All India Institute of Medical Sciences, Jodhpur

Indicative Syllabus for the Post of Radiographic Technician Grade I

Human Anatomy, Physiology & Pathology relevant to Radiology & Imaging.

1. General structure of the human body, anatomic terminology, planes of section- Structure and function of **human cell** with special reference to mitochondria and ribosomes.

2. Elementary tissues of human body- Epithelial tissue, muscular tissue, connective tissues and nervous tissue.

3. Cardio Vascular System - Anatomy of heart and functions- Structure and functions of various parts of the heart, arterial and venous system, brief account on common cardiovascular disorders. Blood pressure and its recording. Anatomy and function of arteries, capillaries and Arterial system, Venous system.

4. Hematology-Composition of Blood - functions of blood elements –Blood Group and coagulation of blood, disorders of blood.

5. Lymphatic system - Name and function of lymph glands, Lymphatics and Lymphatic pathway outline.

6. Respiratory System: various parts of respiratory system and their functions, Anatomy of upper respiratory tract, Structure and functions of lungs, Anatomy of bronchial tree, Physiology of Respiration.

7. Digestive System - names and various parts of digestive system-Buccal Cavity, Pharynx, Esophagus, Stomach, intestine etc.-physiology of digestion and absorption, Structure functions salivary glands. Enzymes, Structure and functions of pancreas, Anatomy of teeth, Pharynx, Oesophagus, Functions of Stomach and duodenum, Small

& Large intestine structure & functions. Anatomy and function of liver, LFT, Physiology of Jaundice. Anatomy of Portal circulation and portal hypertension. Gall bladder, structure and function, Physiology of digestion and food components.

8. Urinary System: various parts of urinary system and its function-structure and function of kidneys- Anatomy of ureters, bladder and urethra -physiology of urine formation, its constituents- pathophysiology of renal disease and edema.

9. Reproductive System physiology and anatomy of Male & Female reproductive system-Prostate & Uterus & Ovaries etc. The Mammary glands –anatomy & physiology and & its importance in imaging.

10. Musculoskeletal System: Classification of bones & joints, structure of skeleton – structure of skeletal muscle – physiology of muscle contraction, Structure and classification of joints, movements at the joints. Bones & Joints of upper extremity, Bones of thoracic cage, Clavicle and scapula, Joints of shoulder girdle, Bones of pelvis, Bones & Joints of lower extremity, Bones of skull and Fontanelles, Base of skull, Bones of face, Cervical spine and atlanto axial joints, Dorsal spine, Lumbo Sacral spine, Mandible and TM joints, Mastoids and PNS.

11. Eye & ENT: Anatomy of Ear, hearing, vision. Anatomy of eye, Orbits including orbital fissure and optic foramina. Nose, Throat- Elementary knowledge on functions of taste, smell,

12. Nervous System various parts of nervous system- Brain and its parts Divisions of brain and its functions–functions of nervous system - Spinal Cord & Nerves, Cranial nerves, Anatomy of nerves, sensory pathway Spinal cord and spinal nerves. The meninges and ventricles of brain and the CSF.

13. Endocrine System: Endocrine glands, their hormones and functions-Thyroid, Parathyroid, Suprarenal, Pituitary, pituitary and Thymus).

14. Surface Anatomy & Surface Markings of Human Body.

General Physics, Radiation Physics & Physics of Diagnostic Radiology.

1.Physics of Diagnostic Radiology : X-ray Tube: Anode & Cathode - Thermionic diode – X-ray valves and tubes –principle and practical aspects – semiconductors – triode valves – cathode ray oscilloscopes – X-ray circuits – self rectifying circuits – half wave pulsating voltage circuits – full valve pulsating voltage circuits - measurement of high voltage – control of KV circuit – mA circuit. X-ray beam quality.

X-Ray Cassettes & Intensifying screens: Fluorescence – constituents of intensifying screens – types of screens-intensification factors-speed of screen-screen unsharpness. Cassette-construction-types of cassettes- use of fluorescent screen in radiology, effect of screen in reduction of patient dose.

