ORDINANCE No. V-46 (B10)

ORDINANCE RELATING TO MD (Radiation Oncology) COURSE AND SYLLABUS

CHAPTER-1

1. This ordinance may be called the "ordinance relating to MDRadiation Oncology course and syllabus"
2. It shall come into force with immediate effect.

CHAPTER-2

SELECTION PROCEDURE AND ELIGIBILITY

1. Students for Post Graduate medical courses shall be selected strictly on the basis of their academic merit.
2. For determining the academic merit, the university shall follow the criterion of: merit as determined by the competitive test conducted by a competent authority
3. The minimum percentage of marks for eligibility for admission to Post Graduate medical courses shall be as per the guidelines issued by apex regulatory body and Central and state government
4. The eligibility for the MD Radiation Oncology course shall be strictly as per the NMC rules and regulations

CHAPTER-3 CURRICULUM

SUBHARTI MEDICAL COLLEGE, MEERUT

MD (Radiation Oncology)

(Programme code – RT-)

Year of Implementation: 2023 – 24

ORDINANCE

DEPARTMENT OF RADIATION ONCOLOGY

SUBHARTI MEDICAL COLLEGE

SWAMI VIVEKANAND SUBHARTI UNIVERSITY

MEERUT (U.P.) 250005

AIM

The aim of teaching postgraduate students in radiation oncology is to prepare them to have adequate knowledge in the subject, covering both theoretical and practical knowledge, in accordance with the institutional goals.

The end product should have acquired knowledge, skills, aptitude and attitudes to be able to function as an independent clinician/consultant and a teacher acquainted with research methodology.

PROGRAMME GOAL

The goal of MDRadiation Oncology course is to produce a competent radiation oncologist who:

Recognizes the health needs of patients and carries out professional obligations in keeping with principles of National Health Policy and professional ethics

• Has acquired the competencies pertaining to radiation oncology that are required to be practiced in the community and at all levels of health care system

• Has acquired skills in effectively communicating with the patients, family and the community.

• Is aware of the contemporary advances and developments in medical sciences.

• Acquires a spirit of scientific enquiry and is oriented to principles of research methodology.

• Has acquired skills in educating medical and paramedical professionals

PROGRAMME OBJECTIVES

Curriculum objective has been to impart essential clinical knowledge so that he/she becomes capable of working up and treating a oncological problem in a logical way inculcating preventive and socioeconomic aspects also in care The objectives of postgraduate degree training programme - in terms of knowledge and skills – are to enable a candidate to

• Recognize the key importance of medical problems in the context of the health priority of the country • Practice the specialty of Radiation Oncology in keeping with the principles of professional ethics

• Identify social, economic, environmental, biological and emotional determinants of Radiation Oncology and know the therapeutic, palliative, rehabilitative, preventive and promotion measures to provide holistic care to all patients

• Take detailed history, perform full physical examination and make a clinical diagnosis; Perform and interpret relevant investigations (Imaging and Laboratory); Perform and interpret important diagnostic procedures;

• Diagnose illnesses in patients based on the analysis of history, physical examination and investigative work up.

• Plan and deliver comprehensive treatment for illness to his patients using principles of rational drug therapy; Plan and advice measures for the prevention of diseases.

• Plan rehabilitation of patients suffering from chronic illness, and those with special needs; manage emergencies efficiently.

• Demonstrate skills in documentation of case details, and of morbidity and mortality data relevant to the assigned situation

• Demonstrate empathy and humane approach towards patients and their families and respect their sensibilities.

• Demonstrate communication skills of a high order in explaining management and prognosis, providing counseling and giving health education messages to patients, families and communities.

• Develop skills as a self-directed learner, recognize continuing educational needs; use appropriate learning resources, and critically analyze relevant published literature in order to practice evidence-based medicine;

• Demonstrate competence in basic concepts of research methodology and epidemiology; Facilitate learning of medical/nursing students, practicing physicians, paramedical health workers and other providers as a teachertrainer

• Play the assigned role in the implementation of national health programs, effectively and responsibly.

• Organize and supervise the desired managerial and leadership skills;

• Function as a productive member of a team engaged in health care, research and education.

KNOWLEDGE: At the end of the course, upon successful completion of training and passing the examination the student is expected to

➢ Acquire comprehensive knowledge of the basics of radiation oncology including all allied specialties related to oncology like anatomy, oncopathology, infections, immunology, preventive oncology, epidemiology, pediatric oncology etc.

➢ Acquire knowledge in the interpretation of common Onco-imaging investigations such as, CT scanning, PET scanning, MRI scanning, MR spectroscopy and Single Photon Emission Computerized Tomography ultra sound etc.

➢ Possess a complete knowledge of all the commonly used oncology procedure diagnostic tests like core needle biopsy, FNAC, ascitic tap, thoracentesis, Bone marrow aspiration / biopsy, CSF tapetc.

➢ Possess knowledge of the recent advances in the subject of radiation oncology and all its allied specialties and working knowledge of the sophisticated and routine equipments.

➢ Possess basic knowledge in Medical Physics, Radiobiology, Genetics and Molecular biology related to oncology

➢ Possess knowledge of principles of research work in the field of radiation oncology and medical oncology in both the clinical and experimental field with the ability to analyze data.

➢ Acquire knowledge in the interpretation of special technique such as IMRT, IGRT, SBRT / SRS, VMATBrachytherapy, Computerized TPS, CT Simulation etc..

