SYLLABUS AND CURRICULUM OF DIPLOMA IN D M R I T COURSE

DIPLOMA IN MEDICAL RADIOLOGY & IMAGING TECHNOLOGY (DMRIT)

DMRIT trains students in operating imaging equipment like X-ray, CT scan, MRI, ultrasound (basic), mammography, and fluoroscopy, as well as in processing, analysing, and handling diagnostic images..

Course Overview

- **Full Form**: Diploma In Medical Radiology & Imaging Technology (DMRIT)
- **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

- **Hospitals: Government & private**
- **Diagnostic Centers**
- **Research Labs**
- **Radiology Equipment Companies**

SEMESTER – I

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRIT101	BASIC HUMAN ANATOMY & PHYSIOLOGY	45 Min	1 Hrs.	50	50
DMRIT102	INTRODUCTION TO HEALTH CARE SYSTEM & PATIENT CARE	45 Min	1 Hrs.	50	50
DMRIT103	BASIC PHYSICS & RADIATION PHYSICS	45 Min	1 Hrs.	50	50
DMRIT104	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
DMRIT201	CLINICAL RADIOGRAPHY	45 Min	1 Hrs.	50	50
DMRIT202	RADIATION PATHOLOGY	45 Min	1 Hrs.	50	50
DMRIT203	RADIATION THERAPY MACHINES	45 Min	1 Hrs.	50	50
DMRIT204	RADIOGRAPHY AND IMAGING TECHNIQUES	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

RADIOGRAPHY AND IMAGING TECHNIQUES

THEORY

1. Introduction to Radiography

- Definition, scope, and role of radiography in medical diagnosis and treatment
- Historical development of radiographic techniques
- Types of radiographic imaging (diagnostic vs. therapeutic imaging)
- Basic principles of image formation

2. Radiation Physics for Imaging

- Interaction of X-rays and gamma rays with matter
- Factors affecting image quality: density, contrast, sharpness, distortion
- Inverse square law and its application in radiography
- Radiation attenuation and beam quality

3. Radiographic Equipment & Accessories

- X-ray tube construction and working
- Control console functions
- Image receptors: film-screen systems, computed radiography (CR), digital radiography (DR)
- Grids and collimators
- Intensifying screens
- Cassettes and holders

4. Patient Positioning & Immobilization

- Anatomical positioning terminology
- General positioning rules for different examinations
- Use of positioning aids and immobilization devices
- Importance of proper positioning in image quality and radiation protection

5. Radiographic Techniques for Skeletal System

- Radiography of upper and lower limbs
- Skull and facial bone radiography
- Spine radiography (cervical, thoracic, lumbar)
- Pelvis and hip radiography

6. Radiographic Techniques for Chest & Thorax

- PA and lateral chest projections
- Special chest views (lordotic, decubitus)
- Radiography for ribs, sternum, clavicle

7. Radiographic Techniques for Abdomen & Pelvis

- Plain abdominal radiography
- Contrast studies for abdomen (Barium meal, follow-through, enema)
- Pelvic imaging with and without contrast

8. Contrast Media & Special Procedures

- Types of contrast agents (positive and negative)

- Preparation of patient for contrast studies
- Indications and contraindications of contrast use
- Special imaging procedures:
    - Intravenous pyelography (IVP)
    - Hysterosalpingography (HSG)
    - Myelography
    - Angiography (basic concepts)

9. Cross-Sectional Imaging Techniques

- Basic principles of CT, MRI, Ultrasound
- Advantages, limitations, and applications in radiotherapy planning
- Imaging protocols for tumor localization

10. Radiographic Image Evaluation

- Common radiographic faults and corrective measures
- Identification of anatomical landmarks in images
- Criteria for acceptable diagnostic image quality

11. Radiation Protection in Imaging

- ALARA principle
- Shielding for patients and staff
- Dose limits for occupational workers and public
- Use of personal dosimeters

12. Film Processing & Digital Image Processing

- Darkroom layout and design
- Film processing steps and chemicals
- CR and DR image acquisition
- Digital image storage (PACS) and retrieval

13. Quality Assurance in Imaging

- Equipment calibration and maintenance
- Image quality control tests
- Documentation and record-keeping

PRACTICAL

- **Orientation & Safety**

- Demonstration of departmental layout and workflow in diagnostic & therapeutic imaging units

