REGULATIONS AND CURRICULUM GOVERNING

MD RADIATION ONCOLOGY PROGRAM

(2024-25)

Name of the Constituent Unit/Centre: Yenepoya Medical college



Deralakatte, Mangalore, Karnataka.

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NOTIFICATION FROM THE UNIVERSITY

YENEPOYA

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YENEPOYA (DEEMED TO BE UNIVERSITY)

OFFICE OF THE REGISTRAR

No.: 56-ACM/11/2024

Date: 20.06.2024

NOTIFICATION

Sub: Syllabus approval of MD Radiation Oncology

Ref: 1. Resolution of the Academic Council at its 56th meeting held on 15.05.2024 vide agenda-11.
2. Resolution of the Executive Council at its 3rd meeting held on 11.06.2024 vide agenda-03.

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Pursuant to the resolutions cited in the above references, the Yenepoya (Deemed to be University) hereby notifies syllabus approval of MD Radiation Oncology under the Faculty of Medicine from the academic year 2024-2025.

REGISTRAR

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To:
PA to Vice Chancellor
Dean of Academics, Yenepoya (Deemed to be University)
Controller of Examinations
Dean, Faculty of Medicine
Professor & Head, Department of Radiation Oncology
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MD IN RADIATION ONCOLOGY

Preamble:

The purpose of PG education is to create specialists who would provide high quality health care and advance the cause of science through research & training.

Oncology is a highly specialized and technical discipline in clinical medicine comprising treatment with ionizing radiations and cytotoxic agents as major arms in non-surgical management and treatment of cancer. With a view to update, by inclusion of newer topics, and to provide a uniform syllabus and course contents in Indian universities and teaching medical institutions, the proposed guidelines provide course outlines based on recent developments in clinical medicine and other disciplines related to oncology.

The **goal** of providing training under this specialty is to enable the post graduate students to acquire complete knowledge in diagnosis and comprehensive management of cancer patients with radiotherapy. This clinical specialty is exclusively focused only on oncology at the post-graduate level. Hence, the doctors trained under this field, after completing their course, should be fully capable of handling cancer patients with non-surgical modalities of diagnosis and treatment. Besides, as per WHO, they should also be capable of guiding and coordinating cancer prevention (?), control, screening, early detection, rehabilitation, palliative and terminal care programs for these patients in the country as per the evolving needs and to meet the objectives of the National Cancer Control Programme of India. The post graduate students would also be expected to have acquired knowledge of various research methodologies, a broad based training in all aspects of cancer science and treatment and be able to plan/coordinate research studies in the departmental, and be a part of inter-departmental or multi-centric, national/international research programmes.

The PG students would have clinical management of these patients during radiation therapy and will also advise and supervise their palliative, supportive and terminal care, whenever needed, in coordination with other supportive staff. By the end of the three year course, the post graduate student is expected to have acquired a wide knowledge of malignant disease processes and efficient management of patients with cancer. The main emphasis during training shall be on radiotherapy (and combined practice with anti-cancer chemotherapy), but a good knowledge of general medicine, surgery, head & neck region, gynaecology and pathology as pertaining to Radiation Oncology.

The purpose of this document is to provide teachers and learners illustrative guidelines to achieve defined outcomes through learning and assessment. This document was prepared by various subject-content specialists. The Reconciliation Board of the Academic Committee has attempted to render uniformity without compromise to purpose and content of the document. Compromise in purity of syntax has been made in order to preserve the purpose and content. This has necessitated retention of “domains of learning” under the heading “competencies”.

SUBJECT SPECIFIC LEARNING OBJECTIVES

The objectives of the MD programme in Radiation oncology is to impart knowledge, practical skills and clinical experience in the non-surgical treatment of cancer.

A. Cognitive domain

The students after successful completion of their training, should have acquired knowledge in the following:

1. Theoretical and practical knowledge for competent, safe, compassionate & ethical multidisciplinary practice of oncology and should contribute to the future *developments in oncology.*
2. The epidemiology, etiology, pathology & natural history of human neoplastic diseases.
3. Knowledge, experience & skill in the clinical diagnosis of human neoplastic diseases.
4. Attain knowledge and a high level of technical expertise in all forms of radiation as a therapeutic tool used in radiotherapy
5. Knowledge of the adverse effects of radiation including radiation related accompaniments.
6. Knowledge and comprehension regarding the use of cytotoxic drugs and biological response modifiers etc in all clinical and research settings with detailed knowledge of adverse effects of these drugs.
7. Knowledge and comprehension with the role of surgery in the management of neoplastic diseases.
8. Knowledge and ability to judiciously combine various modalities in comprehensive, multi-disciplinary management of cancer patients; coordinate

with other specialty experts in the team and plan for use of radiation and cytotoxic drugs integrated into the overall treatment plan

9. A sound knowledge and capability to manage cancer patients as a whole, including

a) Management of oncological emergencies,

b) complications associated with malignant diseases and its management,

c) psychosocial problems,

d) prevention, rehabilitation and palliative care.

10. Knowledge and capacity to interpret current advances in cancer management and research (basic, clinical and applied aspects of research including radiobiology & molecular oncology).

11. Knowledge and capability to plan and coordinate community based screening, early detection, and awareness programmes including community-based research projects.

12. Basic knowledge of the different statistical methods used in collection, analysis and interpretation of data related to cancer (with special emphasis on planning & interpretation of clinical trials)

13. Knowledge and capability to set up the specialty department and facilities for Oncology in different parts of India.

14. Able to interact with the Government and other agencies as a nodal person for planning development of specialty of radiation oncology.

15. A broad knowledge of different types of investigations in the management of patients with cancer.

B. Affective Domain:

The student:

1. Should be able to function as a part of a team, develop an attitude of cooperation with colleagues, and interact with the patient and the clinician or other colleagues to provide the best possible diagnosis or opinion.

2. Always adopt ethical principles and maintain proper etiquette in dealings with patients, relatives and other health personnel and to respect the rights of the patient including the right to information and second opinion.

3. Develop communication skills to word reports and professional opinion as well as to interact with patients, relatives, peers and paramedical staff, and for effective teaching.

C. Psychomotor domain

The student, at the end of the course, should have acquired the following skills: I. Skills and Clinical Experience:

Considerable familiarity and skills in the application of imaging techniques, nuclear medicine procedures, pathology and other aids in the diagnosis and

management of cancers. Post graduate student**s need to have gained a wide range of experience in the areas of patient care which would include** investigation, diagnosis, treatment with radiation, and in palliative and supportive care and to have gained the practical experience detailed below:

1. Radiotherapy – Basic Techniques

a. *Positioning the Patient*

Setting up of a patient in each of the three basic treatment positions (supine, prone and lateral) to allow the patient to be planned and treated effectively and without discomfort,

Setting up the source skin distance for fixed FSD, and extended FSD treatment,

Setting up patients using laser beam alignment,

Making temporary and permanent marks on the patient for field positions (Gentian violet, tattoo).

b. *Immobilisation Techniques*

Application of some of the following immobilisation techniques: head clamp, Velcro strap, polystyrene beads, vacuum bag, breast arm rest,
The construction of thermoplastic beam direction shell.

c. *Methods of Target Volume Determinatio*

Performance of planning using direct vision of the tumour (eg skin tumours), from surface landmarks (eg the parotid bed, breast tumours), with direct screening using simulator (eg lung tumours, bone metastases), including opacification techniques (eg barium swallow, cystogram), by volume transfer to orthogonal radiographs (eg head and neck tumours, brain tumours), Volume determination from planning CT scans for creating a central axis plan and for 3-dimensional CT planning.

d. *Outline Techniques*

Use of manual techniques (flexi-curves, plaster of Paris bandage) and CT derived outlines.

e. *Basic Field Arrangements*

Planning of treatments (under supervision where necessary) using the following field arrangements: Single direct field, Opposed pair of fields using equal and unequal weightings, Opposed pair using wedges, Wedged right-angled pair, Wedged oblique pair, Plans using 3 and 4 fields, Total body irradiation.

f. *Tissue Compensation*

Planning of patients requiring tissue compensation using bolus, wedges and remote tissue compensators

g. ***Shielding***

Planning of patients using lead cut outs and lead masks for simple superficial tumours, Knowledge of the thickness of lead required for superficial, orthovoltage and electron treatments at various energies, Prescription and insertion of eye shields. h. ***Megavoltage Techniques***

Planning of patients incorporating simple lead blocking techniques using standard blocks and cast blocks from templates

i. ***Electrons***

The indications for, and planning of, electron treatments, including the selection of electron energy,
A technique for total skin electron therapy and experience of its use.

