



SEMESTER – IV

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRT401	ONCOLOGY	45 Min	1 Hrs.	50	50
DMRT402	RADIATION HAZARDS & PROTECTION	45 Min	1 Hrs.	50	50
DMRT403	ADVANCED RADIOGRAPHIC TECHNIQUES	45 Min	1 Hrs.	50	50
DMRT404	RADIATION PROTECTION AND SAFETY	45 Min	1 Hrs.	50	50

ONCOLOGY

THEORY

1. Basics of Oncology

- Definition, scope, and importance of oncology in radiology.
- Cancer epidemiology: incidence, prevalence, mortality trends (India & worldwide).
- Etiology of cancer: genetic, viral, environmental, occupational, radiation, lifestyle.
- Differences between benign and malignant tumors.
- Nomenclature, classification, and types of cancers.

2. Cancer Biology & Pathophysiology

- Normal cell cycle and control mechanisms.
- Carcinogenesis: initiation, promotion, progression.
- Tumor growth kinetics and metastasis (routes & patterns).
- Tumor angiogenesis and tumor microenvironment.
- Tumor markers and their diagnostic importance.

3. Staging & Diagnosis of Cancer

- Cancer staging systems: TNM classification, Ann Arbor, Dukes' staging.
- Cancer grading systems.

- Diagnostic workup of cancer patients.
- Imaging modalities in oncology:
 - **X-ray** (screening, metastasis detection).
 - **CT** (staging, planning, follow-up).
 - **MRI** (soft tissue, CNS, musculoskeletal tumors).
 - **Ultrasound** (screening, guidance for biopsy, Doppler in oncology).
 - **PET-CT** (functional imaging, staging & recurrence).
- Biopsy and cytology techniques.
- Cancer screening programs (breast, cervix, colon, lung, prostate).

4. Cancer Treatment Modalities

1. **Surgery in oncology** – diagnostic, curative, palliative, limitations.
2. **Radiotherapy**
 - Principles of radiation therapy.
 - **External Beam Radiotherapy (EBRT)**: Cobalt-60, Linear Accelerator, Proton therapy.
 - **Brachytherapy**: intracavitary, interstitial, applicators.
 - **Modern techniques**: IMRT, IGRT, SRS, SBRT, CyberKnife, Tomotherapy.
 - Radiation dose concepts – Gray, fractionation, dose constraints.
3. **Chemotherapy**
 - Classes of chemotherapeutic drugs.
 - Routes of administration.
 - Side effects and supportive care.
4. **Immunotherapy, Hormonal Therapy, and Targeted Therapy** – basics.
5. **Combined Modalities** – multimodality treatment.

5. Radiology Technologist's Role in Oncology

- Patient preparation and positioning for oncology imaging.
- Protocols for oncology CT, MRI, Ultrasound.
- Handling oncology patients with care, empathy, and confidentiality.
- Contrast studies in oncology – precautions, contraindications, adverse reaction management.
- Role in radiotherapy simulation (CT/MRI-based planning).
- Documentation and record keeping in oncology imaging.

6. Radiation Safety & Protection in Oncology

- Radiation hazards in diagnostic and therapeutic oncology.
- Principles of radiation protection (time, distance, shielding, ALARA).
- Radiation safety measures in radiology & oncology departments.
- Use of PPE, lead aprons, thyroid shields, lead barriers.
- Dosimetry, TLD badges, personnel monitoring.
- Regulatory guidelines (ICRP, AERB, IAEA basics).

7. Complications, Palliative Care & Support

- Acute and late side effects of radiotherapy.
- Common chemotherapy complications.
- Management of nausea, vomiting, mucositis, alopecia, marrow suppression, skin burns.
- Palliative radiology – pain management, relief of obstruction (stents, drainage).
- Psychological aspects of cancer care.
- Role of technologists in palliative and hospice care.