- Familiarization with X-ray, CT, MRI, Ultrasound, and Radiotherapy machines
- Demonstration of **radiation safety measures**:
  - Use of lead aprons, thyroid shields, gonad shields
  - Room shielding awareness
  - Proper handling of personal dosimeters

➢ **Patient Preparation & Communication**

- Introducing self and explaining procedure to patient
- Verification of patient identity and consent taking
- Preparation for various imaging procedures (fasting, contrast use, gowning)
- Immobilization techniques for cooperative and uncooperative patients

➢ **Equipment Handling**

- Switching on/off and warming up X-ray equipment
- Selection of appropriate exposure factors (kVp, mA, exposure time)
- Collimator adjustment and centering
- Cassette handling (CR/DR systems) and plate loading

➢ **Basic Radiographic Positioning**

- **Upper limb**: fingers, hand, wrist, forearm, elbow, humerus, shoulder
- **Lower limb**: toes, foot, ankle, tibia-fibula, knee, femur, hip joint
- **Chest**: PA, lateral, lordotic views
- **Skull**: AP, lateral, Towne's, Waters' view
- **Spine**: cervical, thoracic, lumbar, sacrum, coccyx

➢ **Abdominal & Pelvic Radiography**

- Plain abdomen AP view
- Special projections for urinary tract studies (e.g., IVP series)
- Pelvic AP view and special views for hip joints

➢ **Contrast Study Procedures**

- Assisting in barium swallow, barium meal, barium enema
- Assisting in hysterosalpingography (HSG) and myelography
- Preparation and safe handling of contrast media
- Patient monitoring during and after contrast injection

➢ **Cross-Sectional Imaging (Observation & Assistance)**

- Patient positioning in **CT scan** for head, chest, abdomen, pelvis
- Basics of MRI patient preparation and coil placement

- Observation of ultrasound patient positioning and probe handling (for understanding anatomy & localization)

➢ **Image Processing**

- **Conventional film processing**: developing, fixing, washing, drying
- **CR/DR processing**: image acquisition, post-processing adjustments, and storage
- PACS usage for image retrieval and transfer

➢ **Image Quality Assessment**

- Identifying positioning errors and exposure faults
- Comparing good vs. poor quality radiographs
- Marking anatomical landmarks on films

➢ **10. Quality Control (QC) & Maintenance**

- Daily equipment checks (tube warm-up, detector calibration)
- Cleaning and care of imaging accessories
- Test exposures for checking equipment performance
- Record keeping for QC activities

➢ **Clinical Posting Log Book**

- Maintaining a **practical record book/log book** with:
  - Date & procedure performed/assisted
  - Patient preparation notes
  - Positioning and exposure details
  - Observations and remarks by supervisor

SEMESTER – III

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRIT301	PREVENTIVE MEDICINE AND MEDICAL ETHICS	45 Min	1 Hrs.	50	50
DMRIT302	DARK ROOM TECHNIQUE	45 Min	1 Hrs.	50	50
DMRIT303	CONVENTIONAL RADIOGRAPHY & EQUIPMENT	45 Min	1 Hrs.	50	50
DMRIT304	ADVANCED IMAGING MODALITIES (CR, DIGITAL, CT, MRI)	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

DARK ROOM TECHNIQUE

THEORY

1. Introduction to Dark Room

- Purpose and importance of the dark room in radiography
- Types of dark rooms: **Conventional, Daylight, and Digital Radiography processing areas**
- Layout and design considerations:
  - Size and shape
  - Location (proximity to X-ray room)
  - Light-proofing requirements

2. Illumination in the Dark Room

- Types of lighting: **White light and safe light**
- Safe light filters – types, specifications, and distances from work area
- Effect of improper lighting on films
- Maintenance of illumination systems

3. Construction & Environmental Conditions

- Wall, floor, and ceiling finishes for easy cleaning and light-proofing
- Ventilation and temperature control
- Humidity control and its effect on film handling
- Safety precautions for chemical handling

4. Film Types & Handling

- Structure and composition of X-ray films
- Types of radiographic films: screen films, non-screen films, specialty films
- Film storage:
  - Storage conditions
  - Shelf life and expiry
- Film fogging causes and prevention

5. Intensifying Screens & Cassettes

- Purpose and types of intensifying screens
- Screen care and cleaning
- Cassette types: metal, plastic, flexible, and daylight cassettes
- Loading and unloading of cassettes

6. Film Processing Methods

- **Manual Processing**:
  - Processing cycle: Developing, rinsing, fixing, washing, drying
  - Time–temperature relationship
  - Common processing faults and remedies