Radiography Equipment, Maintenance and Quality Control

1. Mammography system:

History - Imaging requirements- Mammography system - construction/types accessories - tube, compression, grids, AEC etc.- nature of X-Ray beam suitable

– accessories for immobilization - film processing - image quality - image recording devices - interventional procedures – accessories-biopsy equipment attachments - radiation dose- - mammo tomogram-Sonomammography-future developments.

2. CT scan systems:

History- generations of scanners-CT technology -helical/spiral & multi slice C.T- ultra fast scanners-system components - performance parameters - image quality and methods of image reconstruction- radiation dose measurements and technical aspects of Q.A - calibration and image acquisition

3.MRI Scanners: History - basic physical principle - Physical principles -NMR signals– instrumentation- hard ware-MR system components- magnet system- Magnetic shielding- RF shielding- bioeffects of MRI- site selection and safety -reconstruction system - different coils used -NMR signals advantage -imaging methods – pulse imaging sequences - spectroscopy parameters -calibration and image acquisition - reconstructions- 3D images- - image contrast

– factors affecting image quality - artifacts - difference between CT and MRI images-

host computer -viewing archiving- hard copy - image formation and storage device.

4. Angiography and Cine Studies /DSA

Angiography equipment history –Conventional angiography X-Ray equipment - Equipment construction-principle - DSA system basics - digital techniques -subtraction

process-procedures for subtraction - care, choice and installation of the equipment – equipment, pitfalls and complications -pressure injectors- contrast media -accessories-catheters, guide wires-uses of serial imaging devices- cine camera - video-recorder -film processing-radiation protection.

5. Nuclear Medicine Equipment

Nuclear Physics - basics in Nuclear Medicine- Nuclear medicine equipment - Gamma Cameras- rectilinear scanners- radioisotope generators-SPECT-CT & PET-CT-introduction-basic physics and principle involved- equipment basic structure—differences- fusion techniques- image formation-storage devices– advantages-limitations.

6. Recent Advances in Imaging Systems

Mobile units of Computer Radiography & Digital Radiography system.

3D/4D Sonography systems

128 slice & higher slice C.T equipment

3 Tesla & higher T MRI scanners

Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.

7. Picture Archiving and Communication Systems (PACS)-newer advancements – updates - systems designs-transfer restrictions.

Chest Radiography –Basic views (PA & AP) - inspiratory & expiratory films- special chest views & their significance – larynx- trachea- thoracic inlet -Sternum - Ribs – Heart and great vessels – mediastinum -Diaphragm – double exposure technique.

Abdomen & Pelvic Radiography – all projection – the acute abdomen investigation.

Soft tissue radiography:

Preparations, Instructions, Various techniques, positioning of patient for conventional and differential filtration – digital mammography, High and low KV Technique – multiple Duplication – arrangement of radiography – technique for steep range radiography – intensifying screen.

Contrast & Special Radiography procedures.

Non-contrast Special radiography

1. Paediatric Imaging:

special needs of patient and radiographer- use of dedicated equipment and accessories-modified technical considerations - selection of exposure factors- image quality considerations

– radiation protection of the patient - special techniques in children for contrast studies.

2. Geriatric radiography

Equipment and accessories – exposure factor considerations in special care. Elderly patients profile - difficulties during radiography – technical considerations-projections with unconventional special positioning.

3. Trauma/Emergency Radiography

Selection of suitable X-Ray equipment – patient position -radiographic projections and sequence for each patient – modification of routine positioning– radiation protection – patient care.

Contrast radiography

Radiological contrast media – classification -need for radiological contrast media - methods of administration-dosage-reactions to contrast media- role of radiographer in management of patient with contrast reaction.

For all contrast investigations-patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used and dosage-alternative contrast used-side effects and its identification-treatment of complication during the procedure - pathological conditions- indications and contraindications- injection procedure –techniques for radiographic projections - radiographic appearances– radiation protection

Equipment of modern Imaging Modalities

1. Mammography system:

History - Imaging requirements- Mammography system - construction/types accessories - tube, compression, grids, AEC etc.- nature of X-Ray beam suitable – accessories for immobilization - film processing - image quality - image recording devices - interventional procedures – accessories-biopsy equipment attachments - radiation dose- - mammo tomogram-Sonomammography-future developments.

