

Revised Syllabus
For
D.X.T.
Diploma in X-Ray Technician



**LAL BAHADUR SHASTRI HEALTH SCIENCES
AND TECHNICAL COUNCIL, INDIA**

लाल बहादुर शास्त्री आरोग्य विज्ञान एवं प्राविधिक परिषद, भारत

मुख्य कार्यालय : 4वीं मंजिल, प्राइम प्लाजा, इंदरा नगर, लखनऊ

प्रशासनिक कार्यालय : द्वितीय तल, सुनील कम्पलेक्स, वेस्टर्न कचेरी रोड, मेरठ

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Exam :March and Aprail
(To be implemented from 2026-27 session)

Syllabus Of “D.X.T. ” Diploma in X-Ray Technician

First Year (1st Year)

S.NO	Subject	Distribution Of Mark			
		TH	PR	Viva -Voce	Total
DXT-101	Anatomy and Physiology	100	-	-	100
DXT-102	General Radiology Physics	100	-	-	100
DXT-103	Dark Room Techniques	100	-	-	100
DXT-104	Radiation Safety & Protection	100	-	-	100
DXT-105	PRAC I (Dark Room, Radiographic Positioning & Equipment	-	100	-	100
	Total	-	-	-	500

Second Year (2nd Year)

S.NO	Subject	Distribution Of Mark			
		TH	PR	Viva -Voce	Total
DXT-201	Radiodiagnostic Result Correlation	100	-	-	100
DXT-202	Diagnostic Radiography	100	-	-	100
DXT-203	Radiographic Image Acquisition	100	-	-	100
DXT-204	Basic Physics	100	-	-	100
DXT-205	PRAC I (Advanced Diagnostic Radiography, Special Procedures & Viva)	-	100	-	100
	Total	-	-	-	500

First Year (1st Year)

➤ DXT-101 – ANATOMY AND PHYSIOLOGY

Unit 1 – Introduction to Human Body & Radiological Terminology: General anatomical planes (Sagittal, Coronal, Transverse, Oblique), directional terms (Anterior/Posterior, Medial/Lateral, Proximal/Distal, Cephalic/Caudal), body cavities, quadrants, and surface radiological landmarks.

Unit 2 – Osteology of Axial Skeleton (Radiographic Anatomy): Anatomy and radiological features of Skull (Cranial bones, Facial bones, Paranasal sinuses, Orbit, Mandible, Foramina), Vertebral column (Cervical, Thoracic, Lumbar, Sacrum, Coccyx, Intervertebral discs, Curvatures), and Bony Thorax (Sternum, Ribs, Costal cartilages).

Unit 3 – Osteology of Appendicular Skeleton: Upper Extremity: Clavicle, Scapula, Humerus, Radius, Ulna, Carpal bones, Metacarpals, Phalanges, Shoulder and Elbow joints; Lower Extremity: Pelvic girdle (Ilium, Ischium, Pubis, Acetabulum), Femur, Patella, Tibia, Fibula, Tarsals, Metatarsals, Phalanges, Hip, Knee, and Ankle joints.

Unit 4 – Arthrology & Radiographic Joint Spaces: Classification of joints (Fibrous, Cartilaginous, Synovial); Structure of synovial joints (Articular cartilage, Capsule, Synovial membrane, Ligaments, Menisci); Normal radiographic joint space appearance and alignment.

Unit 5 – Respiratory System & Chest Radiography Anatomy: Anatomy of Upper and Lower Respiratory Tracts: Nasal cavity, Pharynx, Larynx, Trachea, Carina, Bronchi, Bronchopulmonary segments, Lungs (Lobes, Fissures), Alveoli, Pleura, Costophrenic and Cardiophrenic angles, Hilum, and Mediastinal compartments.

Unit 6 – Cardiovascular System & Mediastinum: Anatomy of Heart (Chambers, Valves, Great vessels), Pericardium, Systemic and Pulmonary circulations; Normal Cardiothoracic Ratio (CTR) on Posteroanterior (PA) chest radiographs; Coronary and Peripheral vascular system overview.

Unit 7 – Gastrointestinal & Hepatobiliary System: Anatomy of Oral cavity, Pharynx, Oesophagus (constrictions), Stomach (Cardia, Fundus, Body, Pylorus, Rugae), Small Intestine (Duodenum, Jejunum, Ileum, mucosal folds), Large Intestine (Caecum, Appendix, Colon, Rectum, Haustrations); Liver, Gallbladder, Biliary tree, Pancreas, and Spleen.

Unit 8 – Urinary (Excretory) System: Gross anatomy, relations, and radiological landmarks of Kidneys (Cortex, Medulla, Calyces, Renal pelvis), Ureters (physiological constrictions), Urinary Bladder, and Urethra (Male and Female).

