SYLLABUS

for Courses affiliated to the

Kerala University of Health Sciences

Thrissur 680596

BACHELOR OF SCIENCE IN MEDICAL IMAGING TECHNOLOGY (MIT)

(BSc MIT)

Course Code: 026

FROM 2025 ADMISSION YEAR ONWARDS

2. COURSE CONTENT

2.1 Title of Course

The name of the course shall be Bachelor of Science in Medical Imaging Technology-B.Sc. (MIT).

2.2 Objective of the course

The course shall comprise of both theoretical and practical studies in different branches of Medical Imaging Technology and its related subjects such as.

- General (Hospital practice, Patient Care, Ethics, Computer Technology etc).
- Anatomy.
- Physiology.
- Pathology.
- Basic Physics and Electronics.
- Nuclear and Radiation Physics.
- Physics of Medical Imaging and Radiation Safety.
- Radiography, including medical image processing.
- Radiographic imaging.
- Modern Imaging and Recent Advances (including CT, MRI, Interventions, Nuclear Medicine and PET Scan etc.).

At the end of the course the candidate should be.

- Able to do independently, qualitatively good routine radiographic procedures, following standard safe practice guidelines..
- Able to do special investigations under the guidance of specialists in Diagnostic Radiology.
- Able to operate and maintain all equipments used in diagnostic Radiology under guidance of specialists in Diagnostic Radiology and Radiation physicists

2.3 Medium of instruction

Medium of instruction and examinations shall be in English.

2.4 Course outline

From the humble beginnings of plain film techniques, we are now with a wide array of imaging methods using X-rays including mammography and Computed Tomography (CT), ultrasonography, Magnetic Resonance Imaging, Radionuclide scan etc.. Modern diagnostic radiography and Medical Imaging forms an integral part of medical practice, both in making diagnosis and also in treatment.

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With the advancement of technology and need of understanding various diseases and its treatment, the role of Medical Imaging Technologist in radiological examination & Interventional procedures became inevitable in health care. A qualified Medical Imaging Technologist is skilled in both interventional and Diagnostic Radiology.

The purpose of this degree programme is to enable candidate to comprehend the various principles and techniques in diagnostic radiography and to use them in a safe way to the greater benefit of the patient. On graduation the candidate will be eligible to work as a diagnostic radiographer or Medical Imaging Technologist. This course focuses on the innumerable technical procedures for diagnosing various disease processes. The course is designed to meet the new requirements of the health sector, wherein the students are educated and trained in the technical aspects of the procedures, with a special emphasis on the Anatomy and Pathophysiology of the disease process and at times to recognise critical findings.

The primary objective of the programme is to provide the necessary understanding, knowledge, attributes and skills required to undertake appropriate diagnostic imaging examinations in a variety of clinical circumstances. This is a professional degree programme with a prescribed commitment to clinical practice. The candidate will develop knowledge of human Anatomy and the way the body works, both in health and disease.

As well as becoming a competent diagnostic radiographer and Medical Imaging Technologist, the candidate will learn about the physical, psychological and environmental factors that influence the patient-radiographer interaction. They will also acquire knowledge on radiation safety, machines in Medical Imaging, on working of a radiology department, on interaction with radiologist in an appropriate manner beneficial to the patient, and on technical assistance of procedures done by Radiologists, wherever required. Students gain adequate experience, which includes experience in the areas of Conventional X Ray Imaging and Digital Radiography, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine (NM), Ultrasonography(US), Interventional Radiography (IR), PET Scan, Picture Archival & Communication Systems (PACS) etc. Medical Imaging technology as a profession calls for considerable technological expertise.

2.5 Duration of the course.

Three years plus one year of internship. There should be at least 240 working days in an academic year. The number of hours for instruction is mentioned in the detailed syllabus

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2.6. Subjects

First Year.

	Total Hours of Instruction			
Subject	**Theory**	**Practical/ Clinics**	**Tutorials**	**Total**
Anatomy	**100**	**35**	**35**	**170**
Physiology	**100**	**35**	**35**	**170**
Pathology	**100**	**35**	**35**	**170**
General (Hospital practice, Patient Care, Ethics and Computer Technology.	**310**	**200**	**50**	**560**
Radiography and Medical Image Processing(Clinical posting)		**260**	**40**	**300**
TOTAL HOURS				**1440**

Second Year.

	Total Hours of Instruction			
Subject	**Theory**	**Practical/ Clinics**	**Tutorials**	**Total**
Basic Physics and Electronics	**100**	**50**	**50**	**200**
Nuclear and Radiation Physics	**100**	**50**	**50**	**200**
Radiography, including medical image processing.	**100**	**800**	**140**	**1040**
TOTAL				**1440**

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Third Year.

		Total Hours of Instruction		
Subject	**Theory**	**Practical/ Clinics**	**Tutorials**	**Total**
Physics of Medical Imaging and Radiation Safety	**100**	**50**	**50**	**200**
Radiographic imaging.	**100**	**250**	**50**	**400**
Modern Imaging and Recent Advances	**100**	**700**	**40**	**840**
TOTAL				**1440**

Fourth Year.

One-year compulsory rotational postings during which students have to work under the Supervision of experienced staff members in the following areas.

	Postings	**Duration**
1	Conventional radiography	2months
2	Radiographic special procedures, including diagnostic and Therapeutic Interventional Procedures	1 months
3	CR, DR and PACS	1 month
4	Nuclear Medicine/ PET	1 month
5	Ultrasonography	1 month
6	Doppler Imaging	1 month
7	Computed Tomography	2 months
8	Magnetic Resonance Imaging	2 months
9	QA and Radiation Safety	1month

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2.7 Total number of hours 5670

2.8 Content of each subject in each year

HUMAN ANATOMY, PHYSIOLOGY AND PATHOLOGY.

Knowledge of the normal structure and function of the different parts of the body is coupled with some idea of the way in which disease arises and extends, so that the technologist can assist in the various procedures used in diagnosis and treatment. Common terms used in connections with diseases of the different systems are to be studied, no detailed list of diseases is required, but an explanation of those terms which the technologist may encounter in daily work is necessary.

The training in Human Anatomy, Physiology and Pathology will include the following.

- Introduction of human body, cell and various tissues of the body.
- Embryology and development.
- Skeletal system of Human body.
- Muscles of the body.
- Circulatory System.
- The Blood.
- The main arteries and veins of the body & Lymphatic system.
- Digestive system.
- The Liver.
- The Gall bladder, Pancreas & Spleen.
- Respiratory system.
- Endocrine Organs.
- Excretory System.
- Reproductive system.
- Central Nervous System.
- Brain & Cranial Nerves.
- Spinal Cord and peripheral nerves.
- Autonomic nervous system.

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- Organs of taste and smell.

Paper I.

ANATOMY

General Anatomical Terms and Study of the regions of the body.

Description of a typical animal cell: Cell mitosis; genes; sex cell; ova and spermatozoa. Fertilisation of the ovum. Broad lines of embryonic development. Cell function and differentiation of tissues.

Structure of General Tissues: Epithelium; simple and complex epithelia; glands; skin. Connective tissue; fibrous tissue; cartilage; bone; Haversian systems; blood; numbers and types of cells in blood; clotting of blood. Muscle tissue; involuntary, voluntary and cardiac muscle. Nerve tissue.

Bones, joints and locomotors system: General description of bones, their main processes and attachments, including the skull with emphasis on the skull as a whole. Development of bones, Primary and secondary ossification centres; diaphysis, metaphysis and epiphysis. Position and function of main joints. Healing of fractures. Major muscle groups.

Thorax and Abdomen: Structure of thoracic cage, abdominal cavity; diaphragm and mediastinum.

Heart and Blood Vessels: Structure and function of the heart, pericardium, peripheral vascular system; names of main arteries and veins, circulation.

Respiratory system: Nasal passages and accessory nasal sinuses, pharynx and larynx, trachea, bronchi and lungs; pleura, nature and function of respiration.

Lymph node Groups: Lymph and tissue fluid, main lymphatic gland groups and drainage areas, lymphoid tissue and tonsil. Lymphatic system/channels, thoracic duct, thymus.

Reticulo-Endothelial system: Spleen and liver, bone marrow, extent and nature.

Alimentary system: Mouth, tongue and teeth, salivary glands, pharynx and oesophagus, stomach, small and large bowel, liver and biliary tract, pancreas, motility of the alimentary tract; digestion, absorption and metabolism, nutrition and dietetics. Rectum, appendix.

Urinary tract: Kidneys, ureters, bladder and urethra; urine formation and excretion.

Reproductive system: Male genital tract; testes, epididymis, seminal vesicle and prostate; female genital tract; fallopian tubes, ovaries, uterus,

vagina and vulva, the mammary glands; menstruation, pregnancy and lactation.

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Endocrine glands; Anatomy and function of pituitary, thyroid, para thyroids, adrenal, thymus, pancreas and gonads as endocrine organs.

Nervous system: Brain; main subdivisions and lobes; ventricular system, spinal cord, concept of motor, sensory and reflex pathways; meninges and cerebrospinal fluid; its circulation; autonomic nervous system.

Special sensory organs: Structure and function of the eye; structure and function of the ear; structure and function of the skin.

Surface markings and topographical relations; Radiographic Anatomy.
Embryology of Brain, Eye, Ear, Spinal cord, Vertebrae, Heart, Lungs, Thorax Peritoneum, Abdominal Viscera, Reproductive system, Urinary Tract etc.

SUGGESTED BOOKS.

Text books.

Anatomy and Physiology for Radiographers-C.A. Warrick.

Reference books.