- **Automatic Processing**:
  - Components and functioning of automatic film processors
  - Maintenance and troubleshooting

7. Processing Chemicals

- Developer solution: composition, preparation, function of each component
- Fixer solution: composition, preparation, function of each component
- Chemical storage and handling precautions
- Replenishment rates and disposal of used chemicals

8. Processing Defects

- Identification of common film faults:
  - Chemical stains
  - Reticulation
  - Fogging
  - Incomplete fixing/washing
- Causes and prevention

9. Quality Control in Dark Room

- Sensitometry and densitometry basics
- Control strips and step wedge testing
- Preventive maintenance schedules for processors and equipment

10. Transition to Digital Imaging

- Digital imaging workflow vs. darkroom workflow
- CR (Computed Radiography) cassettes and image plates
- Cleaning and maintenance of CR/DR systems
- Disposal of conventional darkroom materials in digital era

PRACTICAL

➢ **Dark Room Orientation**

- Identification of dark room layout (wet side & dry side)
- Checking for light leaks using coin test or visual inspection
- Demonstrating safe entry and exit without light leakage

➢ **Illumination & Safe Light Testing**

- Setting up safe light with correct filter and distance
- Performing **safe light fog test**
- Recording and interpreting results

- Adjusting safe light intensity to avoid film fogging

➢ **Film Handling Skills**

- Loading and unloading of X-ray films in cassettes under safe light
- Handling unexposed and exposed films to prevent scratches or fingerprints
- Proper storage of unused and exposed films

➢ **Intensifying Screens & Cassettes**

- Cleaning and inspecting intensifying screens
- Checking cassette closure and light tightness
- Loading screens with correct film size
- Testing for screen-film contact

➢ **Manual Film Processing**

- Preparation of developer and fixer solutions as per formula
- Setting correct temperature for developer
- Step-by-step manual processing:
    1. Developing (with agitation)
    2. Rinsing
    3. Fixing
    4. Washing
    5. Drying
- Using a thermometer and timer for temperature–time control
- Recording chemical preparation date and replenishment

➢ **Automatic Film Processing**

- Loading films into automatic processor
- Checking chemical levels and replenishment rates
- Cleaning rollers and racks of processor
- Performing routine maintenance as per schedule

➢ **Film Processing Fault Identification**

- Preparing intentional fault films for learning:
    - Underdevelopment
    - Overdevelopment
    - Chemical contamination
    - Light fogging
- Analyzing the cause of each defect and demonstrating prevention

➢ **Quality Control Procedures**

- Using **sensitometer** to expose control strips
- Processing control strips and measuring density with densitometer
- Plotting results on a QC chart and interpreting deviations
- Calibrating processor settings based on QC results

➢ **Dark Room Hygiene & Safety**

- Wearing gloves and protective aprons while handling chemicals
- Safe disposal of exhausted developer and fixer
- Ventilation check and air quality monitoring
- Cleaning work surfaces after processing

➢ **Transition to Digital**

- Loading and unloading CR (Computed Radiography) cassettes
- Cleaning image plates with approved wipes
- Performing erasure cycles in CR systems
- Comparing CR/DR workflow with traditional darkroom workflow

CONVENTIONAL RADIOGRAPHY & EQUIPMENT

THEORY

1. Introduction to Conventional Radiography

- Definition and scope of conventional radiography
- Historical development of X-ray imaging
- Applications in diagnostic radiology

2. X-ray Production & Properties

- Physics of X-ray production
- X-ray tube construction and working principle
- Types of X-ray tubes (stationary & rotating anode)
- Properties of X-rays (physical, chemical, and biological)

3. Components of Conventional X-ray Equipment

- **Control panel**: kVp, mA, exposure time controls
- **X-ray tube head**: tube housing, collimator, filtration
- **Table & Bucky**: fixed, floating, vertical, and horizontal movements
- **Cassette & screen**: types, structure, and use

4. Beam Restriction & Filtration

- Purpose and types of collimators (manual, automatic)

- Inherent and added filtration
- Effects on patient dose and image quality

5. Grids

- Purpose of using grids in radiography
- Types of grids (stationary, moving, focused, parallel, cross-hatched)
- Grid ratio and grid cutoff
- Advantages and limitations

6. Image Receptors

- Screen-film system: types and characteristics
- Intensifying screens: principle and phosphor materials
- Film structure, speed, and sensitivity
- Screen-film contact and testing