Unit 9 – Central Nervous System & Special Senses: Overview of Brain (Cerebrum, Cerebellum, Brainstem, Ventricles, Sella Turcica), Spinal cord, Meninges, Cerebrospinal fluid (CSF) flow; Radiographic anatomy of Internal Auditory Meatus (IAM), Mastoid air cells, and Optic foramen.

Unit 10 – Basic Physiology & Systemic Homeostasis: Overview of respiration mechanics, cardiac cycle, blood pressure, urine formation (GFR), body fluid balance, and temperature regulation.

➤ **DXT-102 – GENERAL RADIOLOGY PHYSICS**

Unit 1 – Fundamentals of Atomic & Radiation Physics: Structure of atom, Bohr's atomic model, Electron shells, Energy levels, Binding energy, Ionization, Excitation, Particulate vs Non-particulate radiation, Electromagnetic spectrum, Properties of X-rays and Gamma rays.

Unit 2 – Production of X-Rays: History of X-ray discovery (Wilhelm Conrad Röntgen); Mechanism of X-ray generation: Bremsstrahlung (Braking radiation) and Characteristic radiation; Factors affecting X-ray emission spectrum (kVp, mA, Exposure time, Filtration, Target material).

Unit 3 – Construction of Modern X-Ray Tube: Stationary vs Rotating Anode X-ray tubes; Components: Cathode assembly (Filament, Focusing cup, Space charge effect), Anode assembly (Tungsten-Rhenium target, Molybdenum stem, Copper rotor), Line Focus Principle (Actual vs Effective focal spot), Anode Heel Effect and its clinical application, Tube housing, Insulating oil, and Stator mechanism.

Unit 4 – Thermal Properties & Rating Charts of X-Ray Tube: Heat units (HU) calculation (Single-phase, Three-phase, High-frequency generators); Tube rating charts, Anode cooling charts, Housing cooling charts; Methods of tube cooling and prolonging X-ray tube lifespan.

Unit 5 – Interaction of X-Rays with Matter: Coherent / Classical scattering (Rayleigh & Thomson), Photoelectric absorption (K-edge, photoelectrons, characteristic secondary X-rays), Compton scattering (scattered photon, recoil electron, angle of scatter), Pair production, and Photodisintegration; Impact on radiographic image contrast and patient dose.

Unit 6 – Attenuation, Absorption & Filtration: Exponential attenuation of X-rays, Linear and Mass attenuation coefficients, Half Value Layer (HVL) and Tenth Value Layer (TVL); Inherent and Added filtration, Total filtration requirements (AERB standards), Compensating filters (Wedge, Trough filters).

Unit 7 – Beam Limiting Devices & Scatter Reduction: Genesis and hazards of scattered radiation; Beam restricting devices: Aperture diaphragms, Cones, Cylinders, Variable-aperture optical Collimators (Collimator light-beam alignment testing); Air-gap technique.

Unit 8 – Radiographic Grids: Construction of grids (Lead strips, Interspace material - Aluminum/Carbon fiber); Grid ratio, Grid frequency, Lead content; Types of grids: Linear parallel, Focused, Crossed, Stationary vs Moving grids (Potter-Bucky diaphragm / Oscillating mechanism); Grid cut-off (Off-level, Off-center, Off-focus, Upside-down errors), and Bucky factor.

Unit 9 – Fundamental Radiographic Exposure Factors: Tube Potential (kVp) and image contrast/penetration; Tube Current (mA), Exposure Time (s), and Milliampere-seconds (mAs) relationship with optical density/receptor exposure; Inverse Square Law and Distance

calculations (Source-to-Image Distance / SID, Source-to-Skin Distance / SSD, Object-to-Image Distance / OID); 15% rule.

Unit 10 – Basic Electrical Principles of X-Ray Generators: Single-phase generators (Half-wave and Full-wave rectification), Three-phase generators (6-pulse and 12-pulse), High-Frequency generators (Inverter technology, Ripple factor comparison), Capacitance discharge and Battery-operated Mobile X-ray units.

➤ **DXT-103 – DARK ROOM TECHNIQUES**

Unit 1 – Layout & Design of Radiographic Dark Room: Location, Size, Floor and Wall materials (Radiation shielding, Chemical resistance), Ventilation (Exhaust systems, Temperature & Humidity control), Light-tightness testing (Coin test), Entrances (Single door, Double door, Maze / Labyrinth, Revolving door), Dry bench vs Wet bench zoning.

Unit 2 – Dark Room Illumination & Safelighting: Direct and Indirect Safelights; Safelight filters (Kodak Wratten 6B for Blue-sensitive film, Kodak GBX-2 for Green-sensitive film, LED safelights); Safe bulb wattage (15W), Distance (minimum 4 feet / 1.2 m), and Safelight fog testing.

Unit 3 – Structure & Composition of Radiographic Films: Base material (Polyester base, Subbing layer), Emulsion layer (Gelatin, Silver Halide micro-crystals - Silver Bromide & Silver Iodide), Supercoat / Protective layer; Single-coated vs Double-coated films; Spectral sensitivity (Monochromatic, Orthochromatic, Panchromatic films), Film speed, Latitude, and Resolution.