1. Gray's Anatomy Descriptive and applied-T.B. Johnstor.
2. Foundation of Anatomy and Physiology-Ross and Wilson.
3. An Atlas of Normal Radiographic Anatomy-Richard & Alvin.
4. Essentials of Human Anatomy-Russell.
5. Blewett and Rackow: Anatomy and Physiology for Radiographers (Butterworth).
6. Dean: Basic Anatomy and Physiology for Radiographers (Blackwell).
7. Fitzgerald: Anatomy 1600 multiple choice question (Butterworth).
8. Hamilton et al: Surface and Radiological Anatomy (Heffer).

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Paper II

PHYSIOLOGY

Introduction.

Reticulo-endothelial system.

Blood: composition of blood, gross structure of RBC, WBC, platelets, its production and functions, physiology of the red and white blood corpuscle's. Anaemia, polycythaemia, leukopenia, leucocytosis, thrombocytopenia, pancytopenia-definition, common causes and clinical significance. Physiology of coagulation, coagulation factors, thrombus formation.

Lymph: lymph formation, functions. Allergic reactions, oedema

Urinary system: general structure and functions of kidneys. Fundamental physiology of urine formation, collection and excretion.

Respiratory system: general physiological functions of respiratory system. Mechanism of ventilation. Pulmonary circulation. Respiratory and non-respiratory functions of lung. Diffusion of gases in lungs and factors influencing diffusion of gases.

Endocrine system: brief description of endocrine organs, its hormones, functions of the hormones, diseases produced by excess and deficiency of the hormones. Thyroid hormone production, role of iodine in detail.

Digestive system: physiology of deglutition, movement of food through oesophagus, stomach, small and large intestines and defecation. Brief study of different digestive juices; its functions. Hormones involved and its role in the digestive system.

Male Reproductive system: secondary sexual characters in males and onset of puberty; functions of gonads. Male reproductive system, physiology of the sperm, normal characteristics and composition of semen, cryptorchidism.

Female reproductive system: secondary sexual characters in females and onset of puberty. Physiology of formation of ovum and menstrual cycle. Pregnancy, infertility and menopause.

Cardiovascu1ar system: general functions of cardiovascular system. Systemic pulmonary circulation. Cardiac cycle, atrial systole and diastole, ventricular systole and diastole. Pulse, blood pressure. Shock. Anaphylactic shock-detection and management.

Nervous system: general introduction and structure. Functions of central nervous

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system-motor, sensory, special senses.

CSF: formation, properties, functions and absorption.

SUGGESTED BOOKS.

Text books.

Anatomy and Physiology for Radiographers-C.A. Warrick.

Reference books.

Best and Taylor-The human body.

Dean, Basic Anatomy and Physiology for Radiographers.

King and Showers-Human Anatomy and Physiology.

Anatomy and Physiology (Chapman and Malabsorption.

Paper III

PATHOLOGY

1. **Disorders of circulation.**
   - Thrombosis.
   - Embolism.
   - Infarction.
   - Oedema.
   - Aneurysms.
   - Varices,
   - Stenosis
2. **Mechanism and changes in inflammation**
3. **Detailed study of tumours.** Characteristics. Classification. Aetiology & pathogenesis. All the common benign and malignant tumours. Malignant tumours and their dissemination.
4. **Common Infection.** Common acute bacterial infection. Detailed study of tuberculosis, Leprosy, Syphilis. Common fungal infection with a short account of opportunistic fungal infection. Brief account of all viral infections including HIV and AIDS. Common infections by protozoa and helminths. Precautions & Handling infectious patients
5. Detailed study of biological effects of radiation. Importance of quality control programmes in various modalities
6. **Degenerative changes**. Fatty change. Necrosis. Gangrene. Pathogenic calcification and age related changes

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7. **Genetic diseases**: Down's syndrome, Haemophilia, Immunology
8. **Common terms used in connection with diseases of the following systems.**

- Bones, joints and locomotor system.
- Thorax and Abdomen.
- Heart and Blood Vessels.
- Respiratory system.
- Lymphoreticular system.
- Reticulo-Endothelial system.
- Alimentary system
- Urinary tract.
- Reproductive system.
- Endocrine glands.
- Nervous system.
- Special sensory organs etc.

DISEASES OF INDIVIDUAL ORGAN SYSTEMS.

1. CVS .
   - IHD
   - RHD.
   - Infective endocarditis.
   - Hypertension.
   - Valvular diseases.
   - Tumours.
2. Lung
   - Pneumonias.
   - TB.
   - Asthma.
   - Tumours.
3. G I T
   - Oral cavity lesions.
   - Oesophageal Carcinoma
   - Peptic Ulcer.
   - Carcinoma stomach.

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- Malabsorption.
- Inflammatory Bowel diseases.
- Dysentery.
- Appendicitis.
- Peritonitis.
- Tumours

4. Gall bladder.
   - Stones.
   - Cholecystitis.
   - Tumours.
5. Pancreas.
   - Pancreatitis.
   - Stones.
   - Diabetes mellitus.
   - Tumours.
6. Male Reproductive system.
   - Hydrocele.
   - Orchitis & Epididymitis.
   - Benign prostate hypertrophy.
   - Brief mention of tumors.
7. Female Reproductive system.
   - Brief account of ovarian tumors.
   - Diseases of pregnancy.
   - Abruptio placenta.
   - Placental Tumours.
   - Ectopic gestation.
8. Breast.
   - Fibro adenoma.

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- Carcinoma breast.

9. Blood.
   - Anaemias.
   - Leukaemia.
   - Bleeding disorders.
10. Lymphoreticular Systems.
   - Lymphadenitis.
   - Lymphomas.
11. Bones.
   - Congenital.
   - Osteomyelitis.
   - Rickets, osteomalacia.
   - Bone tumour
   - Arthritis
12. Endocrine
   - Thyroid.
   - Pituitary.
   - Adrenal.
   - Parathyroid.
13. Brief account of eye and ear infection and Tumours.
14. Skin.
   - Psoriasis.
   - Eczema.
   - Skin tumours (Basal cell carcinoma, squamous cell carcinoma, Malignant Melanoma)

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15. Kidney.
   - Stones.
   - Glomerulonephritis.
   - Pyelonephritis.

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• Renal failure.

•Importance of Urea and Creatinine

• Nephrotic syndrome,

•Tumors.

Reference Books

1. Basic Pathology by Robbins and Kumar, Elsevier
2. Textbook of Pathology by Harsh Mohan Jaypee Brothers Medical Publishers (P).

PAPER IV

GENERAL
(HOSPITAL PRACTICE, PATIENT CARE, ETHICS, COMPUTER TECHNOLOGY,)

HOSPITAL PRACTICE AND PATIENT CARE.

Modern hospital treatment is based on teamwork. It is essential that the student should appreciate the technologist's role and the importance of co-operation with wards and other departments. This is to emphasise the importance of patient welfare.The aim of this subject is primarily to develop and ensure the successful interaction and manipulation of caring and communication skill which radiographers need to practice on a daily basis. This subject provides the students with a clear understanding of their role and responsibilities relevant to special diagnostic procedures, how the hospital organisation exists to serve the patient. It deals with the preparation of the patient before, during and after various diagnostic procedures. It also deals with various contrast agents used for different radiological procedures, their side effects and resuscitation.

1. Hospital management: Hospital structure and organization, Hospital staffing and organization, Department staffing and organization, records related to patients, departmental statistics, professional attitude of the technologist to patients and other members of the staff, medico-legal aspects, accidents in the departments, appointments, organisation, minimising waiting time, out-patient and follow-up clinics, stock-taking and stock keeping. Community orientation and clinical visit

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2. Care of the patient: First contact with patients in the Department, management of chair and stretcher patients and aids for this, management of the unconscious patient, elementary hygiene, personal cleanliness, hygiene in relation to patients (for example clean linen and receptacles, nursing care; temperature pulse and respiration, essential care of the patient who has a tracheotomy, essential care of the patient who has a colostomy, bed pans and urinals, simple application of a sterile dressing.

3. First aid: Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock, insensibility, asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions, prophylactic measures; administration of oxygen, electric shock, burns, scalds, hemorrhage, pressure points, compression band, Fractures, splints, bandaging, dressing, foreign bodies, poisons.

4. Infection: Bacteria, their nature and appearance, spread of infections, auto-infection or cross-infection, the inflammatory process, local tissue reaction, general body reaction, ulceration, asepsis and antisepsis.

5. Principles of asepsis: Sterilization - methods of sterilization, use of central sterile supply department, care of identification of instruments, surgical dressings in common use, including filament swabs, elementary operating theatre procedure, setting of trays and trolleys.

6. Drugs in the department: Storage, classification, labelling and checking, regulations regarding dangerous and other drugs, units of measurement, special drugs, anti-depressive, anti-hypertensive etc.

7. Radiography as a profession-professionalism, projecting a professional image, professional and personal qualities (both essential and desirable) of the radiographer/Imaging technologist.

8. Communication and Relational Skills- development of appropriate communication skills with patients, verbal and non-verbal communication, appearance and behaviour of the radiographer.

9. 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.

10. Communicable diseases (special reference to HIV and AIDS), cross infection and

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prevention, patient hygiene, personal hygiene, departmental hygiene, handling of infectious patients in the department, application of asepsis, inflammation and infection processes.

11. Patient vital signs-temperature, pulse, respiration and blood pressure-normal values and methods of taking and recording them.

12. Medico-legal considerations-radiographer's clinical and ethical responsibilities, misconduct and malpractice, handling female patients, practice in pregnancy.

