SYLLABUS AND CURRICULUM OF DIPLOMA IN X-RAY & ECG TECHNICIAN COURSE

DIPLOMA IN X-RAY & ECG TECHNICIAN (DXET)

This is a **Allied Health Care diploma course** designed to train students in:

- **X-Ray Technology** → Operating X-Ray machines, radiation safety, image capturing & processing.
- **ECG Technology** → Recording electrocardiograms, monitoring cardiac activity, assisting in diagnosing heart-related problems.
- **Patient Care & Safety** → Handling patients during radiological and ECG procedures.

It prepares students to work under radiologists, cardiologists, and physicians in hospitals, diagnostic centers, and clinics.

Course Overview

- **Full Form**: DIPLOMA IN X-RAY & ECG TECHNICIAN (DXET)
- **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 DXET

- **X-Ray Technician**
- **ECG Technician**
- **Radiology Assistant**
- **Cardiology Technician**

- **Lab Assistant in Imaging Centers**
- **Emergency/ICU Technician (with ECG specialization)**

SEMESTER – I

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DXET101	ANATOMY & PHYSIOLOGY	45 Min	1 Hrs.	50	50
DXET102	BASICS OF PHYSICS FOR RADIOLOGY	45 Min	1 Hrs.	50	50
DXET103	BIOCHEMISTRY & PATHOLOGY	45 Min	1 Hrs.	50	50
DXET104	PATIENT CARE & SAFETY	45 Min	1 Hrs.	50	50

ANATOMY & PHYSIOLOGY

THEORY

1. Introduction

- Definition & scope of Anatomy and Physiology
- Levels of structural organization: cells → tissues → organs → systems
- Anatomical positions, planes, directions, body regions

2. Cell Biology

- Structure & function of cell
- Cell organelles: nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes
- Cell division: mitosis & meiosis

3. Tissues

- Epithelial tissue
- Connective tissue (bone, cartilage, blood)
- Muscular tissue (skeletal, smooth, cardiac)
- Nervous tissue

4. Skeletal System

- Classification of bones

- Structure of bone & bone growth
- Names & location of major bones: Skull, Vertebral column, Ribs, Sternum, Pelvis, Limbs
- Joints: types & movements
- Clinical correlation: fractures, dislocations, orthopedic imaging

5. Muscular System

- Types of muscles
- Structure of skeletal muscle
- Physiology of muscle contraction
- Important muscles of chest, abdomen, limbs
- Clinical correlation: muscular injuries, cardiac muscle in ECG

6. Circulatory System (Cardiovascular System)

- Structure of heart: chambers, valves, major vessels
- Blood circulation: systemic & pulmonary
- Cardiac cycle & heart sounds
- Blood pressure, pulse
- Conduction system of heart (SA node, AV node, Bundle of His, Purkinje fibers)
- ECG waves: P wave, QRS complex, T wave – relation with cardiac physiology

7. Blood & Lymph

- Composition & functions of blood
- Blood groups & Rh factor
- Hemoglobin, clotting mechanism
- Lymphatic system: organs & circulation

8. Respiratory System

- Anatomy: nose, pharynx, larynx, trachea, bronchi, lungs
- Physiology: mechanics of breathing, gas exchange, transport of oxygen & CO_2
- Clinical correlation: chest X-rays in pneumonia, TB, asthma

9.Digestive System

- Anatomy: alimentary canal & accessory organs (liver, pancreas, gall bladder)
- Physiology: digestion & absorption
- Clinical correlation: abdominal imaging, barium studies

10. Nervous System

- Central nervous system: brain (cerebrum, cerebellum, brainstem), spinal cord
- Peripheral nervous system: cranial & spinal nerves
- Autonomic nervous system: sympathetic & parasympathetic functions

- Clinical correlation: stroke, seizures, positioning of patients with neurological issues

11. Urinary System

- Kidneys, ureters, bladder, urethra – structure & functions
- Physiology of urine formation
- Clinical correlation: IVP (Intravenous Pyelography), renal imaging

12. Reproductive System

- Male & Female reproductive organs
- Physiology: spermatogenesis, oogenesis, menstrual cycle
- Clinical correlation: precautions for female patients (pregnancy & radiation exposure)

13. Endocrine System

- Major glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Gonads
- Hormones & their functions
- Clinical correlation: diabetes (affecting ECG), thyroid disorders

14. Special Senses

- Eye: structure & functions
- Ear: structure & functions
- Nose, tongue & skin receptors
- Clinical correlation: patient communication, visual/hearing defects

PRACTICAL

- **General Orientation**

- Demonstration of anatomical positions, body planes & directional terms
- Identification of body regions (head, thorax, abdomen, limbs)
- Surface landmarks for ECG lead placement and X-ray positioning

- **Skeletal System**

- Identification of major bones using skeleton models: Skull, Vertebrae, Ribs, Sternum, Pelvis, Upper & Lower Limbs
- Demonstration of types of joints with models/charts
- Clinical correlation: Demonstration of X-ray films of fractures & dislocations

- **Muscular System**

- Identification of important muscles (thoracic, abdominal, limb muscles) using charts/models

- Demonstration of cardiac muscle (microscopic slide/chart)
- Clinical correlation: Role of muscles in patient positioning for X-ray

➢ **Circulatory System**

- Demonstration of external & internal structure of heart (model/chart)
- Identification of chambers, valves, major vessels
- Demonstration of blood circulation pathway (systemic & pulmonary)
- Practical relevance: Location of heart for chest X-rays, ECG electrode placement

➢ **Blood & Lymph**

- Demonstration of blood smear under microscope (RBC, WBC, Platelets)
- Demonstration of lymphatic organs using charts/models
- Clinical correlation: Importance of blood groups & Rh factor (for emergency cases)

➢ **Respiratory System**

- Identification of respiratory organs in models/charts
- Demonstration of lung lobes & tracheobronchial tree
- Clinical correlation: Chest X-rays in TB, pneumonia, asthma cases

➢ **Digestive System**

- Identification of organs in models/charts: Stomach, Intestines, Liver, Pancreas
- Demonstration of accessory glands (salivary, pancreas, gall bladder)
- Clinical correlation: Abdominal X-ray/Barium study films

➢ **Nervous System**

- Demonstration of brain parts (cerebrum, cerebellum, brainstem)
- Demonstration of spinal cord in model/chart
- Clinical correlation: Effect of neurological conditions on ECG/positioning

➢ **Urinary System**

- Identification of kidney, ureter, bladder in models/charts
- Demonstration of nephron structure using diagrams
- Clinical correlation: X-rays & IVP (Intravenous Pyelography)

➢ **Reproductive System**

- Demonstration of male & female reproductive organs in models/charts
- Clinical correlation: Importance of radiation safety in female patients

➢ **Endocrine System**

- Identification of endocrine glands in charts/models (Pituitary, Thyroid, Pancreas, Adrenal, Gonads)
- Clinical correlation: ECG changes in diabetes & thyroid disorders

➢ **Special Senses**

- Demonstration of Eye & Ear anatomy in models/charts
- Identification of tongue (taste areas) and skin receptors
- Clinical correlation: Patient care during radiology/ECG procedures

➢ **Correlation with Radiology & ECG**

- Demonstration of ECG electrode placement on human body (practical exercise)
- Correlation of X-ray films with skeletal & organ anatomy
- Case study demonstration: Normal vs abnormal ECG tracings with cardiac physiology

BASICS OF PHYSICS FOR RADIOLOGY

THEORY

1. Introduction to Physics in Radiology

- Scope & importance of physics in medical radiology
- Role of physics in X-ray production & ECG equipment
- Units & measurements: length, mass, time, volume, density, velocity, acceleration

2. Matter & Energy

- States of matter (solid, liquid, gas, plasma)
- Mass, weight, density & specific gravity
- Energy: definition, forms (mechanical, chemical, electrical, thermal, nuclear, radiant)
- Law of conservation of energy (applied in X-ray production)

3. Heat & Thermodynamics

- Temperature, heat, specific heat, latent heat
- Methods of heat transfer: conduction, convection, radiation
- Application in X-ray tubes (heat production & dissipation in anode)

4. Sound & Waves

- Nature & properties of sound waves
- Frequency, wavelength, amplitude, velocity

- Ultrasound basics (though detailed study is in higher courses)
- Application: Doppler ECG sounds, echocardiography basics

5. Light & Optics

- Nature of light (wave & particle theory)
- Reflection, refraction, lenses & mirrors
- Image formation principles (basis of radiographic images)
- Filters & grids in radiology
- Application: use of lenses in radiographic photography, collimators

6. Magnetism & Electromagnetism

- Magnetic field, magnetic flux, electromagnets
- Electromagnetic induction: Faraday's law, Lenz's law
- Transformers (step-up & step-down) – importance in X-ray machines
- Application in ECG: galvanometers & magnetic fields in recording devices

7. Electricity & Electronics

- Electric charge, current, voltage, resistance (Ohm's law)
- Series & parallel circuits
- AC & DC current
- Capacitors, resistors, inductors (basic role in radiology equipment)
- Rectifiers & diodes (conversion of AC to DC in X-ray units)
- ECG machine basics: electrical signal amplification, filters, grounding

8. Atomic Structure

- Structure of atom (protons, neutrons, electrons)
- Atomic number, mass number, isotopes
- Electron orbits & energy levels
- Ionization & excitation

9. X-Ray Physics

- Discovery of X-rays (Roentgen's contribution)
- Nature & properties of X-rays
- Production of X-rays in X-ray tube (cathode, anode, high-voltage supply)
- Types of X-rays: soft & hard X-rays
- Factors affecting X-ray quality & quantity: kVp, mA, exposure time, distance
- Filtration & collimation

10. Radiation Physics & Interaction with Matter

- Types of radiation: alpha, beta, gamma, X-rays

- Radiation units: Roentgen, Rad, Gray, Sievert, Becquerel
- Interaction of X-rays with matter: photoelectric effect, Compton scattering, pair production
- Attenuation of X-rays (basis of image contrast)

11. Radiation Protection & Safety Basics

- Biological effects of radiation (somatic & genetic)
- Time, distance & shielding principle
- Personal protective devices: lead apron, thyroid collar, lead glass
- Dosimeters & film badges
- ALARA principle (As Low As Reasonably Achievable)

12. Imaging & Recording Physics

- Fluorescence & phosphorescence (basis of intensifying screens)
- Image formation in radiography
- Darkroom physics: safe light, intensifying screen, developer & fixer
- Digital imaging basics (CR, DR)
- ECG paper, graph recording & signal tracing basics

PRACTICAL

- **Units & Measurements**

- Demonstration of measuring instruments (vernier caliper, screw gauge, measuring scales)
- Verification of density & specific gravity of solids/liquids
- Application: Helps understand body density differences in radiology images

- **Mechanics**

- Demonstration of laws of motion using simple apparatus
- Study of force, work, power using weights & pulleys
- Application: Patient positioning & movement in X-ray table/mechanisms

