REGULATIONS OF
BSc. Medical Radiology & Imaging Technology at
Regional Institute of Medical Sciences, Imphal.

The regulation shall be called the Regulation for BSc. Medical Radiology and Imaging Technology Course of Manipur University.

Learning Objectives:

The Aim of BSc. in Medical Radiology and Imaging Technology program is to provide highest and Atomic Energy Regulatory Board (AERB) accredited educational process through formal didactic and state-of-the-art clinical experience that will render qualified, patient focused, compassionate, critical thinkers Medical Radiology and Imaging Technologist for the community who are engaged in lifelong learning. The graduates of the program are prepared to apply for the Level I Radiation Safety Officer (RSO) as per AERB norms.

The regulation & syllabus framed is subject to modification / amendment from time to time by Academic Council of Manipur University

1. Eligibility for Admission:

a) A Candidate seeking admission to this course must have passed 10+2 examination from CBSE / State boards or any other equivalent examination recognized by Manipur University, with at least 50% marks in aggregates of Physics, Chemistry, Biology/Zoology and Botany and English as subjects combination and must have passed in each of these subject.

b) Selection of the candidates will be based on merit i.e. qualifying mark obtained in NEET examination of the year of admission.

c) Age Limit: The candidate should have completed the age of 17 years at the time of admission or would be completing the said age and not more than 25 years on or before 31st December of the year of admission to the first year BSc. MRIT.

d) Lateral Entry Admission to second year for those 10+2 Science with 2 years diploma BSc. MRIT.

i) Candidate who had passed Diploma BSc. MRIT (2years) from any AICTE recognized institution after his/her 10+2 Science, with the aggregate marks of 50% or above is eligible for admission to the second year (lateral entry) BSc. MRIT but subject to the availability of the seats in the Institution.

2. Duration of the Course: 3 years and 1 year of Internship.

3. Medium of Instruction and language of Examination: English

4. Academic Programme: During an academic year, a candidate shall be enrolled only for one programme of studies and shall not appear in any other examination of this or other university.

5. Commencement of the Course: 1st August of each academic year.

6. Commencement of Examination: Examination will be fixed by University after due consultation with the concerned Head of the Institution / department.

7. Working Days: Each academic year shall consist of not less than 180 working days.

8. Registration: A candidate admitted to the course shall register with the Manipur University by remitting the prescribed fees along with the application form for registration duly filled in and forwarded to the University through Head of the Institute/Head of Department within the stipulated date.

9.**Examination:**

There shall be yearly examination to assess the students of BSc. MRIT course.

Eligibility for appearing in examination: A candidate attending less than 75% classes will not be eligible to appear in the University examination.

a) The duration of Examination in theory papers will be of 3 (three) hours and the practical paper will be of 2(two) hours, unless specified otherwise.

b) Maximum number of attempts permitted for each paper is 3 including first attempt.

c) The maximum period to complete the course will be 6 years including 1 (one) year of internship.

d) A student shall not be declared to have passed the examination unless he/she secures at least 50% marks in each theory and practical papers separately after adding the Internal Assessment (IA) marks.

Question Papers:

Total marks for each subject / paper will be 200.

Theory: 100 marks for theory plus 30 marks from internal assessment for theory.

Practical: 50 marks for practical plus 20 marks of internal assessment for practical.

e) External Examiners: External Examiners when and where necessary are to be appointed by the Manipur University from the panel of external examiners approved by relevant academic bodies.

f) Compartmental examination : A compartmental examination shall be conducted within 3 months of declaration of result of the annual (1^{st}, 2^{nd} and 3^{rd}) examination.

g) Internal Assessment (IA):

The internal assessment of 50 marks in each paper shall be assessed from Written examination, Assignment, Seminar and Attendance.

Candidate should have scored a minimum of 50% in Internal assessment of Theory and 50% in Internal assessment of Practicals separately.

The teacher concerned shall have the flexibility to alter the weightages of the parameters in the internal assessment depending on the feasibility of the paper concerned and also on the total marks of the internal assessment.

- Attendance Marks (Max marks):
  The allotment of marks for attendance shall be as follows:

90% and above	5 marks
85% and less than 90%	4 marks
80% and less than 85%	3 marks
75% and less than 80%	2 marks
Attendance less than 75%	1 mark

* The marks for the internal assessment for each paper shall be submitted to the Controller of examination of the university through the Director /Principal / Head / Co-ordinator of the institute / College / Department / Centre before the commencement of the year end examination in question.

h) Date of Examination: As notified by University examination.

i) The result of the successful candidates will be classified at the end of the University examination on the basis of the aggregate marks obtained in all subjects.

j) Qualifying marks for a pass

i) Candidate has to pass separately in Theory and Practical including Viva Voice by getting a minimum of 50% marks in the aggregate marks obtained including internal assessment and Final University Examination.

Declaration of result:

- A successful candidate obtaining 75% and more marks in the grand total aggregate in the first attempt shall be declared to have passed with Distinction.
- A successful candidate obtaining 60% and more but less than 75% of marks in the grand total aggregate shall be declared to have passed with First Class.
- A successful candidate obtaining 50% and more but less than 60% of marks in the grand total aggregate shall be declared to have passed with Second Class.
- A candidate securing 75% or more marks in any papers (Theory + Practical) will be awarded honours in that paper or papers.

Note:- For the lateral entry candidate, Diploma marks will be considered as 1st year. Aggregate may be calculated only from 2nd and 3rd year.

1st Division /Class -	60% and above
2nd Division /Class -	Above 50% below 60%

Practical Training: A practical training of 12 months after completion of Final examination of 3rd year is compulsory as Internship (Adjustment of study tour and project etc. shall be made within this period)

ii) If a candidate fails in either theory or practical, he / she has to re-appear for both theory and practical examination.

iii) Promotion to successive year / next year:

Candidate shall be promoted to the successive year /next year after passing all the requisite yearly exam conducted by Manipur University. Candidate who have passed in not less than 50% of the total papers offered in the yearly examination conducted by the University shall also be provisionally allowed to join the next year to the payment of all fees and dues etc. However such candidates shall have to appear for the back log papers in the next corresponding yearly examination with the payment of examination fees and filling up of the examination form.

10. Maximum duration for completion of the course.

a) The candidates shall be eligible for the Degree of Bachelor of Science in BSc. Medical Radiology and Imaging Technology when they have undergone the prescribed course of study for a period of not less than three years and have passed the prescribed examinations in all subjects.

b) The maximum period to complete the course successfully should not exceed 6 years including 1 (one) year of internship.

11. Completion on Internship: Students before obtaining certificate and mark sheets should obtain satisfactory certificate of completion of Internship from the Head / Dean of Institute. Project, study tour and other course will be done during internship programme as decided by the department.

12. Re-evaluation of Answer Papers: Re-evaluation of answer script will be as per rules and regulation of Manipur University.

13. The University shall ammend the rules and regulations for improvement and from time to time.

14. Course Structure: Proposed subjects / paper in BSc. Medical Radiology and Imaging Technology (Both theory and practical in the various subjects are given below).

Model Curriculum Outline:

Distribution of Teaching Hours in PHASE I (First Year)

Sl. No.	SUBJECT	THEORY (NO. OF HOURS)	PRACTICAL (NO. OF HOURS)	TOITAL (NO. OF HOURS)
1	Human Anatomy	50	50	100
2	Physiology	50	50	100
3	Biochemistry	50	50	100
4	Pathology	50	50	100
5	Microbiology	50	50	100
Total		250	250	500

Distribution of Teaching Hours in PHASE II (Second Year)

SL.NO.	SUBJECT	THEORY (NO. OF HOURS)	PRACTICAL (NO. OF HOURS)	TOTAL (NO. OF HOURS)
1	Radiological Physics-I	50	50	100
2	Radiography and Imaging-I	50	50	100
3	Communication Skill and Computer Sciences (English & computer)	50	50	100
4	Medical Law and Ethics Medical Terminology & Record Keeping	25 +25 =50	50	100
5	Health care System &Research Methodology with Biostatistics	50	50	100
Total		250	250	500

Distribution of Teaching Hours in PHASE III (Third Year)

SL.NO.	SUBJECT	THEORY (NO. OF HOURS)	PRACTICAL (NO. OF HOURS)	TOTAL (NO. OF HOURS)
1	Radiological Physics -II	50	50	100
2	Radiography and Imaging-II	50	50	100
3	Radiological Physics -III	50	50	100
4	Radiography and Imaging-III	50	50	100
5	Quality Control, Assurance, Radiation Safety and Regulations	50	50	100
Total		250	250	500