7. Exposure Factors & Image Quality

- Relationship between kVp, mA, exposure time, and film density
- Influence on image contrast, sharpness, and resolution
- Reciprocity law
- Factors affecting magnification and distortion

8. Patient Positioning for Common Examinations

- Chest, abdomen, skull, spine, extremities
- AP, PA, lateral, and oblique views
- Use of immobilization aids

9. Radiation Protection & Safety

- ALARA principle in conventional radiography
- Use of lead aprons, thyroid shields, gonadal shields
- Safe operating distances and protective barriers
- Role of radiation warning signs and lights

10. Quality Control in Conventional Radiography

- Periodic equipment performance checks
- Timer accuracy, reproducibility, and linearity tests
- Light field–radiation field alignment check
- Screen cleaning and cassette inspection

11. Maintenance of Conventional X-ray Equipment

- Routine preventive maintenance
- Common faults and troubleshooting
- Importance of proper handling and storage of equipment

12. Integration with Darkroom & Film Processing

- Safe handling of exposed films
- Transport to darkroom
- Basic overview of film development and processing defects

PRACTICAL

➢ Orientation to X-ray Room & Safety

- Identification of **X-ray machine components** (tube, collimator, control panel, Bucky, table, grid)
- Positioning of control console and cables for safe workflow
- Checking radiation warning signs and indicators
- Demonstrating safe working distance and protective barriers

➢ Control Panel Operation

- Setting kVp, mA, and exposure time correctly
- Use of exposure charts for different examinations
- Selecting correct focal spot size for imaging requirements
- Testing exposure switch functionality

➢ Tube Head & Collimator Handling

- Adjusting tube height, angle, and centering
- Aligning tube with table and Bucky
- Collimator light field adjustment and centering check
- Testing light field–radiation field congruence

➢ Patient Positioning Techniques

(Performed on phantom or volunteer under supervision)

- AP, PA, lateral, and oblique positions for chest, skull, spine, extremities, abdomen
- Correct alignment of patient, tube, and cassette
- Use of positioning aids (sponges, straps)

➢ Film–Screen & Cassette Handling

- Loading and unloading cassettes in daylight and darkroom
- Selecting correct film size for each examination

- Checking screen-film contact and cassette light tightness

➢ **Grid Usage & Testing**

- Placing and centering stationary or moving grids
- Testing grid alignment and functionality
- Demonstrating the effect of grid cutoff and prevention

➢ **Quality Control in Conventional Radiography**

- Reproducibility of exposure test
- Timer accuracy check using spinning top test
- Focal spot size evaluation (pinhole camera method)
- Linearity and reciprocity law testing

➢ **Accessories & Immobilization**

- Using lead aprons, thyroid shields, gonadal shields
- Handling sandbags, compression bands, and immobilizers
- Demonstrating correct placement of markers (L/R)

➢ **Darkroom Integration**

- Transporting exposed cassettes safely to darkroom
- Processing films as per darkroom SOP (manual or automatic)
- Evaluating processed films for correct density and contrast

➢ **Basic Maintenance & Safety Checks**

- Cleaning and dusting tube housing, collimator lenses, and control panel
- Checking earthing and cable insulation
- Reporting faults and scheduling preventive maintenance

ADVANCED IMAGING MODALITIES (CR, DIGITAL, CT, MRI)

THEORY

1. Introduction to Advanced Imaging

- Evolution from conventional radiography to CR, DR, CT, and MRI
- Advantages & limitations of each modality
- Overview of PACS (Picture Archiving & Communication System) integration

2. Computed Radiography (CR)

2.1 Principle & Technology

- Photostimulable phosphor (PSP) technology
- CR cassette construction and working
- Image plate reader system
- Latent image formation and processing steps

2.2 Image Acquisition & Processing

- Workflow of CR imaging
- Image resolution, spatial frequency, and bit depth
- Artifacts in CR and their correction

2.3 Quality Control & Maintenance

- PSP plate cleaning and erasing
- Routine calibration and performance checks

3. Digital Radiography (DR)

3.1 Principle & Technology

- Flat panel detectors (FPD): indirect & direct conversion
- Scintillator materials and photodiodes
- CCD-based systems

3.2 Image Acquisition & Processing

- DR workflow compared to CR
- Advantages in dose efficiency and speed
- Digital image post-processing (windowing, filtering, edge enhancement)

