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

SEMESTER – I

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

BASIC HUMAN ANATOMY & PHYSIOLOGY

THEORY

1. Introduction

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

2. Cells and Tissues

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

3. Skeletal System

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

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

4. Muscular System

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

5. Circulatory System

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

6. Blood and Lymphatic System

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

7. Respiratory System

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

8. Digestive System

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

9. Nervous System

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

10. Endocrine System

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

11. Urinary System

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

12. Reproductive System

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

13. Special Senses

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

PRACTICAL

➢ Study of Anatomical Models

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

➢ Identification of Organs & Systems (Models/Specimens)

- Heart (external & internal features)

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

➢ Histology Practical (Microscopy)

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

➢ Blood & Circulatory System Experiments

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

➢ Respiratory System Practical

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

➢ Nervous System Practical

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

➢ Charts, Diagrams & Flowcharts

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

INTRODUCTION TO HEALTH CARE SYSTEM & PATIENT CARE

THEORY

1 – Overview of Health Care System

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

2 – Roles & Responsibilities of Health Care Professionals

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

3 – Hospital Departments & Interactions

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

4 – Patient Care Fundamentals

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

5 – Patient Preparation for Imaging

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

6 – Safety in Patient Care

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

7 – First Aid & Emergency Care in Imaging Department

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

8 – Ethical & Legal Aspects

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

PRACTICAL

➢ Orientation to Hospital & Radiology Department

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

➢ Patient Identification & Communication

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

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

➢ **Patient Positioning & Transfer**

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

➢ **Patient Preparation for Imaging**

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

➢ **First Aid & Emergency Response**

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

➢ **Infection Control Practices**

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

➢ **Radiation Protection for Patient**

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

➢ **Documentation & Record Maintenance**

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

➢ **Case Discussions & Simulations**

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

BASIC PHYSICS & RADIATION PHYSICS

THEORY

1 – Fundamentals of Physics

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

2 – Mechanics

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

3 – Heat & Thermodynamics

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

4 – Light & Optics

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

5 – Sound & Ultrasound Physics

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

6 – Electricity & Magnetism

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

7 – Electromagnetic Waves

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

8 – Fundamentals of Radiation Physics

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

9 – Interaction of Radiation with Matter

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

10 – Radiation Units & Measurement

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

11 – Biological Effects of Radiation

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

12 – Radiation Protection

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

13 – Quality Assurance in Radiation

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

PRACTICAL

- **Units, Measurement & Basic Instruments**

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

- **Mechanics Practical**

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

- **Heat & Temperature**

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

- **Light & Optics**

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

- **Sound & Ultrasound**

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

- **Electricity & Magnetism**

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

- **Electromagnetic Waves**

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

- **Radiation Physics Demonstrations**

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

- **Interaction of Radiation with Matter**

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

- **Radiation Measurement & Safety**

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

- **Quality Control in Imaging**

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

➢ **12. Record Work**

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

INTRODUCTION TO RADIOGRAPHY

THEORY

1 – History & Development of Radiography

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

2 – Basics of Radiography

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

3 – X-ray Production & Properties

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

4 – Components of Radiographic Equipment

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

5 – Image Formation & Quality

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

6 – Radiographic Films & Processing

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

7 – Basics of Digital Radiography

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

8 – Radiation Protection in Radiography

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

9 – Patient Care in Radiography

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

10 – Legal & Ethical Aspects

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

PRACTICAL

- **Familiarization with Radiography Department**

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

➢ **Radiographic Equipment Handling**

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

➢ **Image Receptor Handling**

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

➢ **Basic Patient Positioning & Preparation**

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

➢ **Film Processing & Image Evaluation**

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

➢ **Basic Digital Radiography Operations**

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

➢ **Radiation Protection Practices**

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

➢ **Patient Care Skills in Radiography**

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

➢ **Maintenance & Quality Checks**

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

➢ **Practical Record & Assessment**

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