Distribution of marks for Phase I(First Year) University Examination

SL.NO.	SUBJECT	THEORY (External Assessment)	THEORY (Internal Assessment)	PRACTICAL (External Assessment)	PRACTICAL (Internal assessment)	TOTAL
1	Human Anatomy	100	30	50	20	200
2	Physiology	100	30	50	20	200
3	Biochemistry	100	30	50	20	200
4	Pathology	100	30	50	20	200
5	Microbiology	100	30	50	20	200
Total						1000

Distribution of marks for Phase II(second Year) University Examination

Sl. No.	SUBJECT	THEORY (external assessment)	THEORY (internal assessment)	PRACTICAL (external assessment)	PRACTICAL (internal assessment)	TOTAL
1	Radiological Physics-I	100	30	50	20	200
2	Radiography and Imaging-I	100	30	50	20	200
3	Communication Skill and Computer Sciences(English & computer)	100	30	50	20	200
4	Medical Law and Ethics Medical Terminology & Record Keeping	50 + 50=100	30	50	20	200
5	Health care System &Research Methodology with Biostatistics	100	30	50	20	200
Total		500	150	250	100	1000

Distribution of marks for Phase III(Third Year) University Examination

Sl. No.	SUBJECT	THEORY (external assessment)	THEORY (internal assessment)	PRACTICAL (external assessment)	PRACTICAL (internal assessment)	TOTAL
1	Radiological Physics –II	100	30	50	20	200
2	Radiography and Imaging-II	100	30	50	20	200
3	Radiological Physics- III	100	30	50	20	200
4	Radiography and Imaging –III	100	30	50	20	200
5	Quality Control, Assurance, Radiation Safety and Regulations	100	30	50	20	200
Total		500	150	250	100	1000

Distribution of Type of Questions and Marks for Various Subjects

THEORY SUBJECTS HAVING MAXIMUM MARKS = 100
(for Phase I, Phase II and Phase III)

Type of Questions	No. of Questions	Marks for Each Questions
Long Essay	02	10
Short Essay	10	05
Short Answer	10	03

THEORY SUBJECTS HAVING MAXIMUM MARKS = 100
(for Phase I,

1. Long essay- 2 Questions (Second question choice) 2x10= 20 marks
2. Short essay- 10 Questions (Questions no 5 &10 choice) 10x5= 50 marks
3. Short answer- 10 Questions (Questions no 15 & 20 choice) 10x3= 30 marks

Total= 100

INTERNSHIP- minimum 1440 hours (calculated based on 8 hours per day, if 180 working days in a year)

Sl.No.	**Posting**	**Duration**
1.	Conventional radiography	2 months
2.	Radiographic special procedures including diagnostic and Therapeutic Interventional Procedures & Mammography	1 month
3.	CR, DR and PACS	2 months
4.	Record keeping & patient care	1 month
5.	Ultrasonography & Doppler imaging	2 months
6.	Computed Tomography	2 months
7.	Magnetic Resonance Imaging	2 months

PHASE –I BSc MRIT
(FIRST YEAR)

ANATOMY
Theory: 50 hours
Practical's: 50 hours

Introduction:

• Definition of anatomy and its divisions
• Terms of location, positions and planes
• Epithelium-definition, classification, describe with examples, function
• Glands- classification, describe serous, mucous & mixed glands with examples
• Basic tissues – classification with examples

Connective tissue:

• Cartilage – types with example & histology theory
• Bone – Classification, names of bone cells, parts of long bone, microscopy of compact
• bone, names of all bones, vertebral column, intervertebral disc, fontanelles of fetal skull
• Joints – Classification of joints with examples, synovial joint (in detail for radiology)
• Muscular system: Classification of muscular tissue & histology
• Names of muscles of the body

Cardiovascular system:

• Heart-size, location, chambers, exterior & interior, pericardium
• Blood supply of heart
• Systemic & pulmonary circulation
• Branches of aorta, common carotid artery, subclavian artery, axillary artery, brachial artery, superficial palmar arch, femoral artery, internal iliac artery
• Inferior vena cava, portal vein, portosystemic anastomosis, Great saphenous vein, Dural venous sinuses
• Lymphatic system- cisterna chyli & thoracic duct, Histology of lymphatic tissues, Names of regional lymphatics, axillary and inguinal lymph nodes in brief

Gastro-intestinal system Theory:

• Parts of GIT: Oral cavity (lip, tongue (with histology), tonsil, dentition, pharynx, salivary glands, Waldeyer's ring), Oesophagus, stomach, small and large intestine, liver, gall bladder, pancreas, spleen, peritoneum & reflections

Respiratory system

• Parts of RS: nose, nasal cavity, larynx, trachea, lungs, bronchopulmonary segments, diaphragm
• Histology of trachea, lung and pleura
• Names of paranasal air sinuses

Urinary system:

• Kidney, ureter, urinary bladder, male and female urethra
• Histology of kidney, ureter and urinary bladder

Reproductive system:

• Parts of male reproductive system, testis, vas deferens, epididymis, prostate (gross & histology)
• Parts of female reproductive system, uterus, fallopian tubes, ovary (gross & histology) •
• Mammary gland – gross

Endocrine glands:

• Names of all endocrine glands in detail on pituitary gland, thyroid gland& suprarenal gland – (gross & histology)

Nervous system:

• Neuron & Classification of NS

• Cerebrum, cerebellum, midbrain, pons, medulla oblongata, spinal cord with spinal nerve (gross & histology) Meninges, Ventricles & cerebrospinal fluid, Names of basal nuclei

• Blood supply of brain

• Cranial nerves

• Sympathetic trunk & names of parasympathetic ganglia

Sensory organs:

• Skin: Skin-histology & Appendages of skin

• Eye: Parts of eye & lacrimal apparatus, Extra-ocular muscles & nerve supply

• Ear: parts of ear- external, middle and inner ear and contents

Embryology:

• Spermatogenesis & oogenesis

• Ovulation, fertilization

• Fetal circulation

• Placenta

PHYSIOLOGY

Theory: 50 hours
Practical's: 50 hours

General Physiology

• Introduction to cell physiology, transport across cell membrane, Homeostasis.
• Body Fluid compartment & measurement.

Blood

• Introduction- composition and function of blood Plasma proteins, types and functions
• Red blood cells - erythropoiesis, stages of differentiation, factors affecting it, function, normal count, physiological variation.
• Hemoglobin- function, concentration, types & methods of Hb estimation, fate of hemoglobin Jaundice- types Anemia, - types
• ESR, PCV, osmotic fragility & blood indices
• WBC- morphology, production, functions, normal count, differential count, variation, variation Immunity (in brief)
• Platelets- origin, morphology, normal count, function-Platelet plug, bleeding disorder
• Haemostasis - definition, normal haemostasis, clotting factors, mechanism of clotting, anticoagulants disorders of clotting factors.
• Blood group-ABO & Rh system, Rh incompatibility blood typing, cross matching, hazards of mismatched blood transfusion
• RES, spleen and lymph.

Nerve and Muscle

• Neuron structure, types, neuroglia-types, nerve fiber classification, properties of nerve fibers, RMP, action potential, wallerian degeneration
• NMJ, blockers, Myasthenia gravis
• Classification of muscle, structure of skeletal muscle, sarcomere, contractile proteins, Excitation, contraction, coupling, mechanism of muscle contraction, types of contraction, Motor unit, fatigue, rigor mortis, Smooth muscle.

Respiratory system

• Physiological anatomy of respiratory system, muscles of respiration, respiratory & non respiratory functions of lungs, dead space
• Mechanics of breathing, intrapulmonary & pleural pressures Compliance, Surfactant, Hyaline membrane disease
• Lung volumes and capacities
• Respiratory membrane, transport of O2 & CO2
• Chemical regulation of respiration Neural regulation of respiration Hypoxia, Acclamatization, Dysbarism. Artificial respiration
• Definition-Periodic breathing, dyspnoea, apnoea, asphyxia, cyanosis.

Cardiovascular system

• Introduction to CVS & general principles of circulation Properties of Cardiac muscle Cardiac cycle, heart sounds, Pulse Cardiac output, factors and measurement Heart rate
• BP-factors, measurement, Short term regulation Intermediate and long-term regulation of BP
• ECG uses and significance, normal waveform, heart block Coronary circulation, Cutaneous circulation- Triple response Shock
• Effects of exercise on CVS and Respiratory system.