3.3 Quality Assurance

- Detector calibration
- Common DR artifacts and troubleshooting

4. Computed Tomography (CT)

4.1 Basic Principles

- Evolution of CT scanner generations (1st–7th)
- X-ray tube and detector design for CT
- Helical/spiral CT vs. conventional CT

4.2 Image Reconstruction

- Slice thickness and pitch
- Reconstruction algorithms (filtered back projection, iterative reconstruction)
- Hounsfield units and CT number scale

4.3 CT Imaging Protocols

- Head, chest, abdomen, musculoskeletal CT protocols
- Contrast media usage (oral, IV) and precautions

4.4 CT Image Quality & Artifacts

- Factors affecting spatial resolution, contrast, and noise
- Common artifacts (beam hardening, motion, metal)

4.5 Radiation Safety in CT

- Dose reduction techniques (automatic exposure control, tube current modulation)
- CT dose index (CTDI) and dose-length product (DLP)

5. Magnetic Resonance Imaging (MRI)

5.1 Basic Physics of MRI

- Concept of nuclear magnetic resonance (NMR)
- Magnetic field strength (Tesla units)
- Role of hydrogen nuclei in imaging

5.2 MRI Components

- Main magnet (superconducting, resistive, permanent)
- Gradient coils and RF coils
- Shielding and room design

5.3 Image Formation

- T1, T2, and proton density (PD) weighted imaging
- Spin echo, gradient echo, FLAIR, and diffusion sequences
- Slice selection, phase encoding, and frequency encoding

5.4 MRI Protocols

- Brain, spine, musculoskeletal, abdominal, and cardiac MRI protocols
- Use of gadolinium-based contrast agents and safety considerations

5.5 MRI Safety

- Magnetic field hazards and screening
- SAR (Specific Absorption Rate) monitoring
- MRI-compatible devices and patient preparation

6. Digital Image Processing & PACS

- Image storage formats (DICOM)
- PACS architecture and workflow
- Teleradiology basics
- Data compression and retrieval

7. Quality Control in Advanced Imaging

- Daily, weekly, and monthly QC checks for CR, DR, CT, MRI
- Preventive maintenance schedules
- Image quality assessment tools

8. Recent Advances & Trends

- Dual-energy CT
- 3D/4D imaging in CT and MRI
- Functional MRI (fMRI) and MR spectroscopy
- AI-assisted image interpretation

PRACTICAL

➢ **Computed Radiography (CR) – Practical**

- **Demonstration & Identification**
  - Parts of a CR system: cassette, image plate (IP), reader unit
  - PSP plate handling & storage
- **Image Acquisition**
  - Loading/unloading CR cassettes
  - Positioning for standard projections using CR
  - Correct exposure factor selection for optimal image quality
- **Image Processing**
  - Workflow from exposure to display
  - Use of console for brightness, contrast, and windowing adjustments
- **Quality Control (QC)**
  - Image plate cleaning and erasing
  - Checking for CR artifacts (scratches, dust, ghosting)

➢ **Digital Radiography (DR) – Practical**

- **Demonstration & Identification**
  - Flat panel detector types (direct & indirect)
  - Detector handling precautions
- **Patient Positioning & Exposure**
  - DR imaging for chest, abdomen, extremities
  - Exposure parameter selection for DR
- **Image Processing & Manipulation**
  - Real-time image display and post-processing tools
  - Cropping, annotation, and measurement tools
- **QC & Maintenance**
  - Detector calibration
  - Recognizing and correcting DR artifacts

➢ **Computed Tomography (CT) – Practical**

- **Equipment Familiarization**
  - CT gantry, control console, injector system
  - Safety interlocks and patient communication system
- **Patient Preparation**
  - Screening and consent
  - IV cannulation for contrast administration
  - Oral contrast preparation protocols
- **Positioning & Scanning Protocols**
  - Head CT (plain & contrast)
  - Chest CT (HRCT, CECT)
  - Abdomen and pelvis CT
  - Musculoskeletal CT
- **Image Reconstruction & Post-Processing**
  - MPR (Multi-Planar Reconstruction)
  - 3D rendering & volume rendering techniques
- **QC in CT**
  - Daily warm-up and calibration
  - Water phantom scan for HU accuracy check

➢ **Magnetic Resonance Imaging (MRI) – Practical**

- **MRI Equipment Familiarization**
  - Main magnet, gradient coils, RF coils, patient table
  - MRI control console and safety zones
- **Patient Preparation**
  - MRI safety screening (metallic implants, pacemakers)
  - Patient positioning for brain, spine, joints, abdomen
  - Coil selection for different body parts
- **MRI Protocol Execution**
  - Brain MRI (T1, T2, FLAIR, DWI sequences)
  - Spine MRI (cervical, thoracic, lumbar)