j. ***Dose Calculation***

Proficiency in the use of equivalent square tables, Performance of depth dose calculations for single fields and opposed fields using various energies, The principles applied to convert dose to machine units for a range of machines, The principles of computer based treatment planning.

k. ***Radiotherapy Prescriptions***

Writing radiotherapy prescriptions (countersigned where necessary) for all the field arrangements mentioned above, Understanding of dose specification as in ICRU 50 and 62.

l. ***Radiotherapy Machines***

Planning of patients for treatment on a full spectrum of equipment, including superficial x-ray therapy, megavoltage x-ray therapy and megavoltage electron therapy (also orthovoltage x-ray therapy and cobalt-60 therapy, if available)

m. ***Quality Assurance in External Beam Therapy***

Requesting portal imaging and interpreted their appearance satisfactorily in all sites Principles of *in vivo* dosimetry and interpretation of results

n. *Brachytherapy*

The insertion and removal of radioactive sources manually or using an appropriate after-loading device, Interpretation of subsequent check films, Interpretation of the corresponding dose calculation and writing of an appropriate prescription, Removal of live sources and the after-loading device, The placement of implants, Principles of oral and intravenous radionuclide therapy.

o. *Radiation Safety*

The role of the radiation safety and radiation protection supervisor,The meaning of and requirements for controlled and supervised areas and their location, The procedure to be adopted in the case of a spill of radioactive material, Quality assurance practices in radiotherapy and the procedures for dealing with errors in treatment delivery.

2. Radiotherapy Assessment and the Care of Patients on Treatment:

a. *Treatment Review Clinics*

Regular weekly treatment review clinics

b. *Treatment Checks*

Assessment of patient position and treatment field placement(s) in relation to the target volume at the start of treatment, Performance of checks during the course of treatment on the implementation of the treatment plan, position of shielding for critical normal structures and the use of portal imaging, Assessment of changes occurring in patient parameters during treatment and resultant modification of treatment when appropriate, Assessment of normal tissue reactions to radiotherapy, Use of dose volume histograms and in vivo radiation dosimetry techniques.

c. *Symptom Control*

Giving advice on skin care during radiation treatment and on the management of skin reactions, including desquamation, Managing mucosal reactions in oral cavity, oropharynx, nasopharynx, trachea, oesophagus, anus and vagina, Giving dietary advice during abdominal radiotherapy Managing radiation induced nausea and vomiting, diarrhoea, dysphagia, xerostomia and cystitis, Giving prophylaxis for radiation induced cerebral oedema, Giving advice on timing and extent of hair loss with respect to radiation dose, Giving advice for hospitalization, if necessary.

d. *Follow-up*

Managing acute and chronic radiation sequelae, such as pneumonitis, cystitis, chronic bowel complications, gynaecological sequelae (vaginal stenosis, vaginal dryness, infertility and dyspareunia)

3. Supportive and Palliative Care

a. *Pain Relief*

Drug treatment

A wide range analgesic techniques, including simple analgesics, mild and strong opioids, given by a variety of routes, Management of the complications of analgesics, including constipation, nausea, gastro-intestinal discomfort and analgesic intolerance.

Mechanical methods

Prescription, siting and evaluation of TENS analgesia, Referral of patients with refractory pain for procedures such as a nerve block, intrathecal analgesia, rhizotomy or orthopaedic stabilization.

Radiotherapy

Use of radiation to treat painful metastatic disease with single fractions, multiple fractions and hemi- body radiotherapy

b. ***Nausea and Vomiting***

Treatment of nausea and vomiting arising in advanced illness using anti-emetics,

Palliative management of sub-acute intestinal obstruction.

c. ***Anorexia and Dysphagia***

Management, where appropriate, with corticosteroids, progestogens and nasal gastric feeding

d. ***Pleural Effusions and Ascites***

Drainage of pleural effusions and ascites, Other treatments such as pleurodesis.

e. ***Depression and Anxiety***

Knowledge regarding treatment of depression at all stages of cancer management, using counselling and drug techniques with anti-depressants,

Knowledge regarding treatment of anxiety with counselling, anxiolytics and major tranquilisers.

f. ***Hospice Care***

Awareness of local hospice facilities,

A one week (at least) attachment to a hospice or palliative care team.

g. ***Counseling***

Counseling of patients and relatives at all stages of the disease

4. **Investigational Techniques**

a. ***Laboratory Investigations***

Interpretation of the results of haematological, biochemical and radioimmunoassay investigations

b. ***Radiology***

Attendance at regular radiological review sessions involving a consultant clinical radiologist for the examination of plain x-rays, CT scans, magnetic resonance imaging and ultrasound covering the whole spectrum of cancer radiology,

Current indications and techniques in interventional procedures.

c. ***Radiation Medicine Procedures***

Diagnostic Imaging – Gamma Camera, SPECT, PET Scanner, PET-CT and PET-MRI image fusion studies in treatment planning, response evaluation and follow up.

d. ***Pathology***

Attendance at regular pathological review sessions involving a consultant pathologist

e. ***Genetics in diagnosis, prognosis and treatment of cancer***

f. ***Other Procedures***

Indirect laryngoscopy
Lumbar puncture
Skin biopsy
Fibre optic naso-endoscopy
Pelvic EUA and cystoscopy

5. **Site or Disease Specific Procedures**

Assessment, treatment and follow-up, in detail, for each of the anatomical sites and types of tumour,
Presentation and assessment of patients discussed at multidisciplinary team meeting,
Staging,
Radiotherapy – adjuvant, radical and palliative,
Hormone and biological therapy,
Palliative care,

Appropriate follow up,

Acute and late side effects of treatment.

6. **Clinical Trials, Literature and Research**

The aims and format of Phase I to IV clinical trials,

Obtaining informed consent, following study protocols and using data forms,

Research programmes (although research experience is not a prerequisite),

Major areas of current research and of recent important publications,

Submission of a research project to an Ethics Committee,

Structure and functioning of local and national clinical and research cancer networks.

Ethics guidelines of research

7. **Communication and Publication**

Effective communication with colleagues, patients and their carers, Giving clear and comprehensive descriptions of disease processes, investigations and treatment,

Clear expression in English/local script and production of legible script,

Preparing work for publication.

Ethics of research publication

8. **Outpatient and Joint Clinics**

Participation in joint consultative clinics and regular general oncology outpatient sessions, Seeing review and new patients and planning their overall management.

9. **Resource Management and Quality Assurance**

Introduction to the resource management and quality assurance of an oncology service, so as to be able to develop these skills at a later stage

10. **Prevention**

A broad knowledge of the environmental causes of cancer and possible strategies for prevention

11. **Screening**

Details of screening programs for cervical, breast, Head & Neck, Lungs, Prostate, GIT and other cancers which might form a major proportion of cancer cases in the country in the years to come.

12**. Genetics**

The familial aspect of some cancers as in colorectal, breast, ovary, retinoblastoma, multiple cancer syndromes etc and the management of high risk families and genetic counseling.

SUBJECT SPECIFIC COMPETENCIES

1. Demonstrate the ability to diagnose and treat all cases of malignancies using updated guidelines in medical and radiation oncology with special ability to maintain inter disciplinary coordination.
2. Demonstrate the ability to address all emotional issues in patients and family members in relation to diagnosis, therapy, terminal care and mortality related to malignancies
3. Organise proper promotive and preventive care strategies in the community aimed at reducing the burden of care in malignancies
4. Lead and participate in planning and execution of team work related to establishment and maintenance of infrastructure related to radiation therapy, conforming to the updated guidelines
5. Plan and conduct research related to the topic
6. Demonstrate the ability to organise teaching / training sessions for students and health workers in topics related to cancer prevention and care.