PRACTICAL

➤ Patient Handling & Communication

- Demonstration of patient registration, consent, and counseling for oncology imaging.
- Positioning of weak, frail, or post-surgery oncology patients.
- Use of immobilization devices (headrests, masks, vacuum cushions).
- Demonstration of infection control measures in oncology wards/departments.

➤ Diagnostic Oncology Imaging

- **X-ray:**
 - Chest X-ray for lung metastasis.
 - Skeletal survey for bone metastasis.
- **CT:**
 - Positioning for CT chest, abdomen, pelvis, brain in oncology cases.
 - Demonstration of CT simulation for radiotherapy planning.
- **MRI:**
 - Positioning of brain tumor, cervical cancer, and musculoskeletal tumor patients.
 - Demonstration of MR sequences used in oncology (T1, T2, FLAIR, DWI).
- **Ultrasound:**
 - Demonstration of USG-guided FNAC/biopsy.
 - Identification of liver metastasis, breast lump, and pelvic mass.
- **PET-CT (Observation):**
 - Preparation of patient for PET-CT.
 - Demonstration of uptake and scan procedure.

➤ Radiotherapy Practical Skills

- Demonstration of CT simulation procedure (marking, tattooing, immobilization).
- Observation of **External Beam Radiotherapy (EBRT)** – Cobalt-60 unit, Linear Accelerator.
- Observation of **Brachytherapy setup** – applicator insertion, patient preparation.

- Introduction to IMRT/IGRT techniques (observation & demonstration of planning images).

➤ **Radiation Protection in Oncology**

- Demonstration of TLD badge use and reading.
- Safe handling of patients undergoing brachytherapy.
- Practical demonstration of time, distance, and shielding principles.
- Preparation of daily radiation safety checklist for technologists.

➤ **Oncology Case Demonstrations**

- Identification of common cancers in imaging:
 - Brain tumor (MRI)
 - Breast cancer (Mammography/USG)
 - Cervical cancer (MRI/CT, brachytherapy planning)
 - Lung cancer (CT chest)
 - Liver metastasis (USG/CT)
- Case discussion and documentation of findings.

➤ **Emergency & Contrast Reaction Management**

- Demonstration of first aid in fainting, vomiting, or syncope during imaging.
- Emergency response to contrast reactions in oncology patients.
- Use of emergency crash cart/anaphylaxis kit in radiology department.

➤ **Palliative & Supportive Care (Observation)**

- Demonstration of palliative radiology procedures:
 - Stenting (biliary/urinary)
 - Drainage (ascitic/pleural tapping)
- Patient support: oxygen therapy, IV line care, monitoring vitals during imaging.
- Psychosocial care – communication and empathy demonstration with terminally ill patients.

RADIATION HAZARDS & PROTECTION

THEORY

1. Fundamentals of Radiation

- Discovery & nature of ionizing radiation (X-rays, Gamma rays, Particulate radiation).
- Types of radiation sources (natural & man-made).
- Units of radiation measurement:

- Exposure: Roentgen (R)
- Absorbed dose: Gray (Gy)
- Equivalent dose: Sievert (Sv)
- Activity: Becquerel (Bq), Curie (Ci)

2. Biological Effects of Radiation

- Radiation interaction with matter and human tissues.
- Deterministic effects (skin erythema, cataract, radiation burns).
- Stochastic effects (carcinogenesis, genetic mutations).
- Acute Radiation Syndrome (ARS) – symptoms, stages, management.
- Effects of radiation on specific organs: bone marrow, gonads, thyroid, eye.
- Long-term consequences of radiation exposure.

3. Radiation Hazards

- External hazards (from X-ray machines, CT, fluoroscopy, radiotherapy units).
- Internal hazards (inhalation, ingestion, wound contamination).
- Occupational hazards for radiology technologists.
- Radiation accidents: examples (Chernobyl, Fukushima, hospital-based accidents).
- Hazards specific to radiology departments:
 - Diagnostic radiology (X-ray, CT, fluoroscopy).
 - Interventional radiology.
 - Radiotherapy units.
 - Nuclear medicine & PET-CT.