13. Preparation of patients for general radiological procedures: Departmental instructions to out-patients or ward staff, use of aperients, enemas and colonic irrigations, flatulence and flatus, causes and methods of relief, principles of catheterization and intubation, pre medication, its uses and methods, anaesthetized patients, nursing care before and after special X-ray examination (for example in neurological, vascular and respiratory conditions), diabetic patients special attention to food, hazards of trauma.

14. Emergencies in the X-ray department and management: External defibrillation, direct cardiac massage, internal defibrillation, complications; cardiac arrest, respiratory arrest. Bronchography, local anaesthetics; reactions, treatment.

15. Importance of documentation & alerting appropriate authorities regarding mishaps and accidents.

16. Department design and construction

17. Medical ethics:

Definition, Goal Scope, Introduction to Code of Conduct, Malpractice and Negligence - Basic principles of medical ethics- Confidentiality, Autonomy and informed consent – Beneficence, non-maleficence, Equity, Right of patients, Care of the terminally ill- Euthanasia, Organ transplantation, 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, Professional Indemnity insurance policy, Development of standardized protocol to avoid near miss or sentinel events, Obtaining an informed consent. Professionalism and values,

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18. Computer

Introduction to computer, characteristics of computer, block diagram of computer, generations of computer, computer languages.

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).

Processor and memory: The Central Processing Unit (CPU), main memory.

Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.

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.

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.

Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.

Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs

Introduction of Operating System: introduction, operating system concepts, types of operating systems.

Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.

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.

Application of Computers in Clinical Settings.

Practical on fundamentals of computers -Learning to use MS office, MS word, MS PowerPoint, MS Excel, Installation of different software, Data entry efficiency.

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SUGGESTED BOOKS.

Text books.

- Deeley-A guide to Radiotherapy nursing-Livingstone.
- Care of patient in diagnostic Radiography Chesney & Chesney (Blackwell Scientific).

Reference books.

- Chesney's Care of the patient in Diagnostic Radiography-Pauline J. Culmer.
- Aid to Tray and Trolley Setting-Marjorie Hougton.
- First Aid-Haugher & Gardner.
- A guide to Oncology nursing (Livingstone)-Deeley.
- Practical nursing and first-aid-Ross and Wilson. Livingstone.
- Chesney's Care of the patient in Diagnostic Radiography Pauline J. Culmer.(Blackwell Scientific).
- Aid to Tray and Trolley Setting Marjorie Hougton (Bacilliere).
- First Aid' Haugher & Gardner (Hamlyn.).
- Practical nursing and first-aid Ross and Wilson (Livingstone.
- Medical Law and Ethics Purosottam Behera Mittal Publications

  Reflections on Medical Law and Ethics in India Bismi Gopalakrishnan, Mercy Khaute, B Sandeepa Bhat Eastern Law House
- Professionalism, Professional Values and Ethics in Nursing: Suresh K Sharma, Asha P Shetty Jaypee Brothers Medical Publishers

PAPER V

BASIC PHYSICS AND ELECTRONICS

1. Basic concepts: Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table-Isotopes-Ionization-excitation-Binding energy-electron volt-Electromagnetic radiation-Quantum nature of radiation-mass energy equivalence-Fluorescence-electromagnetic spectrum.

2. Heat.

Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transfer-conduction, convection, radiation of heat. Methods of heat dissipation in stationary

and rotating X-ray tubes.

3. Sound.

The nature and propagation of sound waves, the characteristics of sound, wave theory, speed of sound in a material medium, intensity of sound, the decibel, Interference of sound waves, beats, diffraction.

Ultrasonic wave, production of ultrasonic waves, piezo-electric effect in ultrasonography.

Doppler effect, Applications of Doppler effect in Diagnostic Radiology- Echo cardiography, blood flow measurements.

4. Electricity and magnetism:

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,

Electric current, unit, resistance, ohm's law, electric power, Joule's law. DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, the heating effect of current.

Capacitance, dielectric Capacitor, charge and discharge of a Capacitor through a resistance and inductance. series and parallel combination of Capacitors, energy stored on Capacitor, charging and discharging of Capacitors, use of Capacitors in Diagnostic Radiology.

Varying currents-Growth and decay of current in LR circuit, time constant.

Oscillations in an LC circuit.

Alternating currents: Peak and RMS values and current and voltage, circuit containing LR, CR and LCR-Power factor, wattless current, the J operator, series and parallel LCR circuits, Resonance and Q factor, Acceptor and Rejecter circuits.

Magnetism: 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, electromagnets and solenoids. Magnetic induction-magnetic properties-Hysteresis-magnetic effect of current-Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter. Intensity of magnetisation-Magnetic susceptibility; B. H curve, magnetic hysteresis, Dia, para and ferromagnetism.

5. **Electromagnetic Induction**: 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. Induced electro

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motive force-Faradays experiments-laws of electromagnetic induction- Self and mutual induction-Alternating current-AC generator-Peak and RMS values-AC circuits with resistance-capacitance and inductance-Choke. Coil-eddy current. Transformer-theory, design, losses-auto transformer-high voltage, transformer-electric power transmission.

6. **Electromagnetic waves:** Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum Radiation in atmosphere.
7. **Superconductivity**- Introduction, applications in radiology.
8. **Electronics.** Introduction – semiconductors- Conduction in crystals, Energy bands, majority and minority carriers , Intrinsic and Extrinsic semiconductors, n-type and p-type semiconductors,

   Semiconductor diodes: p-n junction-properties forward and reverse bias, characteristics of p-n junction Rectifiers-Half-wave and full wave, ripple factor, Efficiency of HW and FW rectifiers. Filter circuits; Zener diode, regulated power supply.

   Transistors-Symbols, Transistor connections and characteristics, types of amplifiers-voltage and power amplifiers. Transistor connections and characteristics, Transistor as an amplifier, load line analysis, operating point, types of amplifiers-voltage and power amplifiers. Feedback-negative feedback in amplifiers.

Reference books

1. Electricity & Magnetism by D.C. Tayal
2. The Physics of Radiology and Imaging by K Thayalan Jaypee books
3. Electromagnetic Theory, Prabir K. Basu & Hrishikesh Dhasmana, AneBooks
4. Heat & Thermodynamics by S. Loknathan
5. Basic Electronics by V.K.Mehta

PAPER VI

NUCLEAR AND RADIATION PHYSICS.

NUCLEAR PHYSICS.

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Atomic and nuclear structure: Introduction, protons, neutrons, electrons, Atomic number, atomic masses, nuclides and isotopes, atomic models, the hydrogen spectra, difficulties with Rutherford's model, Bohr's atom model, Quantum numbers, Pauli exclusion principle, periodic table of elements.

Cathode rays- Discovery of Cathode rays- nature and properties,

Atomic Nucleus-general properties, Binding energy, packing fraction, Nuclear forces, general ideas on meson theory.

Radioactivity: Structure and property of nucleus, Nuclear forces, Binding energy, Radioactive decay, law of radioactive decay-decay equation, half-life, mean life-excitation, ionisation, charts of radionuclides, alpha, beta, positron, gamma emissions, Auger electrons, electron capture, isomeric transitions, internal conversion,

Natural and artificial radioactivity, naturally occurring radio-nuclides.

Nature of radioactivity, Law of radioactive disintegration, radioactive series. Law of successive disintegration, radioactive equilibrium unit of radioactive strength.

Exponential decay, decay equation, decay constant. Artificial radioactivity-production of radioisotopes-cyclotron-neutron-fission and fusion-chain reaction-atom bomb- nuclear reactor.

Beta-ray spectrum, finite range of Beta-rays, Neutrino hypothesis.

Gamma-ray Spectra absorption by matter, pair production, conversion electrons, electron capture, Auger electron.

Nuclear reactions- Introduction- different nuclear reactions-(α, P), (α, n) reactions, proton bombardment, neutron bombardment, deuteron bombardment, nuclear fission, nuclear fusion, Q values. Nuclear Reactors, production of isotopes.

Nuclear isomerism.

Elementary particles- Basic qualitative idea about elementary particles, examples of Elementary particles.

RADIATION PHYSICS.

X-rays: Introduction, Discovery of x-rays, production and properties, Bremsstrahlung process, Continuous and characteristics X-Rays, Kramers' law, X ray spectra, Duane -Hunt law, factors affecting X-ray emission spectra, X-ray quality and quantity, HVL measurements, , soft and hard X-Rays,. Quality and intensity of x- rays-factors influencing them.

X-ray tube: Historical aspects, requirements for X-ray production, early X-ray tubes-Coolidge tubes,

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construction of X-ray tubes, Cathode, thermionic emission, focusing cup, target and anode, targets-reflection and transmission types, heel effect-significance of heel effect in radiology, tube voltage, current, space charge, tube envelop and housing, X-ray production efficiency, advances in X-ray tube design, Line focus principle.

Modern X- ray tubes- stationary anode, rotating anode, off focus radiation, tube insert and housing- X ray tube cooling- Tube rating.

Specialized X-ray tubes- metallic, biangular, fluoro, CT tubes, Grid controlled and high speed tubes, Dental x ray tubes.

Filtration: x ray spectrum, inherent filtration and added filtration, radiation leakage and scattered radiation.

Heat dissipation methods in x ray tubes, tube rating, heat units, operating conditions and maintenance. Interlocking and X-ray tube overload protection.

X-ray generator circuits- Introduction, Filament current and voltage components of x-ray circuits, KV, mA, mAs , High voltage circuits, High tension transformer, auto transformer, filament circuits, types of exposure switch and timers, principle of automatic exposure control (AEC) and practical operation.

Types of generators- single phase, 3 phase, 6 and 12 pulse circuits-high frequency generators- falling load generators, Capacitors, discharge and grid control systems, constant potential generators.

