

B.Sc. in Radiology and Imaging Technology
West Bengal University of Health Sciences

B.Sc. in Radiology and Imaging Technology

CONTENTS

SECTION-ONE: REGULATIONS

SECTION-TWO: SYLLABUS

SECTION-ONE: REGULATIONS

Duration of course:

Duration shall be for a period of three years followed by one year of internship.

Medium of instruction:

The medium of instruction and examination shall be English.

Scheme of examination:

There will be three examinations one each at the end of 1st, 2nd and 3rd year.

Attendance:

Every candidate should have attended at least 75% of total number of classes conducted in academic year from the date of commencement of the term to the last working day as notified by university in each of the subjects prescribed for that year separately in theory and practical. Only such candidates are eligible to appear for the university examinations in their first attempt.

Subjects and number distribution in different years:

1ST YEAR

Paper I: Human Anatomy

Paper II: Physiology

Paper III: Physics of Radiation and Diagnostic Radiology

Paper IV: Radiography Equipments, Maintenance and Quality Control

2ND YEAR

Paper I: Image Processing and Dark Room Techniques

Paper II: Radiographic Positioning and Techniques

Paper III: Radiobiology and Radiation Safety in Radiodiagnosis

Paper IV: Contrast and Special Radiography Procedures

3RD YEAR

Paper I: Equipments of Advanced Modalities

Paper II: Radiographic Special Procedures and Patient Care

Paper III: Modern Imaging Techniques and Recent Trends In Imaging

Paper IV: Computer Application and Medical Data Entry

Distribution of Marks

1st Year						
Paper	Subject	Theory Exam	Theory Internal	Practical Exam	Internal Practical	Total
I	HUMAN ANATOMY	80	20	80	20	200
II	PHYSIOLOGY	80	20	80	20	200
II	PHYSICS OF RADIATION AND DIAGNOSTIC RADIOLOGY	80	20	80	20	200
IV	RADIOGRAPHY EQUIPMENTS, MAINTENANCE AND QUALITY CONTROL	80	20	NA	NA	100
Total						700

2nd Year						
Paper	Subject	Theory Exam	Theory Internal	Practical Exam	Internal Practical	Total
I	IMAGE PROCESSING AND DARK ROOM TECHNIQUES	80	20	NA	NA	100
II	RADIOGRAPHIC POSITIONING AND TECHNIQUES	80	20	80	20	100
II	RADIOBIOLOGY AND RADIATION SAFETY IN RADIODIAGNOSIS	80	20	80	20	200
IV	CONTRAST AND SPECIAL RADIOGRAPHY PROCEDURES	80	20	80	20	200
Total						700

3rd Year						
Paper	Subject	Theory Exam	Theory Internal	Practical Exam	Internal Practical	Total
I	EQUIPMENTS OF ADVANCED MODALITIES	80	20	80	20	200
II	RADIOGRAPHIC SPECIAL PROCEDURES AND PATIENT CARE	80	20	NA	NA	100
II	MODERN IMAGING TECHNIQUES AND RECENT TRENDS IN IMAGING	80	20	80	20	200
IV	COMPUTER APPLICATION AND MEDICAL DATA ENTRY	80	20	80	20	200
	Total					700

Internal assessment

There will be a minimum two periodical tests preferably one in each term in theory and practical of each subject in an academic year. The average marks of the two tests will be calculated and reduced to 20. The marks of IA will be communicated to the university at least 15 days before the commencement of the university examination.

Schedule of examination:

There will be three examinations in each year at the end of 1st, 2nd and 3rd year respectively. A candidate who satisfies the requirement of attendance, progress and conduct as stipulated by the university shall be eligible to appear for the university examination. Certificate to that effect shall be produced from the head of the institution along with the application for examination and prescribed fees.

Pass Criteria:

A candidate is declared to have passed the examination in a subject if he/she secures 50% marks in theory and 50% marks in practical separately.

Eligibility for the Award of Degree:

A candidate shall have passed in all the subjects of first, second, third year and completed one year internship, to be eligible for award of degree. B.Sc. in Radiology and Imaging Technology

SECTION-TWO: SYLLABUS

1st Year:

PAPER I: HUMAN ANATOMY

Theory

A. General Anatomy:

- i. **Histology**-Cell, tissues of the body, epithelium, connective tissue, cartilage, bone, lymph, muscle, nerve etc.
- ii. **Osteology**-Type of Bone, Growing End, Ossification Centers, Formation, function, growth and repair of bones.
- iii. **General Embryology**-Ovum, spermatozoa, fertilization, differentiation, development of various systems and foetal circulation.
- iv. **Nervous tissue**: Structure of neuron, Synapse, reflex arc, Wallerian Degeneration and regeneration of nerve
- v. **Muscles**: classification, examples, Microscopic features, emphasis on Skeletal Muscles
- vi. **Joints**: Definition, general classification with examples