Renal system, Skin and body temperature

• Kidneys- functions, structure of nephron, type, juxtaglomerular apparatus-structure and function, non- excretory functions of kidney.

• Glomerular filtration rate (GFR)- Definition, normal value, factors affecting GFR Tubular reabsorption - sites, substance reabsorbed, mechanisms of reabsorption Tubular secretion- sites, substance secreted, mechanisms of reabsorption.

• Counter current mechanism of concentration of urine Obligatory and Facultative reabsorption of water Micturition reflex, Diuretics.

• Artificial kidney, renal function tests-clearance tests

• Skin -structure and function, body temperature measurement, physiological variation.

• Regulation of body Temperature by physical chemical and nervous mechanisms-Role of Hypothalamus Hypothermia and fever.

Digestive system

• Physiological anatomy, Enteric nervous system & functions of GIT Saliva- composition, regulation, disorder.

• Deglutition- stages & disorders

• Stomach-functions, composition and regulation of gastric juice Gastric motility, MMC, vomiting reflex. Pancreas- function, composition and regulation of pancreatic juice

• Liver & gall bladder-functions, bile- composition, secretion and regulation Small intestine- Succus entericus-composition, functions & movements Large intestine- functions, movements and defecation reflex

• Digestion & absorption of Carbohydrates, fats and proteins.

Endocrine system

• Classification of Endocrine glands & their hormones & properties-chemistry and receptor, feedback mechanisms of hormone regulation.

• Anterior pituitary hormones- secretion, functions, disorders Posterior pituitary hormones- secretion, functions, disorders Thyroid hormones- secretion, functions, disorders

• Parathyroid hormones- secretion, functions, disorders Calcium homeostasis & disorders Pancreatic hormones, -Insulin and Glucagon secretion, functions, disorders

• Adrenal cortex- Glucocorticoids & Mineralocorticoids, Androgen - secretion, functions, disorders Adrenal medulla- secretion, functions, disorders Thymus & Pineal gland.

Reproductive system

• Introduction to reproductive system, sex differentiation & Puberty Male reproductive system, functions of testosterone & Spermatogenesis

• Female reproductive system, functions of Estrogen, Progesterone, Oogenesis Ovulation & Menstrual cycle Physiological changes during pregnancy, pregnancy tests, parturition & lactation Male & Female contraceptive methods.

Central nervous system

• Introduction to CNS, Sensory receptors classification, properties Synapse– classification, properties Sensory pathways: Anterior spin thalamic tract and Posterior column pathway

• Lateral spin thalamic tract, Types of pain, Referred pain, Thalamus; nuclei and function

• Classification of reflexes, Monosynaptic reflex- Stretch reflex, muscle spindle, inverse stretch reflex. Polysynaptic reflex-Withdrawal reflex

• Motor pathways: Pyramidal pathway and functions, UMNL, LMNL Cerebral cortex (Sensory and motor)- functions, Medulla and Pons-functions Cerebellum –functions, disorders

• Basal ganglia-functions, disorders Hypothalamus and Limbic system-functions CSF, lumbar puncture Sleep, EEG,

• Autonomic Nervous System - Sympathetic and parasympathetic distribution and functions.

Special senses

• Vision –Functional anatomy of eye, visual pathway, lesion Refractive errors, color vision

• Audition – Physiological anatomy of ear, Mechanism of hearing, auditory pathway, deafness Olfaction – modalities, receptor, function, abnormalities

• Gustation-modalities, receptor, function, taste pathway, abnormalities.

BIOCHEMISTRY

Theory: 50 hours
Practical's: 50 hours

Carbohydrate Chemistry

• Classification (Definition/ examples for each class)
• Monosaccharides (classification depending upon number of carbon atoms and functional group with examples)
• Disaccharides (Sucrose/ lactose/ maltose and their composition) • Polysaccharides:
a) Homopolysaccharides (Structure of starch and glycogen)
b) Heteropolysaccharides (Functions).

Lipid Chemistry

• Definition of lipids
• Functions of lipids in the body
• Classification of lipids (subclasses with examples)
• Definition and Classification of fatty acids
• Essential fatty acids
• Phospholipids and their importance

Amino-acid and Protein Chemistry

• General structure of D and L amino acids
• Amino acids; Definition and Classification of amino acids with examples.
• Peptides; definition & Biologically important peptides
• Classification of Proteins based on composition, functions and shape (with examples) • Functions of amino acids and Proteins.

Nucleotide and Nucleic acid Chemistry

• Nucleosides & Nucleotides
• Nucleic acid Definition & types
• Composition & functions of DNA & RNA
• Structure of DNA (Watson and Crick model)
• Structure of tRNA, & functions of tRNA, rRNA, mRNA
• Difference between DNA and RNA.

Enzymes

• Definition & Classification of Enzymes with example • Definitions of Active site, Cofactor (Coenzyme, Activator),
• Proenzyme; Definition and examples (Pepsin & trypsin).

Digestion and Absorption

• General characteristics of digestion and absorption,
• Digestion and absorption of carbohydrates, proteins and lipids.

. Carbohydrate Metabolism

• Glycolysis; Aerobic, Anaerobic, Definition, Site and subcellular site, Steps with all the enzymes and coenzymes at each step, mention the regulatory enzymes, Energetics,
• Citric acid cycle; Pyruvate dehydrogenase complex (reaction and coenzymes), Site and subcellular site, Reactions with all the enzymes and coenzymes, Regulatory enzymes, Energetics
• Significance of HMP Shunt pathway.
• Hyperglycemic and hypoglycemic hormones
• Blood Glucose Regulation.

• Diabetes mellitus (definition, classification, signs and symptoms)
• Glycogen metabolism and gluconeogenesis.

Lipid Metabolism

• Introduction to lipid metabolism, Lipolysis
• Beta oxidation of fatty acids; Definition, Site and subcellular site, Activation of palmitic acid, Transport of activated palmitic acid into mitochondria, Reactions, Energetics.
• Name the different ketone bodies. Note on ketosis.

Amino acid and Protein Metabolism

• Introduction, transamination, deamination, Fate of ammonia, transport of ammonia, • Urea cycle.

Vitamins

• Definition and classification.
• RDA, sources, coenzyme forms, biochemical functions and disorders for the following watersoluble vitamins: Thiamine, Niacin, Pyridoxine, Cobalamine, Folic acid, Ascorbic acid
• RDA, sources, coenzyme forms, biochemical functions and deficiency disorders for the following fat-soluble vitamins; A and vitamin D.

Mineral Metabolism

• Name the macro/ microminerals
• Iron: Sources, RDA, Functions and Disorders of deficiency and excess
• Calcium and phosphorus: Sources, RDA, functions, normal serum levels and hormones regulating their levels.

Nutrition

• Balanced diet (Definition)
• Caloric value; Definition, Caloric values of carbohydrates, proteins and fats
• Total daily caloric requirements of an adult male and female,
• RDA (Definition, standard values for nutrients)
• Basal metabolic rate (BMR); Definition, Magnitude of BMR in men and women, Factors affecting BMR
• Thermic effect/ SDA of food (Definition, values for major macronutrients) • Carbohydrates: Daily dietary requirement.
• Dietary fibers (Definition, functions, importance and their daily requirements)
• Proteins: Daily requirement, Biological value. a. Definition b. Protein used as a standard for this, Protein sources with high and low biological value, Mutual supplementation of proteins
• Fats: Daily requirement, Essential fatty acids (Definition, functions, daily requirement and deficiency manifestations), Saturated and unsaturated fatty acids (Definition, sources, examples).
• Malnutrition

Renal Function Tests

• Name the different tests to assess the kidney functions
• Explain Creatinine clearance & Inulin clearance
• Urinary acidification test

Radioactive Isotopes

• Definition, clinical applications
• Biological effects of radiations

Clinical Biochemistry

A. Definitions of acid, base, pH and pKa [1 hour]
B. Buffers • Definition [2 hours]
• Henderson Hasselbalch equation,
• Principal buffer systems in the ECF ICF and urine

• Bicarbonate and phosphate buffer systems (pKa value, normal ratio of base/acid in the plasma)
• Acidosis & Alkalosis: Definition, classification, causes and biochemical findings, Normal serum levels and condition where they are altered
• Glucose, Protein, urea, uric acid, and creatinine
• Bilirubin, cholesterol
• Serum Electrolytes

Fundamental Chemistry

• Valency, Molecular weight & Equivalent weight of elements and compounds. Normality, Molarity, Molality.

