



SEMESTER – II

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRT201	CLINICAL RADIOGRAPHY	45 Min	1 Hrs.	50	50
DMRT202	RADIATION PATHOLOGY	45 Min	1 Hrs.	50	50
DMRT203	RADIATION THERAPY MACHINES	45 Min	1 Hrs.	50	50
DMRT204	RADIOGRAPHIC PHOTOGRAPHY	45 Min	1 Hrs.	50	50

CLINICAL RADIOGRAPHY

THEORY

1. Introduction to Clinical Radiography

- Definition, scope, and importance of clinical radiography
- Role of a radiographer in patient diagnosis and treatment
- Integration of radiography with other diagnostic modalities
- Workflow in a clinical radiology department

2. Radiographic Anatomy & Positioning

- **Skeletal System** – Radiographic anatomy of:
 - Skull & facial bones
 - Spine – cervical, thoracic, lumbar, sacrum, coccyx
 - Thorax – ribs, sternum, clavicle, scapula
 - Upper limb – shoulder, humerus, elbow, forearm, wrist, hand
 - Lower limb – pelvis, hip, femur, knee, ankle, foot
- **Soft Tissues** – Lungs, heart, abdomen, urinary tract
- **Special Radiographic Views** – Oblique, tangential, axial, lateral decubitus, weight-bearing views

3. General Radiographic Techniques

- Patient preparation and consent
- Positioning principles – anatomical planes, centering points
- Immobilization techniques
- Exposure factor selection (kVp, mA, time)
- Use of grids, cones, and collimators
- Image receptor selection – film, CR, DR

4. Specialized Radiographic Procedures

- **Contrast Media in Radiography**
 - Types (barium, iodine-based, air, CO₂)
 - Indications & contraindications
 - Preparation, administration routes, adverse reactions
- **Contrast Studies**
 - Gastrointestinal tract – barium swallow, meal, follow-through, enema
 - Genitourinary system – IVP, MCU, RGU
 - Hysterosalpingography (HSG)
 - Myelography, sialography, arthrography

5. Radiography of Body Systems

- **Chest Radiography**
 - Routine PA & AP
 - Lateral, oblique, lordotic views
 - Pediatric chest radiography
- **Abdominal Radiography**
 - Erect, supine, decubitus views
 - KUB studies
- **Skeletal Radiography**
 - Trauma series for suspected fractures
 - Special projections for orthopedic evaluation
- **Spine Radiography**
 - Cervical – AP, lateral, oblique
 - Thoracic & lumbar – AP, lateral
 - Scoliosis series

6. Operation Theatre Radiography

- Role of radiographer in OT
- Use of mobile X-ray units in OT
- C-arm fluoroscopy operation & safety precautions
- Aseptic techniques in the sterile OT environment

7. Emergency & Trauma Radiography

- Principles of radiography in casualty settings
- Spinal injury precautions
- Bedside radiography for critically ill patients
- Portable chest and limb radiography

8. Pediatric Radiography

- Patient handling and immobilization for infants and children
- Radiation protection in pediatric imaging
- Common pediatric radiographic exams

9. Geriatric Radiography

- Patient positioning challenges in elderly patients
- Adjustments in exposure for osteoporosis & degenerative changes
- Fall-risk management during procedures

10. Quality Control & Image Evaluation

- Identifying positioning errors
- Film faults and retake minimization
- Quality control tests in radiography
- Record keeping & PACS image management

11. Radiation Protection in Clinical Practice

- ALARA principle
- Protective devices and lead barriers
- Radiation monitoring for staff
- Safe exposure practices for pregnant patients

12. Professional & Ethical Considerations

- Patient confidentiality & informed consent
- Communication skills in clinical radiography
- Legal aspects of radiographic practice

PRACTICAL

➤ Patient Preparation & Positioning

- Identifying the patient & verifying requisition forms
- Explaining the procedure to the patient
- Removing artifacts (jewelry, belts, clothing with metal)
- Positioning the patient according to anatomical planes:
 - **Sagittal, coronal, transverse planes** identification
 - Use of immobilization devices
- Practicing correct centering & collimation

➤ Radiographic Positioning – Skeletal System

Upper Limb

- AP & lateral views: hand, wrist, forearm, elbow, humerus
- Shoulder girdle: AP, lateral, axial views
- Clavicle: AP & axial
- Scapula: AP & lateral