- **Heat & Thermodynamics**

- Demonstration of heat transfer: conduction, convection, radiation
- Measurement of temperature using different thermometers
- Application: Heat production in X-ray tube anode & cooling systems

- **Sound & Waves**

- Demonstration of wave properties: frequency, wavelength, amplitude (using tuning fork/oscilloscope)
- Study of resonance & vibration

- Application: Understanding principles of echocardiography & ultrasound basics

➢ **Light & Optics**

- Experiment on reflection & refraction of light using glass slab/lenses
- Demonstration of image formation with convex & concave lenses
- Study of prism & dispersion of light
- Application: Radiographic image formation, collimators, darkroom safelight

➢ **Electricity**

- Verification of **Ohm's law** using resistors
- Study of series & parallel circuits (bulbs/resistors)
- Demonstration of AC vs DC supply
- Application: Power supply in X-ray & ECG machines

➢ **Magnetism & Electromagnetism**

- Demonstration of magnetic field using iron filings & bar magnet
- Study of electromagnet & solenoid
- Demonstration of transformer action (step-up & step-down model)
- Application: Transformers in X-ray machine high-voltage supply

➢ **Electronics (Basic)**

- Demonstration of rectification (half-wave & full-wave rectifier)
- Study of capacitors & their role in circuits
- Application: Rectification & smoothing in X-ray machines and ECG circuits

➢ **Atomic Physics**

- Demonstration of atomic models using charts/models
- Identification of isotopes & their medical uses (demo charts)
- Application: Understanding ionization, radiation origin

➢ **X-Ray Tube & Imaging Physics**

- Demonstration of X-ray tube parts (cathode, anode, filament, target) using model
- Study of factors affecting X-ray production (kVp, mA, exposure time – demo with equipment/films)
- Observation of X-ray films with different exposures (effect of distance, filtration, collimation)

➢ **Radiation Safety**

- Demonstration of lead apron, thyroid shield, lead glass
- Use of dosimeter/film badge (demo only)

- Application: Radiation protection in clinical practice

➢ **ECG Physics Correlation**

- Demonstration of ECG machine basic circuit (input → amplifier → output graph)
- Demonstration of ECG electrode placement on human subject/dummy
- Study of ECG graph recording

BIOCHEMISTRY & PATHOLOGY

THEORY

Section A – Biochemistry

1. Introduction

- Definition, scope, importance of Biochemistry in medical diagnostics
- Role of biochemistry in radiology & cardiology

2. Biomolecules

- **Carbohydrates**: classification, examples (glucose, glycogen, starch), role in energy
- **Proteins**: amino acids, protein structure & functions, plasma proteins
- **Lipids**: fats, phospholipids, cholesterol, triglycerides – role in cardiovascular health
- **Nucleic acids**: DNA & RNA basics

3. Enzymes

- Definition, properties, classification
- Factors affecting enzyme action (temperature, pH)
- Clinical importance of enzymes in diagnostics (SGPT, SGOT, CK-MB, LDH, Amylase, Lipase)

4. Metabolism

- Carbohydrate metabolism: glycolysis, glycogen, diabetes relevance
- Protein metabolism: nitrogen balance, urea cycle
- Lipid metabolism: role in atherosclerosis, obesity, heart disease
- Clinical correlation: biochemical changes in heart attack (cardiac enzymes)

5. Clinical Biochemistry

- Blood glucose, urea, creatinine, cholesterol, uric acid – diagnostic significance
- Cardiac markers: Troponin, CK-MB, LDH
- Liver function tests (LFT) basics
- Kidney function tests (KFT) basics
- Electrolytes: sodium, potassium, chloride, calcium – relevance in ECG interpretation

Section B – Pathology

1. Introduction

- Definition, scope, importance of pathology for technicians
- Causes of disease (etiology), pathogenesis, lesions

2. Cell Injury & Adaptation

- Reversible & irreversible cell injury
- Necrosis & apoptosis
- Atrophy, hypertrophy, hyperplasia, metaplasia

3. Inflammation & Healing

- Acute & chronic inflammation
- Signs of inflammation (redness, swelling, heat, pain, loss of function)
- Healing & repair, wound healing stages

4. Hematology

- Normal blood composition & values
- Anemia (types, causes, relevance in X-ray/ECG patients)
- Leukemia & other blood disorders
- Coagulation disorders

5. Cardiovascular Pathology

- Atherosclerosis, ischemic heart disease, myocardial infarction
- Hypertension & its effects
- Heart failure, arrhythmias
- Clinical correlation: ECG changes in MI, LVH, arrhythmias

6. Respiratory Pathology

- Pneumonia, tuberculosis, bronchitis, asthma, COPD
- Lung cancer basics
- Clinical correlation: chest X-ray findings in TB, pneumonia, cancer

7. Gastrointestinal & Hepatobiliary Pathology

- Gastritis, peptic ulcer, liver cirrhosis, hepatitis, gallstones
- Clinical correlation: radiology in liver/gall bladder imaging

8. Renal Pathology

- Glomerulonephritis, nephrotic syndrome, renal failure

- Kidney & urinary tract stones
- Clinical correlation: IVP, KUB X-ray, ultrasound

9. Endocrine Pathology

- Diabetes mellitus (type I & II)
- Thyroid disorders (goiter, hyper/hypothyroidism)
- Clinical correlation: ECG changes in diabetes & thyroid disease

10. Musculoskeletal Pathology

- Osteoporosis, bone fractures, arthritis, bone tumors
- Clinical correlation: X-ray changes in bone diseases

11. Neoplasia (Tumors)

- Benign vs malignant tumors
- Common cancers (lung, breast, bone)
- Clinical correlation: radiological detection of tumors

PRACTICAL

A. Biochemistry Practicals

- **Laboratory Orientation**
  - Familiarization with laboratory glassware & instruments (pipettes, centrifuge, colorimeter, spectrophotometer).
  - Demonstration of lab safety precautions.
- **Blood Investigations**
  - Demonstration of blood collection techniques & anticoagulants.
  - Estimation of **hemoglobin** (demo).
  - Estimation of **blood glucose** (using glucometer/biochemical method).
  - Demonstration of **serum cholesterol** & **triglycerides**.
  - Observation of **renal function tests** (blood urea, creatinine).
  - Demonstration of **liver function tests** (bilirubin, SGPT, SGOT).
- **Urine Investigations**
  - Physical examination of urine (color, appearance, specific gravity).
  - Chemical tests for:
    - Glucose (Benedict's test)
    - Protein (heat & acetic acid test)
    - Ketone bodies (Rothera's test)
    - Bile salts & pigments
- **Enzymes & Cardiac Markers**
  - Demonstration of enzyme activity (effect of pH & temperature).
  - Observation of clinical test reports: CK-MB, LDH, Troponin.
  - Clinical correlation: ECG changes in myocardial infarction with elevated cardiac markers.

B. Pathology Practicals

- **Basic Hematology**
  - Preparation & staining of peripheral blood smear.
  - Identification of **RBC, WBC, Platelets** under microscope.
  - Observation of abnormal smears: anemia, leukemia (demo slides).
  - Estimation of **ESR (Erythrocyte Sedimentation Rate)**.
  - Demonstration of **Packed Cell Volume (PCV)**.
- **Clinical Pathology**
  - Demonstration of routine urine analysis (microscopy for pus cells, casts, crystals).
  - Observation of stool sample (demo slides for ova & cysts).
- **Histopathology (Demonstration Only)**
  - Handling of biopsy specimens.
  - Demonstration of fixation, processing & stained tissue slides.
  - Observation of prepared slides: liver cirrhosis, tuberculosis, cancer tissue.
- **Systemic Pathology Correlation**
  - Demonstration of X-ray films in:
    - **Respiratory system**: TB, pneumonia, lung cancer
    - **Skeletal system**: fracture, osteoporosis, bone tumors
  - Observation of ECG tracings in:
    - Myocardial infarction
    - Arrhythmias
    - Electrolyte imbalance

PATIENT CARE & SAFETY

THEORY

1. Introduction to Patient Care

- Principles of patient-centered care
- Duties & responsibilities of X-Ray & ECG Technicians
- Professional ethics & communication skills
- Patient rights & consent (informed & written consent)

2. Patient Handling & Positioning

- Methods of safe patient transfer (from wheelchair/bed to X-ray/ECG table)
- Positioning of patients for:
  - **X-ray examinations** (chest, abdomen, limbs, skull, spine)
  - **ECG recordings** (supine, sitting, bedridden patients)
- Care of **critically ill, pediatric, elderly, disabled & pregnant patients**
- Comfort measures (pillows, immobilization devices, draping)

3. Patient Preparation

- General preparation before X-ray/ECG procedures
- Special instructions:
  - Fasting, bowel preparation (for abdominal X-ray)
  - Removal of metal objects, jewelry, ECG electrode site preparation (skin cleaning, shaving if required)
- Psychological preparation & reassurance of anxious patients

4. Patient Safety

- General hospital safety rules
- Fall prevention & safe movement
- Prevention of hospital-acquired infections (universal precautions, hand hygiene, PPE use)
- Handling of contaminated material, biomedical waste disposal
- First aid in emergencies: fainting, seizures, cardiac arrest, trauma

5. Radiation Safety in X-Ray Technology

- Hazards of radiation exposure (short-term & long-term effects)
- Radiation protection principles:
  - ALARA (As Low As Reasonably Achievable) principle
  - Time, distance & shielding
- Protective devices: lead aprons, thyroid shields, gonadal shields
- Radiation monitoring devices: film badges, TLDs
- Safe use of X-ray equipment & periodic quality checks

6. Safety in ECG Technology

- Safe use of ECG machines & electrodes
- Electrical safety & prevention of shocks
- Skin preparation for proper electrode contact
- Infection control while using ECG electrodes/leads
- Care of bedridden & unconscious patients during ECG recording

7. Emergency Care in Radiology & ECG

- Recognition of common emergencies during X-ray/ECG:
  - Breathlessness, chest pain, fainting, cardiac arrest, allergic reaction to contrast media
- Basic Life Support (BLS) & CPR demonstration
- Use of crash cart & emergency drugs (introductory level)
- Immediate communication with doctors & nursing staff

8. Ethical & Legal Aspects

- Patient confidentiality & medical records maintenance
- Ethical handling of sensitive cases (trauma, medico-legal cases, pregnancy scans)
- Legal responsibilities in radiation & ECG practices
- Importance of patient identity verification before procedures

9. Communication & Soft Skills

- Effective communication with patients, attendants, and healthcare team
- Techniques to reduce patient anxiety & fear
- Dealing with uncooperative or pediatric patients
- Professionalism, empathy & cultural sensitivity

PRACTICAL

➢ Patient Handling & Positioning

1. Demonstration & practice of **safe patient transfer techniques** (from wheelchair, stretcher, and bed).
2. Practice of **body mechanics** for lifting, turning, and supporting patients.
3. Positioning of patients for common **X-ray examinations** (chest, abdomen, limbs, skull, spine).
4. Demonstration of **ECG electrode placement** on normal and bedridden patients.
5. Immobilization techniques for pediatric and uncooperative patients.

