PARAMEDICAL EDUCATION & TRAINING COUNCIL
Ch. No.157/1, Near Laxmi Nagar, Metro Station Gate No 1, Vikas Marg, Delhi-92

SYLLABUS AND CURRICULUM OF DIPLOMA IN D M R T COURSE

DIPLOMA IN MEDICAL RADIOLOGY TECHNOLOGY (DMRT)

Diploma in Medical Radiology Technology (DMRT) trains students in the use of radiation technology for diagnosis and treatment of diseases. It focuses on both **radiography (X-rays, CT, MRI and Ultrasound)** and **radiotherapy (cancer treatment using radiation)**.

Course Overview

- **Full Form**: Diploma In Medical Radiology Technology (DMRT)
- **Duration**: 2 Years + 6 Months (Internship)
- **Eligibility**:
    - 10+2 pass (Science stream – PCB or PCM usually preferred)
    - Minimum 45–50% marks
    - On the basis of 10th (Only Certificate Courses)
    - On the basis of certificate – diploma in same course (lateral entry)

Career Opportunities after D M R I T

- **Radiology Technician / Radiographer**
- **X-Ray Technician**
- **CT / MRI Technician**
- **Radiotherapy Technician**
- **Medical Imaging Assistant**

SEMESTER – I

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRT101	BASIC HUMAN ANATOMY & PHYSIOLOGY	45 Min	1 Hrs.	50	50
DMRT102	INTRODUCTION TO HEALTH CARE SYSTEM & PATIENT CARE	45 Min	1 Hrs.	50	50
DMRT103	BASIC PHYSICS & RADIATION PHYSICS	45 Min	1 Hrs.	50	50
DMRT104	INTRODUCTION TO RADIOGRAPHY	45 Min	1 Hrs.	50	50

BASIC HUMAN ANATOMY & PHYSIOLOGY

THEORY

1. Introduction

- Definition & scope of anatomy and physiology
- Anatomical terminology: planes, positions, directional terms
- Levels of structural organisation: cells → tissues → organs → systems
- Overview of human body systems

2. Cells and Tissues

- Structure of a typical human cell
- Cell organelles and their functions (nucleus, mitochondria, ribosomes, etc.)
- Cell division (mitosis & meiosis)
- Basic tissue types:
    - **Epithelial tissue** (types, functions, locations)
    - **Connective tissue** (bone, cartilage, blood, adipose, ligaments)
    - **Muscle tissue** (skeletal, cardiac, smooth)
    - **Nervous tissue** (neurons, neuroglia)

3. Skeletal System

- Overview of human skeleton
- Classification of bones
- Structure & composition of bone
- Types of joints and their movements
- Major bones of:

- Skull
- Vertebral column
- Thoracic cage
- Upper limb
- Lower limb
- Pelvis

4. Muscular System

- Types of muscles
- Structure of skeletal muscle fibre
- Mechanism of muscle contraction (sliding filament theory)
- Major muscles of the body and their functions

5. Circulatory System

- Structure and functions of the heart
- Blood vessels: arteries, veins, capillaries
- Blood circulation: systemic & pulmonary
- Cardiac cycle & heart sounds
- Blood pressure: definition, normal range, regulation

6. Blood and Lymphatic System

- Composition and functions of blood
- Blood cells: RBCs, WBCs, platelets
- Blood groups & Rh factor
- Lymph & lymphatic vessels
- Lymph nodes & their functions

7. Respiratory System

- Anatomy of respiratory tract
- Structure & functions of lungs
- Mechanism of breathing (inspiration & expiration)
- Exchange of gases
- Regulation of respiration

8. Digestive System

- Anatomy of alimentary canal (mouth to anus)
- Digestive glands: salivary glands, liver, pancreas
- Digestive processes & absorption of nutrients

9. Nervous System

- Divisions: central, peripheral, autonomic
- Structure and functions of brain (cerebrum, cerebellum, brainstem)
- Spinal cord structure and reflex arc
- Cranial and spinal nerves

10. Endocrine System

- Endocrine glands: pituitary, thyroid, parathyroid, adrenal, pancreas, gonads
- Hormones & their functions
- Disorders of endocrine glands (brief)

11. Urinary System

- Structure of kidney & nephron
- Urine formation
- Ureters, urinary bladder, urethra

12. Reproductive System

- Male reproductive organs & gametogenesis
- Female reproductive organs & menstrual cycle
- Fertilisation & pregnancy (brief)

13. Special Senses

- Eye: structure, functions, image formation
- Ear: structure, hearing mechanism, balance
- Taste and smell organs

PRACTICAL

➢ Study of Anatomical Models

- Identification of **human skeleton** and its parts:
  - Skull (individual bones and sutures)
  - Vertebral column (cervical, thoracic, lumbar vertebrae)
  - Thoracic cage (sternum, ribs)
  - Upper limb bones (humerus, radius, ulna, carpals, metacarpals, phalanges)
  - Lower limb bones (femur, tibia, fibula, tarsals, metatarsals, phalanges)
  - Pelvic bones
- Identification of major **joints** and their types

➢ Identification of Organs & Systems (Models/Specimens)

- Heart (external & internal features)