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SYLLABUS

Course contents:

Subjects for Part - I (First Year) Paper - I

Basic Sciences

1. Applied Anatomy and Physiology

A. Applied anatomy of oral cavity, larynx, pharynx, paranasal sinuses, CSF pathways salivary glands, middle ear, external orbit, breast, broncho-pulmonary segments, mediastinum, oesophagus, liver, spleen, stomach, small and large bowels, pelvic and genitor-urinary organs (bladder, uterus, ovary, testis rectum, anal canal etc.), spinal segments

B. Lympahtic system and lymphatic drainage pathway of various organs

C. Relationship of vital structures

D. Surface Anatomy pertaining to various organs

E. Cross Sectional Anatomy pertaining to US/CT/MR/PET images

F. General principles of physiology of respiratory, cardio-vascular, nervous, biliary, reproductive and endocrine systems and fluid-electrolyte-metabolic balance

2. Various Investigative and Imaging Procedures including radio-isotope based procedures in Diagnosis, Staging, Treatment Planning and follow up of cancer patients

3. Pathology of Benign and Malignant Diseases

A. Carcinogenesis - epidemiological studies, molecular studies, genetic basis, oncogenes, tumour growth kinetics

B. Pre-cancerous conditions

C. Methods of dissemination of cancer and its biological behaviour

D. Degree of differentiation of cancer

E. Principles and methods of definite diagnosis

i). Surgical biopsy - various procedures of biopsy
ii). Exfoliative cytology
iii). Fine Needle Aspiration Cytology (FNAC) and biopsy
iv). Tumour markers

F. General histologic and cytologic features of malignancy including features of special staining, surface markers, intracellular markers

G. Classification of benign and malignant tumours and their interpretation

H. Molecular pathology, molecular basis of diagnosis and prognosis of cancers

I. Radiation pathology

4. Staging of various cancers:

i. Evolution of different staging systems for various cancers over the years.

ii. Clinical Staging, WHO Staging, TNM Staging, AJCC Staging and FIGO staging etc of various cancers, as applicable, with their inter-comparisons.

5. International Coding and classification of various neoplastic disorders

i. ICD-9, ICD-O and ICD-10 system of classification and coding of various tumours.

Paper II (Part I)

I. Radiation Physics

The following courses of study and the subjects are recommended for training in MD Radiotherapy and Oncology. It is essential that these topics be covered in detail for better understanding of the basics of radiation treatment, as per subject heads given below:

1. **Atomic and Nuclear Structure**
    A. Atomic structure
        1. Energy levels, binding energy
        2. Transitions, characteristic radiations
    B. Nuclear structure
        1. Mass, atomic and neutron numbers
        2. Nuclear binding energy
        3. Fission, fusion
        4. Nuclear reactors
2. **Radioactive Decay**
    A. Modes of decay
        1. N/P ratio, even-odd relationship
        2. Beta decay
        3. Positron decay and electron capture
        4. Alpha decay
        5. Isomeric transitions, gamma emission, internal conversion
    B. Mathematics of Radioactive Decay
        1. Units, half life, graphing
        2. Transient and secular equilibrium
        3. Radionuclide generators
    C. Natural Radioactivity
        1. Naturally occurring isotopes
        2. Decay series
    D. Artificial Radioactivity
        1. Production by neutron bombardment
        2. Fission products
        3. Production by charged particle bombardment
        4. Radioactivity equilibrium
3. **Production of X-rays**
    A. X-ray tubes
        1. Requirements for X-ray production
        2. Historical development

3. Focal spot size
4. Reflection and transmission targets
5. X-ray production efficiency

B. X ray circuits

1. Primary circuits
2. Secondary circuit
3. Filament circuit
4. Modes of rectification

4. High Energy Treatment Machines

A. Cobalt units
B. Van de graaff generators
C. Linear accelerators
D. Betatrons
E. Resonance transformers
F. Cyclotrons for neutron therapy
G. Microtron, Synchrocyclotron and Particle Accelerators

5. Interactions of X - and Gamma-rays

A. Attenuation of a beam of x- or gamma-rays
   1. Attenuation and absorption coefficients
   2. Attenuation in the body

B. Modes of interaction
   1. Photoelectric absorption
   2. Compton scattering
   3. Pair production
   4. Photo-disintegration

6. Interactions of Particulate Radiations

A. Types of interactions
   1. Elastic, inelastic
   2. Excitation, ionization

B. Properties of particulate radiations
   1. Specific ionization
   2. LET

C. Interactions of heavy charged particles and pions
    1. Bragg's peak
    2. Applications in radiation therapy
D. Interactions of electrons
    1. Interactions with electrons
    2. Interactions with nuclei
    3. Applications to radiation therapy
E. Neutron interactions
    1. Slow neutron interactions
    2. Fast neutron interactions
    3. Applications with radiation therapy
F. Radioactive sources used in diagnosis and therapy - Production and properties

7. Measurement of Radiation Exposure

A. Photon and energy flux density and fluence
B. The roentgen
C. Electronic equilibrium
D. Ionization chambers
    1. Free-air chambers
    2. Thimble chambers
    3. Condenser chambers
    4. Electrometers
    5. Extrapolation chambers
E. Exposure calibration of an X - or gamma - ray beam
    1. Selection of calibration variables
    2. Selection of chamber
    3. Positioning of chamber
    4. Corrections to readings
F. Quality assurance checks on radiation therapy units

8. Radiation Quality

A. Measures of quality
    1. HVL and effective energy

B. Factors influencing quality

1. Variations in quality across a beam
2. Filtration an acceleration potential

9. Measurement of Absorbed Dose

A. Units of radiation dose, dose equivalent, RBE-dose

B. Calculation of dose from exposure

C. Measurement of absorbed dose with an ionization chamber

1. Bragg-Gray cavity theory

D. Direct measurement of absorbed dose

1. Film
2. TLD
3. Calorimetry
4. Chemical dosimetry

10. Calibration of High Energy Photon and Electron Beams

A. Photons

1. Stopping power ratios and energy absorption coefcients
2. Acq
3. C

B. Electrons

1. C_E

11. Dose Distribution, External Beam Therapy

A. Dosimetric variables

1. Backscatter factor
2. Percent depth dose
3. Tissue - air ratio
4. Scatter - air ratio
5. Tissue - maximum and tissue-phantom ratios
6. Isodose distributions
7. Treatment time calculations
8. Fixed SSD and isocentric treatment techniques
9. Beam Modulation

B. Single and multiple field dose distributions

1. Corrections for wedges

2. Design for compensating filters
3. Corrections for surface obliquities
4. Corrections for heterogeneities
5. Dose perturbations at interfaces
6. Adjoining fields
7. Integral dose

C. Dose distribution for rotational therapy

D. Calculation of dose in large, irregular fields

12. Dose Distribution, Sealed Source Therapy

A. Handling of sealed radioactive sources

B. Dose distributions for sealed implant sources

C. Design of sealed source implants

D. Radium and its substitutes

E. Special techniques for ^{192}Ir and ^{125}Ir

F. Other sealed sources in therapy

13. Computerized Treatment Planning

A. External X-and gamma-ray beams

1. Rectangular fields
2. Irregular fields
3. Inverse Planning

B. Electron beams

C. Implanted sources

1. Intracavitary sources
2. Interstitial implants
3. Surface mould

14. **Radiation Protection from External Sources**

A. Concepts and units

1. Quality factors
2. Dose equivalent
3. Protection regulations

B. Treatment room design

1. Primary radiation
2. Scatter

3. Leakage
4. Special problems with high energy photon and electron beam
5. Special problems with neutron, proton and -meson

C. Sealed source storage

D. Protection surveys

E. Personnel monitoring

15. **Radiation Protection from Internal Sources**

A. Body burdens and critical organs

1. Effective half lives for uptake and elimination.

B. Internal dose computations

1. Locally absorbed radiation
2. Penetrating radiation

C. Handling radionuclide therapy patients

D. Licensing procedure for using radionuclides

16. **Planning of a Radiotherapy Department**

A. Building designs

B. Choice of various equipments and sources

C. Acceptance and Calibration Tests

D. Various maintenance steps and procedures

17. **New Radiation Modalities:**

A. Protons

1. Production
2. Processes of absorption
3. Depth dose patterns
4. Advantage compared with x-rays
5. Facilities available

B. Neutrons

1. Production
2. Processes of absorption
3. Depth dose patterns
4. Advantages compared with x-rays
5. Facilities available

C. Pions

1. Production
2. Processes of absorption
3. Depth dose patterns
4. Advantages compared with x-rays
5. Facilities available

D. High energy heavy ions

1. Production
2. Processes of absorption
3. Depth Dose Patterns
4. Advantages compared with x-rays
5. Facilities available

II. Radiobiology (Radiobiology and Laboratory Radiotherapy)

1. Mammalian Cell Radiosensitivity

A. Apoptosis, Interphase and reproductive death
B. Cell survival curves in vitro
C. Characterization of cell survival curves
D. Critical sites and target theory
   1. DNA
   2. Membranes
E. Dose response curves in vivo
   1. Skin clone
   2. Surviving crypts
   3. Bone marrow colonies growing in spleen, monolayer culture
F. Quantitative normal tissue reaction based on systems
   1. Pig skin
   2. Rodent skin
   3. Lung
   4. Esophagus
   5. Kidney
   6. CNS and spinal cord