4. Principles of Radiation Protection

- **Fundamental Principles:** Justification, Optimization (ALARA), Dose Limitation.
- Time, Distance & Shielding as primary protection methods.
- Personal protection methods:
 - Lead aprons, thyroid shields, lead glasses, gonadal shields.
 - Use of protective barriers, screens, lead walls.
- Protective devices in equipment (tube housing, collimators, filters, AEC).
- Safety protocols in fluoroscopy, CT, and interventional radiology.

5. Radiation Monitoring & Safety Standards

- Personnel monitoring devices:
 - Film badge, TLD (Thermoluminescent dosimeter), OSL dosimeter, Pocket dosimeter.
- Area monitoring: survey meters, ionization chambers, Geiger counters.
- Radiation dose limits (ICRP/AERB):
 - Occupational workers
 - Students/trainees
 - General public

- Regulatory agencies: ICRP, IAEA, AERB, NCRP, WHO.
- Quality assurance in diagnostic radiology & radiotherapy equipment.

6. Emergency Preparedness & Radiation Waste Management

- First aid and emergency management in radiation accidents.
- Decontamination procedures for radiation exposure.
- Safe handling of radioisotopes.
- Radioactive waste disposal methods (storage, dilution, decay).
- Safety drills & emergency evacuation in radiology departments.

PRACTICAL

➤ Radiation Monitoring & Measurement

- Demonstration of **film badge, TLD badge, OSL badge, pocket dosimeter**.
- Reading and interpretation of personnel monitoring reports.
- Use of **survey meters, ionization chambers, and Geiger-Müller counters** for area monitoring.
- Calibration of radiation detection instruments (demo only).
- Preparation and maintenance of **radiation dose records**.

➤ Protective Devices & Barriers

- Demonstration of **lead apron, thyroid shield, gonadal shield, lead glasses**.
- Correct positioning of protective barriers (mobile shields, lead glass windows).
- Periodic testing of protective devices for cracks or damage (fluoroscopy check).
- Demonstration of protective features in equipment (tube housing, collimator, filters).

➤ Departmental Safety Practices

- Layout study of **diagnostic radiology, CT, fluoroscopy, and radiotherapy rooms** as per AERB norms.
- Demonstration of **ALARA principles** (time, distance, shielding) in practical settings.
- Safe patient positioning and staff positioning during exposures.
- Use of immobilization devices to minimize repeat exposures.

➤ Radiation Quality Control (QC)

- Practical demonstration of **kVp accuracy test, mA linearity test, timer accuracy test**.
- Half-Value Layer (HVL) measurement for beam quality.
- Beam alignment and collimator congruence testing.
- Phantom studies for patient dose estimation.

- Preparation of a **QA checklist** for diagnostic imaging equipment.
- **Emergency & Accident Management**
 - Mock drill: **response to suspected radiation overexposure accident**.
 - Demonstration of **decontamination procedures** (skin wash, clothes removal, equipment cleaning).
 - Simulation of patient handling in accidental contamination cases.
 - First aid procedures for **Acute Radiation Syndrome (ARS)** cases.
 - Evacuation plan and safe isolation area demonstration.
- **Radioactive Waste Management (if available in department)**
 - Demonstration of safe handling of **radioisotopes**.
 - Labeling, storage, and disposal of radioactive materials.
 - Use of shielding containers and fume hoods.
 - Documentation of waste management protocols.
- **Documentation & Record Keeping**
 - Preparation of **daily radiation logbook**.
 - Maintenance of **personnel dose history**.
 - QC/QA record maintenance.
 - Reporting of radiation safety incidents.