SKILLS

➢ Diagnose and manage majority of conditions in the specialty of Radiation oncology on the basis of clinical assessment, and appropriate investigations.

➢ Possess complete clinical Diagnostic Skills for the recognition of common Oncology diseases.

➢ Acquire skills in the interpretation of special investigations such as CT scanning, PET scanning, MRI scanning, MR spectroscopy and Single Photon Emission Computerized Tomography etc.

➢ Acquire skills in invasive procedures such as lumbar puncture, intrathecal drug administration, pleural tap, ascitic tap and interpretation of relevant histopathology etc.

➢ Acquire exposure in Brachytherapy procedures such as Intra Cavitory, Interstitial, Surface Mould etc.

➢ Able to apply sound clinical judgment and rational cost effective investigations for the diagnosis and management of Oncology Cases in the OPD, WARDs, Emergency Room and Day Care Unit.

➢ Able to do 2-D planning, 3-D planning and treat patients on tele-cobalt therapy, linear accelerator etc.
➢ Able to teach undergraduate MBBS and Post Graduate Students in the subject of Radiation oncology.

➢ Able to perform Clinical and Investigative studies and to present in Seminars, meetings, journal club and conference etc.

➢ Have the ability to organize specific teaching and training program for paramedical staff, associated professionals and patient education programmes.

➢ Should be able to develop good communication skills and give consultations to all other departments of the hospital.

➢ Demonstrate skills in documentation of individual case details as well as morbidity and mortality data relevant to the assigned situation.

➢ Demonstrate empathy and humane approach towards patients and their families and exhibit interpersonal behavior in accordance with the societal norms and expectation.

➢ Develop skills as self-directed learner recognize continuing educational needs: select and use appropriate learning resources.

ELIGIBILITY CRITERIA FOR ADMISSIONS TO THE PROGRAMME

MD Radiation Oncology Course (3 years course)

(A) Any medical graduate withMBBS qualification, who has qualified the Entrance Examination conducted by NMC and fulfill the eligibility criteria for admission to Post Graduate courses at various NMC accredited Medical Colleges in India is eligible to participate in the Centralized counseling for allocation of MDRadiation Oncology seats purely on merit cum choice basis.

(B) Duration of Course: • Post MBBS - 3 Years Every candidate admitted to the training program shall pursue a regular course of study (on whole time basis) in the concerned recognized institution under the guidance of recognized post graduate teacher for assigned period of the course

TEACHING AND TRAINING ACTIVITIES

First year	Basic Sciences related to Oncology (Anatomy, Physiology, Biochemistry, Pathology, Pharmacology, Medical Physics and Radiobiology), by way of didactic lectures, symposia etc. Patient care, history taking, cancer registry and clinical examination, case-sheet writing, preparing discharge summaries, supervised emergency calls, academic activity
Second Year	Overall in-charge of hot area, treatment planning and simulation, mould room, ward work, chemotherapy administration, OPD, Emergency calls. Work related to dissertation.
Third year	Academic activity, Emergency calls, assisting and managing operation theatres for Brachytherapy, Posting in other Oncology centre(s) for 1 month in the beginning of final year. Desirable: Training in advanced technique of radiotherapy.

Minimum radiotherapy exposure required for the trainees:

Mandatory: - 200-250 cases exposure at least for the whole training program. Minimum 30 independent radiotherapy for 3-year course; performed independently/ under supervision on the Linear Accelerator including Brachytherapy.

- At least one Brachytherapy OT in two weeks.

- If any of the sub specialties is not available, the trainee may be posted to other centers where such sub

specialty is available for 4 weeks.

Practical Surgical training curriculum: 3 years

First Year	2 D planning, 3 D planning, Equipments related to radiotherapy, Treatment planning system, simulation and verification etc.
Second Year	Treatment execution, electron beam therapy, Brachytherapy planning, Quality Assurance in radiotherapy, Conformal radiotherapy, use of chemotherapeutic agents, etc.
Third Year	Combined modality therapy, Palliative & Supportive care, latest technique of radiotherapy like IMRT, IGRT, Stereo tactic Radio surgery and Stereo tactic Radiotherapy etc.

Independent radiotherapy and Brachytherapy (supervised), CTRT etc .

Attendance (paper/ poster presentation) in Radiation Oncology / Oncology conferences/workshops: Minimum oneduring 3 year and

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Publication of papers (in peer reviewed journals): at least one.

Theory Syllabus

Paper I

Paper II

Paper III

Paper IV

Paper - I

Radiation Physics and Basic Sciences Related to Radiotherapy - Pathology, Anatomy, Bio chemistry etc.

A. Basic Science related to radiotherapy:

Theory

a. Basics of anatomy relevant to clinical practice i.e. surface anatomy of various viscera, neuroanatomy, important structures/organs anatomical location in the body, details of lymphatic system of all regions, cross sectional anatomy.

b. Basic functioning of various organ system, central of vital functions, pathophysiogicial alternation in diseased states, interpretation of symptoms & signs in relation to pathophysiology.

c. Pathological changes in various organs associated with tumors & their correlation with clinical signs, understanding of various pathogenic processes & possible therapeutic intervention, possible distinction between different types of tumors, grading, immunological effects & genetic alterations.

d. Knowledge about various microorganisms important for their pathogenic potential, important organism commonly seen in clinical practice, levels of therapeutic interventions possible in preventing and/or eradicating organism.

e. Knowledge about pharmacokinetics & Pharmacodynamics of the Cytotoxic and other drugs used for the management of cancer & common problems in a person & in a patient with disease kidneys/liver etc which may result in alternation in metabolism/excretion of the drugs; rationale use of available drugs.

