistor, only inductor, only capacitor. Power factor of the AC circuit.

CHAPTER – III : PHYSICS OF RADIATION

1. Definition of radiation and its types. Electromagnetic [EM] radiation. Radiation as a wave motion. Wave length, Frequency, Amplitude, Velocity and their relations. Concept of quanta, Energy of radiation, Electromagnetic spectrum, Common properties of radiation.

2. Sources of radiation – Natural and Artificial.

3. Radioactivity – Atomic and Nuclear structures, Rutherford, Bohr model, Energy level of Hydrogen atom. Atomic Number, Mass Number, Atomic Mass, Binding energy, Energy level, Nuclear binding energy, NP ratio, Definition of radioactivity, Natural radioactivity, Radioactive decay, Half life, decay constant, Mean line and their relation, Specific activity, Radiation from radioactive elements, Alpha and Beta particles, Gamma radiation and their properties. Radioactive series. Properties of Radium and its daughter products. Radioactive equilibrium. Units of activity. The Curie and Bequarel, Specific Gamma Ray constant.

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FISSION, FUSION, ARTIFICIAL RADIOACTIVITY.

4. X-ray -Conduction of electricity through gases, effect of varying pressure, cathode rays, X-rays. Principles of production of X-rays, Intensity, continuous and characteristic spectrum. Basic Circuit of X-ray tube. Construction of modern X-ray tubes, Filament, Anode, Cathode, Methods of cooling anode, Inherent filtration, added filtration and their effect on quality of spectrum. Rectification. Basic principles of CT & MRI.

CHAPTER – IV : INTERACTION

1. Interaction of X and Gamma rays with matter – Attenuation of a beam of X or Gamma rays, Attenuation and absorption coefficients, Modes of interaction, Coherent scattering, Photoelectric effect, Compton effect, Pair production, Photo disintegration. Basic principles of Interaction of charged particle and neutrons with matter, Bragg peak.

CHAPTER – V : MEASUREMENT OF X AND GAMMA RADIATION

1. The ionizing process. Ionization of air as a basis for a practical system of dosimetry. Exposure, the ROENTGEN and its practical realization. Photon and energy flux density and fluence. Absorbed dose and its units – rad, Gy. Principles of measurement – ionization, different regions of operation of gas filled detectors. Ionization & scintillation detectors. Photographic, calorimetric, thermoluminescence dosimetry principles. Measuring instruments, Dosimeters. Quality of radiation. Half value layer and its measurement.

CHAPTER – VI : ABSORPTION OF X AND GAMMA RAYS

1. Attenuation of beam of X-ray or Gamma rays. Absorption of X and Gamma rays. Linear attenuation coefficient , Mass Electronic and Atomic absorption coefficients. Energy transfer and absorption coefficients. Energy absorption in biological material, the effect of bone on depth dose curves, energy absorption in cavities within bone.

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PAPER -II

Anatomy, Physiology, Pathology and Radiobiology in relation to Radiotherapy

Introduction: The standard aimed is that a more extensive and detailed knowledge is required of surface and regional anatomy, since during the treatment knowledge of the size and position of organs is of paramount importance. Emphasis should be made in the appropriate context on topographical relation of the organs of the body.

CHAPTER– I ANATOMY & PHYSIOLOGY

1. Structure and function of cell; Cell division; Tissue: definition and classification[Gross outline]

2. General anatomical terms and topography of the body – Planes, Regions, Positions, Movements.

3. Skeleton & Joints – Long bones, Vertebrae, Pelvic and shoulder girdles, Hands and Feet, Skull, Face and Teeth; Parts of a classical Long Bone; Out line of different Joints and types of movements.

4. Muscles: classification, structure and function [Gross outline]

5. Brain & Spinal cord with its Coverings and Cavities including Cerebrospinal Fluids and Pituitary gland [Macroscopic anatomy and surface anatomy only].

6. Head and Neck: Oral Cavity & Lips, Pharynx, Larynx, Nasal Cavity and Para nasal sinuses, Salivary glands, Ear; Orbit & its content; Thyroid gland and Nodal areas [Macroscopic anatomy only].

7. Thorax: Structure of thoracic cage, esophagus, trachea, lungs & Pleura, the mediastinum including Thymus, Heart and great vessels and diaphragm [Macroscopic and Surface anatomy].

8. Abdomen: Structure of abdomen & Peritoneum, Retro peritoneal structures [including Kidney], Stomach, Small intestine, Colon, Liver, Pancreas, Spleen. [Macroscopic and Surface anatomy].

9. Pelvis and Perineum: Structure of Pelvis, Rectum & Anus, bladder, prostate, Female genital tract, Male genital tract and inguinal-femoral region [Macroscopic and Surface anatomy].,

10. Lymphatic system and reticulo-endothelial system [Gross outline only] – Position and Function of Lymph nodal regions [including neck, axilla, mediastinum, paraaortic, inguinal], extranodal lymphatic tissues [Waldeyer's ring, Spleen and liver, MALT, bone marrow, Thymus

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CHAPTER – II: PATHOLOGY and RADIOBIOLOGY

Introduction: Teaching of Pathology and the clinical aspect of disease should be at the elementary level with the intention of providing a background to the students' understanding of the work being carried out in the department.

1. Elementary pathology – Degeneration and process of cell death, repair of wounds, inflammation, infection, immunity [Brief outline only].

2. Tumors – Definitions, causes, classification, spread, general effects.

3. Effects of radiation on the body – physical, chemical and biological effects of radiation [including radiation induced cell death]; Principles of Radiotherapy [Differential effects on tumors and tissues]- Therapeutic gain; four R's of Radiobiology and fractionation; Acute and late effects of different organs of the body including skin and mucous membrane; Effects of Whole body acute and chronic radiation exposure; Acute radiation syndrome; Lethal dose.