- Lungs (lobes, bronchi)
- Kidney (cortex, medulla, pelvis)
- Brain (cerebrum, cerebellum, brainstem)
- Eye (parts: cornea, lens, retina, optic nerve)
- Ear (outer, middle, inner structures)
- Digestive tract model (mouth, oesophagus, stomach, intestines)
- Reproductive system models (male & female)

➢ Histology Practical (Microscopy)

- Identification of prepared slides:
    - Epithelial tissues (simple squamous, cuboidal, columnar, ciliated)
    - Connective tissues (bone, cartilage, blood smear)
    - Muscle tissues (skeletal, cardiac, smooth)
    - Nervous tissue (neurons)

➢ Blood & Circulatory System Experiments

- **Blood grouping** (ABO and Rh factor) – demonstration
- **Hemoglobin estimation** – demonstration
- **Peripheral blood smear** examination – demonstration
- Measurement of **pulse rate**
- Measurement of **blood pressure** using sphygmomanometer

➢ Respiratory System Practical

- Demonstration of **spirometer** (lung capacity) – optional
- Observation of respiratory movements

➢ Nervous System Practical

- Demonstration of **reflex actions** (knee jerk reflex)
- Sensory testing (touch, temperature, pain – demonstration)

➢ Charts, Diagrams & Flowcharts

- Identification of systems from wall charts:
    - Skeletal, muscular, circulatory, respiratory, digestive, nervous, endocrine, urinary, reproductive, special senses
- Drawing and labelling basic system diagrams in practical notebook

INTRODUCTION TO HEALTH CARE SYSTEM & PATIENT CARE

THEORY

1 – Overview of Health Care System

- Definition of health and illness (WHO definition)
- Dimensions of health (physical, mental, social, spiritual)
- Levels of health care: primary, secondary, tertiary
- Organisation of the health care delivery system in India
- Roles of government, private sector, NGOs in health care
- Overview of diagnostic and imaging departments in hospitals

2 – Roles & Responsibilities of Health Care Professionals

- Duties and ethics of radiology/imaging technologists
- Inter-professional collaboration in patient care
- Scope and limitations of paramedical staff in radiology
- Legal responsibilities in handling patients and medical images

3 – Hospital Departments & Interactions

- Overview of major hospital departments:
  - Outpatient (OPD)
  - Inpatient (IPD)
  - Emergency / Casualty
  - ICU / CCU
  - Operation Theatre
  - Laboratory services
  - Radiology and Imaging Department
- Communication and coordination between departments

4 – Patient Care Fundamentals

- Principles of patient care in radiology
- Patient rights and responsibilities
- Consent: informed and implied
- Cultural and psychological aspects of patient care
- Communication skills for patient interaction
- Handling special patients (pediatric, geriatric, pregnant women, disabled)

5 – Patient Preparation for Imaging

- Pre-procedure preparation (history taking, allergies, fasting)
- Patient positioning techniques for X-ray, CT, MRI, ultrasound
- Use of immobilisation devices
- Contrast media: types, indications, preparation, patient instructions
- Post-procedure care and observation

6 – Safety in Patient Care

- Basic life support (BLS) principles
- Transporting patients safely (wheelchair, stretcher, bed-to-table transfer)
- Fall prevention strategies
- Radiation protection measures for patients and staff
- Infection control and standard precautions

7 – First Aid & Emergency Care in Imaging Department

- First aid for fainting, seizures, falls, burns
- Management of contrast media reactions (mild, moderate, severe)
- CPR (Cardiopulmonary Resuscitation) – basic steps
- Emergency equipment in the radiology department (crash cart, oxygen cylinder)

8 – Ethical & Legal Aspects

- Patient confidentiality and data protection
- Medical ethics in diagnostic imaging
- Documentation and record-keeping in patient care
- Medicolegal cases (MLC) – handling and protocols

PRACTICAL

➢ Orientation to Hospital & Radiology Department

- Guided tour of:
  - Outpatient (OPD) & Inpatient (IPD) units
  - Emergency / Casualty department
  - ICU / CCU
  - Radiology & Imaging department layout (X-ray, CT, MRI, Ultrasound)
- Observation of workflow from patient arrival to imaging report delivery

➢ Patient Identification & Communication

- Checking patient details (name, age, ID number) before imaging
- Communicating procedure details to patients

- History taking for imaging (present illness, past illness, allergies, pregnancy status)
- Obtaining informed consent (role-play and real cases)

➢ **Patient Positioning & Transfer**

- Bed-to-stretcher and stretcher-to-table transfer techniques
- Wheelchair handling and safety checks
- Positioning for common radiographic views (chest, limb, skull)
- Use of immobilisation devices (sandbags, straps, foam pads)

➢ **Patient Preparation for Imaging**

- Preparing patients for contrast studies (fasting, hydration, allergy checks)
- Removing metallic objects before MRI and X-ray
- Proper gowning for patients
- Monitoring patient comfort during the procedure

➢ **First Aid & Emergency Response**

- Demonstration & practice of:
    - CPR (Cardiopulmonary Resuscitation)
    - Recovery position for unconscious patients
    - Management of fainting, seizures, falls
- Identifying and responding to mild, moderate, and severe contrast reactions
- Location and use of emergency equipment (oxygen cylinder, suction apparatus, crash cart)

➢ **Infection Control Practices**

- WHO handwashing steps – demonstration & practice
- Use of PPE (gloves, masks, aprons, caps)
- Cleaning & disinfection of radiographic cassettes, tables, and accessories
- Waste segregation and disposal according to biomedical waste rules