B. Systems of Human Body (A brief outline):

- i. **Blood Vascular System** – Arteries, capillaries, veins, heart, and lymphatic system.
- ii. **Respiratory System** – Anatomy of upper and lower respiratory tract including nose, larynx, trachea, bronchi, pleura and lungs.
- iii. **Digestive System** – Anatomy of the gastro-intestinal tract.
- iv. **Urogenital System** – Anatomy of Urinary system, male and female reproductive system.
- v. **Endocrine System** – The various organs and production of hormones including definition, structures in general, control of secretions and role of hypothalamus.
- vi. **Integumentary System**
- vii. **Surface Anatomy**

C. Neuro-Anatomy: Microscopic And Gross Study of: -Peripheral Nerves, Cranial Nerves, Autonomic Nervous System, Cerebral Cortex, Midbrain, Pons, Medulla, Cerebellum, Thalamus, Hypothalamus,

Epithalamus, Corpus Striatum, Ventricles, Meninges, Cerebro Spinal Fluid, Blood supply of the Brain, Internal Capsule, Pyramidal System and Extrapyramidal System, Details of Spinal Cord and its Tracts, Neuromuscular Junction, Sensory End Organs etc.

D. Upper Extremity

- i. **Osteology:** Outline the anatomical features, attachments, ossification and side determination of the bones of Upper Limb : Clavicle, Scapula, Humerus, Radius, Ulna, Carpals, Metacarpals, Phalanges
- ii. **Myology**
 - Fascia and Muscles of front and back of upper arm: origin, insertion, nerve supply and action.
 - Muscles of front and back of forearm: origin, insertion, nerve supply and action.
 - Mention the small muscles of hand with their origin, insertion, nerve supply and action.
 - Identify the nerves of upper units and mention their position course, relations and distribution.
 - Detail explanation of joints of upper limb: Scapulothoracic Joint, Shoulder joint, Elbow Joint, Wrist and joints of hand.
 - Indicate the blood vessels of upper limb and mention their position course, relations, distribution and main branches.
 - Lymphatic damage of upper limb
 - Applied anatomy of all structures of Upper Limb

E. Regional Anatomy

Detailed explanation of the following with their applied anatomy

- Pectoral Region
- Scapular Region
- Cubital Fossa
- Axilla
- Brachial Plexus: Position, formation and branches
- Spaces of the hand

F. Runk-Thorax & Abdomen

i. Osteology

Vertebral columns: Identify the parts of typical vertebra and state the main features, attachments and ossification.

Intervertebral disc and mention its part.

Ribs: Parts and main features of typical rib and define true, false and floating ribs.

Sternum: State the parts and anatomical features.

ii. Myology

- Fascia and muscles of back
- Fascia and muscles connecting Upper Limb with vertebral column: origin, insertion, nerve supply and action.
- Intercostal muscles and diaphragm: origin, insertion, nerve supply and action.
- List layers of anterior abdominal wall and mention its origin, insertion, nerve supply and action of these muscles.
- Fascia and muscles of posterior abdominal wall: origin, insertion, nerve supply and action.

iii. Joints of Thorax

- Identify the various joints and explain in detail:
 - Manubriosternal joint
 - Costo vertebral joint
 - Costo transverse joint
 - Costo Chondral joint
 - Chondro sternal joints
 - Inter vertebral joint
- Movements of vertebral column
- Respiratory movements, Mention the course and branches and nerves, blood vessels and lymphatic drainage of trunk-thorax-abdomen.
- Lumbar Plexus: Position, formation and branches.
- Rectus sheath: formation and contents.
- Contents of vertebral canal
- Intercostal space and its contents
- Diaphragm-structures passing through it.
- Applied Anatomy of structures of trunk – thorax – abdomen

G. Pelvis

- i. Features of pubic symphysis and sacroiliac joints.
- ii. Muscles of pubic floor and mention their attachments, action and nerve supply.
- iii. Difference between male and female pelvis.
- iv. Main features of subdivision, boundaries, walls and floor of pelvis.
- v. Urogenital diaphragm (outlines only)
 - Applied anatomy of plexus
 - Lymphatic damage
 - Nerve supply
 - Sacral Plexus
 - Mention the blood vessels of the region with course, variations, distribution and main branches.