ADVANCED RADIOGRAPHIC TECHNIQUES

THEORY

1. Introduction to Advanced Radiography

- Evolution from conventional to advanced radiographic techniques
- Indications and applications of advanced imaging in diagnosis
- Comparison between general radiography and specialized procedures

2. Contrast Media in Advanced Imaging

- Types: **Positive** (iodinated, barium sulfate) and **Negative** (air, CO₂)
- Properties, preparation, dosage, and administration routes
- Adverse reactions, contraindications, and emergency management
- Patient preparation and aftercare in contrast studies

3. Special Radiographic Procedures

a) Gastrointestinal Tract Imaging

- **Barium Swallow** – anatomy visualized, technique, patient positioning
- **Barium Meal** – indications, preparation, imaging sequence
- **Barium Enema** – double and single contrast techniques, complication management
- **Small Bowel Enema** (Enteroclysis)
- Video fluoroscopy in swallowing disorders

b) Genitourinary System Imaging

- **Intravenous Urography (IVU)** – indications, contraindications, procedure
- **Retrograde Pyelography** – equipment, technique, patient care
- **Micturating Cystourethrography (MCU)** – imaging sequence, radiation protection
- **Hysterosalpingography (HSG)** – patient prep, aseptic techniques

c) Hepatobiliary System Imaging

- **Oral Cholecystography** – principles, limitations
- **Endoscopic Retrograde Cholangiopancreatography (ERCP)** – equipment and technique
- **Percutaneous Transhepatic Cholangiography (PTC)**

d) Musculoskeletal System Imaging

- **Arthrography** – knee, shoulder, wrist techniques
- Contrast types and post-procedure care

e) Vascular Imaging

- **Angiography** – principles, equipment, Seldinger technique
- Cerebral, coronary, peripheral angiography
- Digital Subtraction Angiography (DSA) basics

4. Radiographic Positioning for Advanced Procedures

- Specialized patient positioning for contrast and interventional studies
- Immobilization techniques
- Role of positioning aids

5. Fluoroscopy in Advanced Imaging

- Types of fluoroscopic equipment (image intensifier, flat panel detectors)
- Radiation dose considerations in fluoroscopy
- Spot filming and cinefluorography

6. Digital Techniques in Advanced Radiography

- CR and DR in special procedures
- PACS integration for advanced imaging
- Image enhancement and post-processing

7. Radiation Protection in Advanced Techniques

- ALARA principles for high-dose procedures
- Protective equipment for staff and patients
- Dose monitoring and recording

8. Infection Control & Patient Safety

- Sterile field maintenance in interventional and invasive procedures
- Aseptic technique in catheter-based studies
- Pre- and post-procedure monitoring

9. Quality Control in Special Procedures

- QC checks for fluoroscopic and angiographic equipment
- Contrast injector maintenance
- Image quality assessment criteria for advanced techniques

10. Recent Advances & Trends

- Cone Beam CT in interventional radiology
- Hybrid imaging (PET/CT, PET/MRI) in procedural planning
- AI-assisted positioning and dose optimization

PRACTICAL

➤ Patient Preparation & Communication

- Explaining procedure to patient and obtaining consent
- Checking for allergies and contraindications to contrast media
- Preparing patient physically and psychologically for the procedure
- Fasting and pre-procedure medication guidelines

➤ Contrast Media Handling

- Preparation and dilution of barium sulfate suspension
- Preparation of iodinated contrast media for IV and intra-cavitary use
- Safe handling, storage, and disposal of contrast media
- IV cannulation techniques and test dose administration

- Managing adverse reactions and emergency response

➤ **Gastrointestinal Radiography**

- **Barium Swallow:** patient positioning, sequence of exposures, fluoroscopic observation
- **Barium Meal:** upper GI study positioning and exposure techniques
- **Barium Enema:** single and double contrast techniques, patient preparation, insertion of enema tip
- **Small Bowel Enema (Enteroclysis):** nasojejun tube placement and imaging sequence
- Fluoroscopic swallowing function test

➤ **Genitourinary Imaging**

- **Intravenous Urography (IVU):** patient preparation, timing of exposures
- **Retrograde Pyelography:** assisting in sterile preparation and positioning
- **Micturating Cystourethrography (MCU):** catheter placement assistance, imaging during voiding
- **Hysterosalpingography (HSG):** sterile preparation, handling of instruments and contrast