➢ Patient Preparation

6. Demonstration of patient preparation for:
    - X-ray abdomen (bowel prep, fasting)
    - Chest X-ray (removal of metal/jewelry)
    - ECG (skin cleaning, electrode site prep).
7. Practice of psychological reassurance & communication with patients before procedures.

➢ Infection Control & Safety

8. Demonstration of **hand hygiene techniques** (hand washing & sanitization).
9. Use of **PPE**: gloves, masks, aprons, shoe covers, lead aprons.
10. Demonstration of **biomedical waste disposal** (segregation in color-coded bins).
11. Cleaning & disinfection of ECG electrodes and X-ray table after use.

➢ Radiation & Electrical Safety

12. Demonstration of **radiation safety devices**: lead apron, thyroid shield, gonadal shield.

13. Familiarization with **radiation monitoring devices** (film badge, TLD badge).
14. Demonstration of **safe use of ECG machine** (checking leads, avoiding electrical hazards).
15. Practice of proper **cable management** to prevent tripping/fall accidents.

➢ **Emergency Care**

16. Demonstration of **Basic Life Support (BLS)** – CPR on mannequins.
17. First aid practice for fainting, seizures, chest pain.
18. Simulation of **handling a trauma patient** during emergency X-ray.
19. Demonstration of oxygen mask application & patient positioning in breathlessness.
20. Familiarization with **crash cart** & basic emergency drugs (introductory level).

➢ **Communication & Record-Keeping**

21. Role-play exercises for effective **communication with patients & attendants**.
22. Practice of **patient identity verification** before procedures.
23. Maintaining **patient procedure records & consent forms**.

SEMESTER – II

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DXET201	BASICS OF ECG (ELECTROCARDIOGRAM)	45 Min	1 Hrs.	50	50
DXET202	X-RAY & ECG TECHNIQUES	45 Min	1 Hrs.	50	50
DXET203	X-RAY & ECG EQUIPMENT	45 Min	1 Hrs.	50	50
DXET204	RADIATION SAFETY & HAZARDS	45 Min	1 Hrs.	50	50

BASICS OF ECG (ELECTROCARDIOGRAM)

THEORY

1. Introduction to ECG

- Definition, principle & importance of ECG
- Historical background of electrocardiography
- Role of ECG in diagnosis & monitoring

- Basic cardiac physiology: conduction system of the heart (SA node, AV node, Bundle of His, Purkinje fibers)

2. ECG Machine & Equipment

- Types of ECG machines (single channel, multi-channel, computerized)
- Components of ECG machine: electrodes, leads, amplifier, stylus, recording system
- Types of electrodes & lead wires
- Safety precautions in ECG machine handling
- Maintenance & care of ECG equipment

3. ECG Leads & Placement

- Concept of **leads vs electrodes**
- **Standard limb leads (I, II, III)**
- **Augmented limb leads (aVR, aVL, aVF)**
- **Precordial (chest) leads (V1–V6)**
- Correct **placement of electrodes** on patients (supine, sitting, bedridden, obese, pediatric)
- Modified lead placement in emergency & ICU patients

4. ECG Recording Procedure

- Patient preparation: physical & psychological
- Skin preparation (cleaning, shaving if needed, gel application)
- Step-by-step recording procedure
- Common artifacts (muscle tremor, loose electrodes, electrical interference) & their prevention
- Troubleshooting during recording

5. Normal ECG

- Structure of normal ECG waveform:
  - P wave, PR interval
  - QRS complex
  - ST segment
  - T wave, QT interval
- Normal ECG values (rate, rhythm, intervals, axis)
- Correlation with cardiac cycle events

6. Basic ECG Interpretation

- Recognition of:
  - Normal sinus rhythm
  - Bradycardia & Tachycardia
  - Atrial fibrillation & flutter (awareness)

  - Ventricular tachycardia (awareness)
  - Myocardial infarction (ST elevation, T inversion)
- Common electrolyte imbalance changes (K^+, Ca^{2+} abnormalities)

7. ECG in Clinical Practice

- Role of ECG in:
  - Ischemic heart disease
  - Hypertension & cardiac enlargement
  - Arrhythmias
  - Electrolyte disturbances
- Emergency use of ECG in cardiac arrest & myocardial infarction
- Importance of ECG in pre-operative assessment & ICU monitoring

8. Patient Care & Safety in ECG

- Patient identification & consent before ECG
- Psychological reassurance during ECG
- Electrical safety precautions
- Infection control in ECG labs (electrode cleaning, disposable vs reusable leads)
- Care of special patients: pediatric, elderly, unconscious, trauma

9. Documentation & Reporting

- Recording & labeling ECG reports
- Writing patient details correctly
- Preserving ECG records for future reference
- Technician's role vs doctor's role in ECG interpretation

10. Recent Advances in ECG Technology

- Digital & wireless ECG systems
- Holter monitoring (ambulatory ECG) – basics
- Stress ECG (treadmill test – TMT) – awareness only
- Tele-ECG & mobile ECG applications

11. Basic Principle of ECG

1. The heart generates **electrical impulses** during each cardiac cycle (depolarization and repolarization).
2. These impulses create small **voltage differences** on the body surface.
3. **Electrodes** placed on specific points of the skin (limbs and chest) detect these voltage changes.
4. The ECG machine amplifies these signals and records them as **waves on graph paper** (ECG tracing).

PRACTICAL

- **Familiarization & Safety**

1. Introduction to ECG laboratory, instruments & accessories.
2. Identification of ECG machine components (power unit, leads, electrodes, recording system).
3. Demonstration of electrical safety precautions in ECG use.
4. Cleaning & care of ECG electrodes and lead wires.

- **Patient Preparation**

5. Demonstration of patient identification, consent & psychological reassurance.
6. Skin preparation techniques: cleaning, shaving (if required), electrode gel application.
7. Positioning of patients: supine, sitting, bedridden, ICU patient.
8. Special considerations for pediatric, elderly, and trauma patients.

- **Electrode Placement**

9. Practice of correct placement of **limb electrodes** (RA, LA, RL, LL).
10. Practice of correct placement of **chest (precordial) electrodes** (V1–V6).
11. Demonstration of modified lead placement in emergency/ICU settings.
12. Troubleshooting common errors in electrode placement.

- **ECG Recording Procedure**

13. Step-by-step recording of **standard 12-lead ECG**.
14. Practice of **single-channel ECG recording**.
15. Identification & elimination of **artifacts**:

- Muscle tremor
- Loose electrode
- Electrical interference

16. Proper labeling & documentation of ECG reports.

- **Interpretation (Introductory Level)**

17. Identification of **normal ECG waveforms** (P, QRS, T).
18. Recognition of **basic abnormalities**:

- Bradycardia, Tachycardia
- Atrial fibrillation (awareness)
- Myocardial infarction changes (ST elevation, T inversion)

19. Correlation of ECG tracings with patient case reports (demo).

➢ **Emergency & Advanced Applications**

20. Recording ECG in **emergency situations** (chest pain, cardiac arrest – demo).
21. Demonstration of **ambulatory/Holter ECG** (awareness only).
22. Demonstration of **stress ECG (TMT) principle** (introductory awareness).

X-RAY & ECG TECHNIQUES

THEORY

Section A – X-Ray Techniques

1. Introduction to Radiology

- History & development of X-ray
- Role of X-ray technician in healthcare
- Basics of electromagnetic radiation
- Properties & production of X-rays

2. X-Ray Equipment & Components

- X-ray tube structure & function
- Control panel & exposure factors (kVp, mA, exposure time)
- X-ray accessories: grids, filters, cassettes, intensifying screens
- Types of X-ray machines: stationary, mobile, portable, digital radiography

3. Patient Preparation & Positioning

- Patient preparation before X-ray (removal of artifacts, fasting for special exams)
- Positioning methods for:
  - Chest (PA, lateral)
  - Abdomen (supine, erect)
  - Skull & facial bones
  - Spine (cervical, thoracic, lumbar)
  - Extremities (upper & lower limbs)
  - Pelvis & hip joint
- Pediatric & geriatric considerations

4. Radiographic Techniques

- General radiography procedures:
  - Chest, abdomen, spine, skull, extremities
- Contrast studies:

  - Barium swallow, barium meal, barium enema
  - Intravenous urography (IVU/IVP)
  - Hysterosalpingography (HSG)
- Special procedures (introductory): angiography, CT, MRI (awareness level)

5. Image Processing & Quality Assurance

- Film-screen system & darkroom techniques
- Digital radiography (CR, DR) workflow
- Image storage & PACS system
- Common radiographic errors & their corrections
- Quality assurance in radiology

6. Radiation Protection & Safety

- Biological effects of radiation
- Principles of radiation protection (time, distance, shielding – ALARA)
- Use of lead aprons, thyroid shields, gonadal protection
- Radiation monitoring devices (TLD, film badges)
- Regulatory guidelines (ICRP, AERB basics)

Section B – ECG Techniques

7. Introduction to ECG

- Principles of electrocardiography
- Role of ECG technician in diagnosis & monitoring
- Cardiac conduction system (SA node, AV node, bundle branches, Purkinje fibers)

8. ECG Machine & Components

- Types of ECG machines (single channel, multi-channel, digital)
- Components: electrodes, lead wires, amplifier, recorder
- Safety precautions in handling ECG equipment

9. ECG Leads & Placement

- Standard limb leads (I, II, III)
- Augmented limb leads (aVR, aVL, aVF)
- Chest leads (V1–V6)
- Electrode placement for supine, ICU, pediatric & trauma patients
- Modified lead placement in emergencies

10. ECG Recording & Artifacts

- Patient preparation & positioning for ECG
- Step-by-step procedure of recording a standard 12-lead ECG

- Identification & correction of artifacts (tremors, loose electrodes, electrical interference)
- Labeling & documentation of ECG reports

11. Normal & Abnormal ECG

- Normal ECG waveform (P wave, QRS, T wave, intervals, segments)
- Recognition of common abnormalities:
  - Bradycardia, tachycardia
  - Atrial fibrillation, flutter (awareness)
  - Ventricular tachycardia (awareness)
  - Myocardial infarction (ST elevation, T inversion)
- ECG changes in electrolyte imbalance (basic level)

12. Advanced & Emergency ECG Applications

- Use of ECG in ICU & emergency cases
- Introduction to Holter monitoring (ambulatory ECG)
- Introduction to treadmill test (TMT – awareness only)
- Technician's role in cardiac arrest & resuscitation support

Section C – Patient Care & Professionalism

- Patient communication & consent before procedures
- Positioning & comfort measures during X-ray & ECG
- Special care for pediatric, geriatric, critically ill, and pregnant patients
- Infection control & biomedical waste management in radiology & ECG labs
- Ethical & legal responsibilities of technicians
- Record keeping & report management

PRACTICAL

A. X-Ray Techniques

➢ **Orientation & Equipment Handling**

- Identification of parts of an X-ray machine & accessories (tube, collimator, control panel, cassettes, grids).
- Demonstration of radiation safety devices (lead apron, thyroid shield, gonadal shield).
- Practice of equipment care & routine maintenance.