Rectification in X-ray circuits- Self rectification, inverse current, half wave, full wave, full wave bridge rectification. Fuses, switches and interlocks- Exposure switching and timers- HT cables- earthing. Modern x ray circuits.

Interaction of radiation with matter: Introduction- interactions of X-rays with matter-coherent scattering, Photoelectric interaction, Compton interaction, Pair production, annihilation radiation, photonuclear disintegration. dependence on energy and atomic number, , Relative importance of interactions in radiology.

Transmission of x-rays through matter, law of exponential attenuation, attenuation equation, attenuation coefficients- linear, mass, and electronic attenuation coefficients, importance of linear attenuation coefficients in radiology. Interactions of X-rays in the body- fat-soft tissue-bone. contrast media.

Half Value Thickness (HVT), Tenth Value Thickness (TVT) and their relationships. Scattered radiation. Particle interactions. Electron interaction, Neutron interaction, heavy charged particle interactions, LET, range energy relationship.

Quantities and Units:

Fundamental and derived quantity, Physical quantities, their units and measurements. systems of units, SI unit, various quantities used in Diagnostic Radiology and their units such as KV, mA, mAs, Heat

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unit (HU).

Radiation quantities and units: Introduction- Radiation intensity, Photon Fluence.Exposure, SI units of exposure, Roentgen, its limitations, electronic equilibrium-KERMA, Absorbed Dose, SI units, rad, gray, roentgen to rad conversion.Equivalent Dose- quality factor-rem, Sievert. Relationship between absorbed dose and equivalent dose.

Radiation detection and measurements: Introduction, Principle of radiation detection- Principles of ionization chambers, proportional counters, G.M counters and scintillation detectors, semiconductor detector- Gamma ray spectrometer.

Radiation detectors used in various diagnostic machines like CT machines, Gamma Camera etc.

Measuring system- free air ionisation chamber, thimble ion chamber, condenser chamber, secondary standard dosimeter, film dosimeter, OSLD, Chemical dosimeter Biological dosimetry. Thermoluminescent Dosimeter- Principles and different TLD materials, personal monitoring, Pocket dosimeter, Radiation survey meter-Gamma zone monitor-contamination monitor, Isotope calibrator,Proper use and maintenance of radiation measuring devices.

SUGGESTED BOOKS.

1. Christensen's physics of diagnostic radiology by Curry and Dowdey Wolters Kluwer
2. X-Ray Equipment for Student by D.N. And M.O. Chesney Blackwell Science Ltd
3. Basic radiological physics by K.Thayalan Jaypee Brothers Medical Publishers (P) Limited,
4. Textbook Of Radiation Physics For Radiologic Technology by Surendra Maharjan, Suraj Sah Samiksha Publications

PAPER VII.

RADIOGRAPHY INCLUDING MEDICAL IMAGE PROCESSING

The term Radiography implies a full knowledge of the procedure for X- ray examination, preparation of the room, apparatus and instruments, positioning of patients, relative positions of the X-ray tube and patients, relevant exposure factors, use of accessories, such as radiographic cones, grids and position aids etc. The student to be made familiar with radiographic appearance both of the normal subject and of common abnormal conditions where elementary knowledge of the pathology involved will ensure the application of the appropriate

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radiographic technique which may be necessary for various disabilities. The radiation safety precautions for patients, public and staff need to be emphasised here.

For each area studied, emphasis will be given to.

- Anatomy (review).
- Clinical indications.
- Preparation of the room.
- Accessory equipment.
- Preparation of patient.
- Radiation protection.
- Care of patient.
- Routine views.
- Supplementary views.
- Modifications if required (as in cases of trauma).

Special problems: refer to the following list of problems which may necessitate technique variations.

- Children and neonates.
- Seriously ill or injured patients.
- Elderly patients.
- Deaf and blind patients.
- Language difficulties.
- Unconscious patients.
- Anaesthetised patients.

For each view studied will be presented as follows.

- Positioning of patient.
- Immobilisation.
- Identification.
- Centring point.
- Direction of central X-ray relative to the film.
- Parts demonstrated.

PLAIN RADIOGRAPHY.

This includes.

1. Upper extremity-basic views and special views.
2. Lower extremity (including pelvis)-basic views and special views.

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3. Chest including thoracic cage and sternum.
4. Spine-Cervical, dorsal, lumbar, lumbo-sacral (including functional views).
5. Skull-including trauma cases-basic views and special views.
6. Facial bones (nasal bones, zygoma, orbits, maxilla etc.).
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.
14. Macroradiography.
15. Paediatric radiography.

Radiographic technique:

1. Upper limb: Technique for hand, fingers, thumb, wrist joint, carpal bones, forearm, elbow joint, radio ulnar joints and humerus; supplementary techniques for the above. e.g. Carpal tunnel view, ulnar groove, head of the radius, supracondylar projections.

2. Lower limb: Technique for foot, toes, great toe, tarsal bones, calcaneum, ankle joint, lower leg, knee, patella & femur; Supplementary technique: Stress view for torn ligaments-Subtalar joint and talo-calcaneal joint-Inter condylar projection of the knee-Tibial tubercle-Length measurement technique.

3. Shoulder girdle and thorax: Technique for shoulder joint, scapula, clavicle, acromio-clavicular joints, sternum, ribs, sterno-clavicular joint. Supplementary projections and technique in,

- Recurrent dislocation of shoulder.
- Traumatic dislocation of shoulder.
- Cervical ribs.

4. Vertebral column: Technique for Atlanto-occipital joint, cervical spine, cervico-thoracic spine, thoracic spine, thoraco-lumber spine, lumbo-sacral spine, sacrum and coccyx. Supplementary technique to demonstrate

- Scoliosis.
- Kyphosis.

- Spondylolisthesis.
- Disc lesion.
- Union of spinal graft.
- Adaptation of techniques to demonstrate specific pathologies.

5. Pelvic girdle and hip region: Technique for whole pelvis. Ilium, ischium, pubic bones, sacro-iliac joint, symphysis pubis, hip joint, acetabulum, neck of femur, greater and lesser trochanter; Supplementary technique-Congenital dislocation of hips. Epiphysis of femur: Lateral projections for hip joints to show femoral head and neck relationship.

6. Skeletal survey: Skeletal survey for skeletal dysplasia, metabolic bone disease, metastases, hormonal disorder, renal disorders.

7. Skull: Basic projections and special views for cranium, facial bones, nasal bones and mandible. Technique for-petrous temporals, for mastoids-Internal auditory canal-Accessory nasal sinuses-Temporo-mandibular joint-Orbits and optic foramen-Zygomatic arches-Styloid process-Pituitary fossa-Jugular foramen.

8. Dental radiography: Technique for intra oral full mouth-Occlusal projections-Extra oral projections including orthopantomography-Other supplementary techniques.

9. Cardiovascular system: Routine projections for heart and vessels (without the use of contrast agent) Supplementary views for above.

10. Upper respiratory system: Technique for post nasal air ways, larynx, trachea, thoracic inlet, thyroid gland(also in Valsalva Manoeuvres and Phonation).

11. Lungs and mediastinum: Technique for routine projections; Supplementary projections and techniques-antero-posterior, obliques, lordotic and apical projection. Use of penetrated postero-anterior projection-Expiration technique-Technique for pleural fluid levels. Diaphragm: Inclusion of diaphragm on chest and abdominal films.

12. Abdominal viscera: Technique for plain film examination-Projection for acute abdomen patients-Technique to demonstrate (i) foreign bodies (ii) imperforate anus.

13. Radiography using mobile X-ray unit: Radiography in the ward-Radiography in the specialised unit. e.g.-Intensive care unit-Coronary care-Neonatal unit-Radiography in the operating theatre.

Medical Image Processing

Appreciation and application of all the factors listed below will enable the

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student/technologist to produce X-ray films of good quality and diagnostic value. The lectures to be linked with practical demonstration to illustrate the importance of all that goes to make up correct exposure conditions.

1. **Radiographic Film:** Structure of film emulsion-film characteristics (speed, base + fog, gamma, latitude)-effect of grain size on film,response to exposure, Grain technology-Gelatine-Basic film types-Film formats and packing-Direct exposure duplitised films- Single coated emulsions- Films for specialised use, manufacturing process. Structure, properties of different parts, handling, film wrappings, Handling of exposed and unexposed films. Storage of X-ray film

Types of film and applications, advantages/limitations of different types.

safe light requirement

Sensitometry: Photographic density-characteristic curve-information from the characteristic curve-speed and definition.

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2. **Control of scattered radiation**: Methods of minimizing formation of scatter radiation, effectiveness of grids-grid ratio-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.

Grid: Purpose and function, effect on radiation exposure, use of grid, structure and materials. Types: stationary, parallel, focused, crossed-Moving grids. Purpose/advantages/disadvantages.

Intensifying screens: Structure and functions, common phosphors used-types, screen mounting, care and maintenance of film screen contact. Intensifying factor-speed and detail-crossover effect-resolution-mottle-reciprocity-screen asymmetry-cleaning. New phosphor technology-influence of kilo voltage. Photostimulable phosphor Imaging.

Cassettes: Structure and function-Types-single, gridded, film holder-Design features and consideration with loading/unloading-Care and maintenance (cleaning).