4. Factors modifying radiation effect : Patient related – age, state of health, tumor type, site, blood supply, oxygenation, organ at risk, previous treatment; Treatment related - Type of radiation, Dose, volume, total time and fractionation of treatment. LET, RBE and OER; Response to Radiation: Radiosensitivity and Radiocurability

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FINAL YEAR (2ND YEAR)

PAPER – III

RADIOTHERAPY PHYSICS , PART – II

Radiation Quantities and Units:

Kerma, Exposure, Absorbed Dose, Equivalent Dose, Weighting Factors, Effective Dose, Natural Background Radiation, Occupational Exposure Limits, Dose limits to Public.

Radiation Measuring Instruments:

Ionization Chamber, G.M. Counters, Scintillation Detectors, TL Dosimeters and their use in personnel monitoring badges, Pocket Dosimter. Advantages and disadvantages of various detectors.

Radiotherapy Treatment Techniques:

Historical development of Radiotherapy, physical components of Tele-cobalt unit, Linear Accelerator unit, Remote after Loading Brachytherapy unit, Gamma Knife unit, Medical Cyclotron, Simulator. Various types of sources used in Radiotherapy along with their properties.

Physical parameters of dosimetry such as Percentage Depth Dose, Tissue Air Ratio, Tissue Maximum Ratio, Physics of bolus and Phantom materials, Compensators, Wedges, breast device, Shielding Blocks, Patient immobilization devices, Port film, processing and development, Mould room procedures, different types of Brachytherapy, sources used in Brachytherapy, special techniques in Radiotherapy such as SRS, SRT, IMRT, IGRT and Tomotherapy.

Planning Procedure:

Manual contour diagram for isodose plan, tumor localization, field arrangement, use of isodose curves on body contours, estimation of resultant dose on tumor, tissue inhomoginity correction, correction of body curvature, irregular shaped fields, large and very large fields, field junction and field matching.

Quality Assurance in Radiotherapy:

Tools used for QA tests such as Front Pointer, Back Pointer, Laser Alignment etc. Optical and radiation field congruence, Beam shaping locks, beam shaping jaws, Delineator/Diaphragm movements, Isocentric alignment, patient support system, Beam off and on mechanisms, Technician's role in QA tests on Telecobalt/Linear Accelerator/Brachytherapy/Simulator/CT Simulator machines.

Radiation Emergency Preparedness:

Safety and security of radiation sources, case histories of emergency situations and preparedness, equipments and tools including role of Gamma Zone Monitor, Regulatory requirements and prevention of emergency, preventive maintenance and safety culture, role of technicians in handling emergencies.

Radiation Hazard evaluation and control:

Philosophy of radiation protection, Effect of time, Distance and Shielding, calculation of workload, calculation of weekly dose to the radiation worker and general public, good work practices in Radiotherapy, Planning consideration for radiation equipments installation including workload, use factors, effect of different shielding material.

Biological effects of radiation:

The cell, effect of ionization radiation on cell, chromosomal aberration and its application for the biological dosimetry, Somatic effects and hereditary effects, stochastic and deterministic effects, Acute exposure and chronic exposure, $LD_{50/60}$.

Regulatory requirements:

National Regulatory Body, Responsibilities, Organization, safety standards, codes and guides, Responsibilities of licensees, registrants and employers and enforcement of Regulatory requirements.

Demonstration:

- Time, Distance and shielding, measurement of HVT & TVT.
- Familiarization of radiation survey meters and their functional parameters checks.
- Radiological Protection Survey of Radiotherapy installation.

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PAPER – IV

RADIOTHERAPEUTIC PRACTICES & PRINCIPLES OF TREATMENT

Introduction: The emphasis in this subject will be on practical instruction and demonstration.

1. Methods of diagnosis (Elementary principles) – Clinical, radiographic, histological/cytological and biochemical methods.

2. Staging of cancer and their clinical importance[Brief outline].

3. Treatment modalities: General principles of Medical, Surgical and Radio therapeutic methods.

4. Principles underlying choice of treatment -- Age and Performance status of patient, Co morbid conditions, Type of neoplasm [sensitivity to a particular treatment modality], Stage of disease, Accessibility, Nature of tumor bed (Relation to bone, Air and Organ at Risk); Radical and palliative treatment.

5. Cancer in special sites (A brief description of pathology, symptoms, signs, complications, natural history of disease in each site and methods of treatment with **particular reference to radiotherapy techniques** should be given)

i. Head and Neck: Oral Cavity & Lips, Pharynx, Larynx, Nasal Cavity and Para nasal sinuses, Salivary glands, Ear.
ii. Orbit and its content
iii. Thyroid gland
iv. Thorax: Esophagus, Lung, Mediastinum [including Thymus]
v. Abdomen: Stomach, Small intestine, Colon, Liver, Gall Bladder and Pancreas and Kidney.
vi. Pelvis: Testis, Prostate Bladder and Penis, Uterine cervix, Endometrium, Ovary, Vagina, Vulva, Rectum, Anus.
vii. Breast.
viii. Bone tumors and Soft tissue sarcoma.
ix. Brain, Spinal cord and Pituitary.
x. Lymphoid and other hematological malignancies.
xi. Skin.
xii. Benign diseases

6. Care of patients undergoing radiotherapy: Behavior and Physical and emotional support to the patients; Identifying toxicities and other problems; Routine check up and verifications; Care of toxicities; When and how to communicate with Radiation Oncologist and Medical Physicist.

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