➢ **Patient Preparation & Positioning**

- Demonstration of safe patient transfer (wheelchair, stretcher → X-ray table).
- Preparation of patient for X-ray (removal of metallic objects, fasting instructions for contrast studies).

- Positioning & practice on dummies/patients for:
  - **Chest X-ray** (PA & lateral view)
  - **Abdomen X-ray** (supine & erect)
  - **Upper limb & lower limb X-rays**
  - **Skull, cervical, thoracic, and lumbar spine X-rays**
  - **Pelvis & hip joint X-rays**
- Demonstration of pediatric & geriatric positioning.

➢ **Radiographic Procedures**

- Step-by-step recording of standard radiographs.
- Demonstration of **contrast study techniques** (barium swallow, barium meal, IVP – demo only).
- Practice in **portable & mobile X-ray machine use**.
- Identification & correction of common radiographic errors.

➢ **Image Processing**

- Film handling, developing & fixing (for conventional X-ray).
- Demonstration of CR/DR image acquisition.
- Familiarization with PACS system (digital image storage & retrieval).

B. ECG Techniques

➢ **Orientation & Machine Handling**

- Identification of parts of an ECG machine (electrodes, leads, amplifier, recorder).
- Demonstration of machine calibration & care.
- Practice of electrical safety checks.

➢ **Patient Preparation**

- Patient identification & consent.
- Demonstration of skin preparation (cleaning, shaving, electrode gel application).
- Positioning of patients: supine, sitting, bedridden, pediatric, geriatric.

➢ **Electrode Placement**

- Practice of correct limb electrode placement (RA, LA, RL, LL).
- Practice of chest electrode placement (V1–V6).
- Demonstration of modified placement in ICU/emergency cases.

➢ **ECG Recording**

- Step-by-step recording of a **standard 12-lead ECG**.
- Practice of single-channel ECG recording.

- Identification & elimination of **artifacts** (muscle tremor, loose electrodes, electrical interference).
- Proper labeling & documentation of ECG reports.

➢ **Interpretation (Basic)**

- Observation of **normal ECG waveform** (P, QRS, T).
- Demonstration of abnormal tracings (bradycardia, tachycardia, MI – demo slides).
- Case-based practice: ECG recording + patient history correlation.

C. Patient Care & Emergency

➢ **Safety & Emergency Handling**

- Demonstration of infection control practices (hand hygiene, PPE, biomedical waste segregation).
- Practice of radiation safety measures during X-ray.
- Simulation of emergency ECG in a patient with chest pain.
- Demonstration of **CPR & Basic Life Support (BLS)** on mannequins.
- Familiarization with crash cart & emergency drugs (introductory).

X-RAY & ECG EQUIPMENT

THEORY

1. Introduction to Biomedical Equipment

- Definition & classification of medical equipment.
- Overview of diagnostic imaging & cardiac diagnostic equipment.
- Role of X-Ray & ECG machines in healthcare.
- General safety precautions in handling biomedical equipment.

2. X-Ray Equipment

A. Basic Construction & Principles

- History & evolution of X-ray machines.
- X-ray tube: construction, working, filament, anode, cathode, protective housing.
- Tube rating charts & cooling systems.
- X-ray circuits: filament circuit, high-tension circuit, rectifiers, timers.

B. Components & Accessories

- X-ray generator (single-phase, three-phase, high-frequency).
- Control panel – knobs, switches, exposure parameters (kVp, mA, time).
- Collimator & beam limiting devices.

- Grids, filters, cassettes, screens.
- Bucky table, erect stands, fluoroscopy unit.

C. Specialized Equipment

- Mobile X-ray machine.
- Portable bedside units.
- Digital X-ray systems: CR, DR.
- Image Intensifier & Digital Fluoroscopy.
- PACS (Picture Archiving & Communication System).

D. Equipment Care & Maintenance

- Routine checks & preventive maintenance.
- Handling of X-ray tubes & cassettes.
- Radiation protection devices (lead aprons, thyroid shields, gonadal shields).

3. ECG Equipment

A. Basic Principles

- Introduction to electrocardiography equipment.
- Block diagram & working principle of ECG machine.
- Types of ECG machines: single-channel, multi-channel, 12-lead.

B. Components

- Electrodes: limb electrodes, chest electrodes, suction cups, adhesive patches.
- Lead selector switch & amplifier.
- Filters: baseline filter, AC interference filter, muscle tremor filter.
- Recording system: thermal printing vs digital display.

C. Operation & Function

- Calibration of ECG machine.
- Lead systems: standard limb leads, augmented leads, precordial leads.
- Special leads: esophageal, modified chest leads (overview).
- Portable & bedside ECG machines.
- Holter monitoring system (introduction).

D. Equipment Care & Maintenance

- Cleaning & disinfecting electrodes.
- Battery care & charging system.
- Troubleshooting common problems (no tracing, artifact interference).
- Safety measures during ECG recording.

4. Imaging & Recording Systems

- Film-screen system vs digital detectors.
- Conventional film developing equipment.
- Darkroom equipment (safe light, processor, dryer).
- Digital recording systems (CR cassettes, DR detectors).
- ECG paper, grid patterns, digital storage.

5. Safety in Equipment Use

- Radiation hazards & radiation protection.
- International standards (ALARA principle).
- Electrical hazards & safety in ECG machine handling.
- Infection control in equipment handling.
- Biomedical waste disposal related to X-ray & ECG.

6. Quality Assurance & Legal Aspects

- Equipment quality assurance tests.
- Periodic calibration & service requirements.
- AERB (Atomic Energy Regulatory Board) guidelines for X-ray equipment.
- Record keeping & log books.
- Legal & ethical responsibilities of technicians.

PRACTICAL

A. X-Ray Equipment

➢ **Familiarization & Identification**

- Identification of different types of X-ray machines (fixed, portable, mobile).
- Identification of parts of an X-ray tube: cathode, anode, protective housing.
- Identification of control panel components (kVp, mA, exposure time).
- Demonstration of accessories: collimator, filters, grids, cassettes, bucky, stands.

➢ **Equipment Handling & Operation**

- Switching on/off procedures of an X-ray machine.
- Setting exposure factors (kVp, mA, time) on control panel.
- Demonstration of automatic exposure control (if available).
- Handling of CR/DR systems & PACS introduction.
- Practice with mobile X-ray machine operation (ICU/OT use).

➢ **Safety & Maintenance**

- Demonstration of radiation protection devices (lead apron, thyroid shield, gonad shield).

- Checking for radiation leakage (demo by faculty/physicist).
- Routine cleaning & care of cassettes, grids, and detectors.
- Preventive maintenance drills – fuses, cables, switches.
- Demonstration of darkroom setup, safe light test, film developing & drying.

B. ECG Equipment Practicals

➢ Familiarization & Identification

- Identification of different types of ECG machines (single-channel, multi-channel, 12-lead).
- Identification of machine components – electrodes, leads, amplifier, recording system.
- Identification of ECG paper types & calibration markings.

➢ Equipment Handling & Operation

- Demonstration of machine calibration (1 mV = 10 mm).
- Correct connection of leads & cables to machine.
- Recording of a standard 12-lead ECG on a volunteer.
- Demonstration of portable ECG machine & Holter monitor (introductory).

➢ Safety & Maintenance

- Cleaning & disinfecting electrodes and lead wires.
- Checking battery status & charging system.
- Troubleshooting of common problems:
  - No tracing
  - Baseline drift
  - Electrical interference
  - Muscle tremor artifacts
- Routine servicing & preventive maintenance checks.

C. Integrated Practicals

➢ Patient Preparation & Demonstration

- Preparing a patient for X-ray & ECG recording.
- Demonstration of patient positioning for portable X-ray + simultaneous ECG in ICU setup.
- Practicing documentation of equipment use (log book entry).

➢ Emergency & Safety Drills

- Demonstration of handling equipment during power failure (UPS/battery).
- Fire & electrical safety drill in radiology/cardiology unit.
- Mock drill: handling cardiac emergency during ECG recording.

RADIATION SAFETY & HAZARDS

THEORY

1. Basics of Radiation

- Introduction to radiation: ionizing & non-ionizing.
- Discovery & properties of X-rays.
- Interaction of X-rays with matter (photoelectric effect, Compton scattering, pair production – basic overview).
- Sources of radiation: natural background, medical, occupational.

2. Radiation Physics & Units

- Important radiation quantities: Exposure, Absorbed Dose, Dose Equivalent, Effective Dose.
- Units of measurement: Roentgen, Gray, Sievert, Becquerel, Curie.
- Radiation dose limits – occupational exposure, patients, and general public.
- Dose monitoring methods.

3. Biological Effects of Radiation

- Biological response of cells & tissues.
- Deterministic (early) effects vs Stochastic (delayed) effects.
- Acute radiation syndrome.
- Long-term effects: cancer, cataract, sterility, genetic mutations.
- Radiosensitivity of various organs (bone marrow, thyroid, gonads, etc.).
- Radiation risks in pregnant women & children.

4. Radiation Hazards in Medical Imaging

- Hazards in routine diagnostic radiology.
- Risks in fluoroscopy and interventional procedures.
- Hazards in mobile & portable X-ray machines.
- Scatter radiation – causes & methods of control.
- Repeat exposures – causes & reduction strategies.

5.Principles of Radiation Protection

- The **ALARA principle** (As Low As Reasonably Achievable).
- Basic methods: Time, Distance, Shielding.
- Patient protection measures: proper positioning, collimation, shielding.
- Staff protection measures: lead apron, thyroid shield, gloves, lead goggles.
- Public protection: radiation-safe design of X-ray rooms.

6. Radiation Protection Devices & Monitoring

- Protective barriers: primary & secondary.
- Lead-lined walls, doors, and glass windows.
- Personal monitoring devices: TLD badges, film badges.
- Survey meters & area monitoring.
- Quality assurance tests for radiation safety.

7. Regulatory & Legal Aspects

- ICRP (International Commission on Radiological Protection) guidelines.
- AERB (Atomic Energy Regulatory Board, India) rules & regulations.
- IAEA (International Atomic Energy Agency) overview.
- Licensing, installation & certification of X-ray equipment.
- Responsibilities & ethics of radiation workers.

8. Radiation Safety in ECG (Comparison)

- ECG – uses non-ionizing electrical signals (no radiation hazard).
- Potential ECG hazards: electrical shock, infection from electrodes, artifacts.
- Safety practices in ECG environment.