➤ **Musculoskeletal Special Procedures**

- **Arthrography (knee, shoulder, wrist):** sterile setup, positioning, exposure sequence
- Use of contrast injectors in joint studies
- Post-procedure care and immobilization

➤ **Vascular Imaging**

- Preparation for angiographic procedures (cerebral, coronary, peripheral)
- Sterile draping and assisting during catheter insertion
- Setting up and operating power injectors for contrast administration
- Digital Subtraction Angiography (DSA) image acquisition and storage

➤ **Hepatobiliary Imaging**

- Assisting in **ERCP** and **PTC** procedures
- Handling of catheters, guidewires, and sterile instruments
- Patient positioning and monitoring during procedure

➤ **Fluoroscopy Operation**

- Positioning the patient for various fluoroscopic studies
- Adjusting exposure factors to optimize image quality while minimizing dose
- Spot filming and cine acquisition techniques

- Assisting in mobile C-arm fluoroscopy

➤ **9. Digital Imaging Skills**

- Operating CR/DR systems for special procedures
- Post-processing images for optimal diagnostic quality
- Uploading studies to PACS and tagging metadata correctly

➤ **Radiation Safety Measures**

- Use of lead aprons, thyroid shields, and lead glass screens
- Applying ALARA principles during high-dose procedures
- Recording and monitoring dose in special investigations

➤ **Infection Control**

- Hand hygiene and sterile glove techniques
- Cleaning and sterilizing special procedure equipment
- Proper waste disposal according to biomedical waste guidelines

➤ **Logbook & Case Documentation**

- Recording details of each advanced procedure performed/assisted
- Documenting contrast type, dose, and any complications
- Maintaining patient confidentiality in records

RADIATION PROTECTION AND SAFETY

THEORY

1. Introduction to Radiation Protection

- Definition and objectives of radiation protection
- Historical background of radiation hazards
- Importance of radiation safety in diagnostic imaging
- Roles and responsibilities of a radiologic technologist in radiation safety

2. Radiation Physics Basics (Relevant to Safety)

- Nature and properties of ionizing radiation
- Units of measurement:
 - Exposure (Coulomb/kg)
 - Absorbed dose (Gray)
 - Equivalent dose (Sievert)
 - Activity (Becquerel, Curie)

- Interaction of radiation with matter (photoelectric effect, Compton scattering, pair production)
- Factors affecting radiation dose (time, distance, shielding)

3. Biological Effects of Radiation

- Deterministic effects (tissue reactions) and stochastic effects (probabilistic effects)
- Short-term vs long-term effects
- Somatic vs genetic effects
- Acute radiation syndrome
- Effects on specific organs (skin, eyes, thyroid, gonads, bone marrow)

4. International Guidelines and Regulatory Framework

- International Commission on Radiological Protection (ICRP) recommendations
- Atomic Energy Regulatory Board (AERB) – India
- Basic Safety Standards (BSS)
- Permissible dose limits for radiation workers and the public
- Dose constraints for pregnant workers

5. Radiation Detection and Monitoring

- Personal dosimeters:
 - Film badges
 - Thermoluminescent dosimeters (TLD)
 - Pocket dosimeters
- Area monitoring devices:
 - Geiger–Müller counters
 - Ionization chambers
 - Scintillation detectors
- Calibration and maintenance of dosimeters

6. Principles of Radiation Protection (ALARA)

- Time: minimizing exposure duration
- Distance: inverse square law application
- Shielding: lead barriers, lead aprons, thyroid collars, lead glasses
- Beam collimation and filtration
- Use of gonadal shields, breast shields, and immobilization devices

7. Radiation Protection in Diagnostic Radiology

- Safety measures in conventional radiography
- Protection during fluoroscopy and mobile X-ray
- Safety in computed tomography (CT) – dose optimization, AEC use
- Digital radiography dose considerations