➢ **Radiation Protection for Patient**

- Proper use of lead aprons, thyroid shields, gonadal shields
- Collimation and exposure time reduction
- Maintaining safe distances and proper positioning

➢ **Documentation & Record Maintenance**

- Filling patient registration and consent forms accurately
- Recording imaging procedures in departmental logs
- Handling and storing patient reports and digital images (PACS entry)

➢ **Case Discussions & Simulations**

- Discussion of special patient handling (pediatric, geriatric, trauma cases)
- Mock drills for emergency evacuation and resuscitation in radiology

BASIC PHYSICS & RADIATION PHYSICS

THEORY

1 – Fundamentals of Physics

- **Physical quantities & units**
  - SI units, measurement systems, accuracy, and errors
- **Matter & states**
  - Solids, liquids, gases – basic properties
- **Mass, weight, and density**
- **Work, power, and energy**
  - Types of energy – kinetic, potential, mechanical, heat, light, electrical

2 – Mechanics

- **Motion** – types, speed, velocity, acceleration
- **Newton's laws of motion** – applications in radiology (table movement, C-arm movement)
- **Force, torque, and friction**
- **Momentum & impulse**
- **Gravity** – acceleration due to gravity, weight changes in lifts/tilt tables

3 – Heat & Thermodynamics

- Modes of heat transfer – conduction, convection, radiation
- Temperature scales – Celsius, Fahrenheit, Kelvin
- Expansion of solids, liquids, gases
- Thermometers – types & uses in healthcare
- Thermal conductivity & insulation in radiology rooms

4 – Light & Optics

- Nature & properties of light
- Reflection, refraction, and total internal reflection
- Lenses & mirrors – types and uses in optical devices
- Optical instruments in radiology (viewing boxes, magnifiers)
- Fibre optics – principle and uses in endoscopy and imaging

5 – Sound & Ultrasound Physics

- Properties of sound waves – frequency, wavelength, velocity, amplitude
- Audible and ultrasonic ranges
- Production of ultrasound waves
- Basic principles of medical ultrasonography

6 – Electricity & Magnetism

- Electric charges, current, voltage, resistance
- Ohm's law & electrical power
- Series & parallel circuits
- Capacitors & inductors (basic principles)
- Magnetism – types, magnetic fields, electromagnetism
- Electric safety in radiology departments

7 – Electromagnetic Waves

- Spectrum of electromagnetic radiation – radio waves to gamma rays
- Properties of electromagnetic waves
- Importance of X-rays & gamma rays in imaging

8 – Fundamentals of Radiation Physics

- Discovery of X-rays – properties and uses
- Atomic structure – protons, neutrons, electrons, atomic number, mass number
- Isotopes & radioisotopes
- Excitation & ionization
- Production of X-rays:
    - X-ray tube construction & working
    - Bremsstrahlung & characteristic radiation
    - Factors affecting X-ray production (kVp, mA, exposure time)

9 – Interaction of Radiation with Matter

- Absorption, scattering, and transmission of X-rays
- Photoelectric effect
- Compton scattering
- Pair production (basic concept)
- Attenuation of X-rays in tissues

10 – Radiation Units & Measurement

- Exposure, absorbed dose, equivalent dose, effective dose
- Units: Gray (Gy), Sievert (Sv), Becquerel (Bq), Coulomb/kg
- Dose measuring devices: film badges, TLDs, ionization chambers

11 – Biological Effects of Radiation

- Somatic & genetic effects
- Deterministic & stochastic effects
- Acute radiation syndrome (overview)

12 – Radiation Protection

- ALARA principle (As Low As Reasonably Achievable)
- Time, distance, shielding
- Protective devices: lead aprons, thyroid shields, gonadal shields
- Radiation protection for patients, staff, and public

13 – Quality Assurance in Radiation

- Quality control tests for X-ray equipment
- Regular calibration and maintenance
- Darkroom & digital image quality checks

PRACTICAL

- **Units, Measurement & Basic Instruments**

- Demonstration and use of measuring devices (vernier caliper, micrometer, measuring tape)
- Conversion between different units (Celsius ↔ Kelvin, meters ↔ centimeters, etc.)
- Determination of density of solids and liquids

- **Mechanics Practical**

- Verification of Newton's laws of motion (simple apparatus)
- Study of pulley system and calculation of mechanical advantage
- Demonstration of force, torque, and balance in radiographic equipment movement (X-ray tube stand, C-arm)

- **Heat & Temperature**

- Measurement of temperature using clinical thermometer and thermocouple
- Demonstration of heat transfer (conduction, convection, radiation)
- Expansion of solids/liquids – simple experimental setup

- **Light & Optics**

- Reflection and refraction experiments using plane and curved mirrors
- Determination of focal length of convex lens
- Demonstration of total internal reflection (TIR)
- Fibre optic cable demonstration (light transmission)

- **Sound & Ultrasound**

- Demonstration of sound wave properties using tuning fork & resonance tube
- Frequency measurement of a tuning fork
- Demonstration of ultrasound gel use and transducer coupling on phantom (if available)

- **Electricity & Magnetism**

- Verification of Ohm's law using resistors
- Series and parallel circuit setup and measurement of current & voltage
- Demonstration of magnetic field around a conductor using iron filings
- Use of multimeter for measuring voltage, current, resistance
- Safe handling of electrical equipment in radiology department