Lower Limb

- AP & lateral views: foot, ankle, tibia-fibula, knee

- Special knee projections: skyline, tunnel
- Femur: AP & lateral
- Pelvis & hip joints: AP pelvis, lateral hip

Spine

- Cervical spine: AP, lateral, oblique
- Thoracic spine: AP & lateral
- Lumbar spine: AP, lateral, oblique
- Sacrum & coccyx

Chest & Thorax

- Chest PA & lateral
- Special views: lordotic, decubitus
- Sternum, ribs: AP/PA & oblique

Skull & Facial Bones

- Skull: AP, lateral, Towne's, Water's, Caldwell's
- Facial bones: PA, lateral
- Sinuses: Water's, Caldwell's, lateral
- Mandible: AP, oblique, panoramic (if facility available)

➤ **Contrast Study Procedures (*Observation & Participation*)**

- **Gastrointestinal Tract**
 - Barium swallow
 - Barium meal
 - Barium follow-through
 - Barium enema
- **Urinary System**
 - Intravenous urography (IVU)
 - Micturating cystourethrogram (MCU)
 - Retrograde urethrogram (RGU)
- **Other Special Procedures**
 - Hysterosalpingography (HSG)
 - Myelography
 - Arthrography
 - Sialography

➤ **Mobile & Portable Radiography**

- Bedside chest radiography in ICU
- Bedside limb X-rays for trauma patients
- Handling & positioning in restricted spaces
- Mobile unit safety protocols

➤ **Operation Theatre (OT) Radiography**

- Use of **C-arm fluoroscopy**

- Orthopedic OT imaging during fracture fixation
- Sterile handling of equipment & accessories
- Radiation protection for surgical team

- **Pediatric & Geriatric Imaging**
 - Patient immobilization methods for infants & children
 - Special considerations in elderly patient handling
 - Dose adjustment for pediatric & geriatric cases

- **Image Evaluation & Fault Analysis**
 - Identifying correct positioning vs. common errors
 - Checking image quality (density, contrast, sharpness)
 - Recognizing motion blur, artifacts, and improper exposure
 - Suggesting corrections and retake protocols

- **Radiation Safety Practical**
 - Use of lead aprons, thyroid shields, lead gloves
 - Correct collimation & beam restriction
 - Use of personal dosimeter (TLD badge)
 - Safe positioning during exposure

- **Logbook & Case Documentation**
 - Maintaining a **practical logbook** with:
 - Date
 - Patient ID (coded)
 - Exam type & projection taken
 - Exposure parameters used
 - Remarks on image quality
 - Weekly evaluation by faculty/supervisor

- **Departmental Workflow & PACS**
 - Registering patient details in RIS/PACS
 - Retrieving and reviewing previous images
 - Sending completed studies to reporting radiologist
 - Printing or archiving images as per protocol

RADIATION PATHOLOGY

THEORY

1. Introduction to Pathology

- Definition & scope of pathology
- General principles of disease processes
- Cellular responses to injury:

- Cell injury (reversible & irreversible)
- Cell death (necrosis, apoptosis)
- Cellular adaptations (hypertrophy, hyperplasia, atrophy, metaplasia)

2. Inflammation & Repair

- Acute inflammation: causes, vascular & cellular events
- Chronic inflammation: causes, granulomatous inflammation
- Chemical mediators of inflammation
- Healing & repair:
 - Regeneration & fibrosis
 - Factors influencing wound healing

3. Neoplasia

- Definition, classification of tumors (benign vs malignant)
- Characteristics & behavior of tumors
- Etiology of cancer: genetic & environmental factors
- Metastasis & modes of spread
- Tumor grading & staging
- Common cancers relevant to radiology:
 - Lung
 - Breast
 - Cervix
 - Prostate
 - Bone tumors

4. Basic Concepts of Radiation Pathology

- Interaction of ionizing radiation with living tissue
- Determinants of radiation injury:
 - Type & energy of radiation
 - Total dose & dose rate
 - Area of exposure
 - Oxygen effect
 - Radiosensitivity of tissues (Law of Bergonie & Tribondeau)

5. Radiation Effects at Cellular & Molecular Level

- DNA damage: single & double strand breaks, cross-linking, base alterations
- Chromosomal aberrations
- Radiation effects on cell cycle
- Mechanisms of repair after radiation injury