Photochemistry: Principles: Acidity, alkalinity, pH, the processing cycle, development, developer solution. Fixing, fixer solution, washing, drying replenishment, checking and adjusting-latent image formation--nature of developmentconstitution of developer-development time-factors in the use of developer. Fixersconstitution of fixing solution-factors affecting the fixer-replenishment of fixer-silver

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conservation-Drying-developer and fixer for automatic film processor-rinsing-washing and drying. Replenishment rates in manual and automatic processing-Silver recoveryAuto and manual chemicals

Processing: manual processing-care of processing equipment-automatic processormanual VS automatic processing-principles and typical equipment Microprocessor controlled-Cine processing-Daylight systems-Processing faults-maintenance.

Automatic Film Processor: 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.

Processing room: location of the dark room-dark room illumination-equipment and layout-X-ray viewing room-Day light processing-Daylight handling-daylight systems with cassettes-without cassettes.

DarkRoom: The processing area.Dark room design, construction, illumination, entrance, safe lightingtypes.Storage, shelving of films. Cleaning and maintenance.

Monitor images:

Characteristics of the video image-television camera- imaging, camera. Laser-light and laser-laser imaging-laser imagers-imaging plates,Dry cameras.

SUGGESTED BOOKS.

Text books.

1. Diagnostic Radiography Glenda. J. Bryan (ELBS).

2. Positioning in Radiography Clarks (CBS Publishers, New Delhi.).

Reference books.

1. Radiographic positions and Radiological procedures Vinita Merrill (Jaypee Brothers, New Delhi).

2. Manual of Radiographic Technique T. Holn & P.E.S. Palmer (World Health Organisation).

3. Text book of Radiologic-Technology Jacoby and Paris (Mosby).

4. Contrast Radiography Scarrow (Schering Chemical).

5 A manual of Radiographic positioning Greenfield and Cooper (Lippincott).

6. Illustrated guide to X-ray Techniques Culliman (Blackwell).

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7. A Guide to Radiological Procedures Stephen Chapman & Richard Nakielny(
A Prism books (P) Ltd., Bangalore).
8. Applied angiography for Radiographers Paul & Douglas (W.B. Saunder
Company.

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PAPER VIII

.PHYSICS OF MEDICAL IMAGING AND RADIATION SAFETY.

1. Primary radiological image formation- Attenuation- Linear and mass attenuation coefficients-Factors affecting attenuation- application in radiology

   Filters-Introduction, types of filters, inherent and added filters-Heavy metal filters, effect of filters on patient exposure,

   X- ray beam restrictors-aperture diaphragm-cones and cylinders-collimators-functions of restrictor and patient exposure.

2. **Scattered radiation**: significance of scatter-Grid, principle, design and types-terminology,evaluation of grid performance-lead content-Grid cut off-moving girds-Grid selection-air gap technique.
3. Luminescent Screens- introduction , fluorescence, intensifying screens-construction ,structure, screen film contact, phosphor technologies, photostimulable phosphor, Luminescence
4. Physical Characteristics of X-Ray Film and Film Processing-radiographic film-construction-types of films- Photographic Characteristics of X-Ray Film,optical density, characteristic curve, contrast ,speed, latitude, film processing, Automatic processor.

   optical coupling and methods of viewing, recording of intensified image, CCTV, cine fluorography.

5. **Radiographic image**: Image clarity-contrast-factors affecting contrast-Image quality-mottle, fog and scatter, sharpness and resolution-Line spread function-Modulation transfer function-Noise and wiener spectrum. Magnification-distortion-penumbra- unsharpness-inverse square law-evaluation of resolution-quantum mottle-patient exposure.
6. **Body section radiography**: Basic method of tomography-terminology-blurring-section thickness-narrow and wide angle tomography-circular tomography-tomographic motions-phantom images-tomographic angle determination-pan tomography.
7. **Stereoscopy**-Physiology of depth perception, stereoscopic filming-viewing,merits and demerits.

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8. **Xeroradiography:** principles-xeroradiography plate powder development-image development- image quality-liquid toner xeroradiography.

9. Equipment in conventional radiology:

General diagnostic X-ray tubes. The rotating anode X-ray tube, Heavy duty X-ray tubes, grid controlled X-ray tubes, super rotalix metal X-ray tube, mammography X-ray tubes, Micro focus X-ray tube, Super rotalix ceramic X-ray tubes.

X-ray circuits: Main Electric supply and power distribution in diagnostic X-ray circuits, autotransformer, full-wave rectification. Two phase and three phase generators, two-pulse three phase circuit, six pulse three phase circuits, 12 pulse circuits, advantages of the 3-phase generators.

Exposure timers: The electronic timer, automatic exposure control-photo timer,X-ray tube overload protection circuits, Percentage tube overload indication,

Specialized X-ray generators, High Frequency, Shared generators.

The rating of X-ray tubes: Heat transfer through the X-ray tube, maximum power. heat path, tube housing cooling chart.

10. **Equipment for mobile radiography.** Portable/Mobile X-ray unit, Capacitor discharge unit. Cordless mobiles units, Mobile image intensifier, limitations, Mobile Digital Radiography, Equipments for Dental Radiography. Intra oral radiography unit, orthopantomography unit (OPG),cephalostat.

11. **Fluoroscopy**: Fluoroscopic equipments, Image intensifier tubes, Direct fluoroscope, Image intensifier- design, brightness, gain-Imaging characteristics-multi field image intensifiers-Close circuit television-television scanning-television image quality-Fluoroscopic image recorders-TV image recorders. Fluoroscopic screen, tilting tables, over and under couch tubes, safety features, image intensifier tubes. Types of day light film handling system, Quality assurance tests for fluoroscopic equipment.

12. **COMPUTERIZED TOMOGRAPHY (CT):** Historical background, basic principle of CT, data accumulation, CT generations, advancement in CT technology (helical/spiral and multi slice), ultra-fast scanners. Image reconstruction, CT fluoroscopy-Systems and components, CT performance parameters, image quality, artefacts, radiation dose measurements and technical aspects of quality assurance of CT.

13. **DIGITAL RADIOGRAPHY AND PACS:** Direct and Indirect Digital Imaging, Computer Radiography**,** Image acquisition, photostimulable phosphors, digital chest

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radiography, Picture characteristics, archiving possibilities; transfer system and designs, Image recording devices, laser imager and multiformatter, future developments,

14. **MAGNETIC RESONANCE IMAGING:** Introduction, history, Basic Physics of MRI, advantage over other imaging modalities, equipment terminology.

    MR Instrumentation- Types of magnets, RF transmitter, RF receiver, Gradient coils, shim coils, RF shielding, computers, NMR signals, pulse sequences, spectroscopy parameters,. Image formation and storage devices. Relaxation Parameters and Spin Echoes, Magnetic Field Gradients, Slice selection and Frequency Encoding.2-D FT Imaging, k-space.

    Basic Imaging Sequences: Spin-echo and gradient echo. Introduction to in vivo MR Spectroscopy, Single and multi-voxel MRS, introduction to Spectroscopy Imaging (CSI).Flow and Angiography, Advanced Pulse Sequences and Techniques, Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image, Pulse sequence, Spin echo pulse sequence – turbo spin echo pulse sequence - Gradient echo sequence – Turbo gradient echo pulse sequence - Inversion recovery sequence – STIR sequence – SPIR sequence – FLAIR sequence – Echo planar imaging – Advanced pulse sequences.

    Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP

    MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functional MRI. Image Artefacts.Safety Considerations in MRI, site selection and safety

15. **Ultrasound**: Physical characteristics of sound, Basic physics of sound propagation in different media- production of Ultrasound (piezoelectric effect), transducer, Properties of Ultrasound, propagation in tissue, characteristics of ultrasound beam- interaction of ultrasound and matter, absorption, scattering, reflection and refraction, acoustic impedance, quarter wave matching, half and quarter wave length, transmission of pulse and echo modes, Doppler ultrasonography, A, B and M scanning modes. Ultrasound image formation and storage/documentation devices, ultrasonic display,Doppler techniques, real-time ultrasound, Tissue harmonic Imaging, Elastography, ultrasound instrumentation, bio effects and safety considerations.

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16. **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.
17. **Mammography:** Physics aspects of Mammography, generator, X-ray tubes, Accessories, Resolution, quality control. Application and role in medicine.
18. **ISOTOPE IMAGING:** Overview of Radioisotope Imaging-Radionuclide Production-Radiation Protection in Nuclear Medicine-Radiopharmaceuticals-The Gamma Camera and other Imaging Equipment-Quality Control and Performance Assessment of Gamma Camera Systems-Static and Dynamic Scintigraphy-Single Photon Emission Computed Tomography-Clinical Applications of Nuclear Medicine /PET-Positron Emission Tomography-Quantitative Imaging- Applications of Nuclear Medicine Imaging to Radionuclide.

RADIATION SAFETY IN DIAGNOSTIC RADIOLOGY
(as per AERB requirements)

1. Basic Radiation Physics Atomic structure, atomic number, mass number, bound and free electrons, binding energy, ionization, excitation, fluorescence, characteristic x-ray, stability of nucleus, isotopes, radioisotopes, types of radioactive disintegration, directly and indirectly ionizing radiations, x-rays and gamma rays, energy of ionizing radiation, half-life, effective half-life and production of radioisotopes.

2. Production of X-rays Interaction of accelerated electrons with target atoms, conversion of kinetic energy of electrons into x- rays, Bremsstrahlung and characteristic x-rays, x-ray spectrum, types of x-ray tubes (anode, cathode, inherent filters, focal spot), heat production in the anode and cooling mechanism, quality and quantity of x-rays (effect of kV, mA).