B. Physics Related to Radiotherapy

Structure of Matter: Constituents of atoms, Atomic and mass numbers, Atomic and mass energy units, Electron shells, Atomic energy levels, Nuclear forces, Nuclear energy levels.

Electromagnetic radiation, Electromagnetic spectrum, Energy quantization, Relationship between wavelengths, Frequency, Energy

Nuclear Transformation: Natural and artificial radioactivity, Decay constant, Activity, Physical and Biological Effective half-lives, Mean life, Decay processes, Radioactive series, Radioactive equilibrium

Production of X-rays: The X-ray tube, Physics of X-ray production, Continuous spectrum, Characteristic spectrum, Effective of X-ray production, Distribution of X-rays in space, Specifications of beam quality, Measurement of beam quality, Filters and filtration.

Interaction of radiation with matter: Attenuation, Scattering, Absorption, Transmission, Attenuation coefficient, Half Value (HVL), Energy transfer, Absorption and their coefficients, Photoelectric effect, Compton Effect, Pair-production, Relative importance for different attenuation processes at various photon energies.

Electron interactions with matter: Energy loss mechanisms- Collis ional losses, radioactive losses, Ionization, Excitation, Heat production, Delta rays, Polarization effects, Scattering, Stopping power, absorbed dose, secondary electrons.

Interactions of charged particles: Ionization vs. Energy, Stopping power, Linear Energy Transfer (LET), Bragg curve, Definition of particle range.

Measurement of radiation: Radiation Detectors: Gas, Solid-state, Scintillation, Thermo luminescence, Visual Imaging (Film, Fluorescent screens) and their example.

Exposure, Dose, Kerma: Definitions Units (Old, New), Inter-relationships between units, Variation with energy and material. Measurement of exposure (Free are chamber, Thimble chamber), Calibration of therapy beams: Concepts, Phantoms, Protocols (TG 21, IAEA TRS-277, TG 51) dose determination in practice *(brief outline only, details not required)*

Radiotherapy Equipment:

Grenz ray, Contact, Superficial, Orthovoltage& Deep therapy, Super voltage, Mega voltage therapy. Therapy and diagnostic X-ray units - comparison. Filters, factors affecting output, principle of cooling, Betatrons.

Co-60 units: Comprehensive description of the unit, Safety mechanism, Source capsule. Linear accelerators: History, development, detailed description of modern, dual mode linear accelerator, Linac head and its constituents, safety mechanisms, computer controlled linacs, record and verify systems.

Relative merits and demerits of Co-60 and Linac units

Simulators: Need for them, detailed description of a typical unit, CT Simulator

Basic ratios, Factors, Dose distribution, Beam modifications and shaping in Teletherapy beams

Characteristics of photon beams: Quality of beams, Difference between MV and MeV, Primary and scattered radiation.

Percentage depth dose, Tissue-Air Ratio, Scatter Air Ratio, Tissue-Phantom Ratio, Tissue Maximum Ratio, Scatter Maximum Ratio, Back Scatter Factor, Peak Scatter Factor, Off-Axis Ratio, Variation of these parameters with depth, field size, source-skin distance beam quality or energy, beam flattering filter, target material. Central axis depth dose profiles for various energies.

Equivalent square concept, Surface dose (entrance and exit), Skin sparing effect, Output factors.

Practical applications: Co-60 calculations (SSD, and SAD technique), Accelerator calculations (SSD, and SAD technique)

Beam profiles, Isodose curves, Charts, Flatness, Symmetry, Penumbra (Geometric, Transmission and Physical), Field size definition

Body inhomogeneities: Effects of patient contour, Bone, Lung cavities, Prosthesis on dose distribution. Dose within bone / lung cavities, Interface effects, Electronic disequilibrium.

Wedge filters and their use, Wedge angle, Wedge Factors, Wedge systems (External, In-built Universal, Dynamic / Virtual), Wedge Isodose curves

Other beam modifying and shaping devices: Methods of compensation for patient contour variation and / or tissue in homogeneity - Bolus, Buildup material, Compensators, Merits and Demerits. Shielding of dose limiting tissue: Non-divergent and Divergent beam blocks, Independent jaws, Multileaf collimators, Merits and Demerits.

Principles of Treatment Planning - I

Treatment planning for photon beams: ICRU 50 and NACP terminologies. Determination of body contour and localization: Plain film, Fluoroscopy, CT, MRI, Ultrasonography, Simulator based.

Methods of correction for beam's oblique incidence, and body inhomogeneities

SSD technique and Isocentric (SAD) technique: Description and advantages SAD technique

Combination of field: Methods of field addition, Parallel opposed fields, Patient thickness vs. Dose uniformity for different energies in a parallel opposed setup, multiple fields (3 fields, 4 field box and other techniques). Example of above arrangements of fields in SSD and SAD techniques, Integral Dose.

Wedge field technique, rotation Therapy (Arc, and Skip), tangential fields. Beam balancing by weighting. Total and hemi-body irradiation, field junctions.