  - Joint MRI (knee, shoulder)
  - Abdominal MRI
- **Contrast Administration**
  - Gadolinium contrast preparation & safety precautions
- **Image Processing & Post-Processing**
  - Image reformatting and sequence comparison
- **QC in MRI**
  - Phantom scans for SNR and geometric accuracy
  - Checking for MRI artifacts (motion, RF interference, ghosting)

➢ **PACS & Image Management – Practical**

- Uploading CR/DR/CT/MRI images to PACS
- Retrieving and exporting studies
- DICOM viewer usage for measurements and annotations
- Comparing current images with previous studies

➢ **Safety Protocols in Advanced Imaging – Practical**

- Radiation safety in CR, DR, and CT (ALARA principle)
- MRI safety drills and emergency procedures
- Contrast reaction management (basic first aid & drug preparation)

SEMESTER – IV

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DMRIT401	QUALITY CONTROL IN RADIOLOGY & RADIATION SAFETY	45 Min	1 Hrs.	50	50
DMRIT402	IMAGE PROCESSING (FILM TECHNIQUES)	45 Min	1 Hrs.	50	50
DMRIT403	ADVANCED RADIOGRAPHIC TECHNIQUES	45 Min	1 Hrs.	50	50
DMRIT404	RADIATION PROTECTION AND SAFETY	45 Min	1 Hrs.	50	50

QUALITY CONTROL IN RADIOLOGY & RADIATION SAFETY

THEORY

1. Introduction to Quality Control (QC) in Radiology

- Definition & objectives of quality control in diagnostic imaging and radiotherapy
- Importance of QC in patient safety and image quality
- Regulatory requirements and guidelines (AERB, ICRP, NCRP, WHO)

2. QC in Conventional Radiography

- QC tests for X-ray machines:
  - kVp accuracy
  - mA/mAs accuracy
  - Timer accuracy
  - Focal spot size measurement
  - Beam alignment & collimation
  - Half Value Layer (HVL) & filtration checks
  - Image quality evaluation using test phantoms
- Darkroom QC: safelight testing, film storage, processing chemicals

3. QC in Advanced Imaging Modalities

- **Computed Radiography (CR)**
  - Image plate uniformity test
  - Erasure cycle testing
- **Digital Radiography (DR)**
  - Detector uniformity & calibration
  - Artifact detection & correction
- **Computed Tomography (CT)**
  - CT number accuracy (HU accuracy)
  - Low-contrast and high-contrast resolution
  - Slice thickness accuracy
  - CT dose index (CTDI) measurements
- **Magnetic Resonance Imaging (MRI)**
  - Signal-to-noise ratio (SNR) testing
  - Geometric distortion check
  - Image uniformity & ghosting artifacts

4. QC in Radiotherapy Equipment

- **Linear Accelerator (LINAC)**
  - Output constancy checks

  - Beam flatness & symmetry
  - Mechanical isocenter alignment
- **Brachytherapy Units**
  - Source strength verification
  - Applicator calibration
- **Treatment Planning Systems (TPS)**
  - Dose calculation accuracy
  - Software integrity checks

5. Radiation Safety Principles

- Nature and types of ionizing radiation
- Radiation units: Exposure, Absorbed Dose, Equivalent Dose, Effective Dose (R, Gy, Sv)
- Biological effects of radiation: deterministic vs. stochastic effects
- ALARA principle (As Low As Reasonably Achievable)
- Time, distance, and shielding in radiation protection

6. Radiation Safety in Diagnostic Imaging

- Protective barriers in X-ray rooms
- Personal protective devices: lead apron, thyroid shield, lead glasses
- Use of beam collimation & filtration
- Patient dose reduction techniques (e.g., pulsed fluoroscopy, low-dose protocols in CT)

7. Radiation Safety in Radiotherapy

- Treatment room shielding design
- Controlled and supervised areas
- Radiation survey meters & area monitoring
- Brachytherapy source handling & storage safety

8. Radiation Monitoring

- Personnel monitoring devices:
  - TLD (Thermoluminescent Dosimeter)
  - OSL (Optically Stimulated Luminescence dosimeter)
  - Pocket dosimeters
- Reading, reporting, and maintaining dose records

