All India Institute of Medical Sciences, Jodhpur

Indicative Syllabus for the Post of Radiographic Technician Grade – I

(Syllabus is only indicative. The questions can assess any aspect of knowledge, aptitude, attitude and practical skills, which is expected from a trained person to work efficiently at the advertised post)

Section A

40% Questions covering the following topics:-

General Intelligence & Reasoning: It would include questions of non-verbal type. The test will include questions on similarities and differences, space visualization, problem solving, analysis, judgment, decision making, visual memory, discriminating observation, relationship concepts, figure classification, arithmetical number series, non-verbal series etc. The test will also include questions designed to test the candidate's abilities to deal with abstract ideas and symbols and their relationship, arithmetical computation and other analytical functions.

Quantitative Aptitude: This paper will include questions on problems relating to Number Systems, Computation of Whole Numbers, Decimals and Fractions and relationship between Numbers, Fundamental arithmetical operations, Percentages, Ratio and Proportion, Averages, Interest, Profit and Loss, Discount, use of Tables and Graphs, Mensuration, Time and Distance, Ratio and Time, Time and Work, etc.

Computer Knowledge: Candidates' understanding of the Basics of Computer Knowledge, its parts, functions, emails, MS office, etc.

Section B (SUBJECT KNOWLEDGE)

60% Questions to be based on the subject specific to the post with following topics:-

BRIEF SUBJECT TITLES TO BE COVERED

	Main Subjects	Ancillary Subjects
1	Human Anatomy, Physiology and Pathology relevant to Radiology.	Patient care and Medical Ethics
2	General physics, Radiation Physics and Physics of Diagnostic Radiology.	Principles of Medical Emergencies
3	Radio diagnostic Equipment, Maintenance and Quality Control	
4	Clinical Radiography	
5	X-ray Film/ image processing Techniques including introduction to Dark Room Techniques	
6	Contrast and special Radiology procedures	
7	Equipment of modern imaging Modalities	
8	Modern imaging Techniques and Recent Trends in imaging	
9	Quality control, Radiobiology and Radiation Safety in Radio diagnosis /Imaging	

RECRUITMENT CELL - EXAM AIIMS JODHPUR

Basic Human Anatomy relevant to Radiology & Imaging.

1. **General structure** of the human body, anatomic terminology, planes of section.
2. **Surface Anatomy & Surface Markings of Human Body.**

General Physics, Radiation Physics & Physics of Diagnostic Radiology.

1. **Basic concepts:** Basic Units, Heat, Acoustics etc. Basic concepts of power, work, force, energy - Einstein's formula - Electronics, Electricity & Magnetism, -electromagnetic waves - Units and measurements - temperature and heat-SI units of above parameters-Atomic structure- Nucleus - Atomic Number, Mass Number electron orbit and energy levels-Periodic table -Isotopes-Isobars-Ionisation and excitation.
2. **Electromagnetic induction:** Electric charges-electric induction - electric potential-capacitance and capacitors. Electrical energy and power - unit of current-resistance and Ohm's law - circuit laws - heating effect of current - sources of electrical energy - e.m.f. Magnetism-Magnetic effect of an electric current - applications of magnetic field. Electro-magnetic induction, laws of mutual induction and self-induction. Alternating current-transformers theory and losses - practical aspects-reactance –resonance - impedance and power factors.
3. **X-Rays:** Electromagnetic waves - quantum theory of radiation - visible light - fluorescence. X-Rays – properties and production of x-rays –- interaction of electrons with target-spectra of x-rays – the quality and intensity of x-rays – the factors such as Filters, applied voltage affecting quality and intensity-Characteristics X-Rays - factors affecting X-Ray-emission spectra - X-ray Quantity and quality – measurements -heel effect - soft and hard X-Rays - added and inherent filtration - reflection and transmission.
4. **X-Ray Circuits:** Thermionic diode - X-ray valves and tubes -principle and practical aspects - Semiconductors and semiconductor devices-Introduction, energy bands in solids, the semiconductor types, charge carriers and conductivity, p-n junction diode as rectifier, junction transistor -logic gates. – triode valves – cathode ray oscilloscopes. Self-rectifying circuits – Half wave pulsating voltage circuits – full wave pulsating voltage circuits – constant potential circuits – measurement of high voltage – control of KV circuit – MA circuit.-KvP-mA-mAS-HU.
5. **Radioactivity:** Natural and artificial radioactivity-alpha decay-beta decay and spectra – gamma emission-positron decay electron capture and internal conversion-Exponential decay-Half life-Unit of activity-specific activity. Nuclear Fission-Nuclear reactor. Radiation sources-Natural and artificial-production of radio isotopes-reactor produced isotopes-Fission products-Gamma ray source for Medical uses. .