Principles of treatment planning - II

Limitations of manual planning. Description of a treatment planning system (TPS): 2D and 3D TPS. Beam data input, Patient data input (simple contour, CT, MR data, Advantages of transfer through media), Input devices (Digitizer, floppies, DAT devices, Magneto-optical disk, direct link with CT, MR). Beam selection and placement, Beam's Eye View (BEV), Dose calculation and display (Point dose, Isodose curves, Isodose surfaces, Color wash). Plan optimization, Plan evaluation tools: Dose-Volume Histograms (Cumulative and Differential), Hard copy output, Storage and retrieval of plans.

Alignment and Immobilization: External and internal reference marks, Importance of immobilization in radiotherapy, Immobilization methods (Plaster or Paris caste, Perspex casts, bite block, shells, head rests, neck rolls, Alpha-Cradles, Thermoplastic materials, polyurethane foams), Method of beam alignment (Isocentric marks, laser marks and front/back pointers).

Treatment execution: Light field, Cross hair, ODIs, Scales in treatment machines

Treatment verification: Port films, Electronic portal imaging devices, In-vivo patient dosimetry (TLD), diode detectors, MOSFET, Film etc) Changes in patient position, target volume, and critical volume during course of treatment

Electron Beam Therapy

Production of electron beams: Production using accelerators, Characteristics of electrons. Surface dose, percentage depth dose, beam profiles, Isodose curves and charts, Flatness and Symmetry. Beam collimation, variation of percentage depth dose and output with field size, and SSD, photon contamination. Energy spectrum, Energy specification, variation of mean energy with depth. Suitability of measuring instruments for electron beam dosimetry.

Treatment planning: Energy and field size choice, air gaps, and obliquity, Tissue in homogeneity lung, bone, air filled cavities. Field junctions (with either electron or photon beam). External and internal shielding. Arc therapy, use of bolus in electron beam.

Total Skin Electron Irradiation, Intraoperative Radiation Therapy

Physical Principles of Brachytherapy

Properties of an ideal Brachy therapy source, Source used in Brachy therapy : Ra-226, Cs-137, Ir-192, Au-198, Co-60, I-125, Sr-90 / Yt-90, Ru-106, Ta-182 and other new radionuclides, Their complete physical properties. Radium hazards. Source construction including filtration, comparative advantages / disadvantages of these radio nuclides.

Historical background. Radiation and Dose units: Activity used, Exposure, Absorbed Dose, mg-hr, curie, milli-curie destroyed, milligram Radium equivalent, roentgen, rad, Gray. Source strength specification, Brachytherapy Dose calibrator

Technique: Pre-loaded, after loading (manual and remote), Merits and Demerits. Surface, Interstitial, Intracavitary, Intraluminal, Intravascular brachy therapy, Low, Medium, High and Pulsed dose rates. Remote after loading machines, detailed description of any one unit.

Dosage systems: Manchester System (outline only), Paris System (working knowledge)

Treatment Planning: Patient selection, Volume specification, Geometry of implant, Number, Strength and Distribution of radioactive sources, Sources localization, Dose calculating, Dose rate specification, Record keeping, ICRU 38.

Radiation Safety: Planning of brachytherapy facility, Rooms and equipment, storage and Movement control, Source inventory, Disposal, Regulatory requirements.

Beta-ray brachy therapy including methods of use, inspection, storage and transport of sources, dose distribution

Unsealed radionuclides: Concept of uptake, distribution and elimination, activities used in clinical practice, estimation of dose to target tissues, and critical organs, procedures for administering radionuclides to patients.

Quality Assurance in radiotherapy (QART)

Overview of ESTRO QART: Need for a quality system in Radiotherapy, Quality System: Definition and practical advantages, Construction, Development and Implementation of a Quality System

Quality Assurance of Simulator, TPS, Co-60, linear accelerator

Acceptance testing of Simulator, TPS, Co-60, linear accelerator

Radiation Protection and Regulatory Aspects

Statutory Framework - Principle underlying International Commission on Radiation Protection (ICRP) recommendations. ICRP and National radiation protection i.e. Atomic Energy Regulatory Board (AERB) standards. Effective dose limits (ICRP and AERB).

Protection mechanisms: Time, Distance and Shielding. Concept of "As Low As Reasonably Achievable" (ALARA)

Personnel and Area Monitoring: Need for personnel monitoring, Principle of film badge. TLD badge used for personnel monitoring. Pocket dosimeter, Need for area monitoring, Gamma Zone monitors, Survey meters.

Regulatory aspects: Procedural steps for installation and commissioning of a new radiotherapy facility (Teletherapy and Brachytherapy). Approval of Standing Committee on Radiotherapy Development Programme. Type approval of unit. Site plan, Layout of installation/Associated facility: Primary, Secondary barriers, leakage and scattered radiation. Regulatory requirement in procurement of teletherapy/bachytherapy source(s). Construction of building, qualified staff, Procurement of instruments and accessories of unit and performance tests, Calibration of unit, RP & AD approval for clinical commissioning of the unit.

Other regulatory requirements: Regulatory consent NOCs, Periodical reports to AERB and Radiological Physics and Advisory Division (RP&AD) Bhabha Atomic Research Centre (BARC).

Advancements in Radiation Oncology

Virtual Simulation: Principle, CT-Simulation, TPS based simulation, Differences, Merits and Demerits, Practical considerations

Conformal radiotherapy (CRT): Principles, Advantages over conventional methods, Essential requirements for conformal radiotherapy.