- Radiation safety in mammography and dental radiography

8. Radiation Protection in Advanced Imaging

- MRI safety (RF, magnetic field hazards) – though non-ionizing, relevant to technologists
- Safety in nuclear medicine imaging (radioisotope handling, storage, and disposal)
- Safety during interventional radiology and angiography procedures

9. Shielding Design and Room Layout

- Protective barriers (primary and secondary)
- Controlled and uncontrolled areas
- Workload, use factor, and occupancy factor calculations for shielding design
- Lead glass windows and control console design

10. Radiation Safety for Patients

- Justification of radiographic procedures
- Optimizing patient dose – exposure factor selection
- Pediatric radiation protection measures
- Pregnancy screening before exposure
- Use of dose tracking and patient dose records

11. Radiation Emergencies

- Accidental overexposure management
- First aid in radiation accidents
- Reporting protocols for radiation incidents to authorities
- Decontamination procedures for radioactive spills

12. Quality Assurance in Radiation Safety

- Periodic equipment testing (kVp accuracy, timer accuracy, filtration, leakage)
- Preventive maintenance of X-ray machines
- Documentation and record keeping for safety compliance
- Audits and inspections by regulatory bodies

PRACTICAL

➤ Familiarization with Radiation Safety Devices

- Identification and demonstration of:
 - Lead aprons, thyroid shields, gonadal shields, lead gloves
 - Lead glass viewing windows and barriers

- Immobilization devices for patient safety
- Checking integrity of protective devices (visual inspection, damage detection)

➤ **Use of Personal Radiation Monitoring Devices**

- Wearing and handling of film badges, TLD badges, pocket dosimeters
- Proper placement of dosimeters on the body
- Monthly exchange and record maintenance of badge readings
- Interpretation of dose reports and corrective actions if limits approach

➤ **Area Monitoring Procedures**

- Demonstration of Geiger–Müller counter usage for detecting radiation levels
- Use of ionization chambers and survey meters in diagnostic areas
- Mapping radiation leakage around X-ray tubes and control consoles
- Room radiation survey documentation and compliance check

➤ **ALARA Principle Application**

- Practical demonstration of reducing exposure by:
 - Time minimization (shorter fluoroscopy times)
 - Increasing distance (use of mobile lead screens, positioning)
 - Shielding (correct placement of barriers)
- Practical application of inverse square law using measurements

➤ **Patient Radiation Protection Techniques**

- Selection and placement of gonadal shields in different projections
- Use of collimators and beam-limiting devices in practice
- Filtration checks for X-ray tubes
- Pregnancy screening protocols before imaging
- Pediatric positioning and shielding demonstration

➤ **Equipment Safety Checks**

- Testing of protective tube housing for leakage
- Measurement of half-value layer (HVL) for filtration verification
- Timer accuracy check for exposure control
- Checking collimator light-beam alignment and field size accuracy

➤ **Safety in Special Imaging Procedures**

- Radiation protection during mobile X-ray – safe positioning and distance maintenance
- Fluoroscopy dose reduction techniques (pulsed mode, last image hold)
- CT scan dose optimization demonstration (mA, kVp, pitch adjustments)

- Safety measures during interventional radiology (shield placement, scatter reduction)

➤ **Room Shielding Verification**

- Identification of primary and secondary barriers in an X-ray room
- Checking lead lining thickness with radiation survey meters
- Testing lead glass window integrity

➤ **Emergency Response Drills**

- Steps in case of accidental overexposure
- Demonstration of evacuation procedures in a radiation leak scenario
- Handling and reporting of damaged dosimeters
- Basic decontamination procedure for radioactive contamination (if nuclear medicine setup exists)

➤ **Documentation and Quality Assurance**

- Maintenance of radiation safety logbooks
- Record-keeping of personal dose reports and equipment QA results
- Preparation of a monthly radiation safety compliance report
- Familiarization with AERB inspection checklist