2. Factors that Modify Radiation Response

A. The Oxygen effect

1. Effect of oxygen concentration
2. Time of action of oxygen
3. Mechanism of the oxygen effect
4. Implications for radiotherapy
5. Methods to overcome problems of hypoxic cells

B. The age response function

1. The cell cycle
2. Age response for cells cultured in vitro
3. Age response for tissues in vivo
4. Age response for neutrons
5. The oxygen effect through the cell cycle
6. Implications for radiotherapy

C. Potentially Lethal damage

1. Repair *in vitro*
2. Repair *in vivo*
3. PLD and high LET radiations
4. Implications in radiotherapy

D. Sublethal damage

1. Split-dose experiments with cell in vitro
2. Sublethal damage repair in normal tissues
3. Sublethal damage repair in tumours
4. Sublethal damage and hypoxia
5. Sublethal damage and high LET radiations
6. Dq as a measure of repair

E. Dose-rate

1. Dose-rate effects in cells *in vitro*
2. Dose-rate effect in normal tissues
3. Dose-rate effect in tumours
4. Interstitial therapy
5. Beam therapy at low dose rate

F. Radiosensitizers

1. The halogenated pyrimidines

2. Hypoxic cell radiosensitizers
    a. Structure and mode of action b. Enhancement ratio
    c. Metronidazole/misonidazole
    d. Pharmacokinetics in the human e. Clinical limitations
3. Antibiotics

G. Radioprotectors

1. Free radical scavengers

3. **Linear Energy Transfer**

A. Definition
B. Track and energy average
C. LET for different types of radiation
D. OER as a function of LET

4. **Relative Biological Effectiveness (RBE)**

A. Definition
B. RBE for different cells and tissues
C. RBE as a function of dose
D. RBE and fractionation
E. RBE as a function of LET
F. Q factor

5. **Cell and Tissue Kinetics**

A. The cell cycle
B. Autoradiography
C. Constituent parts of the cell cycle
D. Percent labeled mitoses technique
E. Growth fraction
F. Cell loss factor
G. Growth kinetics of human tumours

6. **Tissue Radiosensitivity**

A. Classification based on radiation pathology

B. Types of cell populations

1. Self renewal
2. Conditional renewal
3. Stem cell
4. Differentiated

7. **Time-Dose and Fractionations**

A. The 4 R's of radiobiology

B. The basis of fractionation

C. The Strandquist's plot

D. Nominal standard dose

E. Linear Quadrate equation

8. **Hyperthermia**

A. Methods of heating

1. RF microwaves
2. Ultrasound
3. Water baths

B. Systematic hyperthermia

C. Localized heating

D. Cellular response to heat

E. Repair of thermal damage

F. Thermotolerance

G. Hyperthermia combined with ionizing radiations

H. Time sequence of heat and irradiation

I. Hypoxic cells and heat

J. Effect of pH on the response to hyperthermia

K. Response of transplanted tumours to heat

L. Response of spontaneous tumours to heat

M. Response of normal tissues to heat

N. Heat and the therapeutic gain factor

O. Hyperthermia and chemotherapy

9. **Total Body Irradiation – Acute Effects**

A. Prodromal radiation syndrome

B. Central nervous system / cerebrovascular syndrome

C. Gastrointestinal syndrome

D. Haematopoietic syndrome

E. Mean lethal dose: (LD50)

F. Treatment of radiation accident

10. **Late Effects**

A. Probabilistic/Deterministic (Stochastic/Non-Stochastic) effects

B. Non-specific life shortening

1. Definition
2. In animals
3. In man

C. Carciongenesis

1. The latent period
2. Dose response curve in animals
3. Leukemia
4. Breast cancer
5. Thyroid cancer
6. Bone cancer
7. Skin cancer
8. Lung cancer
9. Other tumours
10. Malignancies in prenatally exposed children

11. **Mechanisms of Radiation Carcinogenesis**

A. Genetics of irradiation

1. Point mutations
2. Relationship to dose
3. Chromosome aberrations
4. Relationship to dose
5. Doubling dose
6. Genetically significant dose (GSD)
7. Genetic effect in humans
8. Background radiation in relation to the GSD

12. Radiation Effects in the Developing Embryo and Fetus

A. Intrauterine death

B. Congenital abnormalities including neonatal death

C. Growth retardation

D. Dependence of the above effects on dose, dose-rate and stage in gestation

E. Carcinogenesis following *in utero* exposure

F. Human experience of pregnant women exposed to therapeutic doses

G. Occupational exposure of potentially pregnant women

H. Elective booking or "10 day rule"

I. The "Practical threshold" for therapeutic abortion

III. Radiation Pathology:

1. Radiophysiology of Human Tissues

A. Effects or irradiation of the skin

1. Clinical manifestations
2. Histological substratum of effects
3. Repair
4. Degree of sequelae
5. Injurious effects

B. Effects of irradiation of bone and cartilage

1. Effects on growing bones and cartilage
2. Effects on adult bones and cartilage
3. Clinical manifestations
4. Histological substratum of effects
5. Functional consequences and sequelae

C. Effects of irradiation of the kidney

1. Clinical manifestations
2. Histological substratum of effects
3. Acute and chronic functional repercussions
4. Permanent Sequelae

D. Effects of irradiation of the lung

1. Acute clinical effects
2. Ultimate effects
3. Histologic substratum of effects
4. Measures to reduce final effects

5. Sequelae

E. Effects of irradiation of nervous tissues

1. Effects on the brain
2. Effects on the spinal cord
3. Effects on the peripheral nerves
4. Clinical manifestations
5. Histological substratum
6. Sequelae

F. Effects of irradiation of the ovary

1. Clinical manifestations
2. Histological substratum
3. Reversibility of effects
4. Therapeutic implications

G. Effects of irradiation of the testis

1. Clinical consequences
2. Histological substratum
3. Reversibility
4. Protective measures

H. Effects of irradiation of the eye

1. Clinical consequences
2. Histological substratum
3. Protective measures
4. Time-dose connotations
5. Sequelae-therapy

I. Effects of irradiation of lymphoid tissues

1. Clinical manifestations
2. Histological manifestations
3. Reversibility

J. Effects of irradiation of the bone marrow

1. Clinical and laboratory manifestations
2. Chronology of effects
3. Histologic substrarum
4. Recovery
5. Therapeutic applications

K. Effects or irradiation of the oral, pharyngolaryngeal and esophageal mucous membrane

1. Clinical manifestations
2. Histological manifestations
3. Repair
4. Sequelae

L. Effects of irradiation of the salivary glands

1. Acute manifestations
2. Histological substratum
3. Dental consequences
4. Prophylaxis

M. Radiation effects observable in clinical radiotherapy

1. Technological protection
2. Role of total dose
3. Role of fractionation
4. Measures of prevention
5. Therapeutic measures

N. Effects of irradiation of human embryo

1. Role of age
2. Role of dose
3. Teratogenic effects
4. Measures of prevention

O. SOMA Scales

IV. Basics of Chemotherapy:

A. Classification, mechanisms of action and pharmacokinetics of anti-cancer (cytotoxic) drugs including Biological Response Modifiers
B. Rationality of using cytotoxic drugs as single agents and as multi-drug protocol in various clinical settings
C. Dosages/Modes/routes of administration of cytotoxic drugs
D. Complications/adverse effects of various cytotoxic drugs

PART – II Paper I

Principles of Radiotherapy allied specialties

I. Clinical Practice of Radiotherapy and Oncology

A. Principles of Radiotherapy

1. General – Radiosensitivity and Radiocurability
   - Tumor lethal dose, Tissue Tolerance and Therapeutic Ratio (TR)
   - Factor influencing TR
   - Target Volume
   - Choice of Time, dose fractionation and technique
2. Teletherapy

Radiation factors

Megavoltage therapy

Orthovoltage therapy

Electron therapy

Heavy particle therapy (Neutron, photon, pi-meson)

3. Brachytherapy

Radium and its substitutes

Practice of - surface, intracavitary and interstitial

Clinical application

Rules and techniques

1. Newer developments
2. Afterloading
3. Low and high dose rates

B. Techniques of Radiotherapy

Small field beam directed therapy

Extended and irregular field therapy

Single, double and multiple field therapy

Beam modification therapy (wedge filter / compensator etc.)