9. Radiation Emergency & Accident Management

- Accidental overexposure – recognition & immediate steps.
- Reporting & documentation of radiation accidents.
- First aid for radiation exposure cases.
- Disaster management preparedness in radiology departments.

PRACTICAL

➢ **Familiarization & Demonstration**

1. **Orientation to Radiation Safety**
   - Demonstration of X-ray room layout, protective barriers, lead-lined doors/windows.
   - Identification of personal protective devices: lead apron, thyroid shield, gonad shield, gloves, goggles.
2. **Introduction to Monitoring Devices**
   - Demonstration of **TLD badge** and film badge use.
   - Familiarization with radiation survey meter / dosimeter (demo by physicist).

➢ **Patient Protection Practicals**

3. **Patient Preparation & Shielding**
   - Demonstration of collimation to reduce exposure.

- Use of gonadal shielding & positioning aids.
- Practice in minimizing repeat exposures.

4. **Safe Positioning & Exposure**
   - Simulation of patient positioning for chest/abdomen X-ray with minimal exposure.
   - Proper communication with patients about radiation safety.

➢ **Staff & Public Protection**

5. **Radiation Safety Drills**
   - Proper wearing of TLD badge & lead apron.
   - Standing at safe distance / behind barriers during exposure.
   - Demonstration of inverse square law (distance vs radiation dose).
6. **Radiation Leakage & Safety Checks**
   - Demo of leakage testing by faculty/physicist (survey meter use).
   - Checking integrity of lead aprons, gloves, and protective glasses.

➢ **Equipment Care & Quality Assurance**

7. **Darkroom & Processing Safety**
   - Safe handling of X-ray films & chemicals.
   - Demo of safe light & darkroom procedures to avoid repeat exposures.
8. **Routine Equipment Safety Checks**
   - Checking warning lights & caution signs in X-ray room.
   - Demo of regular maintenance (switches, fuses, cables).
   - Safe handling of CR/DR plates & detectors.

➢ **Emergency & Accident Management**

9. **Radiation Accident Drill**
   - Mock scenario: suspected overexposure → reporting & documentation.
   - Demonstration of isolation & handling of faulty equipment.
   - Introduction to emergency contacts & hospital radiation safety committee.
10. **First Aid & Disaster Preparedness**
    - First aid steps for radiation exposure.
    - Familiarization with safety manuals & emergency protocols.
    - Evacuation drill in case of radiation leakage.

➢ **Record & Log Work**

11. **Practical Record Book**

- Diagram of radiation safety room layout.
- List of personal protection devices with uses.
- Documentation of drills & safety checks.
- Sample log entry for radiation exposure monitoring.

SEMESTER – III

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DXET301	CARDIAC CYCLE & ELECTRICAL CONDUCTION SYSTEM	45 Min	1 Hrs.	50	50
DXET302	RADIOLOGY AND RADIOGRAPHIC PROCEDURES	45 Min	1 Hrs.	50	50
DXET303	DARK ROOM TECHNIQUE & FILM PROCESSING	45 Min	1 Hrs.	50	50
DXET304	RECORDING OF ECG IN NORMAL & DISEASED CONDITIONS	45 Min	1 Hrs.	50	50

CARDIAC CYCLE & ELECTRICAL CONDUCTION SYSTEM

THEORY

1. Introduction to the Heart

- Overview of the heart: location, size, and structure.
- Layers of the heart wall: epicardium, myocardium, endocardium.
- Heart chambers: atria and ventricles.
- Valves of the heart: atrioventricular (tricuspid & mitral) and semilunar (aortic & pulmonary).

2. Cardiac Cycle

- Definition: sequence of mechanical and electrical events in one heartbeat.
- Phases of cardiac cycle:
    1. **Atrial systole** – atrial contraction & ventricular filling.
    2. **Ventricular systole** – ventricular contraction, AV valve closure, blood ejection.
    3. **Diastole** – relaxation phase, passive filling of atria & ventricles.
- Heart sounds (S1 & S2) and their correlation with valve closure.
- Timing and duration of cardiac cycle (normal adult heart rate).

- Stroke volume, cardiac output, and ejection fraction (basic overview).

3. Electrical Conduction System of the Heart

- Definition and role in initiating & coordinating heartbeat.
- Components of conduction system:
  - **SA (Sinoatrial) node** – natural pacemaker.
  - **AV (Atrioventricular) node** – delay & transmission.
  - **Bundle of His** – pathway from AV node to ventricles.
  - **Right & left bundle branches** – conduction to respective ventricles.
  - **Purkinje fibers** – ventricular depolarization.

4. Generation & Propagation of Cardiac Impulses

- Mechanism of spontaneous depolarization in SA node.
- Transmission of impulses through atria → AV node → ventricles.
- Role of conduction system in synchronizing atrial and ventricular contraction.
- Basic understanding of action potential phases in cardiac cells (overview).

5. Electrocardiographic Correlation

- Relationship between electrical events & ECG waves:
  - P wave → atrial depolarization
  - PR interval → conduction through AV node
  - QRS complex → ventricular depolarization
  - ST segment & T wave → ventricular repolarization
- Significance of cardiac cycle phases in ECG interpretation.
- Basic abnormalities related to conduction system: AV block, bundle branch block, arrhythmias (introductory).

6. Clinical Relevance

- Importance of understanding cardiac cycle for:
  - Accurate ECG recording & interpretation.
  - Timing of procedures like stress test & Holter monitoring.
  - Identifying arrhythmias & conduction abnormalities.
- Awareness of factors affecting cardiac cycle: heart rate, blood pressure, autonomic nervous system influence.

PRACTICAL

➢ **Understanding Cardiac Cycle**

1. **Familiarization with cardiac anatomy**
   - Identification of heart chambers, valves, and major vessels using charts/models.

- Recognition of atrial and ventricular structures in correlation with ECG.

2. **Phases of Cardiac Cycle Demonstration**
   - Visualization of atrial systole, ventricular systole, and diastole using models or animations.
   - Correlation of mechanical events with **heart sounds (S1 & S2)**.
3. **Measurement of Pulse & Heart Rate**
   - Recording radial, carotid, and apical pulse.
   - Correlation of pulse rate with cardiac cycle duration.

➢ **Electrical Conduction System Practicals**

4. **Identification of Conduction System Components**
   - SA node, AV node, Bundle of His, bundle branches, Purkinje fibers – using models/diagrams.
   - Understanding of impulse transmission pathway through the heart.
5. **ECG Correlation with Conduction System**
   - Demonstration of P wave, PR interval, QRS complex, ST segment, and T wave.
   - Recording **normal ECG** of a volunteer and marking waveforms.
   - Observation of **time intervals**: PR interval, QRS duration, QT interval.
6. **Arrhythmia Awareness (Demo Only)**
   - Demonstration of basic ECG abnormalities:
     - Bradycardia & tachycardia
     - AV block (first degree, second degree – demo)
     - Bundle branch block (introductory)

➢ **Cardiac Cycle & ECG Recording**

7. **Stepwise ECG Recording**
   - Patient preparation & electrode placement.
   - Recording 12-lead ECG.
   - Ensuring proper calibration and artifact elimination.
8. **Correlation of ECG with Cardiac Events**
   - Mapping P wave → atrial depolarization → atrial contraction.
   - Mapping QRS → ventricular depolarization → ventricular contraction.
   - Mapping T wave → ventricular repolarization → relaxation.

➢ **Integrated Exercises**

9. **Heart Rate Calculation from ECG**
   - Counting RR intervals & calculating beats per minute.
   - Correlation of ECG-derived heart rate with pulse measurement.
10. **Documentation & Reporting**
    - Labeling ECG tracings with waveforms and intervals.
    - Recording observations in practical logbook.
    - Case study discussions: linking conduction system defects to ECG changes.

RADIOLOGY AND RADIOGRAPHIC PROCEDURES

THEORY

1. Introduction to Radiology

- History and development of radiology.
- Importance and role of X-ray technician in hospitals.
- Types of radiology: diagnostic, interventional, therapeutic.
- Basic physics of X-rays: production, properties, and interactions with matter.

2. X-Ray Equipment

- Components of X-ray machine: X-ray tube, control panel, generator, collimator.
- Types of X-ray machines: stationary, mobile, portable, digital radiography systems (CR & DR).
- Accessories: grids, filters, cassettes, intensifying screens, bucky tables, erect stands.
- Maintenance and care of X-ray equipment.

3. Patient Preparation

- Patient identification and verification.
- Communication and consent.
- Removal of artifacts and preparation for specific radiographic procedures.
- Positioning techniques: supine, prone, erect, lateral, oblique.
- Special considerations: pediatric, geriatric, trauma, and ICU patients.

4. Radiographic Procedures

A. Routine Radiography

- Chest: PA, AP, lateral views.
- Abdomen: supine, erect, KUB.
- Skull and facial bones: PA, lateral, submentovertex, Waters' view.
- Spine: cervical, thoracic, lumbar – AP and lateral views.
- Extremities: upper & lower limbs – AP, lateral, oblique views.
- Pelvis and hip joint: AP, lateral views.

B. Contrast Studies (Awareness/Introductory)

- Barium swallow, barium meal, barium enema.
- Intravenous urography (IVU/IVP).
- Hysterosalpingography (HSG).
- Basic knowledge of contrast media and precautions.

C. Specialized Procedures (Introductory Awareness)

- Fluoroscopy and digital subtraction angiography (DSA).
- Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) – overview.
- Portable X-ray procedures in ICU and OT.

5. Image Processing & Quality Assurance

- Conventional film-screen radiography: film handling, developing, fixing, and drying.
- CR (Computed Radiography) and DR (Digital Radiography) workflow.
- Common errors in radiographs and their correction.
- Introduction to PACS (Picture Archiving & Communication System).
- Quality assurance in radiology – repeat exposure reduction.

6. Radiation Safety

- Biological effects of X-ray radiation.
- Principles of radiation protection (Time, Distance, Shielding).
- Personal protective devices: lead apron, thyroid shield, gonadal shield.
- Safety measures for patient, staff, and public.
- Regulatory guidelines (AERB, ICRP basics).

7. Documentation and Reporting

- Labelling of radiographs.
- Maintenance of patient records and X-ray logbooks.
- Documentation of exposure parameters, positioning, and patient instructions.
- Ethical and legal responsibilities of the X-ray technician.

8. Clinical Relevance

- Correlation of radiographic findings with patient history.
- Importance of accurate positioning in diagnosis.
- Handling emergency cases in radiology (trauma, ICU).
- Awareness of limitations of different radiographic techniques.

PRACTICAL

- **Equipment Familiarization**

1. Identification of X-ray machine components:
    - X-ray tube, control panel, generator, collimator.
2. Identification and handling of accessories:
    - Cassettes, grids, intensifying screens, bucky table, erect stand.
3. Introduction to CR/DR systems and PACS (digital workflow).
4. Demonstration of radiation protection devices: lead aprons, thyroid shields, gloves.