H. Lower Extremity

- i. **Osteology:** Hip bone, femur, Tibia, Fibula, Patella, and bones of the foot
- ii. **Myology**
 - Fascia and muscles in front of thigh: Origin, Insertion, Nerve Supply, and Action
 - Fascia and muscles of medial side of thigh: Origin, Insertion, Nerve Supply, and Action
 - Fascia and muscles of back of thigh
 - Fascia and muscles of gluteal region
 - Fascia and muscles of front of leg and dorsum of foot
 - Fascia and muscles of lateral side of leg
 - Fascia and muscles of back of leg and sole of foot
 - Detailed explanation of joints of Lower Leg: Pelvic Girdle, Hip joint, Knee joint, Ankle joint, joints of foot.
 - Study of the nerves of Lower Leg and mention their position course, relations and distribution
 - Indicate the blood vessels of Lower Leg and mention their position course, relation, distribution and main branches
 - Lymphatic drainage of Lower Leg
 - Explain femoral triangle, Adductor Canal and Subarticular canal
 - Popliteal fossa
 - Anatomy of structures of Lower Leg, Arch of Foot

Practical

- A. Surface Anatomy:** To study, identify and mark the surface land marks on human body.
- B.** To study the muscles of trunk, lower and upper extremities and face on a dissected human body.
- C.** To study the Bones of Human Body with special emphasis on origin and insertion of muscles and ligaments.
- D.** To study the anatomy of joints of upper and lower extremities and vertebral column on models, charts.
- E.** To study the anatomy of C.N.S and P.N.S on models, charts.
- F.** To study the gross anatomy of Respiratory, Digestive, Endocrine, Urinary and Genital system on models, charts.

PAPER II: PHYSIOLOGY

Theory

A. Patient Care:

- i.** Nursing care of a patient
- ii.** Introduction on Physiology.
- iii.** Cell and tissue, its structure.
- iv.** Body Fluid:
 - Blood: Composition and general function of plasma, Blood cells – structure and function- Red Blood cells, white blood cells including numbers and approximate length of life position, structure and function of cell of reticulo endothelial system
 - Blood clotting including bleeding time and clotting time, factors accelerating and slowing the process
 - Blood group and their significance, Rh- Factor, Haemoglobin and ESR
- v.** Formation of Blood, tissue fluid and Lymph

B. Cardio Vascular System

Structure and properties of Heart muscles and nerve supply of Heart.
Structure and functions of arteries, capillaries and veins, Cardiac cycle

and Heart sound, Factors affecting Heart Rate and its regulation, Cardio-vascular reflexes, Blood pressure and its regulation, physiological variation, peripheral resistance, Factors controlling Blood Pressure, Haemorrhage

C. Respiratory System

- i. Mechanism of Respiration, changes in diameters of thorax, Intrapleural and Intrapulmonary pressure, Quantities of Lung Volume, Tidal and Residual Volume, Vital Capacity, Gaseous interchanges in lung and tissues
- ii. Control of Respiration – Nervous and Chemical significance of change in rate and depth, transportation of oxygen and carbon-dioxide, Respiratory states- Hypoxia, Asphyxia, Cyanosis, Acclimatization

D. Digestive System

General arrangement of alimentary canal, liver and pancreas position, structure.

E. Reproductive System

Development of Puberty, Male Sex Hormones, Spermatogenesis, Female Sex Hormones, Menstrual cycle, Ovulation, Pregnancy and Lactation, Function of Placenta

F. Excretory System

Gross and minute structures of kidney, renal circulation, mechanism of formation of urine. Glomerular filtration rate and tubular function, renal function.

G. Endocrine System

Structure and function of pituitary (anterior and posterior) gland, Thyroid, Para-Thyroid, Adrenal Cortex, Adrenal Medulla, Thymus and Pancreas, Blood Sugar regulation

H. Skin Structure and Function

I. Neuromuscular Physiology:

- i. **Cell Membrane:** Ionic and potential gradient and transport

- ii. **Muscle:** Types of Muscular tissue, gross and microscopic structure, function, Basis of muscle contraction, changes in muscle contraction. Electrical – Biphasic and Monophasic action potentials, chemical, thermal and physical changes, Isometric and Isotonic contraction, Motor units and its properties – clonus, tetanus, all or none law, fatigue
- iii. **Nerve:** Gross and microscopic structure of nervous tissue, One Neurone- generation of action potential- nerve impulse-condition
- iv. **Neuromuscular Junction**
 - Degeneration, regeneration of peripheral nerves, Wallerian Degeneration, Electro tonus and Pflagers law.
 - Types and properties of receptors, types of sensations, synaptic reflex arc and its properties – occlusion, summation , subminimal fatigue etc
 - Tracts – Ascending and Descending tracts of the spinal cord, Pyramidal Tracts
 - Functions of Cerebral Cortex
 - Functions of Cerebrum
 - Functions of Cerebellum
 - Functions of Basal Ganglia
 - Thalamus: Connection and function
 - Reticular Formation: Tone, Posture and Equillibrium
 - Autonomic Nervous System
 - Special Senses: Eye – errors of refraction, lesions of visual pathways
 - Speech and its Disorders
 - Ear and vestibular apparatus, taste, olfactory and somatic sesations