Solutions: Definition, use, classification where appropriate, preparation and storage

• Stock and working solutions.
• Molar and Normal solutions of compounds and acids. (NaCl, NaOH, HCl, H_2SO_4, H_3PO_4, CH_3COOH etc.,)
• Preparation of percent solutions – w/w, v/v w/v (solids, liquids and acids), Conversion of a percent solution into a molar solution
• Saturated and supersaturated solutions
• Standard solutions. Technique for preparation of standard solutions and Storage. E.g: glucose, albumin etc.
• Dilutions- Diluting Normal, Molar and percent solutions. Preparing working standard from stock standard.

PATHOLOGY

Theory: 50 hours
Practical's: 50 hours

Clinical Pathology
• Introduction to clinical pathology
• Collection, transport, preservation and processing of various clinical specimens
• Urine examination- collection and preservation, Physical, chemical and microscopic examination for abnormal constituents
• Examination of Body fluids
• Examination of Cerebrospinal fluid (CSF)
• Sputum examination
• Examination of feces

Hematology
• Introduction to hematology
• Normal constituents of Blood, their structure and functions
• Collection of Blood samples
• Various anticoagulants used in Hematology
• Hemoglobin estimation, different methods and normal values
• Packed cell volume
• Erythrocyte sedimentation rate
• Normal Haemostasis
• Bleeding time. Clotting time, prothrombin time, Activated partial Thromboplastin time

Blood Bank- Theory
• Introduction blood banking
• Blood group system
• Collection and processing of blood for transfusion
• Compatibility testing
• Blood transfusion reactions

General Pathology:
1. Cell injury:
a. Definition, causes.
b. Cellular adaptations – Hypertrophy, hyperplasia, atrophy and metaplasia.
c. Types of cell injury – Reversible and irreversible; morphology of reversible injury.
d. Necrosis – Definition and patterns of tissue necrosis.
e. Intracellular accumulations – Lipids, cholesterol, proteins, glycogen and pigments; examples.
f. Pathologic calcification – Types and examples.

2. Inflammation:
a. Definition and signs of inflammation.
b. Types – Acute and chronic inflammation.
c. Acute inflammation – Causes, morphological patterns and outcome.
d. Chronic inflammation – Causes, morphology and examples.
e. Regeneration and repair – Mechanism of cutaneous wound healing.
f. Factors affecting wound healing.

3. Hemodynamic disorders:

a. Edema – Definition, pathogenesis and types: Renal, cardiac, pulmonary and cerebral.

b. Difference between transudate and exudate.

c. Shock – Definition, types of shock with examples: Hypovolemic, cardiogenic and septic shock, stages of shock: Nonprogressive, progressive and irreversible.

d. Thrombosis – Definition, mechanism of thrombus formation (Virchow's triad) and fate of thrombus.

e. Embolism – Definition and types: Thromboembolism, fat, air and amniotic fluid embolism. f. Infarction – Definition and examples.

4. Immune system:

a. Autoimmune diseases – General features, enumerate systemic and organ specific autoimmune diseases.

b. Systemic lupus erythematosus – Manifestations and diagnosis.

5. Neoplasia:

a. Definition and nomenclature of tumors.

b. Differences between benign and malignant neoplasms.

c. Enumerate modes of carcinogenesis: Genes, physical, chemical and microbial agents of carcinogenesis.

d. Modes of spread of tumors.

e. Clinical aspects of neoplasia.

f. Grading and staging of cancers.

g. Laboratory diagnosis of cancer

MICROBIOLOGY

Theory: 50 hours
Practical's: 50 hours

Introduction
• History of Microbiology - Louis Pasteur, Antony Van Leeuvenhoek, Robert Koch, Edward Jenner, Alexander Fleming.
• Use of microscope in the study of bacteria - Types of microscopes - compound microscope, phase contrast microscope, electron microscope, fluorescent microscope, dark ground microscope.
• Morphology of bacterial cell
Growth and Nutrition
• Nutrition, growth and multiplication of bacteria, bacterial growth curve, culture media, culture methods, anaerobic culture methods.
Sterilization and disinfection (8 hours)
• Principles and use of equipment's of sterilization, chemicals used in disinfection, testing of disinfectants.
Biomedical waste management principle and practice 5. Immunology
• Immunity - mechanism of immunity, classification, types Vaccines
• Immunization schedule
• Definition of antigen, antibody, list of antigen antibody reaction (no need of detailed account of antigen antibody reactions)
• Definition of hypersensitivity and classification (no need of detailed account of types of hypersensitivity)
Infection
• Definition, types and mode of transmission
• Hospital acquired infection - causative agents, mode of transmission and prophylaxis. Antimicrobial sensitivity testing
Systematic bacteriology
• Disease caused and laboratory diagnosis of medically important bacteria (Staphylococcus, coagulase negative Staphylococcus, MRSA, Streptococcus pyogenes, Pneumococcus, gonococcus, E.coli, diarrhoeagenic E.coli, Salmonella, Vibrio cholerae, ElTor vibrios, Halophilic vibrios, Shigella, Mycobacterium tuberculosis, Mycobacterium leprae, Atypical Mycobacteria, Treponema pallidum, leptospira)
(no need of classification, antigenic structure, virulence mechanism)
Parasitology
• Introduction to Parasitology
• List of medically important parasites and diseases (E.histolytica, Plasmodium, W.bancrofti, Ascaris, Ancylostoma, B.coli, G.lamblia, T.solium, T.saginata)
• Laboratory diagnosis of parasitic infection (No need of including life cycles)
Virology
• Introduction to virology
• List of medically important viruses and diseases (AIDS, Hepatitis, Rabies, Polio, Arbo viruses)
Cultivation of viruses and laboratory diagnosis of viral infections.

Mycology

• Introduction to Mycology

• Classification of medically important fungi - (based on morphology, spore production, disease production, taxonomy)

• List of medically important fungi and diseases (Candidiasis, Cryptococcosis, Dermatophytes, Aspergillosis, Mucor Mycosis) • Laboratory diagnosis of fungal infections.

PHYSICS-I

Theory: 50 hours
Practical's: 50 hours

OBJECTIVE
Student will have an understanding of important areas in Physics, knowledge of which are essential to appreciate the principles and functioning of equipment and various physical and chemical processes in Medical radiological imaging

Areas covered
1. Units
2. Mechanics
3. Electricity
4. Electronics
5. Magnetism
6. Acoustics
7. Optics
8. Heat
9. Atomic structure and related areas
10. Radioactivity
11. Basics of biological effects of ionizing radiation
12. Basics of radiation protection

CONTENT
Physical quantity, its unit and measurement
Fundamental and derived quantity, SI unit, various physical/radiation quantity used in diagnostic radiology and its unit (for example, KvP, mA, mAS, Heat unit (HU), Radiation exposure, Absorbed dose, Equivalent dose, etc.). Measurements, significant figures/digits in calculation, uncertainty in measurement,
Propagation of errors
Radiation Physics and Mathematics
Number system, graphical representation of complex number, co-ordinates system, relation between polar and Cartesian co-ordinate, exponents, logarithms (to base 10 and e), exponential and logarithmic functions, representation of a function, continuous and discrete function. Trigonometric ratio, use of sine and cosine rules, Limit and continuity of a function, Derivative of a function, rule of differentiation, Integration, definite integral, line integral, Area under curve, infinite and indefinite integrals. partial derivatives of a function,
Note: These topics should be discussed in brief and emphasis should be given on understanding the meaning of the mathematical terms and its application in diagnostic radiology.
Mechanics
Scalar and vector quantity, speed, velocity and acceleration, Equation of motion under constant/uniform acceleration ($v = u+ at$, $S = ut + ½ at2$, $v2 = u2 + 2aS$), relative velocity, projectile, Newton's law of motion, conservation of linear momentum, Basic forces in nature (Gravitational force, electrostatic force, magnetic force, electromagnetic force, the strong and weak forces), study of forces in equilibrium.
Work and Energy, forms of energy : kinetic and potential energy, conservation of energy, work done by constant forces, work done by variable forces. Elastic and inelastic collisons.

Rotational motion : Angular displacement (in degrees and radians), angular velocity, centripetal acceleration, centripetal force.