9. National & International Safety Guidelines

- AERB (Atomic Energy Regulatory Board) rules for diagnostic & therapeutic installations
- ICRP recommendations on occupational dose limits

- NCRP guidelines for radiology practice

10. Quality Assurance (QA) Documentation

- QC logs and maintenance records
- Equipment service & calibration documentation
- Audit procedures for compliance

PRACTICAL

➢ Conventional Radiography QC Tests

- **kVp Accuracy Test** – using kVp meter or non-invasive analyzer
- **mA/mAs Linearity Test** – verifying output consistency at different settings
- **Timer Accuracy Test** – measuring exposure time accuracy
- **Focal Spot Size Measurement** – using pinhole camera or slit camera method
- **Beam Alignment & Collimation Test** – checking light field and radiation field congruence
- **Half Value Layer (HVL) Measurement** – determining beam quality and filtration adequacy
- **Automatic Exposure Control (AEC) Test** – consistency and reproducibility checks
- **Film Processor QC** – safelight testing, chemical replenishment, temperature checks

➢ Computed & Digital Radiography QC

- **Image Plate Uniformity Test** – checking CR cassettes for uniform response
- **CR Erasure Cycle Test** – verifying residual image removal
- **DR Detector Uniformity Check** – ensuring even response across the panel
- **Artifact Identification & Removal** – recognizing and correcting image artifacts
- **Spatial Resolution & Contrast Resolution Measurement** – using standard test phantoms

➢ CT Scanner QC

- **CT Number Accuracy Test** – measuring HU values for water, air, bone, etc.
- **Low-Contrast Resolution Test** – visualizing low-density differences in phantom
- **High-Contrast Resolution Test** – detecting fine detail
- **Slice Thickness Accuracy** – using ramp or wedge phantoms
- **CT Dose Index (CTDI) Measurement** – using dosimetry phantoms and ion chambers

➢ MRI QC

- **Signal-to-Noise Ratio (SNR) Test** – phantom measurements
- **Geometric Accuracy Test** – checking dimensional fidelity of MRI images
- **Image Uniformity Test** – uniformity across the FOV

- **Ghosting & Artifact Evaluation** – identifying causes and prevention
- **Magnetic Field Homogeneity Test** – ensuring even magnetic field strength

➢ **Radiotherapy Equipment QC**

- **LINAC Output Constancy Check** – daily dose output verification
- **Beam Flatness & Symmetry Measurement** – using water phantom or ion chamber array
- **Mechanical Isocenter Test** – laser and gantry alignment verification
- **Brachytherapy Source Strength Verification** – using well-type ionization chamber
- **Treatment Planning System QA** – verifying calculated vs. measured dose

➢ **Radiation Safety Practical Skills**

- **Radiation Survey Meter Use** – measuring leakage radiation and background levels
- **Area Monitoring** – conducting regular radiation surveys in diagnostic & treatment rooms
- **Shielding Verification** – testing lead barriers, doors, and walls
- **Personal Protective Equipment (PPE) Checks** – inspecting lead aprons, gloves, thyroid shields for cracks using fluoroscopy
- **Radiation Signage & Labeling** – proper placement of warning signs in controlled areas

➢ **Personnel Dosimetry & Monitoring**

- **TLD Badge Handling** – correct use, wearing position, and storage
- **Pocket Dosimeter Reading** – recording and logging exposures
- **OSL Dosimeter Handling** – procedures for issue, use, and return
- **Dose Record Maintenance** – updating occupational exposure logs

➢ **QC Documentation & Reporting**

- Maintaining **QC Logs** – recording test results and corrective actions
- Preparing **Radiation Safety Audit Reports**
- Equipment **Preventive Maintenance Scheduling**
- Reporting **Non-Compliance & Incident Cases** to Radiation Safety Officer (RSO)

IMAGE PROCESSING (FILM TECHNIQUES)

THEORY

1. Introduction to Image Processing in Radiology

- Definition and importance of image processing in diagnostic radiology
- Overview of analog vs. digital image processing

- Historical evolution of film processing techniques
- Role of image quality in diagnosis

2. X-Ray Film Fundamentals

- **Composition of X-ray film**
  - Base layer
  - Emulsion layer
  - Protective coating
- Types of X-ray films:
  - Screen films
  - Non-screen films
  - Single-emulsion vs. double-emulsion films
  - Specialty films (mammography, dental, cine films)
- Film sizes and storage conditions