Rotation and Arc therapy

IMRT, IGRT, Tomotherapy

Newer Techniques

Techniques in Brachytherapy

Intracavitary Interstitial

Mould application

Modern development and afterloading devices

C. Clinical Practice

Radical (curative)

Palliative

Pre-operative

Post-operative

Supplementary

Combination (both Pre- & Post operative – Sandwitch technique)

Nutritional care and local hygiene during and after therapy

D. Treatment Planning and Presentation

Mouldroom practices

Simulation

Computerised treatment planning system

Clinical dosimetry

Prescription and execution

E. General histologic and cytologic features of malignancy

F. Classification of benign and malignant tumours and their interpretation

II**. Related Specialties: surgical oncology and medical oncology**

A. Principles and practice of general surgery, gynecology an pediatric surgery as related to cancer

Surgical treatment decisions

Surgical diagnosis and staging of cancer

B. Cancer Chemotherapy and Hormones

Chemotherapy

Principles and clinical practice

Classification of drugs

Clinical application of

a. Single drug therapy

b. Polychemotherapy and various combinations

c. Adjuvant therapy

d. Prophylactic therapy

Complication of the chemotherapy and its management

Recent developments

Drug schedules

Hormone Treatment in Cancer

General principles

Role in cancers of the Breast, thyroid, prostate, kidney etc.

Complications and their management

C. Clinical staging and TNM system

Staging procedures

Methods of clinical staging an TNM classification

D. Terminal care of cancer patients – principles and practice of control of pain

E. Cancer registry and epidemiology

F. Prevention and early detection in cancer

G. Cancer education and oncology organization

H. Statistical methods

Papers II & III

A. Clinical Management in tumors of:

a. Head and Neck

Lip

Oral cavity

Oropharynx

Hypopharynx

Nasopharynx

Supraglottis

Vocal cord

Sub-glottis

Middle ear

Nose and nasal sinuses

Orbit and optic nerve

Lachrymal gland

Salivary gland

Glomus jugulare tumours

Carotid body tumours

Other sites in the region

b. Gastro-Intestinal Tract

Oesophagus

Stomach

Liver

Pancreas and biliary tract

Small bowel

Colon and rectum

Anal canal and peri-anal region

c. Chest

Pleura

Trachea

Lung

Mediastinum and thymus

d. Genito-Urinary Tract

Kidney

Ureter

Bladder

Urethra

Prostate

Penis

Testis

e. Female Genital Tract

Uterine cervix

Uterine body

Vagina

Vulva

Ovary

Fallopian tube

f. Central Nervous System

Brain

Spinal cord

Craniopharyngioma

Chordoma

Acoustic neuroma

Meninges

g. Soft Tissue Sarcomata and Bone Tumours

Adult soft tissue sarcoma

Childhood/adolescent sarcoma

Chondrosarcoma

Osteosarcoma

Ewing's tumour

h. Paediatric Tumours

Medulloblastoma

Neuroblastoma

Nephroblastoma

Retinoblastoma

Embryonal sarcomas

i. Lymphoproliferative and Myeloproliferative Disorders

Hodgkin's lymphoma

Non-Hodgkin's lymphomas

Plasma cell malignancies

Acute and chronic leukaemias

j. Skin

Basal cell carcinoma

Squamous cell carcinoma

Malignant melanoma

Cutaneous lymphoma

Kaposi's sarcoma

k. Endocrine

Breast

Thyroid

Parathyroid

Pituitary

Adrenal

l. Other tumours and tumour- like conditions

m. Metastatic cancer in unknown primary

B. For each of the tumour types and sites listed above, the post graduate students shall learn the:

a. Management

Initial staging investigations including imaging and tumour markers Role of PET-CT in modern day management of cancers Relevant prognostic factors Assessment for treatment

Role of surgery

A management plan, or, where applicable, a range of such plans Ionising Radiation Regulations Roles of surgery, radiotherapy and cytotoxic chemotherapy multimodality approaches to cancer treatment

b. Pathology

The range of tumours that can occur

Their aetiology, incidence and epidemiology

A brief morphology of the common tumours

The natural history of the disease including likely presentation, characteristic growth and metastatic pattern

Staging classifications eg TNM, WHO, FIGO, AJCC, AFIP

Use of tumour markers in diagnosis and treatment of tumours

Use of specialized pathology techniques, eg immunocytochemistry

Interpretation of clinicopathological data in the tumour site specialised multidisciplinary approach to patient management

c. Radiotherapy

i. The role of irradiation in radical and palliative management

ii. Where radical radiotherapy is a treatment option:

1. Staging investigations
2. A definition of tumour volume and target volume boundaries
3. ICRU, AAPM, ICRP reports relevant to clinical oncology

4. An acceptable radiotherapeutic technique, or, where applicable, a range of such techniques
5. The correct treatment position
6. Details of the target volume localization process
7. Use of CT axial images, 3D planning, Inverse Planning, IMRT, IGRT, Irregular shaped fields
8. Verification techniques such as laser alignment, skin tattoos, orthogonal and portal films
9. The approximate dose distributions for the chosen technique
10. An appropriate dose/fractionation regime
11. Relevant dose modifying factors (changes in fractionation, age, associated conditions, target volume, intercurrent infections, previous therapies)
12. Details of the set-up instructions for technologists
13. Appropriate responses to changes of patient parameters or interruptions during treatment
14. The possible acute and late side effects of the irradiation
15. Radiation dose modifying factors, chemotherapy timing in all forms of chemoradiation schedules

d. Drug Therapy: Basic knowledge and understanding of integrating with Radiotherapy

i. The role of cytotoxic, hormonal and biological drugs therapies in radical and palliative management

e. Outcomes

i. The expected outcomes of treatment

ii). ***Biological Therapies***

i. A basic knowledge of the clinical uses of currently used biological therapies including interferons, colony stimulating factors, interleukins, erythropoietin, other growth factors and preparations such as imatinib, geftinib, nimotuzumab, trastuzumab, rituximab, erlotonib etc.

f. **Oncological Emergencies**

The management of the following complications when they are related to cancer:

Ureteric obstruction

Spinal cord compression

Haemorrhage

Mediastinal superior vena caval obstruction

C. Radiotherapy for Benign Disease

The indications for radiotherapy in the treatment of benign conditions, including suitable techniques and dosage schedules, and likely benefits and risks

D. Complications of Treatment

The acute and late complications of oncological treatment and their management including:

Skin reactions

Nausea and vomiting

Diarrhoea

Oedema

Bone marrow toxicity

Neutropenic sepsis

Drug reactions

Cytotoxic extravasation

Alopecia

Cataract

Skin atrophy and ulceration

Colitis, proctitis, gut strictures and perforation

Renal effects

Cardiac effects

Pulmonary effects

Fibrosis and lymphoedema

Endocrine effects (thyroid, pituitary and salivary gland)

Effects on fertility

Incidence of second and radiation induced cancers

E. Symptom Control and Continuing Care

The available medical and surgical techniques for the control of pain, nausea, vomiting and malignant effusions

Treatment of various cancer related conditions and paraneoplastic syndromes including

Hypercalcaemia

Ectopic hormone production

Raised intra cranial pressure

Anaemia

F. Current Research and Literature

Current major research in progress in the form of multicentric trials

Recent major publications in oncology journals

Understanding evidence based medicine and how to read literature

Part IV: Recent Advances and Special Topics

Special Topics

A. Recent advances coming up in various fields as applicable to oncology
B. Causes of treatment failure and retreatment
C. TLI and TBI – Role, Philosophy and Techniques
D. Supportive care in Radiation treatment in combination with chemotherapy/surgery
E. Infections, nutritional and other problems in cancer patients
F. Preventive Oncology
G. Psychosocial aspects of cancer and Rehabilitation
H. Hospice Program
I. Immunotherapy and Role of Monoclonal antibodies in diagnosis, staging and management of cancer
J. Oncological Emergencies
K. Care and Nursing of patients on Radiotherapy and Chemotherapy
L. Cancer Control Programmes
M. International Classification and Coding of Cancer (ICD-9, ICD-O, ICD-10)

N. Research Methodologies in Cancer

This being a highly dedicated PG specialty introducing several new concepts/subjects in the course, it is recommended to divide the entire course into two components consisting of First Year of BASIC CONCEPTS OF THE SPECIALTY and the next two years of INTENSIVE CLINICAL TRAINING IN THE SPECIALTY.

The subjects recommended to be covered during the first year are:

- Basic Sciences including concepts of carcinogenesis & epidemiology of cancer
- Applied anatomy and physiology
- General pathology and pathology of tumours
- Medical physics related to Radiotherapy
- Radiobiology
- Radiation Pathology
- Classification, mechanisms of action and Pharmacokinetics of anti-cancer (cytotoxic) drugs
- Rationality of using cytotoxic drugs as single agents and as multi-drug protocol in various clinical settings
- Imaging techniques
- Staging of cancers of various sites.