Sound

The nature and propagation of sound wave (the characteristics of sound, wave theory), speed of sound in a material medium, intensity of sound, the decibel, Interference of sound waves, beats, diffraction, Doppler's effect, Ultrasonic wave, production of ultrasonic wave (piezo-electric effect) in ultrasonography. Use of principle of Doppler's effect in Diagnostic radiology (e.g. Echo, blood flow measurement).

Heat

Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transfer-conduction, convection, radiation, thermal conductivity, equation for thermal conductivity (k), the value of k of various material of interest in radiology, thermal expansion, Newton's law of cooling, Heat radiation, perfect black body, Stefan law, application in diagnostic radiology (Heat dissipation in both stationary and rotating X-Ray tubes).

Electrostatics

Electric charge (positive and negative charge), Coulomb's law, Electric field, electric potential and potential difference, equipotential lines, the eV (electron volt), Electric potential due to a point charge,Capacitance, dielectric, Capacitor, series and parallel combination of capacitors, energy stored on capacitor, charging and discharging of capacitors, use of capacitors in diagnostic radiology (e.g Mobile X-Ray generators, radiation detectors etc.).

Electricity and Magnetism

DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Krichoff's law, heating effect of current, Ammeter, voltmeter, Galvanometer. Magnets and magnetic field, force on an electric current in a magnetic field, force on electric charge moving in a magnetic field, magnetic field due to straight wire ; force between two parallel wires, Ampere's law, electromagnet and solenoids.

Electromagnetic Induction (A.C. Circuit)

Induced EMF, Faraday's Law, Lenz's law, EMF induced in a moving conductor, changing magnetic flux produces electric field, Transformer, Inductance, Energy stored in a magnetic field, resonance in A.C circuit.

Light

Index of refraction, Snell's law, total internal reflection, lens law, rectilinear propagation of light, umbra and penumbra effect, use of principle of rectilinear propagation of light in radiology (e.g. magnification, patient positioning device, setting areas for exposure, etc.).

Photometry : Total radiation flux, luminosity of radiant flux, Luminous flux : relative luminosity, luminous efficiency, Illuminance, Inverse square law, Lambert's cosine law.

Electromagnetic waves

Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atomsphere.

Atomic structure

Atomic and nuclear structure (protons, neutrons, electrons), Atomic number, atomic masses, nuclides and isotopes, early atomic models, the hydrogen spectra, difficulties with Rutherford's model, Bohr's model, limitations of Bohr's model, the wave function of an electron, Quantum mechanics of hydrogen atom, Quantum numbers, Pauli exclusion principle, periodic table of element.

Radioactivity

Structure and property of nucleus, Nuclear forces, Binding energy, Radioactive decay, law of radioactive decay (decay equation, half-life, mean life), excitation, ionization, characteristic X-Ray, charts of radionuclides,alpha, beta, positron, gamma emissions, Modes of decay, Auger electrons, electron capture, isomeric transitions, internal conversion, Naturally occurring radio-nuclides.

Semiconductors and Semiconductor devices

Introduction, energy bands in solids, the semiconductor, p-type and n-type semiconductors, density of charge carriers and conductivity, p-n junction, p-n junction diode, p-n junction diode as rectifier (halfwave and full-wave rectifier), junction transistor, Logic gates.

Radiation Protection

Somatic and genetic effect of ionising radiation ; need for protection, principle of radiation protection, ALARA, radiation monitoring devices (film badge and TLD), radiation shielding devices available for protecting staff, patient and public and how to use them. (Methods of Radiation Protection of patients, radiation workers and public).

RADIOGRAPHY AND IMAGING –I

Theory: 50 hours
Practical's: 50 hours

Objectives :

1. Correctly position a patient for plain radiography (anatomical areas given in content).
2. Select and perform basic views (projections) for the above, using appropriate radiographic parameters.
3. Differentiate a properly positioned and exposed radiograph from a wrongly positioned and over or underexposed radiograph.
4. Correctly identify anatomical features displayed in radiograph obtained.

CONTENT

1. Upper extremity - basic views
2. Lower extremity (including pelvis) - basic views
3. Chest including thoracic age and sternum
4. Spine - Cervical, dorsal, lumbar, lumbo-sacral (including functional views).
5. Skull – including trauma cases
6. Facial bones (nasal bones, zygoma, orbits, maxilla)
7. Mandible, Temporo-Mandibular Joints, Mastoids, petrous temporal bones
8. Abdomen - erect, supine, lateral decubitus
9. Soft tissue radiography : Larynx, pharynx, nasopharynx, thoracic inlet
10. Dental radiography
11. General Paediatric Radiography
12. Foreign body localization
13. High kV technique

PHYSICS –II

Theory: 50 hours
Practical's: 50 hours

Objectives:

1. Describe the construction and operation of general radiographic and fluoroscopic equipment, Mammographic unit and dental radiographic equipment.
2. Control and manipulate parameters associated with exposure and processing to produce a required image of desirable quality.
3. Practise the procedures employed in producing a radiographic image.
4. Describe methods of measuring exposure and doses of radiographic beams.
5. Describe the principles and applications of basic methods of safety in diagnostic radiology.
6. Carry out quality control for automatic film processing, evaluate and act on results.

AREAS COVERED

1. X-Ray and related equipment
2. X-Ray films and film processing
3. Image characteristics
4. Interaction of ionising radiation with matter
5. Detection of ionising radiation
6. Dosimetry
7. Biological effects of ionising radiation
8. Radiation protection (related to Phase-II topics)
9. Biological effects of non-ionizing radiation
10. Quality assurance (related to Phase-II topics)
11. Presentation and viewing of radiographs
12. Mammography
13. Xeroradiography
14. Dental Radiography

CONTENT

1. Interaction of ionizing radiation with matter
2. Types of interactions of X- and gamma radiation, Photoelectric & Compton, Bremsstrahlung, pair production, annihilation radiation.
3. Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number.
4. Radiation intensity and exposure, photon flux and energy flux density.
5. LET, range of energy relationship for alpha, beta particles and X-Rays.

X-Ray production and properties

Characteristics X-Rays, factors affecting X-Ray emission spectra, X-Ray quality and quantity, HVL measurements, heel effect, soft and hard X-Rays, added and inherent filtration, reflection and transmission targets.

X-Ray tube : historical aspects, construction of X-Ray tubes, requirements for X-Ray production (electron source, target and anode material), tube voltage, current, space charge, early X-Ray tubes (coolidge tubes, tube envelop and housing) cathode assembly, X-Ray production efficiency, advances in X-Ray tubes, anode angulation and rotating tubes.

Common factors affecting thermionic emission, specialized types (metallic, biangular, fluoro, CT) grid controlled and high speed tubes, focal spot size, speed of anode rotation, target angle, inherent filtration, radiation leakage and scattered radiation).

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

X-Ray generators and circuits

Filament current and voltage, X-Ray circuits (primary circuit, auto transformer), types of exposure switch and timers, principle of automatic exposure control (AEC) 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.

Control of scattered radiation and grids/Bucky

Methods of minimizing formation of scatter radiation, effectiveness of grids [types (moving grids), composition and grid ratio) in preventing scattered radiation, use of cones, diaphragm light beam devices and effectiveness of collimation in reducing effects of scatter.
Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.

Radiation units Dosimetry and Detection of ionizing radiation

Units of radiation, ICRU definition of absorbed dose, KERMA exposure, Quality factor, dose equivalent, relationship between absorbed dose and equivalent dose.
Basic principles of ionization chambers, proportional counters, G.M counters and scintillation detectors, thermoluminiscent dosimeters, film batches.

Biological effects of radiation

Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell, DNA, RNA, chromosome, tissue and organ radiosensitivity, cytoplasm, cellular membranes, effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus stochastic and non-stochastic effects, mean and lethal dose, direct and indirect effects, multi target and multi hit theory, factors affecting radiosensitivity, RBE, survival curves, LD50 and oxygen enhancement ratio.
Biological effects of non-ionizing radiation (ultrasound, sound lasers, IR, UV and magnetic fields).

Radiation protection

Natural and background radiation (cosmic, terrestrial).
Principles of radiation protection, time - distance and shielding, shielding calculation and radiation survey, personnel dosimeters (TLD and film batches), occupational exposure, radiation protection of self and patient, ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection.