6. Acute Radiation Syndrome (ARS)

- Hematopoietic syndrome

- Gastrointestinal syndrome
- Neurovascular syndrome
- Stages of ARS: prodromal, latent, manifest illness, recovery/death
- Clinical features & management principles

7. Deterministic & Stochastic Effects

- Deterministic (threshold) effects:
 - Skin erythema, desquamation, epilation
 - Cataracts
 - Sterility
- Stochastic (probabilistic) effects:
 - Carcinogenesis
 - Genetic mutations

8. Radiation Effects on Specific Organ Systems

- Skin & appendages
- Blood & bone marrow
- Gastrointestinal tract
- Lungs
- Liver & kidneys
- Endocrine glands
- Eye (lens)
- Nervous system
- Reproductive system

9. Fetal & Developmental Effects of Radiation

- Radiation hazards during pregnancy
- Stages of embryonic/fetal radiosensitivity
- Possible effects: growth retardation, congenital malformations, mental retardation, carcinogenesis

10. Late Effects of Radiation

- Fibrosis
- Organ atrophy
- Vascular damage
- Radiation-induced malignancies

11. Radiation Pathology in Therapeutic Context

- Pathological changes in tissues post-radiotherapy
- Tolerance doses of organs
- Management of radiation-induced injuries in cancer patients

12. Radiation Protection Principles in Pathology

- Justification, optimization, dose limitation
- ALARA principle
- Protective devices & shielding
- Use of personal dosimeters

PRACTICAL

➤ Introduction to Pathology Laboratory Practices

- Familiarization with pathology lab equipment
- Safety rules for handling biological specimens & slides
- Preparation of histopathology slides (overview)

➤ Microscopy & Slide Observation

- Use of light microscope
- Identification of normal histological features of key organs (skin, liver, lung, kidney, bone marrow, etc.)
- Observation of pathological changes under microscope

➤ Demonstration of Cellular Changes

- Microscopic slides showing:
 - Reversible cell injury
 - Necrosis types (coagulative, liquefactive, caseous, fat)
 - Apoptosis
 - Cellular adaptations (hypertrophy, atrophy, hyperplasia, metaplasia)

➤ Inflammation & Repair

- Slides & gross specimens of acute inflammation (appendicitis, abscess)
- Slides of chronic inflammation (tuberculosis, granulomas)
- Demonstration of wound healing stages

➤ Tumor Pathology

- Slides & gross specimens of benign tumors (e.g., lipoma, adenoma)
- Slides of malignant tumors (e.g., squamous cell carcinoma, adenocarcinoma)
- Observation of tumor grading & staging patterns
- X-ray / CT / MRI images showing tumor masses

➤ Radiation Effects on Cells & Tissues

- Microscopic & gross specimens of radiation injury to:
 - Skin (erythema, ulceration)
 - Bone marrow (hypoplasia/aplasia)
 - GI mucosa (mucosal denudation)
 - Lens (radiation cataract changes)
- Case photographs/images of radiation burns

➤ **Acute Radiation Syndrome (ARS) Demonstration**

- Charting ARS stages with symptoms
- Case discussions based on past medical records
- Observation of hematology reports showing radiation-induced changes (CBC patterns)

➤ **Organ-Specific Radiation Pathology**

- Slides or images showing:
 - Lung fibrosis post-radiation
 - Liver cirrhosis due to radiation
 - Kidney damage (radiation nephropathy)
 - Thyroid gland changes post-radiation
- Radiological images highlighting these changes

➤ **Fetal Radiation Effects**

- Demonstration through charts, diagrams, and documented case studies of prenatal radiation exposure outcomes

➤ **Late Effects & Secondary Cancers**

- Case images or reports showing:
 - Radiation-induced leukemia
 - Solid tumors following radiation therapy
- Discussion of latency periods & dose correlation

➤ **Radiation Protection Demonstrations**

- Use of personal dosimeters (TLD, film badge) in pathology/radiology labs
- Demonstration of lead barriers & shielding in work areas
- ALARA implementation in pathology imaging work

➤ **Record Keeping & Case Documentation**

- Maintaining a radiation pathology practical record book
- Documenting slide observations & image interpretations
- Preparing short case summaries

RADIATION THERAPY MACHINES

THEORY

1. Introduction to Radiation Therapy Machines

- Evolution of radiation therapy equipment
- Classification of radiation therapy machines (kilovoltage, megavoltage, superficial, orthovoltage, teletherapy, brachytherapy)
- General requirements for a radiotherapy unit