The post graduate students should devote **next two years** in learning the science and art of practice of Oncology focusing upon radiotherapy along with knowledge of integration of other modalities in total management of cancer, as elaborated in the subsequent sections.

TEACHING AND LEARNING METHODS

Teaching Methodology

1. **Lectures:** Lectures are to be kept to a minimum. They may, however, be employed for teaching certain topics. Lectures may be didactic or integrated.

   a) **Didactic Lectures:** Recommended for selected common topics for post graduate students of all specialties. Few topics are suggested as examples:

      1) Bio-statistics

2) Use of library

3) Research Methods

4) Medical code of Conduct and Medical Ethics

5) National Health and Disease Control Programmes

6) Communication Skills

These topics may preferably be taken up in the first few weeks of the first year.

b) **Integrated Lectures:** These are recommended to be taken by multidisciplinary teams for selected topics.

2. Theory lectures: seminars in radiation physics, radiobiology, radiation pathology, basic and clinical oncology, clinical radiation therapy, chemotherapy, radiation techniques, computer applications, research methodologies etc.

3. Lectures in other allied disciplines like Psychiatry, Experimental Medicine (with special stress on organization of various research activities & trials in oncology), Community Medicine including preventive oncology, primary and secondary prevention of cancer, early detection and screening programmes in cancer, Planning of cancer control activities, rehabilitation and pain relief, etc.

4. **Journal Club & Subject seminars:** Both are recommended to be held once a week. All PG students are expected to attend and actively participate in discussion and enter in the Log Book relevant details. Further, every post graduate student must make a presentation from the allotted journal(s), selected articles at least four times a year and a total of 12 seminar presentations in three years. The presentations would be evaluated and would carry weightage for internal assessment. A time table with names of the student and the moderator should be announced at the beginning of every year.

5 **Student Symposium**: Recommended as an optional multidisciplinary programme. The evaluation may be similar to that described for subject seminar.

6. Case discussions, journal club

7. **Inter-departmental meetings:** strongly recommended particularly with the Department of Radiodiagnosis at least once a week. These meetings should be

attended by post graduate students and relevant entries must be made in the Log Book.

8. **Teaching Skills:** The postgraduate students shall be required to participate in the teaching and training programme of undergraduate students and interns.

9. Undertake audit, use information technology tools and carry out research, both basic and clinical, with the aim of publishing his work and presenting his work at various scientific fora.

10. Continuing Medical Education Programmes (CME): At least two CME programmes should be attended by each student in 3 years.

11. **Conferences:** The student should attend courses, conferences and seminars relevant to the speciality.

12. A postgraduate student of a postgraduate degree course in broad specialities/super specialities would be required to present one poster presentation, to read one paper at a national/state conference and to present one research paper which should be published/accepted for publication/sent for publication during the period of his postgraduate studies so as to make him eligible to appear at the postgraduate degree examination.

13. Department should encourage e-learning activities.

Note: During the training programme, each post graduate student shall be required to engage in a project under the supervision of a faculty member for a thesis or a dissertation.

Rotation: Postings:

- Posting in various divisions of the department – mould room, treatment planning, simulation room, teletherapy and brachytherapy facilities etc.
- Posting in Radiotherapy OPD and ward by rotation.
- Short postings in departments/divisions of Surgical Oncology, Medical Oncology, Palliative Care, Surgery, Medicine, Gynaecology, ENT, Pathology, Cytology, Haematology, Imaging, cancer registry, as per the direction from Head of the Department.

During the training programme, patient safety is of paramount importance; therefore, skills are to be learnt initially on the models, later to be performed under supervision followed by performing independently; for this purpose, provision of skills laboratories in medical colleges is mandatory.

ASSESSMENT

FORMATIVE ASSESSMENT, ie, during the training

Formative assessment should be continual and should assess medical knowledge, patient care, procedural & academic skills, interpersonal skills, professionalism, self directed learning and ability to practice in the system.

Quarterly assessment during the MD training should be based on:

1. Journal based / recent advances learning
2. Patient based /Laboratory or Skill based learning
3. Self directed learning and teaching
4. Departmental and interdepartmental learning activity
5. External and Outreach Activities / CMEs

The student to be assessed periodically as per categories listed in postgraduate student appraisal form (Annexure I).

SUMMATIVE ASSESSMENT, ie., at the end of training

The summative examination would be carried out as per the Rules given in POSTGRADUATE MEDICAL EDUCATION REGULATIONS, 2000. The examination shall be in three parts:

1. Thesis

Thesis shall be submitted at least six months before the Theory and Clinical / Practical examination. The thesis shall be examined by a minimum of three examiners; one internal and two external examiners, who shall not be the examiners for Theory and Clinical examination. A post graduate student shall be allowed to appear for the

Theory and Practical/Clinical examination only after the acceptance of the Thesis by the examiners.

2. Theory Examination:

There shall be four papers each of three hours duration. These are:

Paper I: Basic Principles in practice of Radiotherapy (Physics, Biology, Pathology, Equipments & Techniques of Radiotherapy)

Paper II: Clinical Radiation Oncology

Paper III: Allied Oncology Practices (Surgical oncology, medical oncology & Palliative Care)

Paper IV: Recent Developments in Oncology, Cancer Control Programmes, Research methodologies in oncology

3. Clinical/ Practical and oral/viva voce examination

Practical Examination should consist of the following:

Long and short cases - a minimum of one long case and two-three short cases should form the basis of clinical examinations

Pathology specimens

Imaging techniques as relevant to clinical oncology, combined radiotherapy, surgery, chemotherapy, radiotherapy techniques, brachytherapy applications, radiation protection, equipments, instruments and other armamentarium/accessories relevant to various Chemotherapy/Radiotherapy procedures, chemo-ports, paracentesis catheters

Computer application in Radiotherapy

Simulation

Mould room technology

Radiotherapy Planning etc.

Oral/viva voce examination shall be comprehensive enough to test the post graduate student's overall knowledge of the subject.

Note 1: During the training programme, each post graduate student should be required to engage himself/herself in an investigative project under the supervision of a faculty member and submit his/her thesis or dissertation according to the rules of the University concerned. The subject for the research should be related to clinical practice of oncology (radiotherapy/combined treatments/Lab Research related with clinical practice).

Recommended Reading

A. Books (latest edition)

1. Basic books of anatomy, applied anatomy, physiology and basic pathology
2. Text books of:

Radiotherapy by Ralston Paterson

Radiotherapy by GH Fletcher

Radiotherapy by Moss

Radiotherapy by Halnan

Oxford Text Book of Oncology

Comprehensive Text Book of Oncology by Moosa

Cancer Principles & Practice of Oncology by DeVita *et al*

Textbook of Oncology by Ackerman & del Regato
Principles & Practice of Radiation Oncology by Perez & Brady

Cancer Medicine by Holland and Frie

Transplantation in Hematology & Oncology by Buchner, Jurgens *et al*

Clinical Oncology by Philip Rubin

Cancer Treatment by Haskell

Medical Physics by Meredith

Medical Physics by Selman

Medical Physics by FM Khan

Radiation Pathology by Rubin & Cassaret
Radiobiology by Eric J Hall
Radiobiology by Steel
Radiation Planning by Lewis & Tapley

Pediatric Oncology by Suttow

Gynecology Oncology by Disaia

Urologic Oncology/GI Cancers/Breast Cancer/Brain Tumors
Radiation Oncology by GK Rath & BK Mohanti

B. Journals and periodicals

Three international and two national journals (all indexed)

Blueprint by Syllabus Domains

MD Radiotherapy syllabus broadly covers:

- **Radiation Physics**
- **Radiation Biology**
- **Clinical Radiation Oncology**
- **Medical Oncology Principles**
- **Imaging in Oncology**
- **Palliative Care**
- **Recent Advances & Technology**
- **Research Methodology & Biostatistics**

The blueprint below distributes questions proportionally.

Notes for Paper Setters

Ensure **clinical relevance** and **case-based orientation** in long essays.

- Maintain **balance across organ systems** (H&N, breast, cervix, lung, GI, GU, CNS).
- Include **technology-based questions** (IMRT, VMAT, IGRT, SBRT, SRS).
- Include **emerging areas**: radiomics, AI in RT, proton therapy, molecular diagnosis and treatment changes.
- Avoid repetition across sections.
- Ensure coverage of **core competencies** expected of an MD Radiation Oncology graduate.

Oncology theory question papers and Weightage

10 short notes, 10 marks each in each paper, total 4 papers, total marks 100,no choices.