Various methods of CRT:

1. With customized field shaping using conventional coplanar beams

2. Multiple non-coplanar MLC beams conforming to target shape

3. Stereotactic radiotherapy

4. Principle of inverse planning and Intensity Modulated Radiation Therapy (IMRT)

- Using 3D compensators
- Static IMRT (Step and shoot technique)
- Dynamic IMRT (sliding window technique)
- Dynamic arc IMRT
- Micro-MLC
- Tomotherapy methods

5. Time gated (4D) radiotherapy

Merits and demerits of IMRT

Stereo tactic irradiation methods: Physics principles, Techniques, Description of units (Gamma knife and Linac based) Merits and demerits, Stereo tactic Radio surgery (SRS) and Stereo tactic Radiotherapy (SRT), Whole body stereo tactic frame

Networking in radiotherapy: Networking of planning and treatment units in a radiotherapy department including Picture Archival Communication System (PACS), Advantages, Patient Data Management.

Paper II

Urinary tract, Genital tract, Breast, Respiratory system, childhood tumors, head & Neck, Mediastinum, Hematepoietic system.

1. Head & Neck

i. Combined modality therapy (Surgery/Radiotherapy/ Chemotherapy) in advanced Squamous cell carcinoma of head & neck
ii. Eye & Orbit
iii. Nasopharynx
iv. Nasal cavity & Para nasal sinuses
v. Salivary glands
vi. Oral cavity
vii. Oropharynx
viii. Hypopharynx
ix. Larynx
x. Management of neck nodes including malignancy of unknown origin
xi. Thyroid

2. Thoracic Tumors

i. Lung: a. NSCLC
b. SCLC

ii. Thymus
iii. Esophagus
iv. Mediastinum

3. Breast

i. Early breast cancer
ii. Locally advanced
iii. Recurrent breast cancer
iv. Metastatic breast cancer

4. Genitourinary Tract

i. Kidney, renal pelvis and ureter
ii. Bladder

5. Male genitourinary tract
    i. Low risk prostate cancer
    ii. Intermediate & high risk prostate cancer
    iii. Testis
    iv. Penis & male urethra
6. Female genito urinary tract
    i. Cervix
    ii. Endometrium
    iii. Ovary & Fallopian tubes
    iv. Vagina, Vulva & Female urethra

7. Hematological Tumors – CLL, CML, ALL, AML other leukemia's, multiple myeloma
    i. Hodgkin's lymphoma
    ii. Non Hodgkin's lymphoma
    iii. Leukemia
    iv. Cutaneous T- Cell lymphoma
    v. Leukemia

8. Pediatric tumors
    i. CNS Tumors in children
    ii. Wilms' tumors
    iii. Neuroblastoma
    iv. Rhabdomyosarcoma
    v. Ewing's tumor
    vi. Lymphomas in children

Paper III

Skeletal system, Reticulo-endothelial system, Central Nervous System, Skin, Gastro Intestinal Tract, Chemotherapy pertaining to human malignancy.

1. Sarcomas of bone and soft tissues

i. Osteosarcoma

ii. Soft tissue sarcoma

iii. Non malignant disease

2. Lymphoma – H.D, NHL, Cutaneous T cell Lymphoma

i. Hodgkin's lymphoma

ii. Non Hodgkin's lymphoma

iii. Leukemia

iv. Cutaneous T-cell lymphoma

3. Primary Intra Cranial Tumors

i. Low grade Gliomas

ii. High grade Gliomas

iii. Pituitary

iv. Spinal canal

v. Ependymoma and other adult brain tumors

4. Skin

i. Skin

ii. AIDS related malignancy

5. Gastro Intestinal Tumors

i. Stomach and small intestine

ii. Pancreas

iii. Liver &hepato biliary tract

iv. Colon and rectum

v. Anal canal

6. Chemo therapy - Clinical chemotherapy

Basic Principles of Chemotherapy

- Chemotherapy drugs

- Newer chemotherapy agents
- Basis for designing different chemotherapy schedules. Standard chemotherapy schedules.
- Chemotherapy practice in various malignancies.
- Chemotherapy practice and results/toxicities in sequential and concomitant chemoradiotherapy.
- Supportive care for chemotherapy.
- The basic principles underlying the use of chemotherapeutic agents.

    1. Classification and mode of action of cytotoxic drugs. The principles of cell kill by chemotherapeutic agents, drug resistance, phase specific and cycle specific action.
    2. Drug administrations. General principles of pharmacokinetics; factors affecting drug concentration 'in vivo' including route and timing of administrations, drug activation, plasma concentration, metabolism and clearance.
    3. Principles of combinations of therapy, dose response curves, adjuvant and neoadjuvant chemotherapy, sanctuary sites, high dose chemotherapy, and regional chemotherapy.
    4. Toxicity of drugs. Early, intermediate and late genetic and somatic effects of common classes of anticancer drugs. Precaution in the safe handling of cytotoxic drugs.
    5. Endocrine manipulation and biological response modifiers. An understanding of the mode of action and side effects of common hormonal precautions used in chemotherapy (including corticosteroids). Use of the major biological response modifiers such as interferon's, interleukins and growth factors and knowledge of their side effects.
    6. Assessment of new agents. Principles of Phase I, II and III studies.
    7. Gene therapy.