Unit 4 – Radiographic Cassettes & Intensifying Screens: Structure and functions of Cassettes (Front and Back construction, Pressure pad, Lead foil backing); Structure of Intensifying Screens (Base, Reflective layer, Phosphor layer - Calcium Tungstate, Rare Earth phosphors like Gadolinium Oxysulfide / Lanthanum Oxybromide, Protective coat); Luminescence (Fluorescence vs Phosphorescence), Screen speed, Quantum Mottle, Cassette-Screen contact testing (Wire mesh test).

Unit 5 – Chemistry of Manual Film Processing (Developing): Mechanism of latent image formation (Gurney-Mott theory); Developing agents (Phenidone-Hydroquinone / Metol-Hydroquinone), Activator / Accelerator (Sodium carbonate/hydroxide), Preservative (Sodium sulfite), Restrainer (Potassium bromide); Time-Temperature method of development, Replenishment of developer solution.

Unit 6 – Chemistry of Rinsing, Fixing, Washing & Drying: Rinse bath / Stop bath; Fixing chemistry: Clearing agent (Ammonium thiosulfate / Sodium thiosulfate), Acidifier (Acetic acid), Hardening agent (Potassium alum), Preservative; Final washing (Running water tank, Hypo retention test); Drying cabinets (Warm filtered air drying).

Unit 7 – Automatic Film Processors (AFP): Working principles and sub-systems of roller automatic processors: Transport roller rack system, Temperature control and circulation system, Replenishment system (microswitches / infrared sensors), Dryer blower system, Daily maintenance and cleaning cycles.

Unit 8 – Film Handling, Storage & Silver Recovery: Unexposed film storage (Temperature < 20°C, Humidity 30-50%, Vertical orientation, Radiation protection); Expiry date monitoring; Chemical effluent handling; Silver recovery methods from exhausted fixer and discarded films (Electrolytic silver recovery, Metallic replacement / Steel wool cartridges, Chemical precipitation).

Unit 9 – Radiographic Film Artifacts & Troubleshooting: Identification, causes, and prevention of Exposure artifacts (Double exposure, Grid cutoff, Motion blur, Jewelry/clothing radiopacities); Processing artifacts (Guide-shoe marks, Pi lines, Roller scratches, Chemical fog, Streaking, Under/over-development); Handling & Storage artifacts (Static electricity tree/crown marks, Crimp marks, Fingerprints, Light leaks, Safelight fog).

Unit 10 – Daylight Processing & Introduction to Dry Laser Imagers: Daylight loading and unloading systems; Photothermographic and Direct Thermal dry laser printers, Dry film chemistry, DICOM network printing interfaces, Advantages over wet chemical processing.

➤ **DXT-104 – RADIATION SAFETY & PROTECTION**

Unit 1 – Radiation Units & Quantities: Exposure (Roentgen, Coulomb/kg), Absorbed Dose (Rad, Gray - Gy), Equivalent Dose (Rem, Sievert - Sv, Radiation Weighting Factor / W_r), Effective Dose (Tissue Weighting Factor / W_t), Kerma, Air Kerma (Gy), Dose Area Product (DAP / KAP), and Cumulative Dose.

Unit 2 – Biological Effects of Ionizing Radiation: Direct vs Indirect action of radiation, Radiolysis of water, Free radical formation, DNA double-strand breaks; Deterministic effects (Tissue reactions - Erythema, Epilation, Cataract, Hematopoietic syndrome, Dose thresholds) vs Stochastic effects (Radiation-induced carcinogenesis, Genetic mutations, Linear No-Threshold / LNT model).

Unit 3 – Acute Radiation Syndromes (ARS) & In-Utero Effects: Bone marrow (Hematopoietic) syndrome, Gastrointestinal syndrome, Central Nervous System syndrome, LD 50/60 concept; Radiation hazards to embryo/fetus during pre-implantation, organogenesis, and fetal growth stages; 10-Day Rule and 28-Day Rule in female radiography.

Unit 4 – International & National Radiation Protection Bodies: Role, recommendations, and regulatory frameworks of ICRP (International Commission on Radiological Protection), ICRU, UNSCEAR, and AERB (Atomic Energy Regulatory Board, India); The Atomic Energy Act (1962) and Radiation Protection Rules (2004).

Unit 5 – Fundamental Principles of Radiation Protection: System of Radiological Protection: Justification of practice, Optimization of protection (ALARA - As Low As Reasonably Achievable), and Dose Limitation; Cardinal principles of external radiation protection: Time, Distance (Inverse Square Law), and Shielding.