3. Interaction of Radiation with Matter Interaction of electrons with matter, Bremsstrahlung, interaction of photon with matter (photoelectric, compton and pair production), influence of photoelectric effect and compton effect on image quality and patient dose, absorption, scattering and attenuation of photons, Half Value Thickness (HVT) and Tenth Value Thickness (TVT), beam hardening, importance of x-ray beam filtration in diagnostic radiology

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4. Radiation Quantities and Units Activity (Becquerel & Curie), energy, exposure(C/kg &Roentgen), air kerma, absorbed dose (Gray & Rad), radiation weighting factors (WR), tissue weighting factors(WT), equivalent dose (Sievert & rem), effective dose (Sievert & rem).

5. Biological Effects of Radiation Interaction of radiation with cell, direct and indirect interactions, effect of radiation on living cells, chromosomal aberration, somatic and genetic effects, deterministic and stochastic (probabilistic) effects, effects of partial and whole body exposures.

6. Operational Limits Introduction to natural background radiation, concept of occupational risk, philosophy of radiation protection, system of dose limitation, ALARA, dose limits to radiation workers and general public, AERB/ICRP recommendations, guidance level for patient dose reduction in radio-diagnosis, dose constraints for comforters of patients.

7. Radiation Detection and Measurement Principle of radiation detection, gas detectors (ionization chamber, proportional counter and GM counter), solid state detectors {Scintillator, semiconductors and Thermo luminescent Dosimeter (TLD)}, radiation monitoring instruments, personnel monitoring, area monitoring, survey meters, direct reading devices, calibration and response of radiation monitoring instruments.

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 Artificial Intelligence in Radiation Safety

8. Radiation Hazard, Evaluation and Control External hazard and their perspective, evaluation and control of hazard due to external radiation: individual and workplace monitoring, application of time, distance and shielding; shielding calculation, requirement of filters with respect to kV of the machine, leakage radiation assessment by workload consideration, radiation protection in diagnostic radiology and radiation protection accessories.

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9. Principles of Diagnostic Radiology Fundamentals of diagnostic radiology, physical principle of image formation, limitations of conventional x-ray imaging, image contrast, contrast media, intensifying screens, optical density, characteristics of x-ray film, fluoroscopic screens, image intensified fluoroscopy, methods to reduce scattered radiation, Bucky grids and image quality.

10. X-ray Imaging Techniques Radiography and fluoroscopy, CT scanning, digital subtraction angiography (DSA), mammography, interventional radiology, digital radiology, bone densitometry, dental radiology.

11. Planning of Diagnostic X-ray Installation General principles of planning of diagnostic installations, site selection, workload, shielding material, openings and ventilation, illumination control, X-ray installation layout, control panel, patient waiting area, warning light and placard, model layouts of diagnostic radiology installations.

12. Quality Assurance in Diagnostic Radiology Importance of QA in Diagnostic radiology, test parameters and test procedures for congruence of optical and radiation fields, central beam alignment, effective focal spot size, exposure time, applied tube potential, total filtration, table top transmission, linearity of timer loading station, linearity of mA loading station, consistency of radiation output, low and high contrast resolution, table top dose rate, radiation leakage though tube housing and collimator, dark room procedures, QA procedures for CT scanner and mammography.

13. **Regulatory Aspects for Diagnostic Radiology:** Regulatory documents such as Act, Rules, Code, Standards and Guides, responsibilities of employer, licensee, Radiological Safety Officer (RSO), radiologist, Radiographer/Technologist regulatory requirements for import, procurement, installation, commissioning, operation, transfer, dismantling and decommissioning of diagnostic equipment, Radiation Protection Programme (RPP). Radiation Incidents and Case Studies, Radiation incidents involving X-ray equipment, over-exposure investigation and case studies, Operational Safety Aspects, Proper use of modality specific radiation protection devices (lead protective barrier, lead aprons, ceiling suspended lead screen, couch-hanging lead rubber flaps etc.), Proper use and storage of TLD badges.

16. **Practical Demonstrations:** Radiation protection survey of a diagnostic x-ray installation, Quality assurance (QA) of medical diagnostic x-ray equipment, practical demonstration of safe work practice and radiation protection measures, Personnel

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monitoring process, demonstration of patient protection measures, Radiation emergency situation preparedness.

SUGGESTED BOOKS.

Text books.

1. Christensen's Physics of Diagnostic Radiology (Lea & Febiger).
2. Fundamental Physics of Radiology, W.J.Meredith and J.B. Massey.

Reference books.

1. First year Physics for Radiographers Hay & Hughes (ELBS).
2. Basic Medical Radiation Physics Stantor (Appleton-Century & Crofts).
3. X-ray Equipment for student Radiographers By: Chesney & Chesney (Blackwell).
4. Manual of Radiographic equipment. By: Sybil M. Stockley (Churchill Livingstone).
5. Principles of Diagnostic X-ray apparatus by: Hill (Macmillan.).
6. Radiologic science for Technologist Stewart C. Bushong, (M Mosby.).

PAPER IX

RADIOGRAPHIC IMAGING.

1. **Radiographic image: C**omponents of image quality - unharness, contrast, image-distinctness, image-size, shape and spatial relationships, density, resolution, sharpness, magnification and distortion of image, noise and blur, Radiographic illuminators and viewing conditions, visual acuity and resolution.

2. **Conventional and contrast radiography.**

   Contrast media: Terms used to describe contrast media, Structure of compounds, Types of contrast media, General principles governing the uses of contrast agents, Strength and quantity of the contrast agents, Method of introduction of the contrast agents, adverse reactions, reactions to contrast media, Preventive measures-Treatment of reaction, Basic emergency equipment and Emergency drugs. The technologist's role in management of adverse reactions

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3. **Urinary system imaging:** Intravenous urography IVU-Retrograde pyelography-Ante grade pyelography-Cystography and micturating cystourethrography-MCU-Ascending Urethrography-RGU-Renal puncture-Vesiculography-Cavernosography, 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.

4. Gastrointestinal tract imaging: Fluoroscopy, general considerations, responsibility of radiographers, Revision of Anatomy and Physiology, clinical indications and contraindications-contrast media used, preparation and dosage-patient 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, pharynx and oesophagus, Barium swallow, Barium meal upper GI,Barium meal and follow through, Hypo tonic duodenography, Barium enema, small bowel enema, distal colography, defaecography, Routine projections for colon and rectum, colonic activators; double contrast studies; contrast study in colostomy. Special techniques for specific disease to be examined, Water soluble contrast media-eg.Gastrograffin studies.

4. **Biliary system:** Plain film radiography- Oral cholecystography-Intravenous cholangiography-Percutaneous cholangiography- Endoscopic retrograde Cholangio Pancreatography(ERCP)-Operative cholangiography-Post-Operative cholangiography (T-tube Cholangiography)-Technique of PTC, ERCP, T-Tube cholangiography peroperative cholangiography.Revision of Anatomy and Physiology-clinical indications and contraindications-contrast media-patient preparation-film series-radiation protectionpatient care.

5. Sialography: Anatomy-Routine technique, procedure-Sialography. Clinical indications and contraindications-patient preparation-contrast media and dosage injection procedure- techniques for radiographic projections-radiographic appearances, radiation protection-patient care.

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6. Hysterosalpingography (HSG): Revision of Anatomy and Physiology- clinical indications and contraindications-contrast injection-projections-radiation protectionpatient care.

7. **Mammography:** Review of Anatomy, Physiology and Pathology of female breast, diagnosis and screening, knowledge about the nature of X-ray beam and equipment suitable for breast imaging, grids and Image receptor requirements, image recording devices-accessories for immobilisation and identification, positioning, techniques for various projections, exposure factors, radiation protection.

   Technique of biopsy procedure-characteristics of benign and malignant lesions, Biopsy equipment attachments, cyst puncture, mammary duct injection, Interventional accessories, patient care, Radiation dose, Image quality

8. **Respiratory system:** Nasopharyngography, Laryngography, Bronchography Central nervous system, Myelography, Cerebral studies, Ventriculography, Encephalography

9. Arthrography: Shoulder, hip, knee, elbow

10. **Discography**: Technique and procedures

11. Angiography-Carotid Angiography (4 Vessels angiography)-Vertebral angiography, Thoracic and Arch Aortography-Selective studies e.g. Renal; inferior and superior), Coeliac axis angiography-Mesenteric arteries. Femoral arteriography Angiocardiography.

12. Venography-Percutaneous Tran-splenic portal venography-Peripheral venography, Intra-osseous venography-Frontal venography, Jugular venography, Inferior and superior venocavography, Renal and adrenal phlebography.

13. Lymphatic system: Techniques for routine projection, soft tissue differentiation for region concerned-Lymphangiography

14. Dacryocystography-Techniques and procedures.

15. Sinusography- Routine Technique and procedure.

16. Procedures that are rarely used: Myelography-indications and contraindications, contrast used-

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patient preparation, technique-film sequence projections-patient care, Pelvimetry, Oral cholecystography, Intravenous cholangiography, Conventional Arthrography.

17. Quality assurance in diagnostic radiology:

Diagnostic Radiology provides a valuable input into the health care delivery system. Efficient utilization of the technology can be assured only through quality assurance procedures. QA Programmes: Meaning of the term, aspects of QA, equipment and staff requirements, benefits of QA procedures in an imaging department, QA in equipment selection phase, QA in equipment installation, acceptance phase, Operational phase, Preventive maintenance.

QA programme at radiological facility, Responsibility, Purchase, Specifications, acceptance, routine testing, Light beam alignment test, Grid alignment test, High and low contrast resolutions, Cassette leak check, Proper screen-film, Evaluation of results, contact test, Safe light test, Test of CT, US and MRI, Record keeping.

QA of Film processing: Manual and automatic- Consideration for storage of film and chemicals, fault tracing, accuracy of imaging-image distortion for digital imaging devices.