J. Physiology of Exercise and Work

- i. Neuromuscular activity, Human Movement, Physiological mechanism in movement behaviour, skill, strength, endurance, analysis of movement
- ii. Circulatory and respiratory response to exercise and work, the heart, blood circulation, body fluid changes, pulmonary ventilation, gas exchange and transport
- iii. Effects of exercise and work on other body functions

Practical

- A. Identification of blood cells and different counts.
- B. White Blood Cell Count.
- C. Red Blood Cell Count. Clotting Time and Bleeding Time
- D. Haemoglobin percentage
- E. E.S.R. and Blood groups.
- F. Bleeding time and clotting time
- G. Pulse rate, Heart rate and measurement of Blood Pressure.
- H. Respiratory rate and Auscultation.
- I. Reflexes – Superficial and Deep Sensations
- J. Tests for functions of Cerebrum.
- K. Tests for functions of Cerebellum.

PAPER III: GENERAL AND RADIATION PHYSICS & PHYSICS OF DIAGNOSTIC RADIOLOGY

Theory

- A. **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.
- B. **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.
- C. **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 radioisotopes-reactor produced isotopes-Fission products-Gamma ray source for Medical uses.

D. 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.

E. 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.

- i. **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.
- ii. **X-ray tables**-floating top table & variable height table.
- iii. **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 diaphragm -Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.
- iv. **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.

Practical

- A. Congruence of Radiation and Optical field and beam.
- B. Determination of focal spot size of diagnostic X-ray tube.
- C. K.V. and Exposure time testing.
- D. Linearity testing of the Timer.
- E. Consistency of M.A. loading.
- F. Consistency of Radiation Output.
- G. Evaluation of Total filtration of the tube.
- H. Film screen contact testing.
- I. Table top Exposure rate measurement in fluoroscopy.
- J. Radiation protection survey, in and around of diagnostic installations.

PAPER IV: RADIO GRAPHY EQUIPMENTS, MAINTENANCE AND QUALITY CONTROL

- A. 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.
- B. 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.
- C. 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 fluoro-graphy-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.

D. Computed Radiography (C.R): equipment parts –advances- principle of imaging – applications- advantages & disadvantages.

E. 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.

F. Mammography: Basic principle, equipment & image acquisition-conventional & digital mammo studies- Mammotomogram.

G. Dental Radiography: Equipment Basics –types of equipments- Intra oral radiography unit-orthopantomograph unit -imaging techniques- Dental films-film types and processing.

H. 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.

I. 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 hard wire 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.

J. Angiography Equipments: Basic physics and principle of image acquisition-conventional angio- DSA-Cardiac Cath lab. Equipments-advantages-limitations -Dosimetry - Maintenance.

2nd Year:

PAPER I: IMAGE PROCESSING AND DARK ROOM TECHNIQUES

A. X-Ray film

X-ray film construction and film characteristics – Composition of single and double coated radiographic films -structure of emulsion- film characteristics; speed, base fog, gamma, latitude -effect of grain size on film response to exposure, interpretation of characteristics curve-exposure to x-rays.

B. Types of Radiographic Films: applications -advantages/limitations of different types Structure, properties of different parts-Film storage - handling -film wrappings- handling of exposed and unexposed films -safe light requirements.

C. Radiographic Image: Meaning of radiographic image contrast, density, resolution, sharpness, magnification and distortion of image, noise and blur. Primary radiological image formation- Image quality – unsharpness- resolution – fog and noise - use of contrast media-density-contrast – brightness- optical density measurements- Image recording devices.

D. Image processing: Film developing principles- acidity, alkalinity, pH, the processing cycle- process of film developing - development - developer solution- constituents of developer. Fixing- fixer solution-

composition of fixer –washing – drying replenishment -checking and adjusting replenishment rates - other processing solution – effect of temperature and development time - film processing methods - common errors and faults while processing manual and automatic processing-latent image formation– silver recovery and economics.

E. Film archieving systems- Image recording devices-Laser imager/camera functioning.

Multiformatter-

Optical Disc. System

Film archieving systems - MOD/disc/PACS etc.