- **Electromagnetic Waves**

- Demonstration of different parts of the electromagnetic spectrum via charts/models
- Identification of X-ray, gamma, and visible light wavelength ranges

- **Radiation Physics Demonstrations**

- Identification of parts of an X-ray tube and control panel
- Demonstration of X-ray production by varying kVp, mA, and exposure time (phantom use)
- Study of beam collimation and effect on image & dose
- Demonstration of inverse square law for radiation intensity

- **Interaction of Radiation with Matter**

- Demonstration of attenuation by different materials (lead, aluminium, plastic, tissue-equivalent material) using dosimeter readings
- Observing image quality differences with varying thickness

- **Radiation Measurement & Safety**

- Demonstration of personal dosimeters (TLD badge, film badge)
- Using a survey meter or ionization chamber to measure radiation levels
- Safe positioning of radiographer during exposure
- Use of protective devices: lead apron, thyroid shield, gonad shield

- **Quality Control in Imaging**

- Darkroom quality control (for film systems) – light leakage test, safelight test
- Image quality check in CR/DR systems (resolution, contrast)
- Regular maintenance checks on X-ray units (demo only)

➢ **12. Record Work**

- All practicals to be recorded with:
  - Title of experiment/demonstration
  - Apparatus used
  - Procedure
  - Observations & readings
  - Result & precautions

INTRODUCTION TO RADIOGRAPHY

THEORY

1 – History & Development of Radiography

- Discovery of X-rays by Wilhelm Roentgen
- Early developments in medical imaging
- Evolution from film-based radiography to digital systems
- Overview of CT, MRI, Ultrasound, PET-CT advancements

2 – Basics of Radiography

- Definition & scope of radiography
- Difference between radiography, fluoroscopy, CT, MRI, and other imaging modalities
- Role of radiographer in the health care team
- Applications of radiography in diagnosis and treatment

3 – X-ray Production & Properties

- Structure and function of X-ray tube
- Mechanism of X-ray production (Bremsstrahlung & characteristic radiation)
- Properties of X-rays
- Factors controlling X-ray quality and quantity (kVp, mA, exposure time)

4 – Components of Radiographic Equipment

- X-ray machine parts (tube, collimator, control panel, generator)
- Image receptors – film, CR cassettes, DR detectors
- Grids and bucky stands
- Portable X-ray machines and mobile units

5 – Image Formation & Quality

- Principles of image formation
- Factors affecting image quality: density, contrast, resolution, distortion
- Geometric factors in radiography (SID, OID, focal spot size)
- Image artefacts – causes and prevention

6 – Radiographic Films & Processing

- Types of X-ray films and intensifying screens
- Film storage and handling
- Darkroom layout and safelighting
- Film processing – manual and automatic
- Common film faults and remedies

7 – Basics of Digital Radiography

- Principles of computed radiography (CR)
- Principles of direct and indirect digital radiography (DR)
- Advantages and limitations of digital systems
- PACS (Picture Archiving and Communication System) basics

8 – Radiation Protection in Radiography

- Hazards of ionizing radiation
- ALARA principle
- Time, distance, shielding
- Use of personal protective devices
- Radiation dose limits for patients and workers

9 – Patient Care in Radiography

- Preparing the patient for X-ray examination
- Positioning basics for chest, extremities, skull, spine
- Communication and reassurance
- Special considerations for pediatric, geriatric, trauma, and pregnant patients

10 – Legal & Ethical Aspects

- Importance of informed consent
- Confidentiality of patient information
- Record keeping in radiography
- Legal responsibilities of a radiographer

PRACTICAL

- **Familiarization with Radiography Department**

- Orientation to radiology department layout
- Identification of diagnostic areas: X-ray room, darkroom, processing area, console area
- Introduction to CT, MRI, Ultrasound & Fluoroscopy rooms (overview only)
- Safety zones and restricted areas in radiology

➢ **Radiographic Equipment Handling**

- Identification and function of X-ray machine parts
- Control panel operation – setting kVp, mA, exposure time
- Collimator adjustment and light field alignment
- Safe movement and positioning of X-ray tube and bucky stand
- Handling of portable/mobile X-ray units

➢ **Image Receptor Handling**

- Loading and unloading of X-ray cassettes (film, CR)
- Proper handling of DR detectors
- Storage and care of cassettes and image plates

➢ **Basic Patient Positioning & Preparation**

- Correct positioning for routine examinations:
    - Chest PA & AP view
    - Extremities (hand, wrist, elbow, knee, foot, ankle)
    - Skull (basic positions)
    - Spine (cervical, thoracic, lumbar – basic views)
- Use of positioning aids: sponges, sandbags, immobilization devices
- Draping and patient comfort techniques

➢ **Film Processing & Image Evaluation**

- Darkroom entry and safelight precautions
- Manual film processing – developer, fixer, washing, drying
- Automatic processor operation
- Identifying and rectifying common processing faults
- Basic image quality evaluation (density, contrast, sharpness)

➢ **Basic Digital Radiography Operations**

- CR cassette loading/unloading in reader
- DR workstation interface basics
- Adjusting window width/level for image optimization
- Basic PACS uploading and retrieval of images