QA of film and image recording devices- Sensitometry , artefacts of films and image recording. Maintenance and care of equipment: Safe operation of equipment, Routine cleaning of equipment, cassette and screens, maintenance of automatic processor and manual processing units, record keeping and log book maintenance.

Reject analysis and objectives of reject analysis programme.

SUGGESTED BOOKS.

Text books.

Radiographic Imaging-Chesney & Chesney, Blackwell Scientific publications.

Reference books.

1. Radiographic imaging-Derrick P. Roberts and Nigel L. Smith. Churchill Livingstone, Edinburgh
2. Radiographic Latent image processing-W.E.J. Mckinney.
3. Photographic processing, quality control and evaluation of photographic material-J.E. Gray.
4. Photographic processing Chemistry-L.F.A. Mason.
5. Physical and photography principles of Medical RadiographySeeman & Herman.
6. Radiographic positions and Radiological procedures Vinita Merrill (Jaypee Brothers.

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7. Contrast Radiography Scarrow (Schering Chemical).
8. A Guide to Radiological Procedures Stephen Chapman & Richard Nakielny A Prism books

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PAPER X.

MODERN IMAGING AND RECENT ADVANCES.

This subject enables the student to learn and understand the advancement in Radio Diagnostic Technology, Imaging equipment and imaging modalities and its clinical applications.

(A). EQUIPMENTS.

1. **Ultra Sound Scanning:** 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-Artefacts-quality control-Acoustic coupling agents-Ingredients-preparation.

2. **Digital Mammography and 3D Tomosynthesis:** Introduction to advanced breast imaging methods, Advantages, principles, computer aided detection, DBT, Duel Energy Contrast enhanced Mammography.

3. **Computed tomography:** Historical information, fundamentals, computer hardware and software. Scanner types, technological considerations of sequential/spiral volume zoom, Basic data acquisition concepts, CT-detector technology, Image reconstruction, CT computer and image processing systems, Image display, storage, recording system, CT control console, Options and accessories for CT systems. CT guided Interventional procedures,

   Data accumulation, image reconstruction, storing the image- viewing the image-evaluation of image, Dosimetry, image quality in CT, Future developments, CT advantages and limitations,

4. **Magnetic Resonance Imaging**: Terminology-Principles, NMR signals- MR system components-The magnet system-The reconstruction system-Host computer, viewing archiving, hard copy-Magnetic shielding-RF shielding.

   MR Instrumentation-Magnetic field gradient coils-Spin echo imaging sequence-multi slice imaging-multi echo imaging-contrast-multi planar imaging-inversion recovery pulse sequence-signal to noise ratio-fast imaging techniques-Newer sequences and emphasis on,

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- Relaxation Parameters and Spin Echoes.
- Magnetic Field Gradients, Slice selection and Frequency Encoding.
- 2-D FT Imaging, k-space.
- Basic Imaging Sequences: Spin-echo and gradient echo.
- Hardware-RF Requirements and RF Coils.
- Image Artefacts.
- Safety Considerations.
- Introduction to in vivo MR Spectroscopy.
- Single and multi-voxel MRS.
- Processing MRS Data.
- Flow and Angiography.
- Advanced Pulse Sequences and Techniques.

safety considerations in MRI.

5. **Digital radiographic imaging:** History and development; Direct and indirect digital Radiography. Theory and Principle-Digital fluoroscopy system-digitized image-digital subtraction techniques-digital image processing-future equipment developments-Clinical application-PACS (Picture Archival and Communication System)-Digital Image quality-Laser film printers. Image acquisition-Digital Spot Imaging (DSI)-Digital chest radiography-Future developments.
6. **Gadgets for Interventional Procedures**. For CT Guided procedures: Fine needle aspiration cytology; Fine needle aspiration Biopsy-Stereo tactic biopsy; Radio surgery. Ultrasound guided procedures: Fine needle aspiration cytology; Fine needle aspiration-Fine needle aspiration Biopsy. Fluoroscopy guided procedures: Endoscopic Retrograde Cholangio-Pancreatography (ERCP); percutaneous nephrolithotomy; Percutaneous nephrostomy; percutaneous trans hepatic biliary drainage; Angioplasty; Embolisation-Trans jugular liver biopsy.
7. **Angiography systems:** Equipment (present and past)-serial imaging devices-subtraction process, accessories and choice-catheters, guide wires. Interventional Angiography: Accessories and uses e.g. coils/stents-Radiation safety-Pressure Injectors: Types, programming, injection protocols and uses. DSA Subtraction process, X-ray equipment, injection pump and serial imaging devices, cine camera, optical system, X-ray equipment and film processing.
8. **Nuclear Medicine:** Introduction, Basic Principle, Instrumentation, Gamma Camera,

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PET, Clinical applications, Newer developments.

9. **Film archiving systems:** Image recording devices-Laser imager/camera-functioning. Multiformatter-Automatic film handling systems-Picture archiving and communications systems (PACS)-Systems designs, transfer restrictions. Optical Disc. System (ODS).

IMAGING.

1. **Sonography.**
   Techniques and 2D, Doppler, 3D and Live 3D Imaging in,

   - Upper and lower abdominal structures.
   - Chest.
   - Thyroid and head and neck.
   - Testis.
   - Breast.
   - Neonatal Brain.
   - Cranial Ultrasonography.
   - Vascular structures.
   - Soft tissues.
   - Pregnant abdomen.
   - Extremities etc.

2. **CT.**

   - Techniques and Imaging of: Head and neck-thorax-abdomen-pelvis-musculo-skeletal system-spine-PNS-Extremities etc.
   - 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.
   - Clinical applications.

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3. MRI.

- Techniques and Imaging of: Head and neck-thorax-abdomen-pelvis-musculo-skeletal system-spine-PNS-Extremities etc.
- 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. Study with newer sequences and techniques.

4. NUCLEAR MEDICINE.

- An overview of Radioisotope Imaging.
- Radionuclide Production-review.
- Radiation Detectors-review.
- Radiation Protection in Nuclear Medicine.
- Radiopharmaceuticals.
- Clinical applications of The Gamma Camera and other Imaging Equipments.
- Quality Control and Performance Assessment of Gamma Camera Systems.
- Static and Dynamic Scintigraphy.
- Single Photon Emission Computed Tomography.
- Quantitative Imaging.
- Clinical Applications of Nuclear Medicine /PET.
- **PET**: Imaging-Newer developments.

5. ANGIOGRAPHY (INCLUDING VENOGRAPHY).

- Abdominal, visceral, peripheral, cerebral and cardiac.
- Revision of Anatomy and Physiology, clinical indications and contraindications, types of contrast.
- Dosage of contrast, patient preparation, equipment, outline of radiological procedure, radiographer's role in the team.

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- 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.

6. INTERVENTIONAL RADIOLOGY.

- Practical interventional radiology in the diseases of the Hepatobiliary, GIT, Urology, Vascular System and other areas.
- Indications and contraindications, pitfalls and complications, role of radiographer/Imaging technologist in the team.
- **Interventional procedures**. CT Guided procedures: Fine needle aspiration cytology; Fine needle aspiration Biopsy-Stereo tactic biopsy; Radio surgery. Ultrasound guided procedures: Fine needle aspiration cytology-Fine needle aspiration Biopsy. Fluoroscopy guided procedures: Endoscopic Retrograde Cholangio-Pancreatography (ERCP); percutaneous nephrolithotomy; Percutaneous nephrostomy; percutaneous trans hepatic biliary drainage; Angioplasty; Embolisation-Trans jugular liver biopsy.

SUGGESTED BOOKS.

Text books.

Recent advances in Radiology and Medical Imaging Lodge & Steiner (Churchill Livingstone).

Reference books.

1. MRI for Technologists Peggy Woodward & Roger F. Freimark (McGraw Hill).
2. Imaging for Students David A. Lisle (Arnold).
3. Digital Subtraction arteriography Charles, Andrew, Joseph (Year book Medical Publishers).
4. Atlas of Interventional Radiology Constantine Cope (J.P. Lippincott.).
5. Principles of Radiographic Imaging Richard R. Carlton (Arlene M. Alder).
6. Radiologic Science for Technologist Stewart C. Bushong (Mosby).

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3. EXAMINATIONS

3.1 Eligibility to appear for exams

No candidates shall be admitted to any year of BSc (MIT) examination unless he/she has a minimum of 80% attendance with the provision for one time condonation up to 5% on medical grounds (condonable limit 75%). Condonation for shortage of attendance shall be vested with a committee constituted by the Principal/Head of Institution, with the Principal/ Head of Institution as the Chairman and five members (senior teachers) in the committee, and remittance of required fee to the University. A candidate who has not attained 80%attendance and the shortage is beyond the condonable limit he/she shall not be eligible to continue the course with the same batch of students. He/ She may obtain special sanction (Condonation of Break of Study) from the institution and the university to continue with the junior batch of students. 50% of the aggregate in each paper towards the internal assessment will be required for appearing in the university examinations.

3.2 Schedule of Regular/Supplementary exams

- Every year, there shall be examinations to test the students.
- Examination may be held twice a year. The first examination in a year shall be the annual examination, and the second examination shall be the supplementary examination.
- The examinations shall be of written/written with practical, including viva voce, carrying maximum marks for each part of a subject and details are shown in section 3.3

First year	
Paper-I	**Anatomy**
Paper-II	**Physiology**
Paper III	**Pathology**
Paper IV	**General (Computer Technology, Hospital practice and Patient Care)**
• **No University examination and only internal examination for Paper IV**.	