F. Automatic processing: Automatic film handling systems -Automated Processors - equipment for Film Processing-functions of various components- film roller transport - transport time -film feed system-Importance and relation to temp, fixed and variable time cycles-Care and maintenance -cleaning routine and methods of cleaning.

G. Radiographic illuminators: and viewing conditions, visual acuity and resolution.

H. Dark Room: Site – layout - dark room design- construction- processing area–illumination-safe light compatibility - entrance safe lighting – types-storage-shelving of films-cleaning and maintenance.

PAPER-II: RADIOGRAPHIC POSITIONING AND TECHNIQUES

A. Introduction

- i. Anatomical Terminology
- ii. Positioning Terminology
- iii. Projection Terminology

B. Shoulder girdle

- i. **Basic and special projections Shoulder non-trauma routine**
 - AP (external rotation)
 - AP (internal rotation)

- Superior-inferior (axial view)
- Inferio-superior axial (Lawrence method)
- Inferio-superior shoulder projection (west point method)
- Posterior oblique – glenoid cavity (grashey method)
- Intertubercular groove (fisk method)

ii. Shoulder (trauma routine)

- AP neutral rotation
- Transthoracic lateral (Lawrence method)
- Tangential projection - supraspinatus outlet (neer method)
- Apical oblique projections (garth method)
- Clavicle
- AP and AP axial
- Acromioclavicular joints:
- AP bilateral with and without weight
- Sternoclavicular joints (PA, RAO, LAO)
- Scapula
- AP
- Scapula Y view
- Lateral recumbent

C. Humerus: Related radiological anatomy, AP, LAT, Horizontal beam LAT, Proximal humerus views

D. Elbow: Related radiological anatomy, AP- fully extended, partially flexed, AP oblique- external and internal rotation, Lateral, Acute flexion (jones method), Trauma axial lateral (coyle method), Radial head lateral

E. Forearm: Related radiological anatomy, AP, LAT

F. Wrist: Related radiological anatomy, PA, AP, PA oblique, Lateral, PA scapula views, Radial deviation, ulnar deviation, Carpal canal-inferiosuperior (gaynor-hart method) • Carpel bridge

G. Hand: Related radiological anatomy, PA, PA oblique, Lateral, Lateral-flexion and extension, AP bilateral oblique (norgaard method)

H. Fingers: Related radiological anatomy, PA, Oblique, LAT

I. Thumb: Related radiological anatomy, AP, PA oblique, Lateral, AP (Roberts method), Skiers thumb (folio method)

J. Femur: Related radiological anatomy, Mid and distal femur, AP, Lateral, Mid and proximal femur, AP, Lateral

K. Knee: Related radiological anatomy, Knee, AP, Oblique- medial and lateral rotations, Lateral, Skyline view, AP (weight bearing), Knee-intercondylar fossa, PA axial (camp coventry and holmblad method) AP axial

L. Leg: Related radiological anatomy, AP, LAT

M. Ankle: Related radiological anatomy AP, AP mortise (15° oblique), Lateral, AP stress

N. Foot: Related radiological anatomy, AP, Oblique, Lateral, AP and lateral weight bearing

O. Calcaneus: Related radiological anatomy, Plantar-dorsal (axial), Lateral

P. Pelvic girdle and proximal femur:

i. Basic & special projections

- Pelvic girdle
- AP pelvis
- Frog lateral (modified cleaves method)
- AP axial for pelvic outlet (taylor method)
- AP axial for pelvic inlet (modified linienfield method)
- Posterior oblique- acetabulum (judet method)
- Hip and proximal femur
- AP unilateral hip
- Axiolateral, inferosuperior (danielius – miller method)
- Unilateral frog leg (modified cleaves method)
- Modified axiolateral (clements-nakayama method)
- Sacroiliac joints: AP, posterior obliques

Q. Chest:

i. Basic & special projections

- PA, LAT

ii. Special:

- AP supine & semierect
- Lateral decubitus
- AP lordotic
- Anterior oblique
- Posterior oblique
- Upper airway: AP, LAT

R. Abdomen: Related radiological anatomy • Basic & special projection • Basic:, AP supine (KUB), Special:, PA prone, Lateral decubitus, Erect AP, Dorsal decubitus, Lateral, Acute abdomen: three-way series.