6. **Interaction of X-and Gamma rays:** Attenuation of X-ray or Gamma rays-absorption and scattering-half value layer-coherent scattering-Photo electric absorption-compton scattering-pair production and photoelectric disintegration. X-Ray transmission through medium-linear and mass attenuation coefficients. HVT - TVT and interaction of charged particle and neutrons with matter. Interaction of X-and Gamma rays in body-fat-soft-tissue-bone-contrast medium-Total attenuation coefficient. Relative important of different types of interactions.

7. **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 generators and circuits-Filament current and voltage, X-Ray circuits -primary circuit-auto transformer-switch and timers- principle of automatic exposure control and practical operation - filament circuit -high voltage circuits - half wave & full wave rectification –three phase circuits. Types of generators, 3 phase, 6 and 12 pulse circuits- falling load generators-capacitors discharge and grid control systems.

X-Ray Grids /Bucky

Scattered Radiation -Significance of scatter – Beam limiting devices.-Grid principle and structure – Types of Grids - vertical bucky- versatile bucky -Stationary grid, parallel grid, focused grid – crossed grid, moving grid – Potter Bucky Diaphragm- Control of scattered radiation and grids/Bucky - Methods of minimizing formation of scatter radiation, types of grids and grid ratio-use of cones – diaphragm/ light beam devices - effectiveness of collimation - limitations of the primary beam/the light beam diaphargm -Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.

X-Ray Casettes & 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. **X-ray machines** – X-Ray tube: historical aspects - early X-Ray tubes (coolidge tubes) - construction of X-Ray tubes, requirements for X-Ray production (electron source, target and anode material), anode angulation and rotating tubes- tube voltage, current - space charge - tube envelop and housing - cathode assembly, X-Ray production efficiency, advances in X-Ray tubes, Common factors affecting thermionic emission -specialized types- grid controlled and high speed tubes. Inherent filtration, radiation leakage and scattered radiation. Heat dissipation methods-

Interlocking and X-Ray tube overload protection -tube rating, heat units - operating conditions, maintenance and Q.A procedures.

2. **Portable/Mobile X-ray units-** Equipment for mobile radiography-principle- uses- mobile image intensifiers– Capacitor discharge unit- advantages and limitations -positioning differences-skill in using mobile units - - radiation protection.- mobile units types-differences-Cordless mobiles-selection of equipment.
3. **Fluoroscopy:** Fluoroscopic equipment-Direct fluoroscopy – The serial changer (spot film device) - Fluoroscopic screen -fluoroscopic image -factors affecting the Fluoroscopic image. Image intensifier tubes – principle construction and function regarding intensified image- cine flurography-mode of operation - Types of day light film handling system-optical coupling and methods of viewing-Automatic brightness control- tilting tables - over and under couch tubes-safety features. The television process – television camera tube– the Cathode ray tube – television image-CCTV. Quality assurance tests for fluoroscopic equipment.
4. **Computed Radiography (C.R)** –equipment parts –advances- principle of imaging – applications-advantages & disadvantages.
5. **Digital Radiography**– principle - photostimulable phosphors-image acquisition-digital spot imaging - equipment parts –advances-imaging– advantages & disadvantages. Picture characteristics - archiving possibilities-transfer system and designs- Image recording devices-laser imager and multiformatter-Future developments.
6. **Mammography** -basic principle, equipment & image acquisition-conventional & digital mammo studies- Mammotomogram.
7. **Dental Radiography –** Equipment Basics –types of equipments- Intra oral radiography unit-orthopantomograph unit -imaging techniques- Dental films-film types and processing.
8. **Tomography:** Theory of tomography – multi section radiography- Tomography equipment-Basic requirements and controls, attachments.

   Computed tomography – Scanning principle – Reconstruction of image – storing the image – viewing the image – evaluation of the image. Types of movements and applications-Effect on image of variation in focus object distance-Object film distance, exposure angle, and tube movement pattern.
9. **Computed Tomography-** Basic physics – Tomography principle - detectors technology-digital fundamentals- Basic data acquisition concepts -Scanning principle - basics of plain studies- Image reconstruction- artifacts- contrast studies,-special procedures – image quality-storing the image – viewing the image – evaluation of the image- Equipment for computed tomography – Table, scanning gantry X-Ray generator – CT control console. Scanner types - technologic considerations of sequential /spiral volume zoom -computer hardware of software– CT computer and image processing system- Options and accessories for CT systems.-Tools for use in CT guided Interventional procedures-Dosimetry- Future developments.

Clinical Radiography

- **Techniques, Preparations, Instructions, Positioning of patient for conventional and digital radiography in the imaging of following-**

Conventional Non contrast radiography-

Extremities Radiography – Hand- Finger –MCP- Wrist joint- Forearm -Elbow joint – humerus - shoulder joint. Foot – Toes- Tarsal bones -Ankle joint - Knee joint – patella – tibia- femur – Hip joint – pelvis - sacroiliac joint.

Spine Radiography -Vertebral column – Atlanta occipital articulation- cervical spine- dorsal spine - lumbar spine – sacrum -vertebral canal- vertebral foramen.

Skull Radiography – general, Sella – temporal bone – mastoid – optic foramen – Internal auditory canal – Superior and inferior orbital fissure – base of skull – facial bones – petrous apex – Zygomatic bone, nasal bone, sinuses of skull – mandible – Tempro-mandibular joint – Paranasal sinuses Radiography.

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.

Macro radiography: Principle sizes of focal spot its limitation in its application.

High kev technique: technique & usefulness.

Foreign body localization: Preparation – Anatomical localization – various projections – use of skin markers – Tangential projection – uses – opaque – foreign bodies.

Dental radiography-types of equipment –techniques- indications-films-dental radiography in trauma patients.

X-ray Film / Image processing Techniques (CR/DR)

Computed Radiography and Digital Radiograph

Principles of CR and DR based systems.
Practical issues and solutions for portable use of CR in trauma and emergency setting (primary survey and secondary survey).

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.

4. Operation theatre radiography

O.T procedures-Operative cholangiography – orthopaedic procedures –maintenance of asepsis – preparation of radiographer and equipment/accessories – careful safe use of mobile and fluoroscopic equipment – radiation protection – patient care – rapid availability of radiographic image-cooperation with OT staff-type of studies done -clinical applications - per operative radiographs- peroperative fluoroscopy studies -patient care-radiation protection of all staff.

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.

5. Sialogram

6. Barium studies- different types – Barium swallow Barium meal study of upper GIT, Barium meal follow through, Barium enema, small bowel enema, distal colography, defaecography.

7. IVP, Cystogram, Anterior Urethrogram RGU, MCU, RGP

8. **Angiography, Diagnostic & therapeutic, venography, Lymphangiogram**
9. **Hysterosalphingography.**
10. **Sinography.**
11. **Fistulogram,**
12. **Ductogram.**

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.

3. 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.

4. MRI Scanners: History - basic physical principle - Physical principles -NMR signals– instrumentation-hard ware-MR system components- magnet system- Magnetic shielding- RF shielding- bio effects 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

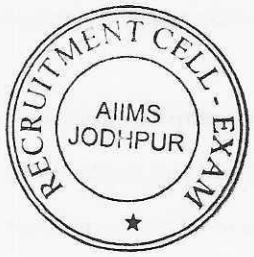
– Factors affecting image quality - artifacts - difference between CT and MRI images- host computer - viewing archiving- hard copy - image formation and storage device.

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.

6. 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.



7. Recent Advances in Imaging Systems

Mobile units of Computer Radiography & Digital Radiography system.

128 slice & higher slice C.T equipment.

3 Tesla MRI scanners.

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

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

Quality Control, Radiobiology and Radiation Safety in Radiodiagnosis /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

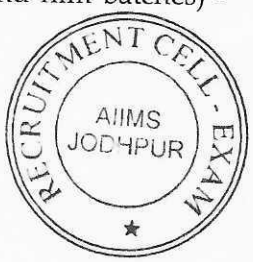
Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell - Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute

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.