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.