Unit 6 – Dose Limits for Radiation Workers & General Public: AERB / ICRP occupational dose limits for radiation workers (20 mSv/year averaged over 5 consecutive years, with a max of 30 mSv in any single year; Eye lens: 20 mSv/year; Skin & Extremities: 500 mSv/year); Dose limits for pregnant radiation workers (1 mSv to fetus during remainder of pregnancy); Dose limits for general public (1 mSv/year).

Unit 7 – Personnel Radiation Monitoring Devices: Principles, construction, wearing protocols, reading frequency, and limitations of Thermo-Luminescent Dosimeter (TLD badges - $\text{CaSO}_4:\text{Dy}$ discs), Optically Stimulated Luminescent Dosimeters (OSLD - $\text{Al}_2\text{O}_3:\text{C}$), Film badges, Direct-reading Pocket Dosimeters, and Electronic Personal Dosimeters (EPD).

Unit 8 – Radiation Survey & Area Monitoring Instruments: Working principle, calibration, and use of Ionization Chambers, Geiger-Muller (GM) Survey Meters, Scintillation detectors; Performing radiation leakage surveys around X-ray tube housing and scatter surveys in diagnostic installations.

Unit 9 – Structural Shielding Design of X-Ray Rooms: AERB layout guidelines for diagnostic X-ray facilities; Primary protective barriers vs Secondary protective barriers; Lead shielding thickness (minimum 1.5 to 2 mm Lead equivalence), Concrete / Brick wall thickness equivalents, Lead-lined doors, Lead glass observation windows (minimum 1.5 mm to 2 mm Pb equivalent), Warning signs, and Red warning lights outside X-ray room.

Unit 10 – Radiation Protection Devices & Practical Safety Protocols: Personal protective apparel: Lead aprons (0.25 mm and 0.5 mm Pb equivalent), Thyroid shields, Gonadal shields (Shadow shields, Contact shields), Lead gloves, Lead goggles, Mobile lead screens; Patient dose reduction protocols (High kVp - low mAs technique, collimation, filtration, avoiding repeat exposures, pediatric radiation protection).

➤ **DXT-105 – PRACTICAL - I (DARK ROOM, RADIOGRAPHIC POSITIONING & EQUIPMENT)**

Unit 1 – Dark Room Layout, Safelight & Light-Tightness Testing: Demonstration of darkroom light-tightness, conducting Coin test for safelight fog, checking exhaust ventilation, dry bench and wet bench cleanliness.

Unit 2 – Loading & Unloading of Radiographic Cassettes: Aseptic and static-free technique of film loading and unloading in dark room without touching emulsion surfaces or creating crimp marks.

Unit 3 – Chemical Solution Preparation for Manual Processing: Preparation of developer and fixer solutions from liquid concentrates and powders, maintaining specific dilution ratios, temperature measurement using darkroom thermometer.

Unit 4 – Manual Processing & Time-Temperature Development: Performing manual development, stop bath rinsing, fixing, running water washing, and drying of exposed X-ray films; maintenance of replenishment records.

Unit 5 – Automatic Processor Operation & Maintenance: Operating automatic roller X-ray processor, checking bath temperatures (developer 34-35°C), replenishment rates, rack cleaning, and wash tank draining.

Unit 6 – Intensifying Screen Care & Cassette Contact Test: Cleaning intensifying screens with antistatic cleaning fluid; performing Screen-Film Contact Test using wire mesh tool under fluoroscopy/radiography.

Unit 7 – X-Ray Machine Controls & Operation: Powering on X-ray machine, setting exposure parameters (kVp, mA, Exposure time / mAs) on control console, operating Bucky selection switch, tube angle indicator, and collimator light field.

Unit 8 – Patient Positioning for Upper Extremity Radiography: Positioning, centering, and exposure factors for Hand (PA, Oblique), Wrist (PA, Lateral), Forearm (AP, Lateral), Elbow (AP, Lateral), Shoulder (AP External/Internal rotation), and Clavicle.

Unit 9 – Patient Positioning for Lower Extremity Radiography: Positioning, centering, and exposure factors for Foot (AP, Oblique), Ankle (AP, Lateral, Mortise view), Leg / Tibia-Fibula (AP, Lateral), Knee (AP, Lateral, Skyline/Patellar view), and Femur (AP, Lateral).

Unit 10 – Radiation Protection Devices & Practical Logbook: Proper wearing and storage of Lead Aprons, Thyroid shields, Gonadal shielding on patients, TLD badge wearing protocols, and maintenance of daily practical logbook followed by viva-voce.

Second Year (2nd Year)

➤ DXT-201 – RADIODIAGNOSTIC RESULT CORRELATION

Unit 1 – Principles of Radiographic Image Evaluation: Systematic approach to analyzing radiodiagnostic images: Verification of patient demographic details, anatomical markers (R/L), collimation borders, exposure adequacy (penetration & contrast), artifact recognition, and technical quality rating.