Paper I

Sl.No.	Topics	Weightage	Marks allotted	No. of questions
1.	Radiation physics	**20**	**20**	**2**
2.	Radiation biology	**30**	**30**	**3**
3.	Applied anatomy/physiology	**10**	**10**	**1**
4.	Pathology of cancer/Radiation pathology	**10**	**10**	**1**
5.	Equipments/techniques of radiation	**20**	**20**	**2**
	Total	**100%**	**100**	**10**

Paper II

Sl.No.	Topics	Weightage	Marks allotted	No. of questions
1.	Principles and Practice of Radiotherapy of skin, Head & neck tumors	**30**	**30**	**3**
2.	Principles and Practice of Radiotherapy of Central and Peripheral Nervous System, GI Tract Tumors.	**20**	**20**	**2**
3.	Systemic therapies used in skin, Head & neck, Central and Peripheral Nervous System, GI Tract Tumors.	**20**	**20**	**2**
4.	Radiotherapy for benign disease	**10**	**10**	**1**
5.	Allied oncology role (Surgical/speech-swallowing/occupational therapy)	**10**	**10**	**1**
	Total	**100%**	**100**	**10**

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Paper III

Sl.No.	Topics	Weightage	Marks allotted	No. of questions
1.	Principle and Practice of Radiotherapy of Thoracic Region, Breast, Genito Urinary System tumors	**20**	**20**	**2**
2.	Principle and Practice of Radiotherapy of Lymphoreticular System, Musculo-Skeletal System and Paediatric Tumors	**30**	**30**	**3**
3.	Principles of chemotherapy/Systemic therapy used in Thoracic Region, Breast, Genito Urinary System, Lymphoreticular System, Musculo-Skeletal System and Paediatric Tumors	**30**	**30**	**3**
4.	Allied oncology role (palliative care, nuclear medicine)	**20**	**20**	**2**
	Total	**100%**	**100**	**10**

Paper IV

Sl.No.	Topics	Weightage	Marks allotted	No. of questions
1.	Recent advances or techniques coming up in various fields of oncology	**30**	**30**	**3**
2.	Special radiationweightageprint techniques/complications and management of toxicities of radiation or chemotherapy/ New drugs in oncology	**20**	**20**	**2**
3.	Oncological emergencies/rehabilitation in cancer treatment	**20**	**20**	**2**

4.	Cancer control programs Preventive oncology Research methodologies in cancer	**30**	**30**	**3**
	Total	**100%**	**100**	**10**

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M.D. Degree Examination

Time: 3 Hours **Max. Marks: 100**

RADIATION ONCOLOGY – PAPER I

(Radiation Physics, Radiobiology, Radiation Pathology,

Radiation Equipment, Techniques)

Your answers should be specific to the questions asked.

Draw neat, labeled diagrams wherever necessary.

Short answers for each sub-question

Answer all the questions.

10 × 10 = 100 marks

(Each sub-question 2.5marks)

1. A patient is being treated on a LINAC with a 6 MV photon beam at 100 cm SSD with a 5 × 5 cm field size.
   A. Discuss the factors affecting PDD.
   B. Discuss the concept of TMR and explain the difference between TPR and TMR.
   C. How are corrections made for tissue heterogeneity in dose calculations?
   D. Beam-modifying devices used in a LINAC.

2. In a patient receiving electron beam therapy with a 6 MeV beam,

   A. Explain how R90, R80, and Rp are used in treatment planning.

   B. Explain the principles of making an electron cutout.

   C. Techniques used in TSET for a uniform skin dose.

D. Cerrobend block.

3. Discuss the cell repair mechanism and its clinical application with reference to the following:

   A. NHEJ pathway.

   B. P53 mutation.

   C. ATRX gene.

   D. DNA methylation.

4. Discuss the clinical applications of the following radiobiological principles, with an example:

   A. Alpha/beta ratios of normal and tumor tissue.

   B. The biologically effective dose.

   C. Gap correction strategies in treatment interruption.

   D. EQD2 Gy.

5. Discuss briefly the mechanism of action of the following molecular targets in clinical practice

   A. EGFR inhibitors

   B. RAS inhibitor pathway

   C. Antiangiogenic pathway

   D. PI3K/AKT pathway

6. Discuss the radiation pathogenesis in the following

   A. Radiation Cystitis

   B. RILD

   C. Consequential Late effects

   D. Radiation Pneumonitis

7. Discuss the impact of the following pathological factors with clinical examples

   A. Extranodal extension

   B. LVSI

   C. Perineural invasion

   D. Tumor infiltrating lymphocytes

8. Explain the function of the following units in a linac

   A.Thyratron

   B.Microwave generator

   C.Electron gun

   D.SF6 use and its environmental impact

9. In the practice of Brachytherapy, explain the following

   A. Pulse dose rate system

   B. Advantages of Mold Brachytherapy

   C. Indexer length and catheter tip correction

   D. Advantages of Volume prescription in Cx Brachytherapy

10. Discuss the advantages of the following techniques in radiation therapy briefly

    A. Adaptive Radiation

    B. Non-coplanar beams

    C. Respiratory Gating

    D. Contact X-rays

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M.D. Degree Examination

Time: 3 Hours **Max. Marks: 100 Marks**

Radiation Oncology- PAPE R – II

Clinical Oncology

Your answers should be specific to the questions asked

Draw neat, labeled diagrams wherever necessary

Answer All the Questions **10 x 10 = 100 Marks**

1. A 40-year-old gentleman with no tobacco or alcohol habits presents with a rapidly enlarging mass in the upper neck, 6x6cm in size, with no associated weight loss or fever. FNAC from the mass revealed a poorly differentiated neoplasm.

   A. What will be your differential diagnosis, and how would you investigate the case?
   B. What IHC markers would you select for establishing a diagnosis?
   C. What would be the treatment modality you would choose in an unknown primary {MUO}
   D. Detail the RT planning you would adopt for a curative goal.

2. A 47-year-old gentleman presented with complaints of swelling in Rt neck region for 2 months. Examination revealed a 4 x 4cm ulcero-proliferative growth in Rt tonsillar region extending to the anterior pillar and the glosso-tonsillar sulcus. Neck examination was suggestive of 3 x 3cm mobile Rt level II node. No other palpable nodes. CECT neck s/o growth in Rt tonsil with Rt level II cystic node.

   A. What is the further management?

B. Comment on Radiation dose, concurrent CT schedule, fractionation and portals used.
C. Role of HPV in etiology and prognosis
D. Changes in recent AJCC staging (8th edition in oropharyngeal cancer)

3. A 35-year-old lady presents with bleeding per rectum. Clinical evaluation showed a growth 5cm from the anal verge. He is referred from the surgery department for an opinion on preoperative Chemoradiation treatment following biopsy confirmation of an adenocarcinoma.

   A. What are the investigations you would review before the treatment for an appropriate treatment plan, and how do they help in the TNM staging?
   B. What are the potential toxicities you would discuss with the patient regarding pre-op and post-op radiation therapy, and what measures you would adopt to minimize the toxicities during simulation and planning?
   C. Compare short-course and long-course radiation based on radiobiological principles (List 4 points).
   D. What are the boundaries of the CTV you would contour in a 3D plan, and the nodal stations you would include?

4. A 65-year-old gentleman, ECOG PS-1 and an avid tennis player, presents with voiding difficulties and nocturia. Clinical exam revealed a Gr3 prostatomegaly. The blood test done outside shows a Total PSA level of 26ng/ml.

   A. How would you investigate this case further for diagnosis and staging? Compare ISUP grade groups with Gleason scoring. Briefly explain risk stratification in prostate Ca.
   B. What would be your treatment plan for a T3bN2Mo? Generate a prescription with the OAR constraints for a moderately hypofractionated RT schedule.
   C. List three guideline changes in prostate cancer management from the STAMPEDE trial observations.
   D. What are the treatment strategies used in Castration resistant disease with metastasis?