2. Basic Principles of Radiation Production

- Physics of X-ray & gamma-ray production
- Bremsstrahlung & characteristic radiation
- Radioactive decay principles for therapy sources (Co-60, Cs-137, Ir-192)
- Linear accelerator beam production

3. Superficial & Orthovoltage Therapy Units

- Structure and components
- Energy range & beam characteristics
- Applications and limitations
- Patient positioning & safety

4. Teletherapy Machines

- **Cobalt-60 Teletherapy Unit**
 - Construction & working
 - Source characteristics and replacement
 - Beam collimation systems
 - Safety features
- **Linear Accelerator (LINAC)**
 - Components: electron gun, waveguide, accelerator structure, target
 - Modes of operation (photon mode, electron mode)
 - Beam flattening filters & multi-leaf collimators (MLC)
 - Image-guided radiotherapy (IGRT) integration

5. Brachytherapy Units

- Types of brachytherapy: low dose rate (LDR), high dose rate (HDR), pulsed dose rate (PDR)
- Remote afterloading machines

- Common sources: Ir-192, Cs-137, Co-60, I-125
- Applicators & treatment techniques

6. Simulator Units

- X-ray simulator – structure & working
- CT simulator – principles & advantages
- Role in treatment planning

7. Specialized Radiation Therapy Machines

- Stereotactic radiosurgery (SRS) units: Gamma Knife, CyberKnife
- Proton therapy machines (cyclotron, synchrotron)
- Tomotherapy
- Intraoperative radiotherapy systems (IORT)

8. Beam Modifying Devices

- Wedges, bolus, compensators, blocks, MLC
- Electron applicators & cones
- Patient immobilization devices

9. Quality Assurance (QA) of Radiation Therapy Machines

- Daily, weekly, monthly, annual QA tests for LINAC & Cobalt units
- Dosimetry checks
- Safety interlock verification

10. Radiation Safety & Regulatory Requirements

- AERB / IAEA guidelines for installation & operation
- Radiation monitoring devices (survey meter, area monitor, personal dosimeter)
- Emergency procedures for source leakage or malfunction

11. Maintenance & Troubleshooting

- Routine maintenance schedules
- Common mechanical & electrical faults
- Reporting and logging maintenance activities

12. Recent Advances in Radiation Therapy Equipment

- Volumetric modulated arc therapy (VMAT)
- Intensity modulated radiotherapy (IMRT) delivery systems
- Adaptive radiotherapy machines
- Artificial intelligence integration in radiotherapy machines

PRACTICAL

➤ Familiarization & Demonstration

- Identification of different radiation therapy machines (Cobalt-60, LINAC, Brachytherapy units, Simulators)
- Demonstration of basic machine components and control panels
- Orientation to treatment room layout and safety zones

➤ Machine Start-Up & Shutdown Procedures

- Pre-use checks for LINAC and Cobalt units
- Power ON/OFF sequence and warm-up procedures
- Emergency shutdown protocols

➤ Cobalt-60 Teletherapy Unit Practical

- Source ON/OFF demonstration
- Collimator movement and field size selection
- Gantry and couch movement controls
- Safety interlock demonstration

➤ Linear Accelerator (LINAC) Practical

- Mode selection: photon and electron beams
- Energy level selection and verification
- Multileaf collimator (MLC) operations
- Beam shaping and field setup
- Daily output check procedure

➤ Brachytherapy Equipment Practical

- Handling and loading applicators (LDR/HDR)
- Remote afterloading system demonstration
- Radiation source storage and transfer
- QA of brachytherapy afterloader

➤ Simulator & CT Simulator Practical

- Patient positioning for simulation
- Marking of isocentre and reference points
- Imaging acquisition and transfer to treatment planning system
- Immobilization device usage

➤ **Beam Modifying Devices Handling**

- Placement of wedges, bolus, compensators
- Field block cutting and positioning
- Electron applicator attachment

➤ **Quality Assurance (QA) Practical**

- Daily machine QA checks (output, field symmetry, flatness)
- Monthly QA demonstration (mechanical accuracy, beam energy)
- Annual QA overview
- Use of QA tools: ionization chamber, electrometer, water phantom

➤ **Radiation Safety & Monitoring**

- Use of survey meter and area monitor
- Checking personal dosimeter (TLD/OSL) readings
- Room radiation level measurement during operation
- Safe handling and storage of radioactive sources