Unit 2 – Chest Radiograph Image Correlation & Pathological Findings: Radiological correlation of normal chest anatomy vs common pathologies: Lobar Pneumonia (consolidation, air bronchograms), Pulmonary Tuberculosis (cavitation, apical infiltrates, miliary mottling), Pleural Effusion (meniscus sign, blunting of costophrenic angles), Pneumothorax (hyperlucency, absent lung markings, visceral pleural line), Atelectasis/Collapse, Cardiomegaly (CTR > 50%), and Pulmonary Edema (bat-wing appearance).

Unit 3 – Abdominal Radiograph Image Correlation (Plain & Acute Abdomen): Correlation of normal gas patterns vs pathological findings: Intestinal Obstruction (multiple air-fluid levels, step-ladder pattern on erect view), Pneumoperitoneum / Bowel Perforation (free gas under right dome of diaphragm / crescent sign), Paralytic Ileus, Radio-opaque Gallstones and Urinary calculi (KUB region).

Unit 4 – Skeletal Radiograph Correlation (Trauma & Fractures): Radiological description of bone fractures: Location (epiphysis, metaphysis, diaphysis), Extent (complete, incomplete/greenstick, hairline), Configuration (transverse, oblique, spiral, comminuted, segmental, impacted), Displacement, Angulation, Overriding, Joint Dislocation vs Subluxation; Bone healing phases (callus formation).

Unit 5 – Bone Pathologies & Degenerative Disorders: Radiological signs of Osteoarthritis (joint space narrowing, subchondral sclerosis, osteophytes), Rheumatoid Arthritis

(periarticular osteopenia, marginal erosions), Osteoporosis (cortical thinning, pathological vertebral compression fractures), Osteomyelitis (sequestrum, involucrum), and benign vs malignant bone lesions (Codman's triangle, sunburst periosteal reaction).

Unit 6 – Skull & Paranasal Sinus Radiographic Correlation: Radiological correlation of Cranial fractures (Linear, Depressed skull fractures, Base of skull), Sella turcica enlargement, Paranasal Sinusitis (mucosal thickening, air-fluid levels in maxillary/frontal sinuses on Waters view), and Mandibular fractures.

Unit 7 – Spine Radiograph Correlation & Deformities: Spondylolisthesis (pars interarticularis defect / Scottie dog sign on oblique view), Spondylosis, Intervertebral disc space reduction, Spinal trauma (Wedge compression fractures, Chance fracture, Jefferson & Hangman's fractures), Scoliosis and Kyphosis angles.

Unit 8 – Correlation of Contrast Studies (Barium Investigations): Radiographic evaluation and defect recognition in Barium Swallow (Achalasia cardia - bird's beak sign, Oesophageal carcinoma - apple core / shouldering, Strictures), Barium Meal & Follow-Through (Peptic ulcer, Crohn's disease - string sign), and Barium Enema (Carcinoma colon, Diverticulosis, Ulcerative colitis - lead pipe colon).

Unit 9 – Correlation of Urinary Contrast Studies (IVU & MCU): Evaluation of Intravenous Urography (IVU / IVP): Nephrogram phase, Pyelogram phase, Hydronephrosis grading, Ureteric calculus obstruction, Renal parenchymal mass; Micturating Cystourethrography (MCU): Vesicoureteric Reflux (VUR grades I-V) and Posterior Urethral Valves (PUV).

Unit 10 – Technical Audit & Clinical Correlation Documentation: Maintaining radiodiagnostic image quality audit registers, reporting technical discrepancies, documenting critical radiological findings, preparing structured patient reports, and effective clinical communication with Radiologists and referring Physicians.

➤ **DXT-202 – DIAGNOSTIC RADIOGRAPHY**

Unit 1 – Radiography of the Chest & Thorax: Techniques, positioning, centering, respiration instructions, and exposure parameters for Chest PA, Chest Lateral, Anteroposterior (AP) Supine/Erect, Lateral Decubitus (for fluid/air demonstration), Apical Lordotic view, Sternum (RAO, Lateral), Ribs (AP/PA and Oblique views for upper/lower ribs).

Unit 2 – Radiography of the Abdomen & Pelvis: Plain Abdomen KUB (AP Supine), Abdomen Erect (for air-fluid levels), Left Lateral Decubitus, Pelvis AP, Hip AP and Lateral (Frog-leg lateral / modified Cleaves method), Cross-table lateral hip, and Sacroiliac (SI) joints (AP and Oblique views).

Unit 3 – Radiography of the Vertebral Column (Spine): Cervical Spine: AP, Lateral, Both Obliques, Open-mouth Odontoid / Peg view, Swimmer's view (Cervicothoracic junction), Flexion & Extension dynamic views; Thoracic Spine: AP, Lateral; Lumbar Spine: AP, Lateral, Oblique (for pars interarticularis), L5-S1 spot lateral view; Sacrum & Coccyx (AP and Lateral views).