5. Discuss the following prehabilitation measures you would take in a 55 yr old planned to be treated for a tonsillar cancer(T3NoMo) to improve the quality of life
    A. Measures to improve the swallowing functions
    B. Treatment planning strategies
    C. Post-treatment follow-up strategies
    D. How would the RT planning strategies and Quality of life change if it is HPV positive

6. A 65-year-old person is diagnosed to have a growth in the esophagus 30-35 cm, biopsy confirming it as a moderately differentiated SCC
    A. Briefly create an algorithmic treatment plan used in the department for a radical or palliative approach, integrating a multidisciplinary approach.
    B. Discuss three concurrent CTRT schedules used in Esophageal cancer and their associated toxicities.
    C. How are PTVs generated in a 3D plan of the ca Esophagus for primary and boost fields?
    D. What are the dose constraints fixed for the Lung and Heart in IMRT treatment?
7. Discuss briefly the current guidelines for radiation therapy in the following benign conditions
    A. Keloid
    B. Heterotopic bone formation
    C. Osteoarthritis
    D. AVM

8. Discuss the types of clinical and radiological presentation and the therapeutic strategies in the following molecular subtypes of Glioma
    A. IDH mutant Vs IDH wild type
    B. MGMT unmethylated
    C. H3K27M mutated
    D. 1P19q codeleted

9. Discuss the role of the following agents in Head Neck Ca
    A. Nivolumab

B. Cetuximab
C. Nimorazole
D. Palifermin

10. Discuss the clinical evidence, mechanism of action, and situations where you would use the following agents in Colorectal cancer
    A. Irinotecan
    B. Bevacizumab
    C. Pembrolizumab
    D. Tegafur S-1

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M.D. Degree Examination)

Time: Three Hours **Max. Marks: 100 Marks**

Radiation Oncology - PAPER – III

Your answers should be specific to the questions asked

Draw neat, labeled diagrams wherever necessary

Answer All the Questions **10 x 10 = 100 Marks**

1. A 45-year-old premenopausal woman presents with a lump in the left breast measuring 5 × 3 cm and a single, mobile 2 cm axillary lymph node.

   A. How would you evaluate and stage this patient?

   B. Outline the management plan for carcinoma of the left breast, clinical stage cT3N1M0, triple-positive (ER+, PR+, HER2+).

   C. Discuss the role of half-beam block and wedges in radiotherapy planning for breast carcinoma.

   D. List two essential differences between EORTC and RTOG contouring guidelines for post-mastectomy radiation

2. A 20-year-old male presents to the Surgery Outpatient Department with complaints of left-sided scrotal swelling.

   A. Enumerate the differential diagnoses of scrotal swelling in a 20-year-old male and outline the investigations needed to diagnose and stage testicular germ cell tumors.

B. Describe the management approach for Stage IIB seminoma, with a detailed discussion on radiotherapy planning.
C. List the prerequisites before radiotherapy planning and outline the follow-up protocol after treatment in patients with testicular cancer.
D. What are the salvage treatment options for recurrent disease?

3. A 45-year-old male presents with a rapid growth in the right upper arm.MRI reveals an enhancing Tumour in the bicipital groove measuring 5cm.

A. Discuss the key principles of management
B. Primary brachytherapy planning principles
C. Merits and demerits of pre- and post op radiation therapy
D. Role of adjuvant and salvage Chemotherapy for metastatic disease

4. A 5-year-old child presents with a swelling over the retromolar region with pain and difficulty in opening the mouth and proptosis of the rt eye of 3m duration. FNAC of the mass revealed a round-cell neoplasm.

A. Discuss the differential diagnosis and management
B. The role of molecular markers
C. The radiation therapy principles followed in treatment
D. Late toxicities

5. A 36-year-old gentleman presents with an ulceroproferative growth at the anal verge. Biopsy from the lesion was reported as moderately differentiated SCC.

A. Outline the management principles and the staging investigation required in this case, with emphasis on the specific tests required.
B. What are the measures adopted in the Simulation protocol in IMRT planning?
C. Discuss the shrinking field strategies used in radiation therapy planning, the dosage used and the field borders in each phase.

D. Summarize the RT dose de-escalation strategies to reduce toxicities. What are the acute and late toxicities associated with Chemoradiation, and how are they managed?

6. A 65-year-old gentleman post-CABG on blood thinners was evaluated for hematuria. Cystoscopy revealed proliferative growth in the rt lateral wall of the bladder extending to the trigone. He underwent a TURBT subsequently for a Grade 3 transitional cell carcinoma.
   A. Discuss a care plan for further evaluation and management?
   B. Discuss the role of Trimodality treatment in bladder cancer.
   C. What simulation protocol would you use in RT planning, and describe the extent of the planning target volumes for T2aNoMo bladder Ca?
   D. Briefly discuss Intravesical chemotherapy and where it is clinically useful.
7. A 65-year-old gentleman, ECOG PS-1 and an avid tennis player, presents with voiding difficulties and nocturia. Clinical exam revealed a Gr3 prostatomegaly. The blood test done outside shows a Total PSA level of 26ng/ml.

   A. How would you investigate this case further for diagnosis and staging? Compare ISUP grade groups with Gleason scoring. Briefly explain risk stratification in prostate ca.
   B. What would be your treatment plan for a T3bN2Mo? Generate a prescription with the OAR constraints for a moderately hypofractionated RT schedule.
   C. List three guideline changes in prostate cancer management from the STAMPEDE trial observations.
   D. What are the treatment strategies used in Castration resistant disease with metastasis?

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   D. What are the dose constraints fixed for the Lung and Heart in IMRT treatment?

10. Discuss the role of occupational therapy and rehabilitative measures in the following clinical situation

    A. Prevention of Lymphoedema
    B. Trismus
    C. LARS
    D. Microaspiration

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M.D. Degree Examination

Time: Three Hours **Max. Marks: 100 Marks**

RADIATION ONCOLOGY - PAPER- IV

Your answers should be specific to the questions asked

Draw neat labeled diagrams wherever necessary

Answer All the Questions **10 x 10 = 100 Marks**

1. 35-year-old man presented to the OPD with headache, multiple episodes of generalized seziures since 1 month. MRI was suggestive of 5 x 4cm well defined non enhancing lesion in Rt temporal lobe, no midline shift. Patient underwent sub total excision of the mass. Histopathology was suggestive of IDH mutant Grade II astrocytoma. (3+2+2+3 marks)
   a) Adjuvant treatment options
   b) Comment on drug "Vorasidenib"
   c) Any evidence on delaying or avoiding adjuvant radiation
   d) IDH as prognostic or predictive factor in glioma

2. Craniospinal irradiation (3+2+2+3 marks)
   a) Indications and dose fractionation
   b) Techniques of delivery
   c) Field matching techniques
   d) Target volumes and toxicities of treatment

3. 76 year old man presented with complaints of gradually progressing weakness of bilateral lower limbs associated with back pain since 2 months. MRI spine was suggestive of multiple lesions in dorsal and lumbar spine with associated soft tissue component causing cord compression at D10 Spine. (2+3+3+2 marks)

   a) First line of management
   b) Role of radiation
   c) Additional investigations if any
   d) Possible sites of primary

4. Next generation sequencing (4 +4+2 marks)

   a) What is it and how is it done?
   b) Role in Non Small cell lung carcinoma
   c) Targeted agents which can be used following NGS results in lung cancer

5. Evidence based medicine (2+4+4 marks)

   a) Levels of evidence
   b) Meta analysis
   c) Forest plot

6. Cancer prevention strategies (4+4+2 marks)

   a) National cancer control program
   b) HPV vaccination
   c) Name any 2 cancers amenable for screening

7. Advanced techniques of radiation (5 + 5 marks)

   a. Proton therapy- Indications, Physics and radiobiology
   b. Flash RT

8. Total skin electron therapy (3 +5 +2 marks)
   a. Indications
   b. Dose, fractionation, delivery techniques
   c. Toxicities

9. Immunotherapy (4 +4+2 marks)
   a. Mechanism of action in cancer
   b. Rationale and molecular basis in combining with radiation
   c. Name 2 immunotherapeutic drugs with their uses

10. Nuclear medicine (5 + 5 marks)

    a) PRRT
    b) Common isotopes used for unsealed radionuclide therapy in bone metastases

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Checklist

Name of the Department/Unit :

Name of the PG Student :

Period of Training : FROM……TO……

Sr. No.	PARTICULARS	Not Satisfactory	Satisfactory	More Than Satisfactory	Remarks
		1 2 3	4 5 6	7 8 9	
1.	Journal based / recent advances learning				
2.	Patient based /Laboratory or Skill based learning				
3.	Self directed learning and teaching				
4.	Departmental and interdepartmental learning activity				
5.	External and Outreach Activities / CMEs				
6.	Thesis / Research work				
7.	Log Book Maintenance				

Publications **Yes/ No**

Remarks*______

***REMARKS: Any significant positive or negative attributes of a postgraduate student to be mentioned. For score less than 4 in any category, remediation must be suggested. Individual feedback to postgraduate student is strongly recommended.**

SIGNATURE OF ASSESSEE SIGNATURE OF CONSULTANT SIGNATURE OF HOD