S. KUB: Related radiological anatomy, Positioning- AP/Lat

T. Cervical spine: Related radiological anatomy, Basic views, AP open mouth (C1 and C2), AP axial, Oblique, Lateral, Erect, Trauma lateral (horizontal beam), Cardiothoracic junction (swimmers view), Special views, Lateral- hyperflexion and hyperextension, AP (fuchs method) or PA (judd method), AP wagging jaw (ottonello method), AP axial (pillars)

U. Thoracic spine: Related radiographic anatomy, AP, Lateral, Oblique

V. Lumbar spine, sacrum and coccyx: Related radiographic anatomy, Lumbar spine, AP, Oblique, Lateral, Lateral (L5 - S1), AP axial (L5 - S1), Scoliosis series, AP or PA, Erect lateral, AP (Ferguson method), AP - R and L bending, Spinal fusion series, AP or PA - R and L bending, Lateral - hyperextension and hyperflexion, Sacrum and Coccyx, AP axial sacrum, AP axial coccyx, Lateral sacrum, Lateral coccyx

W. Pediatric radiography: Positioning, care and radiation protection while handling babies

X. Skull and cranial bones and facial bones: Related radiological anatomy, Basic & special projections, Cranium, Base of skull, Sella

turcica, Mastoids, Optic foramina and Orbits, Nasal bone, TM joint, Facial bone, Zygomatic arches, Mandible, Para nasal sinuses

Y. Neck: Positioning- AP, LAT

Z. Dental radiography: Introduction, Terminology, Dental formula, Intra – oral radiography, Bite wing, Periapical radiography, Occlusal radiography, Extra oral oblique lateral, Cephalometry, Orthopantomography

Practical: Application of Different Radiographic Positioning technology in different treatments.

PAPER III: RADIOBIOLOGY & RADIATION SAFETY IN RADIODIAGNOSIS:

Theory

A. 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.

B. 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.

C. 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 -Calibration of Radiation Monitoring Instruments.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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. Guidance level for patients dose reduction in radio-diagnosis. Dose constrains for comforters of patients. Radiation incidents involving X-Ray equipments, over exposure investigations and case studies.

Practical

- A. Time, Dose, Shielding, Measurement of HVT & TVT
- B. Familiarization of Radiation Survey meters and their functional performance checks
- C. Radiological Protection Survey of Diagnostic X-Ray installation
- D. Diagnostic Imaging: Quality Assurance – M. M Rehani
- E. AERB safety requirements- Atomic Energy Act, Radiation protection rules.

PAPER IV: CONTRAST & SPECIAL RADIOGRAPHY PROCEDURES:

Theory

- A. Non-contrast Special radiography-

- i. **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.
- ii. **Geriatric radiography:** Equipment and accessories – exposure factor considerations in special care. Elderly patients profile - difficulties during radiography – technical considerations-projections with unconventional special positioning.
- iii. **Trauma/Emergency Radiography**
- iv. Selection of suitable X-Ray equipment – patient position -radiographic projections and sequence for each patient – modification of routine positioning– radiation protection – patient care.
- v. **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 - clinical applications- per operative radiographs- peroperative fluoroscopy studies -patient care-radiation protection of all staff.

B. Contrast radiography

- i. **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.
- ii. **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.

C. Sialogram

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

E. Percutaneous Transhepatic Cholangiogram, ERCP, T-Tube cholangiography, per-operative cholangiography.

F. IVP-rapid sequence-infusion pyelography-high dose urography, Cystogram, Anterior Urethrogram RGU, MCU, RCP

G. Angiography, Diagnostic & therapeutic, venography, Lymphangiogram

H. Orthography, Discography

I. Myelogram

J. Hysterosalphingography

K. Sinography

L. Fistulogram

M. Ductogram

Practical: Topic same as theory.

3rd Year:

PAPER-I: EQUIPMENTS OF ADVANCED MODALITIES

Theory

A. 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.

B. 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 impedance piezoelectric 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.

C. 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-

D. 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.

E. Angiography and Cine Studies /DSA:

Angiography equipments 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.

F. Nuclear Medicine Equipments:

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

G. Recent Advances in Imaging Systems:

Mobile units of Computer Radiography & Digital Radiography system.

3D/4D Sonography systems

128 slice & higher slice C.T equipments.

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.

Bone Densitometry

H. Picture Archiving and Communication Systems (PACS):

Newer advancements – updates - systems designs-transfer restrictions.

Practical: Topic same as theory.