Unit 4 – Radiography of the Skull & Facial Bones: Skull: AP, PA, True Lateral, Towne's view (30° caudad for occipital bone), Submentovertical (SMV / Base of skull); Facial bones: Waters view (Occipitomental - open/closed mouth), Caldwell view (Occipitofrontal 15°), Lateral facial bones, Zygomatic arches (Jug-handle / SMV view), Nasal bones (Soft tissue lateral), and Mandible (PA, Lateral Oblique 30°).

Unit 5 – Radiography of Paranasal Sinuses (PNS) & Mastoids: PNS: Waters view, Caldwell view, Lateral PNS, SMV view; Mastoids & Temporal bone: Law's view, Schuller's view, Stenvers view, Mayer's view, and Optic Foramen (Rhese view).

Unit 6 – Special Radiographic Contrast Media: Classification of contrast agents: Negative (Air, CO₂) vs Positive contrast (Barium sulfate formulations, Water-soluble iodinated contrast - Ionic like Diatrizoate vs Non-ionic monomer/dimer like Iohexol, Iopamidol, Iodixanol); Osmolality, Viscosity, Toxicity, Adverse reactions (Mild, Moderate, Severe anaphylaxis) and Emergency management protocols (Adrenaline, Antihistamines, Hydrocortisone).

Unit 7 – Gastrointestinal Contrast Procedures: Patient preparation, contrast administration, fluoroscopy spotting, and overhead radiographic projections for Barium Swallow, Barium Meal (Single and Double contrast), Barium Meal Follow-Through (BMFT), Small Bowel Enema (Enteroclysis), and Barium Enema (Single and Double contrast techniques).

Unit 8 – Genitourinary Contrast Procedures: Intravenous Urography (IVU / IVP): Patient preparation (Bowel preparation, fasting, Serum Creatinine check), Control film, Contrast injection, 5-min, 15-min compression, release film, full-bladder and post-void films; Retrograde Pyelography (RGP), Micturating Cystourethrography (MCU), Ascending Urethrography (ASU), and Hysterosalpingography (HSG) technique for female infertility.

Unit 9 – Biliary, Sialography & Fistulography Procedures: T-Tube Cholangiography, Operative Cholangiography, Endoscopic Retrograde Cholangiopancreatography (ERCP assisting); Sialography (Parotid and Submandibular ducts cannulation); Sinography and Fistulography (technique, water-soluble contrast injection, orthogonal projections).

Unit 10 – Mobile / Bedside & Emergency Trauma Radiography: Operation of Mobile X-ray units in Intensive Care Units (ICU), Neonatal ICU (NICU), Coronary Care Units (CCU), and Emergency Trauma wards; Radiation safety during mobile radiography; Operating Theatre C-Arm fluoroscopy assisting during Orthopedic and Urological surgeries.

➤ **DXT-203 – RADIOGRAPHIC IMAGE ACQUISITION**

Unit 1 – Fundamentals of Digital Imaging & Image Characteristics: Analog vs Digital signals, Analog-to-Digital Converter (ADC), Pixel (Picture element), Pixel size, Pixel pitch, Matrix size (512x512, 1024x1024, 2048x2048), Bit depth / Dynamic range, Voxel; Spatial Resolution (Line pairs per mm / lp/mm), Contrast Resolution, Signal-to-Noise Ratio (SNR), Contrast-to-Noise Ratio (CNR), Detective Quantum Efficiency (DQE).

Unit 2 – Computed Radiography (CR) Technology: Components of CR system: Photostimulable Phosphor (PSP) imaging plate structure (Protective coat, Barium

Fluorohalide phosphor doped with Europium - BaFX:Eu²⁺, Reflective layer, Conductive layer, Support base, Barcode backing).

Unit 3 – CR Image Processing & Readout Mechanism: Latent image formation and F-center electron traps in PSP plate; CR Reader scanning mechanism: Red helium-neon / diode laser beam stimulation, Blue-violet photostimulated luminescence (PSL) emission, Optical light guide, Photomultiplier Tube (PMT) / Photodiode, ADC conversion; High-intensity white light erasure cycle; Plate handling and artifact prevention.

Unit 4 – Digital Radiography (DR) - Direct vs Indirect Conversion: Flat Panel Detectors (FPD): Indirect Conversion DR (Scintillator layer - Cesium Iodide / CsI or Gadolinium Oxysulfide / Gd₂O₂S coupled to Amorphous Silicon / a-Si Thin Film Transistor / TFT array or CCD/CMOS sensors); Direct Conversion DR (Amorphous Selenium / a-Se photoconductor directly coupled to TFT array, electrode bias voltage); Comparison of DQE and resolution between CR, Indirect DR, and Direct DR.

Unit 5 – Digital Image Processing & Post-Processing Operations: Pre-processing operations: Flat-fielding, Dark noise correction, Bad pixel correction; Image Processing: Histogram analysis, Volume of Interest (VOI), Look-Up Tables (LUT) application; Post-processing tools: Windowing (Window Width / WW for contrast, Window Level / WL for brightness), Spatial frequency filtering (Edge enhancement, Smoothing), Pan, Zoom, Inversion, Rotation, Measurement tools (Distance, Angle, Cobb angle).