➢ **Radiation Protection Practices**

- Demonstration of ALARA principle in practice
- Correct use of lead aprons, thyroid shields, gonad shields
- Use of radiation monitoring devices (TLD badge)
- Safe distance & shielding during exposure

➢ **Patient Care Skills in Radiography**

- Patient identification and verification of examination request
- Communication skills during procedure explanation
- Assisting immobile, pediatric, and elderly patients during positioning
- Handling emergency situations in the X-ray room (e.g., fainting, breathing difficulty)

➢ **Maintenance & Quality Checks**

- Daily equipment warm-up procedures
- Checking light field and radiation field congruence
- Visual inspection of cassettes, detectors, and screens
- Reporting equipment faults to supervisor

➢ **Practical Record & Assessment**

- Maintenance of a **logbook** of cases assisted and performed
- Practical viva on equipment, positioning, and safety
- Evaluation based on skill, accuracy, and adherence to safety protocols

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, CO_2)
  - 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

SEMESTER – III

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRT301	PREVENTIVE MEDICINE AND MEDICAL ETHICS	45 Min	1 Hrs.	50	50
DMRT302	RADIOGRAPHIC EQUIPMENT & MAINTENANCE	45 Min	1 Hrs.	50	50
DMRT303	FIRST AID AND CPR	45 Min	1 Hrs.	50	50
DMRT304	CT, MRI & ULTRASOUND	45 Min	1 Hrs.	50	50

PREVENTIVE MEDICINE AND MEDICAL ETHICS

THEORY

1. Introduction to Preventive Medicine

- Definition, scope, and importance of preventive medicine in healthcare
- Natural history of disease & levels of prevention (primordial, primary, secondary, tertiary)
- Concepts of **health** and **disease**
- Determinants of health – physical, mental, social, and environmental

2. Epidemiology

- Definition, aims, uses, and basic principles
- Types of epidemiological studies (descriptive, analytical, experimental)
- Measures of disease frequency: incidence, prevalence, morbidity, mortality
- Surveillance and notification of diseases

3. Communicable Diseases

- Modes of transmission and prevention of:
  - Tuberculosis
  - Hepatitis B & C
  - HIV/AIDS
  - COVID-19
  - Typhoid, cholera, malaria
- Universal precautions for infection control in healthcare settings

4. Non-Communicable Diseases (NCDs)

- Common NCDs: cardiovascular diseases, diabetes, cancer, stroke
- Risk factors, screening, and preventive strategies
- Role of lifestyle modification and patient education

5. Environmental Health

- Safe water supply and sanitation
- Waste disposal (including biomedical waste management in radiology departments)
- Hospital infection control
- Radiation hazards and protection measures

6. Immunization

- Immunization schedules (national & special vaccines)
- Cold chain maintenance
- Post-exposure prophylaxis for healthcare workers (e.g., Hepatitis B, rabies)

7. Occupational Health

- Occupational hazards in radiology:
  - Radiation exposure
  - Musculoskeletal strain
  - Stress and fatigue
- Safety guidelines & use of personal protective equipment (PPE)
- Periodic health checkups for radiology staff

Medical Ethics

8. Introduction to Medical Ethics

- Definition and importance of ethics in healthcare
- Difference between ethics, morals, and laws
- Principles of biomedical ethics:
  - Autonomy
  - Beneficence
  - Non-maleficence
  - Justice

9. Patient Rights & Responsibilities

- Patient confidentiality and privacy (including imaging records)
- Informed consent – purpose, types, and legal aspects
- Right to information and refusal of treatment

10. Professional Conduct

- Code of conduct for radiology professionals
- Maintaining dignity and respect towards patients
- Avoiding discrimination based on gender, religion, caste, or economic status
- Truthfulness and transparency in reporting

11. Legal Aspects in Radiology

- Relevant acts and laws:
  - PCPNDT Act (Prohibition of Sex Selection)
  - Atomic Energy Regulatory Board (AERB) guidelines
  - Consumer Protection Act in healthcare
- Medicolegal documentation in imaging

12. Ethical Issues in Radiology

- Handling incidental findings
- Ethical concerns with AI and digital image manipulation
- Reporting errors and accountability
- Conflict of interest in medical practice

13. Communication Skills

- Communicating with patients empathetically
- Breaking bad news sensitively
- Interpersonal skills with colleagues and other healthcare workers

PRACTICAL

➢ Infection Control & Universal Precautions

- Demonstration of **hand hygiene techniques** (WHO 7-step method)
- Proper use and disposal of **personal protective equipment (PPE)** – gloves, masks, gowns, lead aprons
- Safe handling and disposal of contaminated materials in radiology departments
- Needle stick injury prevention and post-exposure protocol

➢ Biomedical Waste Management

- Segregation of biomedical waste according to **color-coded bins**
- Handling of **radiographic films** and chemicals safely
- Proper disposal of expired contrast media and radioactive materials as per AERB guidelines

➢ **Immunization & Post-Exposure Prophylaxis**

- Observation of vaccination procedures in healthcare facilities
- Demonstration of maintaining **cold chain** for vaccines
- Preparation of a checklist for post-exposure prophylaxis for Hepatitis B, HIV, and rabies

➢ **Hospital Infection Control Practices**

- Visit to the hospital infection control unit
- Preparation of a **radiology-specific infection control plan**
- Demonstration of equipment cleaning and disinfection protocols (e.g., ultrasound probes, X-ray cassettes, CT gantry)