X-Ray film and Image processing

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.Latent image formation ; process of film developing (composition of fixer, developer and other processing solution), common errors and faults while processing (densitometry), automatic processing(processing cycle), developer replenishment, silver recovery and economics.
Image intensifiers and cassettes (structure and function) ; types of image intensifiers and relative advantage, loading and unloading of cassettes and their care/maintenance ; effects of kV and mA on variation of emitted radiation intensity, determination of relative speeds, film contrast, film screen contact.
Film storage, handling.

Factors affecting Image Quality

Meaning of radiographic image contrast, density, resolution, sharpness, magnification and distortion of image, noise and blur.

Radiographic illuminators and viewing conditions, visual acuity and resolution.

Quality assurance of the related equipment and its benefits w.r.t visual assessment.

Dark room design and accessories

Site, layout and safe light compatibility.

Mammography and Xerography

Background, diagnosis and screening, equipment, tube, AEC, grids, compression and image receptors, film processing and radiation dose.

Photo conduction and xerography plates, equipment exposure and developing of plates, image quality and advantage, future developments.

Portables and Mobiles

Types of mobile units, mobile image intensifiers, advantages and limitations, radiation protection.

Dental Radiography

Equipment, film types and processing.

RADIOGRAPHY AND IMAGING –II

Theory: 50 hours
Practical's: 50 hours

OBJECTIVES

1. Correctly position for radiography of a particular anatomical area.
2. Correctly select appropriate projection/projections to demonstrate the area of interest.
3. Use appropriate radiographic parameters to produce a radiograph with satisfactory results.
4. Competently use radiographic/fluoroscopic equipment and associated accessories.
5. Correctly identify anatomical features on the radiographs and identity some major pathological and traumatic conditions.
6. Help in administration of correct contrast dosage.
7. Take all correct steps for radiation protection.

CONTENT

Conventional – non-contrast radiography

Same topics as in Phase-I but additional views :

Upper extremity – lower extremity (including pelvis) – Chest (including thoracic cage) – spine - skull – facial bones – mandible, TMJ, mastoid etc. - abdomen – soft tissue radiography – dental - paediatric - foreign body localization.

For all : radiographic and technical considerations, equipment requirement, conditions essential for optimal image quality.

Conventional contrast radiography

1.Urinary system imaging (IVU, MCU, RGU)

Revision of anatomy and physiology, clinical indications and contraindications - patient preparation -contrast media used and dosage - physiological process by which urinary tract is outlined - film sequence (projection and timing), normal anatomy on films, additional techniques, radiation protection, care of patient during and after examination.

Pathological conditions of urinary system : kidneys, ureter, urinary bladder, urethra.

2. Gastrointestinal tract imaging

(Barium swallow, Barium meal upper GI, Barium meal follow through, Barium enema, small bowel enema, distal colography, defaecography).

Revision of anatomy and physiology - clinical indications and contraindications - contrast media used : preparation and dosage - patient preparation – preparation of equipment – control of radiographic and fluoroscopic equipment – film sequence – radiographic projections – radiation protection – patient management – after care of patient – radiographer's role in the team.

Pathological conditions of the GI tract.

3. Biliary system (PTC, ERCP, T-Tube cholangiography, per-op. cholangiography)

Revision of anatomy and physiology – clinical indications and contraindications – contrast media – patient preparation – film series - radiation protection – patient care - normal anatomy.

Pathological conditions of biliary system.

4. Sialography and sinography

Anatomy - Clinical indications and contraindications – patient preparation – contrast media and dosage – injection procedure – techniques for radiographic projections - radiographic appearances – radiation protection – patient care.

Pathological conditions.

5.Hysterosalpingography (HSG)

Revision of anatomy and physiology – clinical indications and contraindications – contrastinjection-

6. Procedures which are obsolete or rarely used : An overview

• Myelography – indications and contraindications – contrast used – patient preparation – injection technique – film sequence – projections – patient care
• Pelvimetry
• Oral cholecystography/intravenous cholangiography
• Dacrocystography
• Arthrography
• Discography

Conventional – non-contrast - special situations

1.Paediatric Radiography

Special needs of patient and radiographer – equipment considerations (use of dedicated equipment and accessories)
Technical considerations - the need to modify "adult" techniques – selection of exposure factors – image quality considerations – radiation protection of the patient - special techniques peculiar to children as follows :
– Anorectal malformation – contrast study
– intersex disorders - contrast study
– esophageal atresia – pre/post op.
– intussusception
– congenital dislocation of hip
– scoliosis
– Leg–length measurements
– assessment of bone age
– non accidental injury
– radiography of babies in incubators

2.Geriatric radiography

Understanding patient profile - possible difficulties during radiography – Technical considerations – need to carry out standardised projections in unconventional position – equipment and accessories – exposure factor considerations in view of variations in skeletal tissue – special care.

3. Trauma/Emergency Radiography

Limb fractures - Fracture of thoracic cage, spine, skull – GIT obstruction – lung collapse – pleural effusion – pneumo-thorax. Selection of suitable X-Ray equipment – patient position - radiographic projections and sequence for each patient – modification of routine positioning, X-Ray tube and film – radiation protection – patient care.

4. Operation theatre radiography

Operative cholangiography – orthopaedic procedures – pre-operative chest.
Strict observation of asepsis – preparation of radiographer and equipment/accessories – careful safe use of mobile and fluoroscopic equipment – radiation protection – patient care – protection of theatre staff – rapid availability of radiographic image.

5. Mammography

Anatomy and Physiology of female breast – knowledge about the nature of X-Ray beam suitable for breast imaging – equipment suitable for generating such X-radiation – image recording devices – accessories for immobilisation and identification, positioning, techniques for various projection ; exposure factors, radiation protection – technique of biopsy procedure – characteristics of benign and malignant lesions – patient care – female attendant.

PHYSICS-III

Theory: 50 hours
Practical's: 50 hours

OBJECTIVES

1. Describe the construction and operation of advanced imaging equipment : CT, MRI, Sonography, Angiography.
2. Apply quality control procedures for these equipment.
3. Discuss and apply radiation protection principles and codes of practice.
4. Have an understanding of processing of images in digital form and be familiar with recent advances in imaging.

AREAS COVERED

1. Automatic exposure devices
2. Automatic film handling systems
3. X-Ray room/dark room planning, management and maintenance of X-Ray Department
4. Image recording devices
5. Cine radiography
6. Angiography including DSA, Venography
7. C.T
8. Sonography
9. MRI
10. Digital Radiography
11. Picture Archiving and Communication Systems (PACS)
12. Quality control (for Phase-III topics)
13. Protection (related to Phase-III topics)
14. Fundamentals; concepts and applications of processing of images in digital form using computer based system
15. Newer advancements - updates

CONTENT

Advanced computerized tomography (CT)

Historical background, various generations of scanners, advancement in CT technology (helical/spiral and multi slice), ultra fast scanners

System components, CT performance parameters, image quality and methods of image reconstruction, radiation dose measurements and technical aspects of Q.A. (quality assurance).

Digital Radiography and PACS

Image acquisition, photostimulable phosphors, digital chest radiography and future developments

Picture characteristics, archiving possibilities; transfer system and designs

Image recording devices, laser imager and multiformatter

Fluoroscopic equipment and image intensifiers

Fluoroscopic screen, tilting tables, over and under couch tubes, safety features, image intensifier tubes.Types of day light film handling system, types of optical coupling and methods of viewing, recording of intensified image, CCTV, cine fluorography

Diagnostic Ultrasound

Basic physics of sound propagation in different media, production of Ultrasound (piezoelectric effect), transducer, half and quarter wave length, transmission of pulse and echo modes, Doppler Ultrasonography,

A, B and M scanning modes.

Properties of Ultrasound (propagation in tissue, absorption, scattering, reflection and refraction, acoustic impedence).

Ultrasound image formation and storage/documentation devices.

Magnetic Resonance Imaging

History, advantage over other imaging modalities, equipment terminology, physical principle, NMR signals, pulse sequences, spectroscopy parameters, hardware, site selection and safety.

Image formation and storage devices

Angiography and Cine Radiography

DSA Subtraction process, X-Ray equipment, injection pump and serial imaging devices, cine camera, optical system, X-Ray equipment and film processing

RADIOGRAPHY AND IMAGING III

Theory: 50 hours
Practical's: 50 hours

A. Equipments for Radiography and processing techniques

Objectives

Upon completion of this, students will be able to
(i) Describe the construction and operation of general radiographic equipment
(ii) Practise the procedures employed in producing a radiographic image
(iii) Control and manipulate parameters associated with exposure and processing to produce a required image quality
(iv) Carry out routine procedures associated with maintenance of imaging and processing systems.