Unit 6 – Exposure Indicators & Dose Management in Digital Radiography: Standardized Exposure Indicators (EI, Target EI / EIT, Deviation Index / DI as per IEC 62494-1); S-number (Fuji), Exposure Index (Carestream/Kodak), IgM (Agfa); Concept of 'Dose Creep' in digital radiography, strategies to optimize exposure parameters and minimize patient dose.

Unit 7 – Picture Archiving & Communication System (PACS) & DICOM: PACS architecture: Image acquisition gateway, PACS core server, Storage archives (SAN, NAS, Cloud storage), Diagnostic reporting workstations; DICOM (Digital Imaging and Communications in Medicine) standard, DICOM header metadata (tags), DICOM services (Store, Query/Retrieve, Modality Worklist, Print).

Unit 8 – Hospital Information System (HIS) & Radiology Information System (RIS): Integration of HIS, RIS, and PACS; Electronic Medical Record (EMR); Modality Worklist Management (MWL), Scheduling, Patient tracking, Billing, Radiologist transcription/voice recognition reporting, HL7 (Health Level Seven) protocol for medical data exchange.

Unit 9 – Quality Assurance (QA) & Quality Control (QC) in Radiography: AERB Quality Assurance protocols for X-ray machines: Congruence of Optical and Radiation field, Beam alignment test, Focal spot size determination (Star pattern, Slit camera, Pinhole), Accuracy of Tube Potential (kVp) and Timer, Linearity of mA stations, Output reproducibility, Half Value Layer (HVL) filtration check, Tube housing radiation leakage test (< 1 mGy/hr at 1 meter).

Unit 10 – Digital Radiography Artifacts & Daily QA Checks: CR/DR specific artifacts: Ghosting / image lag, Dead pixel lines, Software processing errors, Stitching artifacts in whole-spine/long-leg radiography, Moiré pattern artifact (grid-frequency aliasing); Daily and

weekly quality control tests using SMPTE / TG18 test patterns for diagnostic display monitors.

➤ **DXT-204 – BASIC PHYSICS**

Unit 1 – Advanced Electricity & Magnetism in Radiology: Electric charges, Coulomb's law, Potential difference, Capacitance; Magnetic fields, Electromagnetism, Electromagnetic induction (Faraday's law, Lenz's law), Mutual induction, Self-induction; Magnetic circuits and eddy currents.

Unit 2 – Transformers & Autotransformers in X-Ray Circuits: Principles of step-up (high-tension) and step-down (filament) transformers; Transformer turn ratio, Voltage and Current transformations; Energy losses in transformers (Copper loss, Hysteresis loss, Eddy current loss, Laminated core construction); Autotransformer construction and kVp selection.

Unit 3 – High-Voltage Generator Circuits & Rectification: Components of X-ray circuit: Primary low-voltage circuit, Filament circuit, High-voltage secondary circuit; Solid-state semiconductor diodes (P-N junction rectifiers); Half-wave rectification, Full-wave bridge rectification; Voltage waveform ripple: Single-phase (100% ripple), Three-phase 6-pulse (13.5% ripple), Three-phase 12-pulse (3.5% ripple), High-frequency inverter (< 1% ripple).

Unit 4 – Exposure Timers & Automatic Exposure Control (AEC): Electronic exposure timers, mAs timers; Automatic Exposure Control (AEC / Phototiming): Ionization chamber detectors vs Solid-state sensors, Detector chamber selection (Left, Center, Right), Back-up timer safety setting (150-200% of expected mAs or 600 mAs max limit), Density selector controls (+1, +2, -1, -2), Troubleshooting AEC positioning errors.

Unit 5 – Fluoroscopy Physics & Image Intensifier (IITV) Systems: Principles of real-time dynamic fluoroscopy; Image Intensifier Tube construction: Input phosphor (Cesium Iodide / CsI:Na), Photocathode (Photoemission), Electrostatic focusing lenses, Anode, Output phosphor (Zinc Cadmium Sulfide / ZnCdS:Ag); Flux gain, Minification gain, Total Brightness Gain; Multi-field (Magnification) mode and impact on resolution and patient dose; Television camera tube (Vidicon/Plumbicon), CCD sensor, and Flat Panel Fluoroscopy detectors (FPD).

Unit 6 – Digital Fluoroscopy & Digital Subtraction Angiography (DSA): Principles of Digital Subtraction Angiography (DSA); Pre-contrast mask image, Post-contrast image, Real-time logarithmic subtraction; Roadmap mode, Pixel shifting for motion artifact correction, Frame rate selection (frames per second / fps) and pulsed fluoroscopy dose reduction.