➢ **Radiation Protection Measures**

- Demonstration of use of **radiation monitoring devices** (TLD badge, pocket dosimeter)
- Checking and proper positioning of lead barriers, lead glass, and lead aprons
- Mock drill on safe evacuation during a radiation hazard

➢ **Screening & Preventive Health Measures**

- Participation in community health camps for **NCD screening** (BP, blood sugar, cancer awareness)
- Observation of preventive imaging techniques (e.g., mammography for breast cancer screening)

➢ **Patient Interaction & Ethical Practice**

- Role-play exercises on **informed consent** taking for imaging procedures
- Simulated patient counseling for:
    - Radiation safety
    - Procedure explanation
    - Contrast media risks
- Practicing **empathetic communication** and active listening skills

➢ **Legal & Ethical Documentation**

- Preparation of sample consent forms for X-ray, CT, MRI, and radiation therapy
- Mock documentation of PCPNDT records for ultrasound procedures
- Understanding confidentiality: practice scenarios of maintaining patient data security

➢ **Case Studies & Ethical Dilemmas**

- Group discussion on real-life ethical issues in radiology (e.g., incidental findings, patient privacy, error reporting)
- Problem-solving activities for ethical conflicts in imaging practice

➢ **Professionalism in the Radiology Department**

- Observing and noting professional behavior of radiographers and technologists

  Practicing teamwork and coordination with other healthcare professionals

RADIOGRAPHIC EQUIPMENT & MAINTENANCE

THEORY

1. Fundamentals of Radiographic Equipment

- Introduction to radiographic equipment – types and classification
- Basic electrical concepts applied in radiology (voltage, current, resistance, power, AC/DC)
- Electrical supply in X-ray departments – single-phase, three-phase, high-frequency systems
- Transformers and rectifiers used in X-ray machines
- Components of X-ray circuit

2. X-Ray Tube & Tube Housing

- Construction and working of X-ray tube
- Stationary vs. rotating anode tubes
- Tube rating charts (anode cooling, tube loading)
- Tube housing and oil cooling system
- Filtration and collimation devices (fixed and variable collimators, light beam diaphragms, cones, cylinders)
- Beam restrictors and grids

3. X-Ray Generators

- Types of X-ray generators:
  - Single phase
  - Three phase (6-pulse & 12-pulse)
  - High-frequency generators
  - Constant potential generators
- Automatic exposure control (AEC) systems
- kVp, mA, mAs selection mechanisms
- Timer circuits and exposure switches

4. Radiographic Accessories & Patient Positioning Aids

- Bucky tables, wall stands, cassette holders, tilting tables
- Compression devices and positioning aids
- Image intensifiers and fluoroscopy equipment
- Spot film devices and cine radiography units

5. Advanced Radiographic Equipment

- Digital radiography (CR & DR systems) – components and workflow
- PACS (Picture Archiving and Communication Systems) – basics
- Mammography units – design and special features
- Dental radiographic units
- Portable and mobile X-ray units
- C-arm image intensifiers used in operation theatres
- CT scan equipment – basic introduction
- MRI equipment – basic introduction

6. Maintenance of Radiographic Equipment

- Principles of preventive maintenance
- Care of X-ray tube, cables, generator, control panel, and collimators
- Daily/weekly/monthly maintenance checklists
- Safety measures for electrical and mechanical handling
- Troubleshooting common faults (flickering, uneven density, artifacts, overheating)
- Darkroom equipment maintenance (developer, fixer tanks, safelights, automatic processors)
- Care and maintenance of digital systems

7. Radiation Safety & Quality Control

- Basic radiation protection devices in equipment (lead shielding, tube housing, aprons, barriers)
- Equipment quality control tests:
    - kVp accuracy
    - Timer accuracy
    - mA linearity
    - Focal spot size test
    - Beam alignment & collimation check
    - Half value layer (HVL) test
- Importance of routine quality assurance (QA) in radiology departments

PRACTICAL

- **Familiarization & Identification**

- Identification of parts of X-ray machine (tube, collimator, control panel, generator, cables).
- Identification of Bucky table, wall stand, cassette holder, and positioning devices.
- Identification of cassettes, intensifying screens, grids, cones, and collimators.

➢ **X-Ray Tube & Collimator**

- Demonstration of stationary and rotating anode tubes.
- Handling and care of tube housing and collimators.
- Checking light beam diaphragm (field size vs. radiation field).

➢ **X-Ray Generators & Control Panels**

- Demonstration of single-phase, three-phase, and high-frequency generators.
- Operation of control panel – setting kVp, mA, timer, and exposure.
- Demonstration of exposure switch and safety interlocks.

➢ **Radiographic Accessories**

- Practical use of Bucky table, wall stand, and compression devices.
- Demonstration of fluoroscopy unit and image intensifier.
- Handling of portable/mobile X-ray unit.
- Demonstration of C-arm operation in OT setup.

➢ **Digital Imaging Equipment**

- Practical handling of CR cassettes and DR detectors.
- Demonstration of image processing in CR/DR systems.
- Care and maintenance of imaging plates and digital detectors.
- Demonstration of PACS – storage and retrieval of images.