**PAPER-II: RADIOGRAPHIC SPECIAL PROCEDURES AND
PATIENT CARE**

A. Introduction to the subject:

- i. Diagnostic procedures
- ii. Therapeutic procedures

B. Contrast media:

- i. Definition
- ii. Classification
- iii. Chemistry
- iv. Physiology
- v. Toxicity
- vi. Treatment- emergency drugs
- vii. C M used in USG

C. Intravenous Urogram (IVU/IVP):

- i. Anatomy of urinary system
- ii. Indications Contraindications & Risk factors
- iii. Contrast media, Preparation, procedure
- iv. Filming technique
- v. IVU in children
- vi. Special views & modifications of Urogram
- vii. Nephrotomogram
- viii. Complications & after care

D. Retrograde pyeloureterography:

- i. Indications & contraindications
- ii. Procedure & filming
- iii. Complications & aftercare

E. Micturating Cystourethrogram (MCU):

- i. Anatomy of lower urinary tract
- ii. Indications & contraindications
- iii. Preparation, Procedure & filming
- iv. Complications
- v. Other techniques

F. Ascending Cystourethrogram (ASU):

- i. Indications & contraindications
- ii. Preparation, technique, procedure
- iii. Filming
- iv. Complications & after care

G. Myelogram:

- i. Anatomy of spinal cord
- ii. Definition, indication & contraindication
- iii. Preparation requirements & contrast media
- iv. Lumbar, cisternal & lateral cervical puncture
- v. CT myelogram

H. Contrast media in GIT:

- i. Introduction
- ii. Properties of an ideal barium preparation
- iii. Advantages of barium sulphate preparation
- iv. Manufacture
- v. Characteristics influencing coating
- vi. Adverse effects
- vii. Other contrast media used
- viii. Contrast media used for CT in GIT

I. Barium swallow

- i. Anatomy of upper GI tract
- ii. Indications & contraindications
- iii. Contrast
- iv. Procedure and techniques
- v. Specific conditions
- vi. Complications

J. Barium meal

- i. Anatomy of stomach
- ii. Indications & contraindications
- iii. Preparation
- iv. Contrast media

- v. Standard views
- vi. Conventional single contrast study
- vii. Double contrast barium study
- viii. Biphasic study of upper GIT
- ix. Hypotonic duodenography
- x. After care & complications

K. BMFT

- i. Anatomy of GI tract
- ii. Indications & contraindication
- iii. Contrast medium
- iv. Patient preparation
- v. Small bowel follow through
- vi. Dedicated small bowel follow through
- vii. Peroral pneumocolon
- viii. Retrograde small bowel examination
- ix. Advantages, disadvantages & complications

L. Enteroclysis

- i. Anatomy of small bowel
- ii. Indication contraindication
- iii. Equipment, contrast medium
- iv. Preparation
- v. Techniques
- vi. Single contrast study
- vii. Double contrast study
- viii. Air D C enteroclysis
- ix. Comparison
- x. Advantages, disadvantages & after care

M. Barium enema

- i. Anatomy of large bowel
- ii. Definition, indication, contraindication Contrast
- iii. Preparation and positioning
- iv. DCBE, SCBE
- v. Special barium enema studies Aftercare & complications

N. HSG

Anatomy of female reproductive system Definition, indication and contraindication Equipments, procedures & techniques After care & complications Sonosalpingiography

O. FTR

- i. Definition, indication and contraindication Instrumentation
- ii. Timing of the study, patient preparation Technique and filming
- iii. Other methods
- iv. Post procedure follow up and complications

P. Sialography

- i. Anatomy of salivary glands
- ii. Definition, indication & contraindication
- iii. Equipments
- iv. Preparation of the patient
- v. Procedure & filming

Q. Dacrocystography

- i. Anatomy of nasolacrimal duct
- ii. Definition, indications & contraindication
- iii. Materials and techniques
- iv. Complications & after care
- v. Other techniques

R. Catheters

- i. Classification
- ii. Catheters used for different studies
- iii. Sterilization of catheters
- iv. Balloon angioplasty catheters

S. Angiography (cerebral, visceral, peripheral)

- i. Anatomy of blood vessels
- ii. Definition indication & contraindication
- iii. Patient preparation and precautions
- iv. Local anaesthesia
- v. Direct needle puncture
- vi. Catheter angiography

vii. Percutaneous transluminal angioplasty

T. T-tube / PTC / direct portal Venography overview

U. Biliary system procedures (PTBD/ERCP/PTC)

V. Bronchography and phlebography overview

W. Introduction to Patient Care

- i. Responsibilities of the Healthcare facility**
- ii. Responsibilities of the Imaging Technologist**

X. Nursing Procedure in Radiology

- i. General abdominal preparation**
- ii. Clothing of the patient**
- iii. Giving an enema Handling the emergencies in Radiology First aid in the X-Ray department.**

Y. Patient care during Investigation

- i. G.I. Tract**
- ii. Biliary tract**
- iii. Respiratory tract**
- iv. Gynecology**
- v. Cardiovascular**
- vi. Lymphatic system**
- vii. C.N.S etc**

Z. Infection Control

- i. Isolation technique**
- ii. Infection sources**
- iii. Transmission modes**
- iv. Procedures**
- v. Psychological considerations**
- vi. Sterilization & sterile techniques.**

AA. Patient Education

- i. Isolation technique**

- ii.** Infection sources
- iii.** Transmission modes
- iv.** Procedures
- v.** Psychological considerations
- vi.** Sterilization & sterile techniques.