Paper IV

Radiotherapy including radiobiology, Radioactive isotopes, recent advances, imaging system and their use in the treatment planning, benign diseases, palliative & supportive care.

1. Radiobiology

Introduction of Radiation Biology

Interaction of Radiation with matter

Types of radiation excitation and ionization. Radiation chemistry: direct and indirect effects, free radicals, oxygen effect and free radical scavengers, LET and RBE theory, dual action theory, intracellular repair, general knowledge of repair models.

Introduction to factors influencing radiation response.

Physical factors: dose, dose quality, dose rate, temperature

Chemical factor: Oxygen, radio sensitizers, radio protectors

Biological factors: type of organism, cell type and stage, cell density and configuration, age, sex.

Host factors: Partial and whole body exposure.

Relevance of radiation biology in radiotherapy.

Interaction of ionizing radiation on mammalian cells.

The cell: structure and function; relative radio sensitivity of nucleus and cytoplasm, mitosis, cell cycle, principle of DNA, RNA and protein synthesis, radiation effects on DNA, strand breakage and repair, common molecular biology technique.

Cell injury by radiation: damage to cell organelle like chromatids, chromosomes; interphase death, apoptosis, mitotic death, micronucleus induction, SLD, PLD. Oxygen effect: mechanism, hypoxia, OER, reoxygenation in tumors, significance in radiotherapy. Dose rate. Brachytherapy sources including ^{252}Cf. Radiobiology of low, high dose rate & pulsed brachytherapy, hyper fractionation, significance in radiotherapy. Effect of low LET and high LET radiation on cell. Cell survival curves.

Effect of sensitizing and protective agents. Dose modifying factors and their determination. Variation of response with growth and the progression of cell through the phases of cell cycle.

Physical factors influencing cell survival; relative biological effectiveness (RBE); its definition and determination, dependence upon linear energy transfer, dose, dose rate and fractionation. Hyperthermic and photodynamic injury.

Biological hazards of irradiation; dose protection and LET, effects on the embryo and the fetus, life shortening, leukaemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population. Biological basis of radiological protection.

Organ radio sensitivity and radio responsiveness, concept of therapeutic index.

Acute effects of Radiation

Concept of mean lethal dose

Radiation Syndromes: BM, GI, CNS, cutaneous

Suppression of immune System: mechanism, consequences

Total Body irradiation

Biological dosimetry: Blood counts, BM mitotic index. Chromosome aberrations in peripheral blood lymphocytes

Radiation accidents: typical examples

Radiation Effects on Major Organs/tissues

Acute & late effects on all normal organs & tissue including connective tissue, bone marrow, bones, gonads, eye, skin, lung, heart, central nervous system tissues, peripheral nerves, esophagus, intestine, kidney, liver & thyroid with special reference to treatment induced sequelae after doses employed in radiotherapy.

Normal tissue tolerances

Late effects of radiation (somatic)

Sterility, cataracts and cancer

Carcinogenesis: mechanisms in vitro and in vivo, oncogenes and antioncogenes.

Radiation induced cancer of occupational, medical or military origin.

Recent controversial results for low level exposure, risk estimates.

Late Effects of Radiation (Genetic)

Mutations*:* definition, types, potential hazards.

Low level radiations: sources, potential hazards, stochastic and deterministic (non-stochastic) effects, high background areas and cancer.

Effects of Radiation on Human Embryo & Fetus

Lethality, congenital abnormalities and late effects (Leukemia and childhood cancer) severe mental retardation. Doses involved.

Biology and Radiation Response of Tumors

Tumor growth; kinetics of tumor response. Growth fraction, cell loss factor.

Volume doubling times, potential volume doubling times, repopulation, and accelerated repopulation.

Radio curability: definition, factors involved, tumor control probability curves.

Factors determining tumor regression rates. Causes of failure to control tumors by radiation: tumor related, host related technical/mechanical errors.

Relationship between clonogen number and tumor control probability. Local tumor control and impact on survival.

Applied Radiobiology

Fractionation: rationale, factors involved (4 R's)

Time, dose, and fractionation relationship: Isoeffect curves, isoeffect relationships, e.g. NSD, CRE formalisms and their limitations, partial tolerance, means of summating partial tolerance, steepness of dose response curves.

Multi-target, two component and linear quadratic model. Alpha/beta ratios for acute and late effects and means of deriving these value. Isoeffective formulae. Clinical applications of the LQ model, hyper fractionation, accelerated fractionation, hypo fractionation, CHART, split dose treatments.

Brachytherapy - low dose rate, high dose rate and pulsed treatments.

Introduction to new techniques to optimize radio-curability; combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitizers, high LET radiation. Photodynamic therapy.

The volume effect, general principle and current hypotheses.

Shrinking Field technique.

Combination Radiation-Surgery

Pre-, post and intra-operative radiation.

Rationale, radiobiological factors, current clinical results.

Irradiation of sub-clinical disease, debulking surgery, importance of clonogen numbers.

Combination Radiation-Chemotherapy

Definitions of radio sensitizers, synergism, potentiation, antagonism.

Radiosensitzers: type, mechanism

Hyperthermia

Sources, rationale (historical example), advantages and disadvantages, thermo tolerance. Cellular damage: comparison and contrast with radiation, thermal and non-thermal effects of ultrasound, microwaves, radiofrequency, etc. General host responses (immunology, metastases).