➢ **Maintenance & Troubleshooting**

- Daily/weekly/monthly preventive maintenance checklists.
- Cleaning and care of cassettes, screens, grids, and CR plates.
- Checking and replacing fuses, cables, and connections.
- Fault finding in common X-ray equipment issues (overheating, uneven density, artifacts, flickering).
- Darkroom equipment care (safelight, developer, fixer tanks, automatic processor).

➢ **Quality Control (QC) Tests**

- kVp accuracy test.
- Timer accuracy test.
- mA linearity and reproducibility test.
- Beam alignment and collimation test.

- Measurement of Half Value Layer (HVL).
- Focal spot size test.
- Leakage radiation survey of tube housing.

➢ **Documentation & Records**

- Preparation of maintenance records and QC logbook.
- Recording of equipment servicing and calibration reports.

FIRST AID AND CPR

THEORY

1. Introduction to First Aid

- Definition, aims, and principles of first aid
- Role and responsibilities of a first aider
- Contents of a first aid box (hospital, community, radiology department)
- Basic rules of handling patients in emergency situations

2. First Aid in Common Medical Emergencies

- Unconsciousness, fainting, and syncope
- Shock (types, signs, management)
- Seizures, stroke, diabetic emergencies
- Heat stroke, hypothermia, dehydration, burns, frostbite
- Allergic reactions and anaphylaxis
- Drowning and choking

3. First Aid in Injuries

- Wounds: types, bleeding control (direct pressure, elevation, tourniquet, pressure points)
- Fractures, sprains, and dislocations – immobilization techniques
- Head injury, spinal injury – precautions in radiology setup
- Poisoning (inhalation, ingestion, injection, absorption) – general management
- Foreign bodies (eye, ear, nose, skin)

4. Cardiopulmonary Resuscitation (CPR)

- Introduction and importance of CPR in emergencies
- Basic Life Support (BLS) – adult, child, and infant
- Chain of survival
- Steps of CPR (CAB – circulation, airway, breathing)
- Use of Automated External Defibrillator (AED)

- Recovery position and post-resuscitation care

5. First Aid in Radiology Department

- Electric shock & burns due to equipment
- Contrast reaction emergencies (mild, moderate, severe)
- Radiation exposure accidents – immediate response
- Handling fainting patients during X-ray/CT/MRI procedures
- Emergency evacuation in radiology department

6. Transportation of Patients

- Methods of lifting and carrying patients (single rescuer, two-person, stretcher methods)
- Spinal board and cervical collar application
- Safe patient transfer in radiology setup (wheelchair, stretcher, trolley)
- Transport during trauma, fractures, or unconsciousness

PRACTICAL

Practical Exercises & Demonstrations

- **First Aid Kit**
  - Identification of items in a first aid box.
  - Preparation and arrangement of a first aid box for radiology department.
- **Bandaging & Wound Care**
  - Demonstration of triangular bandage applications (arm sling, head bandage, chest).
  - Roller bandage applications (hand, foot, joints).
  - Application of pressure bandage for bleeding control.
  - Demonstration of dressing techniques for wounds and burns.
- **Bleeding & Shock Management**
  - Demonstration of control of external bleeding (direct pressure, elevation, pressure points, tourniquet).
  - Positioning of patient in shock (Trendelenburg, supine).
- **Fracture & Immobilization**
  - Application of splints (upper limb, lower limb, spinal).
  - Immobilization techniques using improvised materials.
  - Demonstration of cervical collar and spinal board application.
- **Airway & Breathing Emergencies**
  - Heimlich maneuver for choking (adult, child, infant).
  - Rescue breathing (mouth-to-mouth, mouth-to-nose) demonstration.
  - Recovery position practice for unconscious but breathing patients.
- **Cardiopulmonary Resuscitation (CPR)**

- Adult Basic Life Support (BLS) – CAB sequence (Chest compression, Airway, Breathing).
- Child & Infant CPR demonstration.
- Use of AED (Automated External Defibrillator) in simulated emergency.

➢ **Radiology-Specific Emergencies**
- First aid for contrast media reactions (mild, moderate, severe).
- First aid for electric shock from radiology equipment.
- Emergency handling of fainting/syncope in X-ray/CT room.
- Demonstration of radiation accident first aid procedure.

➢ **Patient Handling & Transport**
- Lifting and carrying techniques (single rescuer, two-person, chair carry).
- Stretcher handling (loading, unloading, shifting).
- Safe transfer of trauma and unconscious patients.
- Evacuation drill for radiology department emergencies.

CT, MRI & ULTRASOUND

THEORY

1. Introduction to Advanced Imaging Modalities

- Evolution of CT, MRI, and Ultrasound in radiology
- Comparison with conventional radiography
- Applications and advantages in diagnostic imaging

2. Computed Tomography (CT)

1. **Basics of CT**
   - Principles of CT imaging
   - Generations of CT scanners (1st to modern spiral/MDCT)
   - CT system components – X-ray tube, detectors, gantry, patient couch, computer system
2. **Image Acquisition & Processing**
   - Slice thickness, pitch, reconstruction, windowing, multiplanar reconstruction (MPR), 3D imaging
   - Contrast media used in CT (types, dosage, precautions, reactions)
3. **CT Procedures**
   - CT brain, chest, abdomen, pelvis, spine, extremities
   - Special CT studies (angiography, virtual endoscopy, HRCT, cardiac CT)
4. **CT Safety & QA**
   - Radiation dose in CT & dose reduction strategies (ALARA, shielding, pediatric dose)
   - Artefacts in CT and their correction
   - Quality assurance in CT