3. Film Sensitometry

- Characteristic curve (Hurter & Driffield curve)
- Base + fog level
- Film speed
- Film contrast and latitude
- Optical density measurement
- Factors affecting sensitometric properties

4. Screen–Film Systems

- Intensifying screens – function, construction, and types
- Rare earth screens vs. calcium tungstate screens
- Screen-film matching for optimal image quality
- Screen speed, resolution, and efficiency

5. Darkroom Design & Equipment

- Layout and workflow of a radiographic darkroom
- Safe lighting types and requirements
- Film storage and handling protocols
- Darkroom ventilation and environmental control

6. Film Processing Techniques

- **Manual film processing**
  - Steps: developing, rinsing, fixing, washing, drying
  - Time–temperature relationship in development
  - Chemical composition of developer and fixer
- **Automatic film processing**

- Components of an automatic processor
- Processing cycle and replenishment systems
- Advantages and limitations

7. Processing Chemicals

- Developer composition:
  - Developing agents (e.g., hydroquinone, phenidone)
  - Preservatives, activators, restrainers
- Fixer composition:
  - Clearing agents (e.g., ammonium thiosulfate)
  - Acidifiers, hardeners, preservatives
- Common processing faults due to chemical issues

8. Image Quality Factors in Film Techniques

- Resolution, contrast, density, sharpness, and noise
- Factors affecting film image quality:
  - Exposure parameters
  - Processing conditions
  - Screen-film contact
  - Darkroom errors

9. Common Film Faults & Artifacts

- Causes and prevention of:
  - Fogging (light, radiation, chemical)
  - Processing streaks
  - Roller marks in automatic processing
  - Pressure marks and static artifacts
  - Screen scratches

10. Film Handling & Archiving

- Proper handling to prevent scratches and fingerprints
- Film identification methods
- Archival storage standards (temperature, humidity)
- Film retrieval and record-keeping systems

11. Quality Control in Film Processing

- Sensitometric control strips and step wedges
- Daily processor QC tests
- Replenishment rate checks
- Troubleshooting processing issues
- Maintaining processing logs

PRACTICAL

➢ Darkroom Setup & Safety

- Demonstration of ideal **darkroom layout** for manual and automatic processing
- Setting up **safe lighting** and checking safe-light fog using the **coin test**
- Darkroom hygiene and maintenance protocols
- Safe handling and storage of unexposed and processed films

➢ Film Handling & Loading

- Loading and unloading X-ray cassettes in **darkroom conditions**
- Proper handling of **intensifying screens** and checking screen-film contact using **wire mesh test**
- Film identification methods (lead markers, printed labels)

➢ Manual Film Processing

- Preparation of **developer and fixer solutions**
- Step-by-step **manual film processing**:
  - Development (time-temperature control)
  - Rinsing
  - Fixing
  - Washing
  - Drying
- Demonstration of **temperature control** and its effect on image quality
- Observation of **underdeveloped** and **overdeveloped** films for learning purposes

➢ Automatic Film Processing

- Loading films into an **automatic processor**
- Understanding processor parts and film transport path
- Checking and replenishing chemicals
- Daily and weekly maintenance of the processor

➢ Sensitometry & Quality Control

- Preparing and using **sensitometric strips**
- Plotting a **characteristic curve (H&D curve)**
- Measuring **optical density** with a densitometer
- Recording **base + fog level, speed, and contrast**
- Comparing processed films under different development conditions

➢ Chemical Maintenance

- Safe handling and disposal of processing chemicals

- Cleaning intensifying screens with **approved screen cleaner**
- Replacing or regenerating exhausted developer and fixer
- Identifying chemical contamination problems

➢ **Troubleshooting Film Faults**

- Recognizing and correcting:
  - Light fog
  - Radiation fog
  - Chemical fog
  - Reticulation marks
  - Static marks
  - Roller marks in automatic processing
  - Uneven development or fixing stains

➢ **Image Quality Assessment**

- Comparing films processed at different times, temperatures, and chemical strengths
- Evaluating **contrast, density, resolution, and sharpness** visually
- Recording observations in QC logbook

➢ **Archiving & Storage**

- Proper drying and archiving of processed films
- Storing films in humidity- and temperature-controlled conditions
- Retrieving archived films efficiently

➢ **Practical Record Maintenance**

- Maintaining **daily processing QC records**
- Documenting film faults and corrective actions taken
- Reporting processor malfunction and chemical change schedules

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