- **Patient Preparation & Safety**

5. Verification of patient identity and consent.
6. Patient communication & instructions.
7. Removal of artifacts and preparation for specific radiographs.
8. Positioning techniques: supine, prone, erect, lateral, oblique.
9. Special patient care: pediatric, geriatric, trauma, ICU patients.

- **Radiographic Procedures – Routine X-rays**

10. Chest X-ray: PA, lateral views.
11. Abdomen: supine, erect, KUB.
12. Skull and facial bones: PA, lateral, submentovertex, Waters' view.
13. Spine: cervical, thoracic, lumbar – AP and lateral.
14. Extremities: upper & lower limbs – AP, lateral, oblique.
15. Pelvis and hip joint: AP, lateral.

- **Radiographic Procedures – Special & Portable X-rays**

16. Portable X-ray procedures in ICU/OT.
17. Awareness demonstration of contrast studies:
    - Barium swallow, barium meal, barium enema, IVU/IVP, HSG.
18. Basic introduction to fluoroscopy, CT, MRI (demo only).

- **Image Processing & Quality Checks**

19. Handling conventional film: developing, fixing, drying.
20. CR/DR workflow and image acquisition.
21. Identification and correction of common errors in radiographs.
22. Proper labelling and storage of radiographs.

- **Radiation Safety in Practicals**

23. Use of personal protective equipment (lead apron, thyroid shield, gloves).
24. Safe distance & positioning for operator during exposure.
25. Demonstration of TLD badge use and monitoring.
26. Awareness of ALARA principle in practical settings.

- **Documentation & Reporting**

27. Recording exposure parameters, patient position, and type of radiograph.
28. Maintaining X-ray logbook & PACS documentation.
29. Case-based discussion linking radiographs to patient history.

- **Integrated Clinical Exercises**

30. Step-by-step practice of a full radiographic session:
    - Patient preparation → positioning → exposure → processing → documentation.
31. Mock drills for emergency/ICU portable X-ray situations.
32. Team exercises for patient handling, safety, and workflow efficiency.

DARK ROOM TECHNIQUE & FILM PROCESSING

THEORY

1. Introduction to Dark Room

- Purpose and importance of dark room in radiography.
- Types of dark rooms: conventional manual vs semi-automatic vs automatic processing.
- Basic layout: safe light, workbench, storage, processing area.
- Importance of temperature, ventilation, and humidity control.

2. X-Ray Film

- Types of X-ray films: conventional, single-emulsion, double-emulsion, screen film.
- Film structure: base, emulsion, protective coating.
- Sensitivity and speed of films.
- Storage, handling, and expiration of X-ray films.

3. Safe Light & Dark Room Illumination

- Concept of safe light and its characteristics (wavelength, intensity).
- Location of safe light in darkroom.
- Effects of incorrect safe light on film fogging.
- Testing safe light quality.

4. Film Handling

- Loading cassettes and removing exposed film.
- Care in handling to prevent scratches, fingerprints, and bending.
- Identification of film orientation, markers, and labels.
- Precautions to avoid double exposure.

5. Chemical Processing of X-ray Films

A. Manual Processing

- Chemicals used: developer, fixer, water (rinsing).

- Preparation and mixing of chemicals.
- Temperature, time, and agitation control.
- Stepwise processing: development → rinsing → fixing → washing → drying.
- Common processing faults and their correction.

B. Automatic Processing

- Overview of automatic processors.
- Loading films into automatic processors.
- Maintenance and cleaning of automatic processors.
- Troubleshooting common automatic processing errors.

6. Quality Control & Assurance

- Factors affecting film quality: exposure, processing, storage.
- Film artifacts: scratches, static marks, chemical stains, fogging.
- Steps to ensure consistent high-quality radiographs.
- Periodic testing and preventive maintenance of dark room equipment.

7. Waste Management & Safety

- Disposal of used chemicals and fixer solutions.
- Environmental hazards of silver recovery and chemical effluents.
- Personal safety: gloves, aprons, ventilation.
- Avoiding contamination and chemical burns.

8. Documentation & Record Keeping

- Keeping records of chemical batches, expiry, and processing logs.
- Recording faults and corrective actions.
- Documentation of dark room maintenance and cleaning schedules.

PRACTICAL

➢ **Dark Room Familiarization**

1. Identification of dark room layout:
    - Safe light, workbench, chemical tanks, storage area.
2. Demonstration of **ventilation, temperature, and humidity control**.
3. Awareness of **personal safety**: gloves, aprons, eye protection.

➢ **X-Ray Film Handling**

4. Identification of film types: single-emulsion, double-emulsion, screen film.
5. Proper loading and unloading of cassettes.
6. Orientation, markers, and labeling of films.

7. Handling precautions: avoiding scratches, fingerprints, bending, and double exposure.

➢ **Safe Light Demonstration**

8. Testing safe light quality and intensity.
9. Understanding effects of incorrect safe light: film fogging.
10. Placement of safe light in dark room for maximum safety.

➢ **Manual Film Processing**

11. Preparation and mixing of chemicals: developer, fixer, water.
12. Stepwise processing of exposed film:
    - Development → Rinsing → Fixing → Washing → Drying.
13. Controlling temperature, timing, and agitation for optimal results.
14. Identification and correction of **manual processing faults**:
    - Underdevelopment, overdevelopment, streaks, stains, fogging.

➢ **Automatic Film Processing**

15. Loading films into automatic processor.
16. Observing stepwise automatic processing.
17. Maintenance and cleaning of automatic processor.
18. Troubleshooting common errors in automatic processing.

➢ **Quality Control & Assurance**

19. Identifying film artifacts: scratches, static marks, chemical stains.
20. Practice maintaining consistent film quality.
21. Comparison of manual vs automatic processed films.
22. Recording observations in practical logbook.

➢ **Waste Management & Safety**

23. Safe handling and disposal of used chemicals.
24. Awareness of silver recovery and environmental hazards.
25. Maintaining cleanliness and hygiene in dark room.

➢ **Integrated Practical Exercises**

26. Complete workflow exercise:
    - Film exposure → cassette handling → manual/automatic processing → quality evaluation → documentation.
27. Case-based problem-solving: correcting processing faults.
28. Demonstration of maintaining logs and recording chemical batch information.

RECORDING OF ECG IN NORMAL & DISEASED CONDITIONS

THEORY

1. Introduction to ECG

- Definition and importance of ECG in cardiac diagnosis.
- Overview of electrical activity of the heart.
- Principles of ECG recording: electrodes, leads, and paper calibration.
- Safety measures during ECG recording.

2. ECG Equipment & Leads

- Types of ECG machines: single-channel, multi-channel, 12-lead.
- Components: electrodes, lead wires, amplifier, display/recorder.
- Limb leads: I, II, III; augmented leads: aVR, aVL, aVF.
- Precordial (chest) leads: V1–V6.
- Preparation, placement, and precautions for electrodes.

3. Recording ECG in Normal Conditions

- Patient preparation: skin cleaning, electrode placement, rest conditions.
- Calibration of ECG machine (1 mV = 10 mm).
- Recording standard 12-lead ECG in normal healthy individuals.
- Identification of normal waveforms:
  - P wave → atrial depolarization
  - PR interval → conduction through AV node
  - QRS complex → ventricular depolarization
  - ST segment & T wave → ventricular repolarization
- Measurement of heart rate, rhythm, and intervals.

4. Recording ECG in Diseased Conditions

- ECG recording in patients with common cardiac conditions:
  - **Arrhythmias**: sinus tachycardia, sinus bradycardia, atrial fibrillation, atrial flutter, ventricular tachycardia.
  - **Conduction abnormalities**: AV block (first, second, third degree), bundle branch block.
  - **Myocardial ischemia and infarction**: ST elevation, ST depression, T wave inversion.
  - **Other abnormalities**: premature atrial/ventricular complexes, pacemaker rhythms.
- Adjustments needed during recording in diseased conditions.
- Safety precautions and patient monitoring during abnormal ECG recordings.

5. Documentation & Interpretation Basics

- Labelling ECG tracings: patient details, date, time, lead identification.
- Recognizing normal vs abnormal waveforms.
- Maintaining ECG record logbook.
- Basic guidelines for reporting to physician (non-diagnostic role).

6. Practical Considerations

- Handling ECG electrodes, cables, and machines hygienically.
- Preventing artifacts: muscle tremor, baseline drift, electrical interference.
- Special patient considerations: pediatric, geriatric, obese, ICU patients.
- Portable ECG recording in emergency/ICU setups.

PRACTICAL

➢ ECG Equipment Familiarization

1. Identification of ECG machine components: electrodes, lead wires, amplifier, display/recorder.
2. Familiarization with single-channel, multi-channel, and 12-lead machines.
3. Checking ECG machine calibration and battery/power supply.
4. Handling and cleaning of ECG electrodes and cables.

➢ Patient Preparation & Electrode Placement

5. Verification of patient identity and explanation of procedure.
6. Preparation of skin: cleaning, shaving if necessary, applying electrode gel/pads.
7. Correct placement of limb leads: RA, LA, RL, LL.
8. Correct placement of precordial leads: V1–V6.
9. Special considerations for pediatric, geriatric, obese, or ICU patients.

➢ Recording ECG in Normal Conditions

10. Calibration of ECG machine: 1 mV = 10 mm, standard paper speed 25 mm/sec.
11. Recording 12-lead ECG in a healthy volunteer.
12. Identification of normal ECG waves: P wave, PR interval, QRS complex, ST segment, T wave.
13. Measuring heart rate, rhythm, and intervals.
14. Observation and correction of common artifacts: baseline drift, muscle tremor, electrical interference.

➢ Recording ECG in Diseased Conditions

15. Demonstration/recording in patients with common cardiac conditions:

- **Arrhythmias**: sinus tachycardia, sinus bradycardia, atrial fibrillation, atrial flutter, ventricular tachycardia.
- **Conduction abnormalities**: AV block (1st, 2nd, 3rd degree), bundle branch block.
- **Ischemic changes**: ST elevation, ST depression, T wave inversion.
- **Other abnormalities**: premature atrial/ventricular complexes, pacemaker rhythms.

16. Adjustments needed during recording in diseased conditions.
17. Ensuring patient safety during abnormal ECG recording.

➢ **Portable & Emergency ECG Recording**

18. Demonstration of portable ECG recording in ICU/OT/emergency setups.
19. Quick setup, electrode placement, and safe operation under emergency conditions.
20. Troubleshooting issues during portable ECG recording.

➢ **Documentation & Reporting**

21. Labelling ECG recordings with patient details, date, time, and lead identification.
22. Maintaining ECG logbook and filing records.
23. Noting observations, abnormalities, and technician remarks (non-diagnostic).