Use along with radiotherapy and chemotherapy: optimum sequencing of combined modalities. Current limitations to the clinical use of hyperthermia.

High LET Radiation

Comparison and contrast with low LET radiation.

Neutron source (including 252Cf) and boron neutron capture (outline only). Advantages and disadvantages of neutrons, RBE values, hazards of low dose and low energy neutrons, RBE values, hazards of low dose and low energy neutron, use in radiotherapy, combination with low LET, current clinical results.

Other high LET particles: protons, high energy heavy nuclei, application to radiotherapy, current clinical results.

2. **Radio-active isotopes used for diagnosis & therapy.**
3. **Benign diseases-**
    - Radiotherapy in non malignant diseases.
    - Endovascular brachytherapy
4. **Palliative & Supportive care –**
    - Palliation of brain & spiral cord metastasis.
    - Palliation of bone metastasis
    - Palliation of visceral recurrences and metastases
    - Pain management.

DISSERTATION PROTOCOL& THESIS

The candidates are required to submit the thesis before 12 months of final year.Guidelines for Submission of Thesis Protocol & Thesis by candidates Research shall form an integral part of the education program of all candidates registered for MD. The Basic aim of requiring the candidates to write a thesis protocol & thesis/dissertation is to familiarize him/her with research methodology. The members of the faculty guiding the thesis/dissertation work for the candidate shall ensure that the subject matter selected for the thesis/dissertation is feasible, economical and original. The protocol for a research proposal (including thesis) is a study plan, designed to describe the background, research question, aim and objectives, and detailed methodology of the study. In other words, the protocol is the 'operating manual' to refer to while conducting a particular study. The candidate should refer to the NMC Guidelines for preparation and submission of Thesis Protocol before the

writing phase commences. The minimum writing requirements are that the language should be clear, concise, precise and consistent without excessive adjectives or adverbs and long sentences. There should not be any redundancy in the presentation. The development or preparation of the Thesis Protocol by the candidate will help her/him in understanding the ongoing activities in the proposed area of research. Further it helps in creating practical exposure to research and hence it bridges the connectivity between clinical practice and biomedical research. Such research exposure will be helpful in improving problem solving capacity, getting updated with ongoing research and implementing these findings in clinical practice.

Guidelines for protocol

The thesis protocol should be restricted to the following word limits.

• Title : 120 characters (with spacing) page

• Synopsis [structured] : 250-300

•Introduction : 300-500

• Review of literature : 800-1000

• Aimand Objectives : Up to 200

• Material and Methods: 1200-1600

• 15 - 25References [ICMJE style] from core articles related to topic.

It is mandatory to have Institutional Ethics Committee approval before initiation of the research work. The researcher should submit an appropriate application to the ethics committee in the prescribed format of the ethics committee concerned.

Guidelines for Thesis

1. The proposed study must be approved by the institutional ethics committee

2. The thesis should be restricted to the size of 100 pages (maximum). This includes the text, figures, references, annexure, and certificates etc. It should be printed on both sides of the paper; and every page has to be numbered. Do not leave any page blank. To achieve this, following points may be kept in view:

a. The thesis should be typed in 1.5 space using Times New Roman/Arial/ Garamond size 12 font, 1" margins should be left on all four sides. Major sections viz., Introduction, Review of Literature, Aim & Objectives, Material and Methods, Results, Discussion, References, and Appendices should start from a new page. Study proforma (Case record form), informed consent form, and patient information sheet may be printed in single space.

b. Only contemporary and relevant literature may be reviewed. Restrict the introduction to 2 pages, Review of literature to 10-12 pages, and Discussion to 8-10 pages.

c. The techniques may not be described in detail unless any modification/innovations of the standard techniques are used and reference(s) may be given.

d. Illustrative material may be restricted. It should be printed on paper only. There is no need to paste photographs separately.

3. Since most of the difficulties faced by the residents relate to the work in clinical subject or clinically-oriented laboratory subjects, the following steps are suggested:

a. The number of cases should be such that adequate material, judged from the hospital attendance/records, will be available and the candidate will be able to collect case material within the period of data collection, i.e., around 6-12 months so that he/she is in a position to complete the work within the stipulated time.

b. The aim and objectives of the study should be well defined.

c. As far as possible, only clinical/laboratory data of investigations of patients or such other material easily accessible in the existing facilities should be used for the study.

d. Technical assistance, wherever necessary, may be provided by the department concerned. The resident of one specialty taking up some problem related to some other specialty should have some basic knowledge about the subject and he/she should be able to perform the investigations independently, wherever some specialized laboratory investigations are required a co-guide may be co-opted from the concerned investigative department, the quantum of laboratory work to be carried out by the candidate should be decided by the guide & co-guide by mutual consultation.

4. The clinical residents are not ordinarily expected to undertake experimental work or clinical work involving new techniques, not hitherto perfected or the use of chemicals or radioisotopes not readily available. They should; however, be free to enlarge the scope of their studies or undertake experimental work on their own initiative but all such studies should be feasible within the existing facilities.

5. The residents should be able to freely use the surgical pathology/autopsy data if it is restricted to diagnosis only, if however, detailed historic data are required the resident will have to study the cases himself with the help of the guide/co-guide. The same will apply in case of clinical data.

6. Statistical methods used for analysis should be described specifically for each objective, and name of the statistical program used mentioned.