➤ **Maintenance Demonstration**

- Routine cleaning and inspection procedures
- Lubrication of moving parts (where applicable)
- Basic troubleshooting steps for common errors

➤ **Emergency Drills**

- Source stuck in ON position – simulated response
- Power failure during treatment – safe patient removal procedure
- Equipment fault reporting and documentation

➤ **Record-Keeping & Documentation**

- Treatment logbook entry
- QA test documentation
- Radiation safety records and incident reporting

RADIOGRAPHIC PHOTOGRAPHY

THEORY

1. Introduction to Radiographic Photography

- Definition, scope, and importance of radiographic photography

- Historical development of radiographic imaging
- Role of photography in medical radiology

2. Photographic Principles

- Nature of light and image formation
- Photographic exposure (aperture, shutter speed, ISO)
- Lenses: types, focal length, resolution
- Depth of field and magnification

3. Photographic Materials

- Films: types of radiographic films (screen, non-screen)
- Film structure: base, emulsion, protective layer
- Sensitometry & characteristic curves (H & D curve)
- Intensifying screens: types, uses, care, and maintenance

4. Darkroom Techniques

- Darkroom layout and design
- Safe light types and uses
- Film processing: developer, fixer, washing, drying
- Manual vs. automatic processing
- Film storage and handling

5. Radiographic Image Recording

- Principles of image formation in radiography
- Factors affecting image quality (density, contrast, resolution, distortion, artifacts)
- Image sharpness and blurring
- Photographic copies and duplication

6. Digital Radiographic Photography

- Transition from conventional to digital systems
- CR (Computed Radiography) and DR (Digital Radiography)
- Image receptors in digital radiography
- PACS (Picture Archiving and Communication System) basics
- Image post-processing techniques

7. Radiographic Photographic Equipment

- Cameras and accessories for medical photography
- X-ray cassettes and grids
- Fluorescent screens and film-screen combination

- Automatic film processor

8. Special Techniques in Radiographic Photography

- Contrast media photography (barium, iodine-based studies)
- Motion studies and cine-radiography
- Angiographic photography
- Mammography photography
- Photographic documentation in radiotherapy

9. Quality Control in Radiographic Photography

- Film quality assessment
- Detection and prevention of artifacts
- Maintenance of darkroom & processing equipment
- Radiation protection in radiographic photography

10. Legal & Ethical Aspects

- Ethical issues in medical photography
- Confidentiality and patient rights
- Medico-legal value of radiographs

PRACTICAL

➤ Darkroom Techniques

- Demonstration of darkroom layout, lighting & safelight conditions
- Loading and unloading of X-ray films in cassettes
- Film handling techniques to avoid artifacts
- Film identification & marking methods

➤ Film Processing

- Preparation of developer & fixer solutions
- Manual film processing (developing, rinsing, fixing, washing, drying)
- Use of automatic film processor
- Demonstration of temperature & time control in processing
- Film storage & archival methods

➤ Intensifying Screens & Cassettes

- Mounting, cleaning, and maintenance of intensifying screens
- Handling and maintenance of X-ray cassettes
- Effect of screen–film combinations on image quality

➤ **Image Quality & Fault Analysis**

- Identification of good vs. poor quality radiographs
- Recognition of common film faults (fogging, reticulation, scratches, stains, static marks, under/over exposure)
- Correction methods for film faults
- Preparation of photographic copies and duplicates of radiographs

➤ **Radiographic Image Recording**

- Demonstration of different exposure factors affecting density, contrast, sharpness & magnification
- Use of grids & beam collimation to improve image quality
- Practice in special positioning for better photographic output

➤ **Digital Radiographic Photography (Introductory Practical)**

- Demonstration of Computed Radiography (CR) & Digital Radiography (DR) systems
- Scanning and digitization of conventional radiographs
- Use of PACS (Picture Archiving and Communication System) for image storage/retrieval
- Simple post-processing techniques (contrast adjustment, cropping, annotation)

➤ **Special Procedures**

- Demonstration of radiographic photography in contrast studies (Barium swallow, IVP, angiography – observation based)
- Practice in mammographic film handling (if available)
- Basic cine-radiography demonstration (if facility exists)

➤ **Quality Control & Safety**

- Routine darkroom cleaning and maintenance
- Safe handling & disposal of chemicals
- Checking film screen contact using test tools
- Radiation safety precautions while handling radiographic films