3. Magnetic Resonance Imaging (MRI)

1. **Basics of MRI**
   - Principles of nuclear magnetic resonance (NMR)
   - Relaxation times (T1, T2, PD)
   - MRI system components – magnet, gradient coils, RF coils, computer, patient table
   - Types of magnets – permanent, resistive, superconducting
2. **Image Formation & Sequences**
   - Pulse sequences: Spin echo, Gradient echo, FLAIR, STIR, Diffusion, Perfusion, MR angiography
   - MRI contrast agents (Gadolinium-based) – safety and contraindications
3. **MRI Procedures**
   - MRI brain, spine, joints, abdomen, pelvis, cardiac MRI
   - MR angiography and MR spectroscopy – basics
4. **MRI Safety & QA**
   - MRI safety zones & bioeffects (heating, projectile effect, noise, implants)
   - Safety precautions for patients with implants (pacemakers, clips, prostheses)
   - Artefacts in MRI and troubleshooting
   - Quality assurance in MRI

4. Ultrasound

1. **Basics of Ultrasound**
   - Principles of sound waves and ultrasound imaging
   - Transducers – types and frequencies
   - Ultrasound system components – transducer, console, display
2. **Ultrasound Imaging Modes**
   - A-mode, B-mode, M-mode, Doppler (Color, Power, Spectral)
   - 3D and 4D ultrasound basics
3. **Ultrasound Procedures**
   - Abdominal ultrasound (liver, gall bladder, kidney, pancreas, spleen)
   - Pelvic ultrasound (uterus, ovaries, prostate, bladder)
   - Obstetric ultrasound (fetal imaging and biometry)
   - Vascular studies (Doppler applications)
   - Musculoskeletal ultrasound basics
4. **Safety & Artefacts**
   - Ultrasound bioeffects (thermal, mechanical index)
   - Safety guidelines in obstetric ultrasound
   - Common artefacts and troubleshooting

5. Contrast & Patient Care in CT, MRI & Ultrasound

- Types of contrast media (iodinated, gadolinium, microbubble agents)
- Patient preparation for CT, MRI, and ultrasound procedures
- Emergency handling of contrast reactions
- Positioning and communication with patients during scans

- Infection control in imaging departments

PRACTICAL

➢ CT (Computed Tomography) Practical

1. Identification of CT machine components – gantry, couch, control console, detector system.
2. Demonstration of patient positioning:
    - CT brain, chest, abdomen, pelvis, spine, extremities.
3. Setting scan parameters – slice thickness, pitch, window levels.
4. Demonstration of contrast administration techniques – IV injection, timing, precautions.
5. Post-processing techniques – MPR (multiplanar reconstruction), 3D reconstruction, windowing (lung, bone, soft tissue).
6. Artefact recognition (motion, beam hardening, metal streak) and troubleshooting.
7. Demonstration of radiation dose monitoring & ALARA principles.
8. Preparation of CT quality assurance checklist.

➢ MRI (Magnetic Resonance Imaging) Practical

1. Identification of MRI system parts – magnet, RF coils, gradient coils, console, patient table.
2. Demonstration of MRI safety procedures: patient screening, MRI zones, removal of metallic objects.
3. Positioning of patients for:
    - MRI brain, spine, knee, abdomen, pelvis.
4. Demonstration of pulse sequences: T1, T2, FLAIR, STIR, GRE, DWI (demo only).
5. Use of surface coils and phased-array coils.
6. Administration of MRI contrast (gadolinium) – dosage, precautions, contraindications.
7. Identification of common artefacts (motion, susceptibility, ghosting).
8. Preparation of MRI safety and QA checklist.

➢ Ultrasound (USG) Practical

1. Identification of ultrasound equipment – console, probes (linear, convex, phased array, endocavitary).
2. Demonstration of probe handling and use of coupling gel.
3. Patient preparation and positioning for ultrasound.
4. Demonstration of routine scans:
    - Abdominal scan (liver, kidneys, pancreas, spleen).
    - Pelvic scan (uterus, ovaries, prostate, bladder).
    - Obstetric scan – fetal biometry basics.
5. Doppler ultrasound demonstration – vascular studies (carotid, abdominal vessels).

6. Demonstration of 3D/4D ultrasound (if available).
7. Artefact identification in ultrasound imaging.
8. Infection control and probe disinfection techniques.

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, CO_2)
- 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): nasojejunal 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

LIST OF HOLIDAYS

TOTAL DAY IN 1 YEAR	365/366
SUNDAY	52 DAYS
SUMMER VACATION	10 DAYS
WINTER VACATION	10 DAYS
GAZETTED HOLIDAYS	23 DAYS
OTHER HOLIDAYS	20 DAYS
TOTAL HOLIDAYS	115 DAYS
TOTAL WORKING DAYS	365-115=250

TOTAL HOURS

THEORY CLASS PER DAY	**3 HOURS**
PRACTICAL CLASS PER DAY	4 HOURS
TOTAL HOURS PER DAY	7 HOURS
TOTAL HOURS IN 1 YEAR	250*7=1750
TOTAL HOURS IN 6 MONTHS	875 HOURS

Chairman

Paramedical Education & Training Council