• Title- A good title should be brief, clear, and focus on the central theme of the topic; it should avoid abbreviations. The Title should effectively summarize the proposed research and should contain the PICO elements.

• Introduction- It should be focused on the research question and should be directly relevant to the objectives of your study.

• Review of Literature - The Review should include a description of the most relevant and recent studies published on the subject.

• Aim and Objectives - The 'Aim' refers to what would be broadly achieved by this study or how this study would address a bigger question / issue. The 'Objectives' of the research stem from the research question formulated and should at least include participants, intervention, evaluation, design.

• Material and Methods- This section should include the following 10 elements: Study setting (area), Study duration; Study design (descriptive, case-control, cohort, diagnostic accuracy, experimental (randomized/nonrandomized)); Study sample (inclusion/exclusion criteria, method of selection), Intervention, if any, Data collection, Outcome measures (primary and secondary), Sample size, Data management and Statistical analysis, and Ethical issues (Ethical clearance, Informed consent, trial registration).

• Results- Results should be organized in readily identifiable sections having correct analysis of data and presented in appropriate charts, tables, graphs and diagram etc.

• Discussion–It should start by summarizing the results for primary and secondary objectives in text form (without giving data). This should be followed by a comparison of your results on the outcome variables (both primary and secondary) with those of earlier research studies.

• Summary and Conclusion- This should be a précis of the findings of the thesis, arranged in four paragraphs: (a) background and objectives; (b) methods; (c) results; and (d) conclusions. The conclusions should strictly pertain to the findings of the thesis and not outside its domain.

• References- Relevant References [ICMJE style] should be cited in the text of the protocol (in superscripts).

• Appendices -The tools used for data collection such as questionnaire, interview schedules, observation checklists, informed consent form (ICF), and participant information sheet (PIS) should be attached as appendices. Attach the master chart.

LOG BOOK

A candidate shall maintain a log book of operations (assisted / performed) during the training period, certified by the concerned post graduate teacher / Head of the department / senior consultant on monthly basis.

This log book shall be made available to the board of examiners for their perusal at the time of the final examination.

The log book should show evidence that the before mentioned subjects were covered (with dates and the name of teacher(s) The candidate will maintain the record of all academic activities undertaken by him/her in log book .

1. Personal profile of the candidate
2. Educational qualification/Professional data
3. Record of case histories

4. Procedures learnt

5. Record of case Demonstration/Presentations

6. Every candidate, at the time of practical examination, will be required to produce performance record (log book) containing details of the work done by him/her during the entire period of training as per requirements of the log book. It should be duly certified by the supervisor as work done by the candidate and countersigned by the administrative Head of the Institution.

7. In the absence of production of log book, the result will not be declared

Leave Rules --- As per the rules notified by NMC from time to time

EXAMINATION

Theory Examination

1. The theory examination comprises of four papers, maximum marks 100 each.

2. There are 10 short notes of 10 marks each, in each of the papers. The number of short notes and their respective marks weightage may vary in some subjects/some papers.

3. Maximum time permitted is 3 hours.

4. Candidate must score at least 50% in the aggregate of four papers to qualify the theory examination.

5. The paper wise distribution of the Theory Examination shall be as follows:

PAPER 1: Physics and Basic Sciences Related to Radiotherapy - Pathology, Anatomy, Bio chemistry etc.

Paper 2: Urinary tract, Genital tract, Breast, Respiratory system, childhood tumors, head & Neck, Mediastinum, Hematopoietic system.

Paper 3: Skeletal system, Reticulo-endothelial system, Central Nervous System, Skin, Gastro Intestinal Tract, Chemotherapy pertaining to human malignancy.

Paper 4: Radiotherapy including radiobiology, radioactive isotopes, recent advances, imaging system and their use in the treatment planning, benign diseases, palliative & supportive care.

Practical Examination:

1. Maximum Marks: 300.

2. Comprises of Clinical Examination and Viva.The details are as follow

- One long case

- Two short cases
- Radiology viva
- Pathology specimen's viva
- Grand Viva

3. MD candidates shall also be examined in radiotherapy procedures.

4. Oral examination shall be comprehensive enough to test the candidate's overall knowledge of the subject.

5. Candidate must obtain a minimum of 50% marks to qualify for the Practical Examination

RECOMMENDED BOOKS

- Perez & Brady's Principles and Practice of Radiation Oncology
- Gunderson and Tepper's Clinical Radiation Oncology
- Abeloff's Clinical Oncology
- Radiation Oncology: A Question-Based Review
- Chabner, Bruce A; Longo, Dan L. Cancer Chemotherapy, Immunotherapy and Biotherapy: Principles and Practice.
- Khan, Faiz M. The physics of radiation therapy.
- Eric J Hall. Radiobiology for the Radiologist
- Barrett and Dobbs Practical Radiotherapy Planning
- Target volume definition in radiation oncology by Anca-Ligia Grosu, Carsten Nieder and Nils Henrik Nicolay.

SUGGESTED JOURNALS

- International Journal of Radiation Oncology, Biology and Physics
- Radiotherapy and Oncology
- Clinical Oncology
- Seminars in Oncology
- Seminars in Radiation Oncology

- Journal of Clinical Oncology
- Cancer
- Journal of cancer research and therapeutics
- Medical Physics
- Journal of Medical Physics
- Journal of Radiotherapy in Practice
- Practical Radiation Oncology