2. Ultrasonography/ Doppler systems:

Basic acoustics principle- Basic physics of sound propagation in different media, production of Ultrasound (piezoelectric effect), ultrasound terminologies – interaction of ultrasound with matter – ultrasound properties propagation in tissue, absorption, scattering, reflection and refraction- acoustic impedence – piezo electric effect – transducer – Pulsar – receiver – beam/sensitivity and gain - generators- A, B and M scanning & echo modes- transducers-techniques of sonography-equipment selection- display methods – ultrasound image formation - data storage and display – image and artifacts – doppler instrumentation – doppler equation – transducer – quality assurance and performance tests – bio effects and safety considerations. Types of machines –portable systems- acoustic coupling agents-ingredients/preparation.

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History- generations of scanners-CT technology -helical/spiral & multi slice C.T-ultra fast scanners-system components - performance parameters - image quality and methods of image reconstruction- radiation dose measurements and technical aspects of Q.A -calibration and image acquisition

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– factors affecting image quality - artifacts - difference between CT and MRI images- host computer -viewing archiving- hard copy - image formation and storage device.

5.Angiography and Cine Studies /DSA

Angiography equipment history –Conventional angiography X-Ray equipment - Equipment construction-principle - DSA system basics - digital techniques - subtraction process-procedures for subtraction - care, choice and installation of the equipment – equipment, pitfalls and complications -pressure injectors-contrast media -accessories-catheters, guide wires-uses of serial imaging devices-cine camera - video-recorder -film processing-radiation protection.

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Quality Control, Radiobiology and Radiation Safety in Radiology /Imaging.

1. Radiation Quantities and Units

Radiation- Radioactivity- Sources of radiation - natural radioactive sources - cosmic rays-terrestrial radiation - - man made radiation sources. Units of radiation - Quality factor - Flux-Fluence-Kerma- Exposure- Absorbed dose- Equivalent Dose- Weighting Factors-Effective Dose - Occupational Exposure Limits - Dose limits to public.

2. Biological Effects of radiation

Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell -Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus -Somatic effects and hereditary effects- stochastic and deterministic effects-Acute exposure and chronic exposure-LD50 - factors affecting radio-sensitivity. Biological effects of non-ionizing radiation like ultrasound, lasers, IR, UV and magnetic fields.

3. Radiation detection and Measurements: Ionization of gases- Fluorescence and Phosphorescence -Effects on photographic emulsion. Ionization Chambers – proportional counters- G.M counters- scintillation detectors – liquid semiconductor detectors – Gamma ray spectrometer. Measuring systems – free air ionization chamber – thimble ion chamber – condenser chamber – Victorian electrometer – secondary standard dosimeters – film dosimeter – chemical dosimeter- thermoluminescent Dosimeter. -Pocket dosimeter-Radiation survey meter- wide range survey meter -zone monitor-contamination monitor -their principle-function and uses. Advantages & disadvantages of various detectors & its appropriateness of different detectors for different type of radiation measurement.

4. Radiation protection:

Radiation protection of self and patient- Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey –ALARA- personnel dosimeters (TLD and film batches)- occupational exposure.

5. Q.A in Diagnostic Radiology

Quality assurance (Q.A), acceptance testing and quality control tests in Radiology-

Meaning of the terms used and aspects of a QA programme, equipment and staff requirements, benefits of QA procedures in an imaging department –NABH guidelines. Verification of Optical & Radiation field congruence, Beam alignment, Focal spot size, Linearity of tube current mA and Timer, applied potential, HVT and total tube filter, Contact between film and intensifying screen, contrast resolution, Grid alignment, Special techniques like mammography, CT - CT Dose Modulation-Patient dose management.

6. Radiation Hazard evaluation and control

Philosophy of Radiation protection, effects of time, Distance & Shielding. Calculation of Work load, weekly calculated dose to radiation worker & General

public Good work practice in Diagnostic Radiology. Planning consideration for radiology, including Use factor, occupancy factors, and different shielding material.

7. Regulatory Bodies & regulatory Requirements:

International Commission on Radiation Protection (ICRP) / National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements.

8. Role of Radiographer in Planning, QA & Radiation Protection:

Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-Ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines – Planning of X-ray rooms, dark rooms – Inspection of X-Ray installations - Registration of X-Ray equipment installation- Certification -Evaluation of workload versus radiation factors – Occupational exposure and protection Tools/devices.

ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection.