



Notes :

- *The total syllabus is divided into 11 units. Of these Unit 1-5 are covered in paper I and Units 1- 6 in paper II.*
- *Distribution of marks has been made based on the relative importance of each topic in regular work.*
- *The subjects in Paper I comprises of basic subjects and basic Radiography*
- *The subjects in paper II comprises of mainly advanced Radiographic procedures and techniques and use of digital technology*
- *Subjects like USG and Color Doppler , Angiographic Techniques etc which are handled mainly by Radiologists themselves and not by Radiographers have been given assigned lesser marks.*

Standard (Recommended) Text book :

- *Text Book of Radiology for Technicians and Residents – Dr.Satish Bhargava*
- *Handbook of Medical Radiography – C.Ramamohan*
- *A guide to Radiological Procedures – Stephen Chapman and Richard Nakielny*
- *Human Anatomy – B.D.Chaurasia*
- *Basic Anatomy and Physiology – Ross and Wilson*

## **DETAILED SYLLABUS**

### **TECHNICAL PAPER – I (150 MARKS)**

- **Unit 1 HumanAnatomy 40 marks**
  - Anatomical positions, terms,description,basic embryology and development
  - Musculo –skeletal system, bones, joints, types of joints, muscles, types of muscles, vertebral column, upper and lower limbs
  - Cardio-vascular system including heart, major blood vessels, arteries, veins, capillaries,lymphatics
  - Respiratory system including the lungs, trachea, bronchus, broncho-pulmonary segments,alveoli, arterial supply, venous drainage, pulmonary circulation etc
  - Central Nervous system including the brain, spinal cord, central and peripheral nervous system, brachial plexus, sacral plexus,cranial nerves.
  - Head and neck including the skull, external ear, middle ear, inner ear, temporal bone, paranasal sinuses, pharynx , larynx, oral cavity, face, tongue, nasal cavity , eyes .
  - Gastro-Intestinal tract including the Esophagus, Stomach,Small Intestine – Duodenum , Jejunum, Ileum, Cecum, appendix, Large intestine – Ascending , Transverse, Descending colon, Hepatic and Splenic flexures, Sigmoid Colon, Rectum and anal canal
  - Hepato-Biliary system including the Liver, Gall Bladder, Biliary tree, Pancreas, Spleen.
  - Genito-Urinary system – including Kidneys, Ureters, Urinary Bladder, Urethra, Male and Female reproductive system including testes, prostete, seminal vesicles, uterus,cervix, fallopian tubes, ovaries, penis,vagina,vulva.
  - Endocrine system including the Endocrine glands like Pituitary, Thyroid, Adrenal,Parathyroid.

- **Unit 2 Basic Physiology** **20 marks**
  - Functional organization of body structures, musculo-skeletal system, skeletal muscles, smooth muscles, blood cells, plasma, blood groups, lymphatics .
  - Physiology of Cardio-vascular system including heart and circulation, blood pressure, arteries ,veins, capillaries
  - Physiology of Respiration including lungs, trachea, bronchus, broncho-pulmonary segments, gas exchange
  - Physiology of excretory system including the structure and functional unit of kidneys , formation and excretion of urine, reasorbtion of water, process of micturition.
  - Male and female reproductive system including the spermatoxoa, oocytes, hormonal changes
  - Physiology of the hepato-biliary system including formation and circulation of bile, portal circulation, porto-systemic anastomosis
  - Physiology of the Gastro-intestinal system including the process of digestion, digestive enzymes, water reasorbtion, formation and excretion of stool, gastro-colic reflexes.
  - Function of the nervous system including autonomic nervous system, CSF, cranial nerves , sensory and motor systems.
  
- **Unit 3 Basic Pathology** **10 marks**
  - Basic pathological conditions, cellular structure, pathogenesis of disease , inflammation, types and definition,. Degeneration, cell death, granulomatous inflammation, healing process
  - Hemodynamic disorders like hemorrhage, ischemia, infarction
  - Hypersensitivity reactions , Infections – bacterial, viral, parasitic, worm infestation
  - Tumours, benign and malignant, common cancers affecting various systems, neoplasia, metastasis, lymphadenopathy.
  
- **Unit 4 Radiation Physics and Protection** **30 marks**
  - X-Ray production and properties: Introduction to X-rays , history, origin, , construction of X-Ray tubes, requirements for X-Ray production (electron source, target and anode material), tube voltage, current, space charge, cathode assembly, efficiency, stationary and rotating tubes, kVp , mAs.
  - Common factors affecting thermionic emission , specialized types , focal spot, target angle Heat dissipation methods, tube rating, heat units, operating conditions, maintenance and Quality assurance procedures.
  - Image and its characteristics: Formation of radiological image, latent image, intensifying screens, factors affecting image quality, quality assurance tests. Factors affecting image quality : radiographic image contrast, density, sharpness, magnification, distortion of image, noise, blur. Scattered radiation, appliances to reduce scattered radiation, grids – stationary and moving, use of cones, diaphragm, light beam devices, collimation .
  - X-ray generators and circuits : Filament current and voltage, primary circuits, auto transformers, types of exposure switch and timers, principle of automatic exposure control (AEC), filament circuit, high voltage circuits, half and 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

- Radioactivity: Structure and property of nucleus, nuclear forces, binding energy, radioactive decay, characteristic X-Ray, charge of radionuclides, alpha, beta, positron, gamma emissions, modes of decay, auger electrons, electron capture, isomeric transitions, internal conversions, naturally occurring radionuclides. Interaction of X-rays with matter, types of interaction of X-rays, gamma radiation, Photoelectric and Compton, Bremsstrahlung, pair production, annihilation radiation
- Radiation Unit Dosimetry and Detection of Ionizing radiation: Units of radiation, SI units, ICRU definition of absorbed dose, quality factor, dose equivalent, relationship between absorbed and equivalent dose, patient dose, occupational exposure, natural and background radiation, population exposure. Basic principles of ionization chamber, proportional counter, GM counters, scintillation detector, thermoluminescent dosimeters (TLD)
- Biological effects of radiation including excitation and free radical formation, DNA, RNA and tissue radiosensitivity. Effects of ionizing radiation, non-ionizing radiation, stochastic and non-stochastic effects, mean and lethal dose.
- Principles of radiation protection – time, distance, shielding AERB Guidelines, Bhabha Atomic Research Centre (BARC) Room layout, construction and installation Quality assurance, radiation leakage, devices to measure radiation Principles of ALARA, radiation protection in mobile units, exposure during pregnancy, 10 day rule.

• **Unit 5 Radiography and Dark Room Techniques**

**50 marks**

- Skull Radiography – including AP/Lateral views, base of skull view, radiological base line, radiography of the pituitary gland, mastoids, various specialized views of skull radiography Radiography of Para nasal sinuses (PNS), - Water's view, Towne's view, X-ray of nasal bone, TM joint. Radiography of soft tissue of neck – special considerations
- Radiography of upper extremity, bones and joints – views techniques. Radiography of lower extremity – views, techniques. Special views for small joints – wrists, MCP, IP joints, tarsal bones etc.
- Chest radiography – various views, techniques, decubitus views. Radiography of ribs, soft tissues. Abdominal radiography – erect, supine, KUB – views, techniques. Radiography of pelvis – views and techniques
- Radiography of hips, pelvis – views and techniques, precautions. Radiography of spine, vertebral column – views, techniques. Special care in vertebral injury cases. Radiography in trauma patients, CV junction radiography techniques
- Dental, Orthopantomograms, Pediatric Radiography, Mobile Radiography,
- Introduction of dark room, layout, ventilation, illumination, developer, fixer tanks. Dry bench, wet bench, pass boxes. Characteristics, features and requirements of safe light. Process of developing, fixing, rinsing
- Film material, construction of films, types of films, storage of films, sizes. Film speed, high speed, low speed. Newer film types – laser films, dry and wet laser films.
- Screens- Construction of screen, uses of screen, types of screens. High speed, low speed, care of screens, film-screen combination – advantages, technique modification in relation to speed. Principles of fluorescence and phosphorescence, rare earth screens, blue and green screens.
- Film processing – manual, automatic film processing, washing, drying, hangers – clip hangers, channel hangers. Chemicals- Developers, fixers, rinser, replenisher solution etc. Advantages, disadvantages of automatic, manual processing. Film fog – definition, types of fog, causes of fog. Effect of temperature, sunlight in improper storage, old films, artifacts. Cassettes – Design, care, construction, types and mounting.

## TECHNICAL PAPER – II ( 150 MARKS)

- **Unit 1 Digital Radiography and Mammography** **30 marks**
  - Physics of Film – Screen Mammography Special features of mammography equipments including tubes, grids, screens and films Equipment – tube, compression techniques, Automatic exposure control.
  - Imaging Techniques and views-conventional and supplementary, grids, techniques in dense breasts, compression techniques,
  - Breast cancer screening, BIRAD classification .Current trends in screening of breast cancer.Radiation dose and screening issues- specificity and sensitivity, advantages, hazards of screening
  - Characterisation of breast lesion, role of biopsy, FNA, interventional procedures in breast. Stereotactic biopsy guides attachments.
  - Anatomy of Breasts and basic breast diseases.
  - Basic Uses of Digital Technology in Radiography, PACS, DICOM, Cloud Computing, Filmless Radiology
  - Computerised Radiography systems, Digital Radiography systems, Digital tomosynthesis – uses and advantages.
  - Multi-Format cameras, Thermal paper printers, Laser printers- Dry and wet laser printers.
  
- **Unit 2 Special Radiographic Procedures** **30 marks**
  - Introduction to contrast media, oral and iv contrast agents, new generation contrast agents.Reaction to contrast agents and management of reaction to contrast agents.Drugs and emergencies in radiology department including anesthesia in radiology department.
  - Sialography , Myelography, Cisternography, ArthrographyDacryo-cysto rhinography ( DCR)
  - T-Tube cholangiography ,Endoscopic Retrograde Cholangio pancreatography ( ERCP) Percutaneous transhepatic cholangiography ( PTCA)
  - Barium swallow ,Barium meal, Hypotonic duodenography ,Barium meal follow through and Enteroclysis ,Barium enema
  - Intra-venous urography ( IVU),Retrograde Urography ( RGU) and Urethrogram Micturating Cysto-Urethrography ( MCU) Percutaneous nephrostomy ,Hystero-salpingography ( HSG)
  
- **Unit 3 CT Scan techniques** **30 marks**
  - Basic physics, tube technology, rating, detector technology, generators, stabilizers, gantry, console etc.Data acquisition, various methods, types and generation of CT Scanners, filters, tiltSpiral CT , slip ring technology, advantages.Post processing, softwares , work stationImage reconstruction and display parameters.Hounsefield units , values of normal tissues.Use of oral , rectal, iv contrast in CT Scan, dose consideration , administration , patient preparation.Principles of window, grey scale contrast optimization
  - Clinical application of CT scan.CT Scan techniques of brain, chest ,abdomen, head and neck, etc. Recording CT images, filming techniques, cameras and archiving , digital archiving CD, DVD, MOD etc Normal CT anatomy of various organs, common pathologies.Post processing and multiplanar reconstruction.
  - Multi slice CT .HRCT – lungs and temporal boneCT angiographic procedures, coronary angiography using CT, calcium scoring techniques , uses.Pressure injectors , advantages, scan delay, principle of one arm circulation time. Special

procedures like virtual endoscopies, colonoscopies, bronchoscopy, perfusion imaging – techniques and clinical uses. Advantages and limitations of CT scans, artifacts, techniques to minimize artifacts.

- **Unit 4 MRI techniques** **30 marks**
  - Basic physics , data acquisition, relaxation time, gradient , spin echo techniques. Larmor frequency – equation and constant. Effect of magnetic field on cells. Magnets – types of magnets, permanent magnets, superconductor magnets, field strength – tesla. Close and open magnets. Slice selection , RF coils , types of coils and uses.. Image reconstruction , display and recording devices.
  - Sequences in MRI , basic sequences, T1, T2 weighted images, newer sequences. IV contrast agents in MRI .
  - Applications of MRI in brain imaging, spine imaging, abdomen and pelvis imaging, imaging of joints , head and neck .
  - Special MRI procedures like MR Angiography, MRCP, Arthrography, MR enteroclysis. Functional MRI, Diffusion and Echoplanar imaging.
  - MRI room design and installation. Copper shielding of MRI rooms, specifications.. Effect of shielding on image quality. Safety factors , precautions in MRI
  
- **Unit 5 Angiography , Ultrasound and Color Doppler** **10 marks**
  - Angiographic techniques in radiology Conventional angiography , setting up of cath labs, rapid sequence film techniques. DSA, Selective and Super-selective angiographies, indications , uses , techniques. Coronary angiographic techniques – conventional , CT coronary angiography, ecg gating , contrast dose, automatic injectors.
  - Basic physics of Ultrasound Imaging, terminology, principles. Image acquisition, transducer technology, display controls, recording and archiving of USG images. Advantages and uses of Ultrasound , Coupling agents – ingredients, preparation , application
  - Routine abdominal USG, High frequency USG , M-Mode sonography, use of small parts, testes, breasts, A-scan, B-scan, thyroid, neonatal brain. Use of USG in interventions, USG in pregnancy , fetal USG screening, Endoluminal sonography – TVS, TRS , Trans-perineal USG, color doppler in pregnancy, Doppler evaluation of in-utero fetus. PNDT act including its aims and objectives.
  - Basic Principles of color Doppler, uses of color Doppler, Pulsed Doppler , Continuous wave Doppler, power angiography. Use of Doppler in non-vascular conditions. Basics of Echocardiography and use of Echocardiography including B-mode, M-Mode , Color Doppler, Continuous wave Doppler in echocardiography
  
- **Unit 6 Aptitude Test** **20 marks**
  - **Numerical And Figurework Tests: (4 Marks)**

These tests are reflections of fluency with numbers and calculations. It shows how easily a person can think with numbers. The subject will be given a series of numbers. His/Her task is to see how the numbers go together to form a relationship with each other. He/She has to choose a number which would go next in the series.

- **Verbal Analysis And Vocabulary Tests: (6 Marks)**

These tests measure the degree of comfort and fluency with the English language. These tests will measure how a person will reason with words. The subject will be given questions with alternative answers, that will reflect his/her command of the rule and use of English language.

- **Visual And Spatial/3-D Ability Tests: (4 Marks)**

These tests are used to measure perceptual speed and acuity. The subject will be shown pictures where he/she is asked to identify the odd one out; or which comes next in the sequence or explores how easily he/she can see and turn around objects in space.

- **Abstract Reasoning Tests: (6 Marks)**

This test measures the ability to analyse information and solve problems on a complex, thought based level. It measures a person's ability to quickly identify patterns, logical rules and trends in new data, integrate this information, and apply it to solve problems.

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