Area covered

1. Main electric supply and distribution
2. Diagnostic X-Ray circuits/Exposure timers/AEC etc.
3. Specialized X-Ray generators - high frequency/shared
4. Cassettes/construction/types/care
5. Grid/construction/types/uses
6. Intensifying screens/construction/type/care/uses
7. Film/construction/type/used in ?
8. Diagnostic X-Ray tubes (past/present/future)
9. Tube rating and tube supports
10. X-Ray tables/bucky/bucky stands
11. Equipment for fluoroscopy and flurography
12. Equipment for mobile radiography
13. Equipment for MMR radiography
14. Equipment for dental radiography (+ Cephalu/panromax)
15. Equipment for Tomography
16. Equipment for film processing (Automatic)
17. Dark room (the processing area)
18. Film processing

CONTENTS

1. Main Electric supply and Distribution /Diagnostic X-ray circuits

The X-Ray circuit
The autotransformer
Full wave rectification two-pulse
Three phase circuit six pulse
Advantages of the 3-phase over single phase
Radiographic advantages of 3 phase X-Ray generators over single phase.
12 pulse circuit

2. Exposure timers /AEC

The electronic timer
Automatic exposure control – photo timer/iontomat
X-Ray tube overload protection circuits.
Loadix, percentage tube overload indication.

3. Specilazed X-Ray generators
High Frequency
Shared generators
4. Cassettes
Structure and function
Types - single, gridded, filmholder.
Design features and consideration with loading/unloading
Care and maintenance (cleaning)
5. Grid
Purpose and function, effect on radiation exposure, use of grid, structure and materials.
Types : stationary, parallel, focused, cross-hatch Moving grids. Purpose/advantages/disadvantages.
6. Intensifying screens
Structure and functions, common phosphors used for determination of relative speeds, types, screen mounting, care and maintenance of film screen contact.
7. Radiographic Film
Structure, properties of different parts, handling, film wrappings. Handling of exposed and unexposed films.
Types, applications, advantages/limitations of different types, safe light requirements.
8. Diagnostic X-ray tubes
The stationary anode X-Ray tube
The rotating anode X-Ray tube :
The insert/filament/anode rotation/anode/anode speed
X-Ray tube inherent and added filtration
Heavy duty X-Ray tube
The grid controlled X-Ray tube
The super rotalix metal X-Ray tube
Mammography X-Ray tube
Micro focus X-Ray tube
Super rotalix ceramic X-Ray tube
9. Tube rating & tube supports
The rating of X-Ray tubes - maximum power
Type of rectification (three phase)
Focal area
Speed of anode rotation
Heat transfer through X-Ray tube
Heat path
Anode, tube housing cooling chart
X-Ray tube supports
Floor stands
Floor to ceiling stands
'C' aim supports
Advantages of ceiling suspend tubes
10. X-ray tables/bucky & LBD
Floating top table
Variable height table
The vertical bucky
The versatile bucky

Limitations of the primary beam/the light beam diaphargm.

11. Equipment for Fluoroscopy

Fluoroscopic equipment
The serial changer (spot film device)
Image intensifier tubes
Triple field image intensifier
Television cameras
The vidicon camera tube
The plumbicon camera tube
Kinescopy - Roll and cut film cameras
Cine fluorography - mode of operation, cine pulsing
Automatic brightness control
Quality assurance tests for fluoroscopic equipment.

12. Equipment for mobile radiography

Portable X-Ray unit
Capacitor discharge unit
Cordless mobiles
Mobile image intensifier, limitations.

13. Equipment for MMR (Mass Miniature Radiography)

Design and construction and function
Film loading, care.

14. Equipment for Dental Radiography

Intra oral radiography unit
The orthopantomograph unit (OPG)

15. Equipment for Tomography

Tomography equipment
Basic requirements and controls, attachments
Types of movements and applications
Effect on image of variation in focus object distance,
Object film distance, exposure angle, tube movement pattern

16. 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).

17. Dark Room

The processing area
Dark room design, construction, illumination, entrance safe lighting - types
Storage, shelving of films
Cleaning and maintenance.

18. Film Processing

Principles : Acidity, alkalinity, pH, the processing cycle, development, developer solution.
Fixing, fixer solution, washing, drying replenishment, checking and adjusting
Replenishment rates, manual and automatic processing
Silver recovery
Auto and manual chemicals.

B.IMAGING

OBJECTIVES

1. Student should be able to competently handle the special imaging equipment i.e. ultrasound, CT, MRI, angiographic equipment and their related accessories.
2. Demonstrate good understanding of the normal anatomy and common pathological conditions on the images obtained using these special equipment.
3. Should take all precautions in the protection of staff and patient.
4. Should have knowledge of the advantages and limitations of each equipment.

CONTENTS

1. U/S system - basic/care
Transducers - construction types and uses\
Image display and recording systems
Interventional - accessories
+ Colour Doppler /portable systems
2. CT systems (operation) – care/basic trouble shooting Present/Past/Future

3. Digital radiography systems
e.g - DSI
4. Angiography systems - present/past
DSA system - basics
DSA - accessories/choice off Catheters/guidwires Interventional accessories,
Coils/stents/chemoembo
– choice
5. Pressure Injectors - types/construction/uses programming
6. MRI equipment - basic/past/present uses accessories coils etc. Interventional accessories
7. Mammography system - construction/types accessories for interventional procedures Biopsy equipment
8. Film archieving systems - MOD/disc/PACS etc.
9. Care, choice and installation of the equipment
10. Quality assurance of special equipments and radiation protection.

SONOGRAPHY

Terminology - physical principle. Different types of machines –
Portable etc.
U/S generators, different modes, doppler U/S. clinical applications.
Image display & recording systems
Transducers (scanning probes)
Types and shapes/choice/care and maintenance
Recording devices/orientation of the image
Focus of the beam/sensitivity and gain
Artifacts/quality control
Acoustic coupling agents - Ingredients/preparation
Review of equipment - summary of applications -

Techniques for :
– Upper and lower abdominal structures
– Thyroid
– Testis
– Breast
– Neonatal Brain
– Vascular structures (including extremity)
– Pregnant abdomen

CT

Historical, digital fundamentals, computer hard wire of software. Scanner types, technologic considerations of sequential/spiral volume zoom – CT (advantages and limitations).Basic data acquisition concepts
CT – detectors technology , Image reconstruction
CT computer and image processing system,Image display, storage, recording system, CT control console
Options and accessories for CT systems.
Tools for use in CT guided Interventional procedures.
Dosimetry, image quality in CT.
Future developments.

Head and neck – thorax – abdomen – pelvis - musculo-skeletal system – spine – PNS
Anatomy – clinical indications and contraindications – patient preparation – technique – contrast media types, dose, injection technique; timing, sequence - image display – patient care – function of image processing facilities, CT anatomy and pathology of different organ systems.

Magnetic Resonance Imaging

Terminology :
– Physical principles, NMR signals
– MR system components
– The magnet system
– The reconstruction system
– Host computer, viewing archiving, hard copy
– Magnetic shielding
– RF shielding
Head and Neck, Thorax, Abdomen, Musculoskeletal System.
Clinical indications and contraindications, types of common sequences, effects of sequence on imaging, patient preparation, paramagnetic agents and dose, additional techniques and recent advances in MRI : MRS blood flow imaging, diffusion/perfusion scans etc.; strength and limitations of MRI; role of radiographer.

Angiography (including Venography)

Equipment (present and past)
serial imaging devices,subtraction process, (contrast media)
Accessories and choice - catheters, guide wires.
Intervential Angiography:
Accessories and uses e.g coils/stents
Radiation safety.

Abdominal, visceral, peripheral, cerebral and cardiac [for cerebral and cardiac arteriography – posted in Neuro- and Cardiac-Radiology Deptts., respectively]
Revision of Anatomy and Physiology, clinical indications and contraindications, types of contrast and dosage, patient preparation, equipment, outline of radiological procedure, radiographer's role in the team viz. Control of radiographic and fluoroscopic equipment, including exposure factors for serial programmes, video-recorder, procedures for subtraction, digital techniques, radiation protection, general patient management before -during and after the procedure. Vascular anatomy and pathological conditions.

Interventional Radiology

Practical interventional radiology in the diseases of the Hepatobiliary, GIT, Urology and Vascular System
(non Neuro/Cardiac).
Indications and contraindications, equipment, pitfalls and complications, role of radiographer in the team. .