➢ **Integrated Practical Exercises**

24. Full ECG recording session: patient prep → electrode placement → recording → observation → documentation.
25. Case-based exercises for abnormal ECG patterns.
26. Artifact recognition and correction exercises.

SEMESTER – IV

PAPER CODE	SUBJECT NAME	THEORY HOURS	PRACTICAL HOURS	THEORY MARKS	PRACTICAL MARKS
DXET401	ECG INTERPRETATION	45 Min	1 Hrs.	50	50
DXET402	ADVANCED RADIOLOGY PROCEDURE	45 Min	1 Hrs.	50	50
DXET403	ADVANCED RADIATION PROTECTION & QUALITY CONTROL	45 Min	1 Hrs.	50	50
DXET404	RADIOGRAPHIC TECHNIQUES AND DIAGNOSTIC	45 Min	1 Hrs.	50	50

ECG INTERPRETATION

THEORY

1. Introduction to ECG Interpretation

- Importance of ECG in diagnosis and patient management.
- Difference between ECG recording and interpretation.
- Understanding ECG paper: time, voltage, calibration.
- Review of normal cardiac cycle and conduction system relevant to ECG.

2. Normal ECG

- Components of ECG waveforms: P wave, PR interval, QRS complex, ST segment, T wave, QT interval.
- Normal durations and amplitudes:
  - P wave: 0.08–0.12 sec
  - PR interval: 0.12–0.20 sec
  - QRS complex: 0.06–0.10 sec
  - QT interval: 0.36–0.44 sec
- Normal ECG patterns for adult, pediatric, and geriatric patients.

3. Heart Rate and Rhythm Analysis

- Methods of heart rate calculation from ECG:
  - Small box method, large box method, 6-second method.
- Assessment of rhythm:
  - Regular vs irregular rhythms.
  - Sinus rhythm, sinus arrhythmia, sinus tachycardia, sinus bradycardia.

4. Abnormalities of P Wave and PR Interval

- Atrial enlargement: right and left atrial abnormalities.
- AV conduction abnormalities:
  - First-degree AV block
  - Second-degree AV block (Mobitz I & II)
  - Third-degree AV block
- Pre-excitation syndromes: WPW syndrome (overview).

5. QRS Complex Abnormalities

- Ventricular conduction defects: bundle branch blocks (right & left).
- Ventricular hypertrophy: right and left.
- Ventricular ectopics: premature ventricular contractions (PVCs).

6. ST Segment and T Wave Changes

- Myocardial ischemia and infarction patterns:
  - ST elevation, ST depression
  - T wave inversion, hyperacute T waves
- Pericarditis and other ST/T abnormalities (introductory).

70 Arrhythmias

- Atrial arrhythmias: atrial fibrillation, atrial flutter.
- Supraventricular tachycardia.
- Ventricular arrhythmias: ventricular tachycardia, ventricular fibrillation.
- Recognition of pacemaker rhythms.

8. Miscellaneous ECG Findings

- Electrolyte disturbances: hyperkalemia, hypokalemia (basic patterns).
- Drug effects on ECG (digitalis, antiarrhythmics – overview).
- Artifacts and technical errors affecting ECG interpretation.

9. Clinical Correlation

- Linking ECG changes to patient symptoms and clinical history.
- Identifying **emergency ECG findings** requiring immediate physician attention.
- Awareness of limitations: DXET technician's role is **non-diagnostic but supportive**.

PRACTICAL

➢ ECG Equipment Familiarization

1. Identification of ECG machine components relevant to interpretation.
2. Checking calibration and paper speed: standard 25 mm/sec, 10 mm/mV.
3. Demonstration of ECG printout handling and storage.

➢ Normal ECG Analysis

4. Identification of ECG waveforms: P wave, PR interval, QRS complex, ST segment, T wave, QT interval.
5. Measurement of intervals and amplitudes: PR, QRS, QT.
6. Determination of heart rate using small box, large box, and 6-second methods.
7. Assessment of rhythm: regular vs irregular, sinus rhythm verification.

➢ Interpretation of Common Abnormalities

8. **P Wave & PR Interval Changes:**
   - Right & left atrial enlargement.

- First-degree, second-degree, third-degree AV block.
- Pre-excitation (WPW) overview.

9. **QRS Complex Abnormalities:**
   - Right and left bundle branch block.
   - Ventricular hypertrophy patterns.
   - Premature ventricular contractions (PVCs).
10. **ST Segment & T Wave Changes:**
    - Myocardial ischemia: ST depression, T wave inversion.
    - Myocardial infarction: ST elevation, pathological Q waves.
    - Pericarditis (introductory).
11. **Arrhythmias:**
    - Atrial fibrillation and atrial flutter.
    - Supraventricular tachycardia (SVT).
    - Ventricular tachycardia, ventricular fibrillation.
    - Pacemaker rhythms.
12. **Electrolyte & Drug Effects:**
    - Hyperkalemia and hypokalemia ECG patterns.
    - Overview of drug-induced ECG changes.

➢ **Artifact Recognition and Correction**

13. Identification of common ECG artifacts: baseline drift, muscle tremor, electrical interference.
14. Corrective measures for recording errors.

➢ **Clinical Correlation Exercises**

15. Case-based exercises: linking ECG abnormalities to patient history and symptoms.
16. Prioritization of emergency ECG findings requiring immediate physician attention.
17. Documentation of findings in logbook (technician notes, non-diagnostic).

➢ **Integrated Practical Exercises**

18. Full ECG interpretation session:
    - Review normal ECG tracing.
    - Analyze abnormal ECG cases (arrhythmias, ischemia, conduction defects).
    - Measure intervals, heart rate, and rhythm.
19. Comparative analysis of multiple ECGs to identify progression of disease or recovery.

ADVANCED RADIOLOGY PROCEDURE

THEORY

1. Introduction to Advanced Radiology

- Definition and scope of advanced radiology procedures.
- Role of DXET in specialized imaging under supervision.
- Overview of modern imaging modalities and techniques.
- Safety and ethical considerations in advanced radiology.

2. Fluoroscopy

- Principles of fluoroscopy and real-time imaging.
- Components of a fluoroscopic unit.
- Clinical applications: GI studies, urinary tract, barium swallow.
- Radiation safety considerations specific to fluoroscopy.

3. Contrast Studies

- Introduction to contrast media: types, indications, contraindications.
- Gastrointestinal contrast studies:
  - Barium swallow, barium meal, barium enema.
- Urinary system: intravenous urography (IVU), retrograde pyelography.
- Gynecological studies: hysterosalpingography (HSG).
- Basic handling, storage, and safety precautions with contrast media.

4. Computed Tomography (CT)

- Basic principle of CT imaging.
- CT components: gantry, X-ray tube, detectors, computer system.
- Patient preparation for CT scans.
- Common CT protocols: head, chest, abdomen, and pelvis.
- DXET technician's role: positioning, patient care, safety under supervision.

5. Magnetic Resonance Imaging (MRI)

- Basic principles of MRI and magnetic field safety.
- MRI components: magnet, gradient coils, RF coil.
- Patient screening for contraindications (pacemaker, metal implants).
- Technician's role: patient positioning, coil placement, safety supervision.

6. Ultrasound Imaging

- Principles of ultrasonography.
- Equipment components: transducer, monitor, control panel.
- DXET role in preparing patient and assisting radiologist.
- Safety and hygiene considerations.

7. Digital Radiography and PACS

- CR (Computed Radiography) and DR (Digital Radiography) workflow.
- PACS (Picture Archiving & Communication System) overview.
- Image acquisition, storage, and retrieval.
- Technician's responsibilities in image quality and documentation.

8. Interventional Radiology

- Introduction to minimally invasive procedures using imaging guidance.
- Examples: angiography, biopsy, catheter placements.
- DXET role: assisting radiologist, patient preparation, safety precautions.

9. Radiation Safety in Advanced Procedures

- ALARA principle application in fluoroscopy, CT, and interventional radiology.
- Use of lead aprons, shields, and TLD badges in advanced imaging areas.
- Dose monitoring and patient/staff safety protocols.

10. Documentation & Reporting

- Maintaining logbooks for advanced imaging procedures.
- Proper labelling of images and records.
- Ethical and legal responsibilities of DXET in advanced procedures.

PRACTICAL

➢ Equipment Familiarization

1. Identification of advanced radiology equipment:
    - Fluoroscopy unit, CT scanner, MRI, ultrasound machine.
2. Components of each unit and their functions.
3. CR (Computed Radiography) and DR (Digital Radiography) systems overview.
4. PACS (Picture Archiving & Communication System) workflow and image handling.

➢ Patient Preparation & Positioning

5. Verification of patient identity and explanation of procedure.
6. Patient preparation for different procedures: fasting, hydration, contrast administration.
7. Correct positioning for:
    - Fluoroscopy (barium studies, urinary studies)
    - CT scans (head, chest, abdomen, pelvis)
    - MRI scans (head, spine, extremities)
    - Ultrasound (abdomen, pelvic, obstetric)
8. Special considerations for pediatric, geriatric, obese, and ICU patients.

- **Fluoroscopy Practical**

9. Setting up fluoroscopic unit under supervision.
10. Patient positioning and movement for real-time imaging.
11. Observation of image quality, radiation safety measures, and lead shielding.
12. Basic demonstration of GI and urinary fluoroscopy procedures.

- **Contrast Studies Practical**

13. Handling and storage of contrast media.
14. Demonstration of barium swallow, barium meal, barium enema (simulation or under supervision).
15. Intravenous urography (IVU) patient positioning.
16. Hysterosalpingography (HSG) procedure overview and patient prep.
17. Safety precautions and emergency response for contrast reactions.

- **Computed Tomography (CT) Practical**

18. Familiarization with CT scanner components.
19. Patient positioning for head, chest, abdomen, and pelvis CT scans.
20. Observation of CT protocols and slice selection under supervision.
21. Radiation safety and shielding for staff and patient.

- **MRI Practical (Demonstration/Observation)**

22. Screening patients for contraindications (implants, pacemakers, metallic objects).
23. Patient positioning and coil placement.
24. Observing scan protocol and image acquisition.
25. Safety precautions: noise protection, magnetic field safety.

- **Ultrasound Practical (Assisted Observation)**

26. Familiarization with transducer and control panel.
27. Patient positioning and scanning procedure under radiologist supervision.
28. Handling gel and hygiene precautions.
29. Observation of normal and abnormal findings (if possible).

- **Radiation Safety**

30. Application of ALARA principle in fluoroscopy, CT, and portable studies.
31. Use of lead aprons, shields, and TLD badges.
32. Dose monitoring and documentation.

- **Documentation & Reporting**

33. Labelling images and maintaining proper records.

34. Recording exposure parameters, patient position, and contrast media used.
35. Maintaining logbooks for advanced radiology procedures.

➢ **Integrated Exercises**

36. Full workflow demonstration: patient prep → positioning → exposure → image acquisition → documentation.
37. Case-based exercises for simulated advanced radiology scenarios.
38. Safety drills and emergency response simulations.