PAPER-III: MODERN IMAGING TECHNIQUES AND RECENT TRENDS IN IMAGING

Theory

A. Computed Tomography Protocols:

- i. **Head:** Routine head, Sinuses, Facial / orbit, Temporal bones, Trauma head, Vascular head (CTA), Cross sectional anatomy
 - a. **Neck:** Soft tissue neck, Larynx and vocal cords, Vascular neck (CTA) Cross sectional anatomy
- ii. **Spine and Musculoskeletal:** Lumbar, Cervical, Thoracic, Spinal trauma, Upper extremity, Lower extremity, Pelvic girdle; hips, Musculoskeletal trauma, Cross sectional anatomy
- iii. **Chest:** Routine chest, HRCT, Vascular chest (e.g., PE), Chest trauma, Airway (trachea, bronchus), Heart (e.g., cardiac scoring, Angiography), Cross sectional anatomy
- iv. **Abdomen:** Routine abdomen, Liver (multi-phase), Kidneys (with contrast), Pancreas, Adrenals, GI tract, Abdominal trauma, Vascular abdomen (CTA), Cross sectional anatomy
- v. **Pelvis:** Routine pelvis, Bladder, Pelvic trauma, Vascular pelvis (CTA), Colorectal studies, Cross sectional anatomy
- vi. **Special Procedures:** Biopsies, Drainage / aspirations
- vii. **Image Display and Post Processing:** Geometric measurements (e.g., stent graft, distance), ROI, Retrospective reconstruction

B. Ultrasonography Protocol:

- i. **Head & Neck:** Soft tissue neck, Larynx and vocal cords, Arteries and veins, Cross sectional anatomy
- ii. **Abdomen:** Routine abdomen, Liver, Kidneys, Pancreas, Adrenals, GI tract, Abdominal trauma, Arteries & Veins, Cross sectional anatomy
- iii. **Pelvis:** Routine pelvis, Bladder, Pelvic trauma, Colorectal studies, Cross sectional anatomy
- iv. **Upper limb & Lower limb:** Arteries and veins
- v. **Special Procedures:**
Biopsies, Drainage / aspirations

C. Digital Radiography Techniques:

- i. Computed radiography
- ii. Digital radiography
- iii. PACS
- iv. DSA
- v. Mammography
- vi. Dental radiography
- vii. Macro radiography
- viii. Digital x ray techniques of whole body

D. Magnetic Resonance Imaging:

- i. **Head and Neck:** Routine brain, Internal auditory canal, Orbit, Pituitary, Vascular head, Cranial nerves, Posterior fossa, Head trauma, Sinuses, Soft tissue neck, Vascular neck
- ii. **Spine:** Thoracic, Lumbar, Cervical, Sacrum / coccyx, Spinal trauma, Bony pelvis
- iii. **Thorax:** Brachial plexus, Mediastinum, Cardiovascular, Breast, Aorta, Heart and great vessels
- iv. **Abdomen and Pelvis:** Liver / spleen / pancreas*, Kidneys, Adrenals, MRCP, Vascular, Male pelvis, Female pelvis
- v. **Musculoskeletal System:** Upper limb, Lower limb

Practical: Topic same as theory.

PAPER-IV: COMPUTER APPLICATION AND MEDICAL DATA ENTRY:

Theory

- A. Information technology including hardware, software, characteristics of systems**
- B. Spreadsheets and presentations**
- C. Databases**
- D. Administrative Decision Making Support Systems**
- E. Clinical Decision Making Support Systems**
- F. Healthcare Information Systems and Departments**
- G. Strategic Planning and Implementation of Healthcare Information Systems**
- H. Networks**

- I. Life Cycle of Healthcare Information Systems to include budgeting, proposals, and project management**
- J. Electronic Health Records**
- K. Human factors in Healthcare Information Systems**
- L. Communication Technology**
- M. Imaging Technology**
- N. Standards for Electronic Health Records**
- O. Protection and security of healthcare information and systems**

Practical:

- A. Operation of personal computer.**
- B. Data storage, reporting, data presentation in computer.**
- C. Application of MS-office in pathological laboratories**