Digital Radiography Systems

Image acquisition
Digital Spot Imaging (DSI)
Digital chest radiography
Future developments

Pressure Injectors:

Types, programming,injection protocols,uses.

.**Mammography system**

Background, diagnosis and screening.
Imaging requirements
Equipment - tube, compression, grids, AEC
Image receptor requirements.
Radiation dose, Image quality
Interventional - accessories
Biopsy equipment attachments.

Film archieving systems

Image recording devices
Laser imager/camera-functioning.
Multiformatter
Automatic film handling systems
Picture archieving and communications systems (PACS)
Systems designs, transfer restrictions.
Optical Disc. System (ODS)
Patient care and hospital administration
1. Hospital structure and organization
2. Radiography as a profession - professionalism, projecting professional image, professional and personal qualities (both essential and desirable) of the radiographer.
3. Communication and Relational Skills - development of appropriate communication skills with patients, verbal and non-verbal communication, appearance and behaviour of the radiographer.
4. Moving and lifting patients - hazards of lifting and manoeuvring patients, rules for correct lifting, transfer from chair or trolley to couch and vice-versa, safety of both "Lifter" and "the Lifted" must be emphasised. Highlight on handling of geriatric, paediatric and trauma patients.

5. Communicable diseases (special reference to AIDS), cross infection and prevention, patient hygiene, personal hygiene, departmental hygiene, handling of infectious patients in the department, application of asepsis, inflammation and infection processes.
6. Patient vital signs - temperature, pulse, respiration and blood pressure - normal values and methods of taking and recording them.
7. Medico-legal considerations - radiographers clinical and ethical responsibilities, misconduct and malpractice ; handling female patients, practic in pregnancy.
8. Radiological contrast media - classification, need for radiological contrast media, methods of administration, dosage, reactions to contrast media, role of the imaging department and the radiographer in management of patient with contrast reaction.

X-Ray room specifications and administrative information

Setting up of a new X-Ray unit, staff requirement, AERB (Atomic Energy Regulatory Board) specifications
for site planning and mandatory guideline

Communication Skill and Computer Sciences
(English & computer)

Theory: 50 hours
Practical's: 50 hours

Communication and soft skills

Major topics to be covered under Communication course27 –

1. Basic Language Skills: Grammar and Usage.
2. Business Communication Skills. With focus on speaking - Conversations, discussions, dialogues, short presentations, pronunciation.
3. Teaching the different methods of writing like letters, E-mails, report, case study, collecting the patient data etc. Basic compositions, journals, with a focus on paragraph form and organization.
4. Basic concepts & principles of good communication
5. Special characteristics of health communication
6. Types & process of communication
7. Barriers of communication & how to overcome

Basic computers and information science

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating system and software, and MS windows, Word processing, Excel data worksheet and PowerPoint presentation. Topics to be covered under the subject are as follows:

1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.
2. Input output devices: Input devices(keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices(monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit (CPU), main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.
5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.
8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of operating system.
10. Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Practical on fundamentals of computers -

1. Learning to use MS office: MS word, MS PowerPoint, MS Excel.
2. To install different software.
3. Data entry efficiency

Medical Law and Ethic
(including terminology & record keeping)

Theory: 50 hours
Practical's: 50 hours

Medical law and ethics

The important and relevant topics that need to focus on are as follows:
1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia
7. Organ transplantation
8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events
11. Obtaining an informed consent.

Medical terminologies and record keeping
1. Derivation of medical terms.
2. Define word roots, prefixes, and suffixes.
3. Conventions for combined morphemes and the formation of plurals.
4. Basic medical terms.
5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots.
6. Interpret basic medical abbreviations/symbols.
7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system.
8. Interpret medical orders/reports.
9. Data entry and management on electronic health record system.

Health care System &Research Methodology with Biostatistics

Health care System
Theory: 50 hours
Practical's: 50 hours

1. Introduction to healthcare delivery system
a. Healthcare delivery system in India at primary, secondary and tertiary care
b. Community participation in healthcare delivery system
c. Health system in developed countries.
d. Private Sector
e. National Health Mission
f. National Health Policy
g. Issues in Health Care Delivery System in India
2. National Health Programme- Background objectives, action plan, targets, operations, achievements and constraints in various National Heath Programme.
3. Introduction to AYUSH system of medicine
a. Introduction to Ayurveda.
b. Yoga and Naturopathy
c. Unani
d. Siddha
e. Homeopathy
f. Need for integration of various system of medicine
4. Health scenario of India- past, present and future
5. Demography & Vital Statistics-
e. Demography – its concept ealth care System &Research Methodology with Biostatistics
f. Vital events of life & its impact on demography
g. Significance and recording of vital statistics
h. Census & its impact on health policy
6. Epidemiology
i. Principles of Epidemiology
j. Natural History of disease
k. Methods of Epidemiological studies
l. Epidemiology of communicable & non-communicable diseases, disease transmission, host defense immunizing agents, cold chain, immunization, disease monitoring and surveillance
Research Methodology and Biostatistics
The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings.
1. Introduction to research methods
2. Identifying research problem
3. Ethical issues in research
4. Research design
5. Basic Concepts of Biostatistics
6. Types of Data

7. Research tools and Data collection methods
8. Sampling methods
9. Developing a research proposal
10. Accessing research literature: Use of databases and other sources
11. Understanding research design: Qualitative and quantitative methodologies - their differences and potential integration.
12. Evaluating research and its potential for informing practice. Developing research questions and devising methods for their investigation. Ethical issues in research
13. Analysis: Analysis of qualitative and quantitative data. Utilisation of appropriate software to assist in the retrieval of information and data analysis
14. Clinical audit: Distinctiveness of research and audit processes and their function
15. Research Skills and Management: The role of evidence based practice within health and welfare

Quality Control, Assurance, Radiation Safety and Regulations

Theory: 50 hours
Practical's: 50 hours

Quality Control in Radiology and Radiation Safety

1. Objectives of quality Control: Improve the quality of imaging thereby increasing the diagnostic value; to reduce the radiation exposure; Reduction of film wastage and repeat examination; to maintain the various diagnostic and imaging units at their optimal performance.
2. Quality assurance activities: Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance.
3. Quality assurance programme at the radiological faculty level: Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Quality assurance practical exercise in the X ray generator and tube; Image receptors from processing; Radiographic equipment; Fluoroscopic equipment; Mammographic equipment; Conventional tomography; Computed tomography; Film processing, manual and automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration
4. Quality assurance programme tests: General principles and preventive maintenance for routine, daily, weekly, monthly, quarterly, annually – machine calibration. Basic concepts of quality assurance – LASER printer - Light beam alignment; X-ray out-put and beam quality check; KVp check; Focal spot size and angle measurement; Timer check; mAs test; Grid alignment test; High and low contrast resolutions; Mechanical and electrical checks; Cassette leak check; Proper screen-film contact test; Safe light test; Radiation proof test; Field alignment test for fluoroscopic device; Resolution test; Phantom measurements - CT, US and MRI.
5. Quality assurance of film and image recording devices: Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution; Distortion; Artifacts of films and image recording. Monitor calibration. SMPTE pattern
6. Maintenance and care of equipment: Safe operation of equipment; Routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipments; Record keeping and log book maintenance; Reject analysis and objectives of reject analysis programme.
7. Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.

Radiation safety and regulations in diagnostic Radiology

Radiation Quantities and Units: Radiation- Radioactivity- sources -cosmic rays terrestrial radiation - - man made radiation sources. Units of radiation - Quality factor - Flux- Fluence-Kerma- Exposure- Absorbed dose- Equivalent Dose- Weighting 1. Radiation Quantities and Units: Radiation- Radioactivity- Sources of radiation - natural radioactive 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 – 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. Dose and Dosimetry, CT Dose Index (CTDI, etc.), Multiple Scan Average Dose (MSAD), Dose Length Product (DLP), Dose Profile, Effective Dose, Phantom Measurement Methods, Dose for Different Application Protocols, Technique Optimization. Dose area product in fluoroscopy and angiography systems, AGD in mammography.
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. 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.

6. Quality Assurance and quality control of Modern Radiological and Imaging Equipment which includes Digital Radiography, Computed Radiography, CT scan, MRI Scan, Ultrasonography and PACS related. Image artifacts their different types, causes and remedies, Newer Radiation safety protocols and recent advances in radiation safety including AERB guidelines.