Unit 7 – Physics of Mammography: Dedicated Mammography X-ray tube: Molybdenum (Mo) and Rhodium (Rh) targets, Beryllium exit window, K-edge filtration (Mo 0.03mm, Rh 0.025mm) for low-energy characteristic X-rays (17.5 keV and 19.6 keV); Low kVp range (24-32 kVp), Compression paddle benefits (uniform thickness, reduced scatter, motion reduction, lower dose), Heel effect orientation (cathode at chest wall), High-resolution detectors.

Unit 8 – Physics of Computed Tomography (CT) - Overview: Historical development (Godfrey Hounsfield); Generations of CT scanners (1st to 4th generation, Spiral/Helical CT,

Multi-Detector CT / MDCT); Gantry components: High-capacity X-ray tube, Slip-ring technology, Bow-tie filters, Collimators (Pre-patient and Post-patient), Scintillator-photodiode detector arrays; Pitch concept; Hounsfield Units (CT numbers for Water 0, Air -1000, Bone +1000, Fat, Blood).

Unit 9 – Ultrasound & Magnetic Resonance Imaging (MRI) Physics Basics: Ultrasound: Piezoelectric effect, Transducer construction, Sound wave propagation, Acoustic impedance, Reflection, Refraction, Attenuation, A-mode, B-mode, M-mode, Doppler effect; MRI: Nuclear magnetic resonance of Hydrogen protons, Magnetic field strength (Tesla), Radiofrequency (RF) excitation pulse, Larmor frequency, T1 and T2 relaxation mechanisms, Superconducting magnet safety and missile effect precautions.

Unit 10 – Radiation Safety Regulations & AERB Licensing in India: Atomic Energy Regulatory Board (AERB) safety codes for Medical Diagnostic X-ray equipment and installations (AERB/SC/MED-2); e-LORA (e-Licensing of Radiation Applications) portal registration, Layout approval, Equipment procurement permission, Commissioning license, Periodic QA certification (every 2 to 5 years), Appointment of Radiological Safety Officer (RSO), and Decommissioning procedures.

➤ **DXT-205 – PRAC I (ADVANCED DIAGNOSTIC RADIOGRAPHY, SPECIAL PROCEDURES & VIVA)**

Unit 1 – Advanced Skull, Sinuses & Facial Radiography Practice: Positioning, tube angulation, centering, and radiographic execution of Towne's view, Submentovertical (SMV), Waters view (PNS), Caldwell view, Lateral skull, and Mandible oblique views.

Unit 2 – Spine & Thoracic Cage Radiography Practice: Positioning and exposure for Cervical Spine (AP, Lateral, Open-mouth, Swimmer's view), Thoracolumbar spine (AP, Lateral, Obliques for facet joints), Pelvis AP, and Sacroiliac joint views.

Unit 3 – Pediatric Radiographic Techniques & Immobilization: Specialized pediatric immobilization devices (Pigg-O-Stat, sandbags, immobilization bands), radiation dose reduction protocols (gonadal shielding, no-grid technique for infants), pediatric chest and extremity radiography.

Unit 4 – Operation of Computed Radiography (CR) System: Hands-on scanning of exposed PSP plates in CR reader, patient demographic entry on CR console, applying image processing algorithms, windowing, annotations, and sending images to DICOM printer and PACS.

Unit 5 – Operation of Direct Digital Radiography (DR) System: Operating Flat Panel Detector (FPD) DR system, selecting anatomical APR (Anatomically Programmed Radiography) presets, checking Exposure Indicator (EI / DI), applying digital collimation, and post-processing tools.

Unit 6 – Barium Contrast Procedures Assisting (Fluoroscopy): Assisting Radiologist during Barium Swallow, Barium Meal & Follow-Through, Barium Enema; preparation of barium suspensions (high density vs low density), setting up fluoroscopy foot-switch, patient turning maneuvers, and spotting projections.

Unit 7 – Intravenous Urography (IVU / IVP) Hands-On Assisting: Patient pre-procedure verification, assisting during non-ionic contrast injection, operating ureteric compression band, timing and taking timed serial radiographs (5-min, 15-min, post-void), recognizing acute contrast reactions and assisting emergency management.

Unit 8 – Mobile Radiography in ICU / Trauma Ward: Setting up mobile X-ray unit in ICU/Ward, connecting power supply, positioning cassette in plastic cover under critical/intubated patients, wearing lead apron, using long exposure cable (minimum 2 meters) or wireless exposure trigger.

Unit 9 – Quality Assurance (QA) Practical Tests on X-Ray Machine: Conducting Light Beam Collimator alignment test, Vertical beam alignment test using 9-penny test / collimator test tool, checking lead aprons for cracks under fluoroscopy, and evaluating monitor SMPTE test pattern.

Unit 10 – Radiodiagnostic Case Portfolio, Internship Logbook & Grand Viva: Evaluation of documented 50 specialized radiographic case examinations (Routine, Trauma, Pediatric, and Contrast procedures), image evaluation critique with viva-voce examination.