ADVANCED RADIATION PROTECTION & QUALITY CONTROL

THEORY

1. Introduction

- Definition, scope, and importance of radiation protection in modern imaging.
- Role of X-Ray & ECG technicians in radiation safety and quality assurance.
- Regulatory authorities: ICRP (International Commission on Radiological Protection), AERB (Atomic Energy Regulatory Board, India).

2. Radiation Physics & Biological Effects

- Interaction of X-rays with matter.
- Types of radiation (primary, scattered, leakage).
- Biological effects of radiation: deterministic vs stochastic.
- Radiation dose units: Gray (Gy), Sievert (Sv), Becquerel (Bq).

3. Principles of Radiation Protection

- ALARA principle (As Low As Reasonably Achievable).
- Time, distance, and shielding as protective measures.
- Personal protective equipment (PPE): lead apron, thyroid collar, lead glasses, gonad shields.
- Staff protection vs patient protection.

4. Radiation Protection in Imaging Modalities

- Radiography: collimation, filtration, exposure optimization.
- Fluoroscopy: dose reduction techniques, pulsed fluoroscopy.
- CT: dose modulation, shielding, pediatric considerations.
- Advanced imaging: digital radiography dose management.

5. Radiation Monitoring

- Personal dosimeters: film badge, TLD (Thermoluminescent Dosimeter), OSL (Optically Stimulated Luminescence).
- Area monitoring devices.
- Dose limits for radiation workers and patients.
- Record-keeping and dose reporting.

6. Quality Control in Radiology

- Definition and importance of quality control (QC).
- Acceptance testing, routine testing, and preventive maintenance.
- QC tests for X-ray machines: kVp accuracy, timer accuracy, mA linearity, exposure reproducibility.
- QC in CT: image noise, contrast resolution, slice thickness, dose calibration.
- QC in fluoroscopy: resolution, contrast, and dose measurement.

7. Quality Assurance in Film & Digital Systems

- QC in darkroom: safelight, fog test, film-screen contact test.
- QC in CR/DR systems: image uniformity, dead pixel test, erasure cycle test.
- PACS (Picture Archiving and Communication System) data quality.

8. Emergency Preparedness & Radiation Incidents

- Common radiation hazards and accidental exposures.
- Emergency protocols in case of overexposure, equipment failure, or contrast reaction.
- Role of technician in first response and reporting.

9. Legal, Ethical & Regulatory Aspects

- AERB guidelines for diagnostic radiology.
- International radiation protection standards.
- Legal responsibilities of technicians.
- Ethical aspects of patient care during radiation exposure.

10. Quality Improvement & Documentation

- Continuous quality improvement programs in radiology.
- Maintaining radiation logbooks.
- QC audit and documentation practices.
- Role of technician in clinical governance.

PRACTICAL

- **Radiation Protection Practicals**

1. **Identification & Handling of PPE**
   - Lead apron, thyroid collar, lead glasses, gonad shields.
   - Proper storage and inspection for cracks/damage.
2. **Radiation Protection Devices**
   - Demonstration of collimators, filters, and grids.
   - Use of shielding barriers (lead-lined walls, screens).
3. **Patient Protection**
   - Correct positioning with minimal exposure.
   - Use of gonadal shielding in pelvic X-rays.
   - Pediatric dose reduction techniques.
4. **Staff Protection**
   - Safe positioning during portable X-rays and fluoroscopy.
   - Use of lead barriers and distance measures.
   - Rotational duties in high-radiation areas.

- **Radiation Monitoring Practicals**

5. **Personal Dosimeter Use**
   - Demonstration of film badge, TLD, OSL dosimeters.
   - Wearing, storage, and handling procedures.
   - Interpreting dose reports.
6. **Area Monitoring**
   - Placement of area radiation monitors in X-ray and CT rooms.
   - Checking for leakage radiation around X-ray tube housing.

- **Quality Control (QC) in X-Ray**

7. **X-Ray Equipment QC Tests** *(under supervision)*
   - kVp accuracy test.
   - Timer accuracy check.
   - mA linearity and reproducibility test.
   - Collimator and beam alignment test.
   - Half-Value Layer (HVL) measurement for beam quality.
8. **Darkroom QC Tests (for film-based systems)**
   - Safelight fog test.
   - Film-screen contact test.
   - Processor QC: temperature, chemical strength, replenishment.

- **QC in Digital Imaging (CR/DR)**

9. Image uniformity test.
10. Dead pixel/line detection on DR detectors.
11. Erasure cycle test in CR systems.

12. PACS workflow validation: image transfer, storage, retrieval.

➢ **QC in CT & Fluoroscopy**

13. **CT QC Tests** *(observation/demo)*

- Slice thickness accuracy.
- Image noise and uniformity.
- Contrast resolution check.
- Dose output measurement.

14. **Fluoroscopy QC**

- Resolution and contrast checks.
- Entrance surface dose measurement.
- Pulsed fluoroscopy dose reduction demo.

➢ **Emergency & Safety Drills**

15. Handling suspected over-exposure incident.
16. Demonstration of safe evacuation in case of radiation accident.
17. First-aid measures for contrast reaction during advanced imaging.
18. Documentation of radiation incidents in logbooks.

➢ **Documentation & Logbook Maintenance**

19. Recording daily QC checks.
20. Maintaining radiation exposure records of staff and patients.
21. Preparing QA (Quality Assurance) reports under supervisor guidance.

RADIOGRAPHIC TECHNIQUES AND DIAGNOSTIC

THEORY

1. Introduction to Radiographic Techniques

- Definition, scope, and importance of diagnostic radiography.
- Role of the X-Ray & ECG Technician in diagnosis.
- Overview of conventional vs modern radiographic methods.

2. Patient Preparation & Positioning

- General patient preparation for radiography.
- Immobilization techniques and use of positioning aids.

- Positioning terminology: AP, PA, lateral, oblique, axial, tangential.
- Importance of correct positioning for diagnostic accuracy.

3. Radiographic Techniques of the Skeletal System

- Skull and facial bones.
- Spine: cervical, thoracic, lumbar, sacrum, coccyx.
- Upper limb: shoulder, humerus, elbow, wrist, hand.
- Lower limb: pelvis, hip, femur, knee, ankle, foot.
- Joints: specialized views (e.g., intercondylar, skyline).

4. Radiographic Techniques of the Thorax

- Chest X-ray (PA, lateral, oblique).
- Special chest views: lordotic, expiratory, decubitus.
- Diagnostic importance in respiratory and cardiac diseases.

5. Radiographic Techniques of the Abdomen & Pelvis

- Plain abdominal radiography.
- Supine and erect abdominal studies.
- Special procedures:
    - Barium meal, barium enema.
    - Intravenous urography (IVU).
    - Hysterosalpingography (HSG).

6. Radiographic Techniques of the Head & Neck

- Skull (AP, lateral, Towne's, Waters' view).
- Paranasal sinuses.
- Orbit, mandible, TM joint.
- Cervical spine and soft tissue neck.

7. Contrast Radiographic Techniques

- Contrast media: types, preparation, precautions.
- GI tract: barium swallow, barium meal follow-through.
- Urinary system: IVU, retrograde pyelography.
- Biliary system: cholecystography (overview).
- Gynecological studies (HSG).

8. Advanced Radiographic Techniques

- Fluoroscopy: principles and diagnostic applications.
- CT basics in diagnostic radiography.
- MRI overview in musculoskeletal and neuroimaging.

- Ultrasound overview for abdomen and pelvis.

9. Radiographic Pathology & Diagnostic Correlation

- Recognition of normal vs abnormal radiographs.
- Common pathological conditions detectable on X-ray:
  - Bone fractures, dislocations, arthritis, bone tumors.
  - Pneumonia, tuberculosis, pleural effusion, lung cancer.
  - Intestinal obstruction, renal calculi, gallstones.
- Case-based interpretation exercises (technician level).

10. Radiation Safety in Diagnostic Radiography

- Application of ALARA in diagnostic imaging.
- Dose optimization for skeletal, chest, abdominal, and pediatric studies.
- Patient shielding and exposure minimization.
- Technician safety protocols.

11. Documentation & Quality Assurance

- Recording patient details, exposure factors, and positioning.
- Maintaining logbooks for diagnostic radiology procedures.
- Quality assurance in radiographic imaging.
- Ethical and legal considerations in diagnostic imaging.

PRACTICAL

➢ Equipment Orientation

1. Identification of parts of X-ray machine (tube, collimator, control panel, Bucky, grids).
2. Handling of cassettes, screens, CR/DR plates.
3. Use of positioning aids: sponges, straps, immobilizers.
4. Calibration and safety checks before use.

➢ Patient Care & Preparation

5. Patient identity verification and explanation of procedure.
6. Preparation for skeletal, chest, abdominal, and contrast studies.
7. Demonstration of immobilization techniques.
8. Use of lead shielding for patient protection.

➢ Skeletal Radiography Practicals

9. Positioning for upper limb radiographs: hand, wrist, forearm, elbow, humerus, shoulder.

10. Positioning for lower limb radiographs: foot, ankle, knee, femur, pelvis, hip.
11. Positioning for spine radiographs: cervical, thoracic, lumbar, sacrum, coccyx.
12. Skull radiographs: AP, lateral, Towne's, Waters' views.

- **Thoracic Radiography Practicals**

13. Chest radiographs: PA, lateral, oblique.
14. Special chest views: lordotic, expiratory, decubitus.
15. Demonstration of portable/ICU chest X-rays.

- **Abdominal & Pelvic Radiography Practicals**

16. Supine and erect abdominal X-rays.
17. Positioning for urinary tract studies (IVU, retrograde pyelography – demo).
18. Gynecological study (HSG – demonstration).

- **Contrast Study Practicals**

19. Preparation and safe handling of contrast media.
20. Demonstration of barium swallow and barium meal positioning.
21. Barium enema patient preparation and positioning.
22. Observation of contrast flow in fluoroscopy.

- **Advanced Radiography (Observation/Demonstration)**

23. Fluoroscopy positioning and patient safety measures.
24. CT basic positioning for head, chest, abdomen.
25. MRI positioning demonstration (if available).
26. Ultrasound preparation and patient positioning.

- **Radiographic Pathology Identification**

27. Recognition of fractures and dislocations on radiographs.
28. Identifying chest abnormalities: pneumonia, TB, pleural effusion.
29. Recognition of urinary calculi and intestinal obstruction.
30. Case-based exercises: differentiating normal vs abnormal films.

- **Radiation Safety in Practice**

31. Demonstration of ALARA principle during routine and special radiography.
32. Use of collimators, filters, grids for dose reduction.
33. Proper use of personal protective equipment (PPE).

- **Documentation & Logbook**

34. Recording exposure factors for each study.

35. Maintaining radiographic procedure logbook.
36. Proper film/digital image labelling and PACS entry.

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