



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)

THEORYs

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.

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.

4. 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.

5. 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.