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Second year	
Paper V	**Basic Physics and Electronics**
Paper VI	**Nuclear and Radiation Physics**
Paper VII	**Radiography, including Medical Image Processing**

Third year	
Paper VIII	**Physics of Medical Imaging and Radiation Safety**
Paper IX	**Radiographic imaging**
Paper X	**Modern Imaging and Recent Advances**

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3.3 Scheme of examination showing maximum marks and minimum marks

(Max-Maximum and Min-Minimum for a pass, NA-not applicable)

FIRST YEAR EXAMINATION

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Vivavoce		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper I Anatomy	100	50	50	25	150	75							150	75
Paper II Physiology	100	50	50	25	150	75							150	75
Paper III Pathology	100	50	50	25	150	75							150	75
Paper IV General (Computer Technology, Hospital practice and Patient Care)	NA	NA	50	25	50	25							50	25
TOTAL	300	150	200	100	500	250							500	250

.

SECOND YEAR EXAMINATION

Paper and Subjects	Theory						Practical/ Viva (University)						Grand Total	
	University		Internal		Total		University		Vivavoce		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper V Basic Physics and Electronics	100	50	50	25	150	75							150	75
Paper VI Nuclear and Radiation Physics	100	50	50	25	150	75							150	75
Paper VII Radiography, including Medical Image Processing	100	50	50	25	150	75	100	50	50	25	150	75	300	150
TOTAL	300	150	150	75	450	225	100	50	50	25	150	75	600	300

.

THIRD YEAR EXAMINATION

Paper and Subjects	Theory						Practical/viva(University)						Grand Total	
	University		Internal		Total		University		Vivavoce		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper VIII Physics of Medical Imaging and Radiation Safety	100	50	50	25	150	75			50	25	50	25	200	100
Paper IX Radiographic imaging	100	50	50	25	150	75	100	50	50	25	150	75	300	150
Paper X Modern Imaging and Recent Advances	100	50	50	25	150	75	100	50	50	25	150	75	300	150
TOTAL	300	150	150	75	450	225	200	100	150	75	350	175	800	400

3.4 Model question paper for each subject with question paper pattern

All the question papers are of standard type. Each theory paper will be of 3 hours duration with a maximum of 100 marks. It predominantly consists of brief answer-type questions and essay-type questions.

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MODEL QUESTION PAPER REG NO:
QP CODE: NAME:

FIRST YEAR B.Sc (MIT) DEGREE EXAMINATION….20…

Paper I
ANATOMY

Time: 3 Hours Max Marks:100

Answer all Questions.
Draw Diagrams wherever necessary

Essay (2x15=30)

1. Describe the gross anatomy of lung. Mention the various structures at the right hilum and their relationships.
2. Name the paranasal sinuses. Short notes: Describe the anatomy of maxillary sinus.

(8x5=40)

Short notes:

3. Corpus callosum
4. Stomach
5. Spleen
6. Mediastinum and contents
7. Knee joint
8. Anal canal
9. Gall Bladder
10. Middle ear

Answer briefly

11. Simple epithelium
12. Neuron
13. Haversian system
14. Fertilization
15. Carpal bones
16. Cardiac Muscle
17. Mandible
18. Structure of lymph node
19. Mesentery
20. Palatine tonsil

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MODEL QUESTION PAPER REG NO:
QP CODE: NAME:

FIRST YEAR B.Sc (MIT) DEGREE EXAMINATION….20…

Paper I
ANATOMY

Time: 3 Hours Max Marks:100

Answer all Questions.
Draw Diagrams wherever necessary

Essay (2x15=30)

1. Describe five important characteristics of a malignant cell. Discuss the differences between benign and malignant tumours.
2. What are renal calculi? Describe the aetiology, pathogenesis, types and effects of renal calculi?

(8x5=40)

Short notes:

3. Morphological features of tuberculous infection
4. Pathogenesis of thrombosis
5. Pathogenic calcification
6. Gross and microscopy of infective endocarditis
7. Gross and microscopy of peptic ulcer
8. Breast cancer
9. Fibro adenoma
10. Microcytic, hypochromic anaemia

Answer briefly

11. Papillary carcinoma thyroid
12. Osteomyelitis
13. Psoriasis
14. Nephrotic syndrome
15. Chronic myeloid leukaemia
16. Leiomyoma uterus
17. Acute appendicitis
18. Chronic cholecystitis
19. Hydrocele
20. Asthma

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Model Question Paper

Second YEAR B.Sc. (MIT) DEGREE EXAMINATION.....20

Paper V Basic Physics and Electronics

Time: 3 Hours **Max Marks: 100**

Answer all Questions. **Draw Diagrams wherever necessary.**

Essay **2x15=30**

1.

a. Explain in detail working of Moving Coil Galvanometer, Derive expression for sensitivity .

b. Explain the conversion of Galvanometer to Ammeter

2. Explain the CE characteristics of a transistor, Draw input and output characteristics.

Short Notes **8x5= 40**

3. Explain the principle of transformer
4. Define electromagnetic induction
5. Explain the crystal structure
6. Faithful amplification
7. Load line analysis of a transistor.
8. What is specific heat capacity
9. What are superconductors and their use
10. BH curve.

Answer briefly: **10x3 =30**

11. Resistivity
12. Farad
13. Doppler effect
14. Mention PN junction.
15. Equivalent capacitor.
16. Optical fibre
17. Self-induction
18. choke coil.
19. Electromagnetic waves.
20. Conductor and insulator .

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Model Question Paper

Second YEAR B.Sc. (MIT) DEGREE EXAMINATION. 20

Paper VI

Nuclear and Radiation Physics

Time: 3 Hours **Max Marks: 100**

Answer all Questions. **Draw Diagrams wherever necessary.**

Essay: **2x15=30**

1. Explain different radiation detectors. Explain in detail of construction and working principles
2. Describe the components of an X-ray tube with the help of a neat diagram. Explain the functions of each component.

Short notes: **8x5=40**

3. Derivation of the equation for radioactive decay.
4. What is excitation and ionisation in relation with energy and potential
5. Discuss the Bohr atom model.
6. Heel effect of an X ray tube.
7. Explain about radioactive equilibrium with appropriate example
8. Photoelectric effect and is its relevance in diagnostic radiology
9. Explain radiation detection and measurements.
10. Describe X ray spectrum

Answer briefly: **10x3=30**

11. Thermionic emission
12. Heel effect
13. Dose and KERMA
14. Write a note Coherent scattering.
15. Define Half Life
16. Define Atomic and Mass Number
17. Exposure rate constant
18. Isotope
19. cathode rays
20. Attenuation coefficient

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Reg.No…….

Second year BSc. MIT Degree Examination
…….20….

Paper VII
Radiography including Medical Image Processing

Time: 3 hours Total Marks:100

Answer all questions
Draw diagrams wherever necessary

Essay (2x10=20)

1. Describe in detail the structure and principle of intensifying and fluoroscopic screens, discuss their application in diagnostic Radiology.
2. Name the skull bones. Describe in detail the various X-rays taken in case of a road traffic accident.

Short notes (10x5=50)

3. Automatic film processor
4. Scaphoid views
5. Stationary grid
6. Image intensifier
7. Artefacts in radiographic film
8. Anode heel effect
9. Waters' view
10. X-ray fixer
11. Role of Tungsten in Radiology
12. Slip ring technology

Answer briefly (10x3=30)

13. TLD
14. Safe light
15. Dental film
16. Rare Earth screens
17. Macroradiography
18. Developer
19. Bucky.
20. Grid ratio
21. Monitor image

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22. Replenisher

THIRD YEAR B.Sc. (MIT) DEGREE EXAMINATION 20

Paper VIII: Physics of Medical Imaging and Radiation Safety

Time: 3 Hours Max Marks: 100

Answer all Questions.
Draw Diagrams wherever necessary.

Essay: 2x15=30

1 Explain the quality assurance procedures required for a modern conventional X-ray machine.

2. Explain different CT Generations and describe about Basic Design and Operating Principles of CT machine

Short notes: (8x5=40.

3. Dose Limits.
4. Rare earth screens.
5. Artefacts in X-ray films.
6. Constructions of automatic film processor
7. Uses of single coated X-ray film
8. Stochastic Effects .
9. Basic elements of radiation safety.
10. Dose reduction strategies in fluoroscopy.

Short answers on: (10 x 3 = 30)

11 Dark room safe light.
12. AERB
1 3 CTDI measurement.
14. Inverse square law.
15. Fog
16. ALARA.
17. Factors affecting focal spot size.
18. Filtration..
19. Timer linearity test..
20. Effective dose.

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Reg.No. ……

Paper IX Radiographic Imaging

Time: 3 hours Total Marks:100

Answer all questions

Draw diagrams wherever necessary

Essay (2x10=20)

Essay (2x10=20)

1. Write in detail the technique, indications and contraindications of Double contrast Barium enema.
2. Enumerate the factors affecting the radiographic quality. What are the methods to improve radiographic quality.

Write short notes on (10x5=50)

3. ERCP
4. Nephrogram
5. Adverse reactions to contrast agents
6. Hysterosalpingography
7. Myelography
8. Double contrast barium enema
9. MR contrast agents
10. Barium swallow
11. Sialography
12. MCU

Answer briefly (10x3=30)

13. Iodinated contrast media
14. High density Barium
15. Enteroclysis
16. Mammographic views
17. T tube cholangiography
18. Low osmolar contrast media
19. Preparation for IVU
20. Film contrast
21. Pelvimetry

.

22. RGU

Third year BSc. MIT Degree Examination….20..

Paper X Modern Imaging and recent Advances

Time: 3 Hours **Answer all questions**
Marks:100

I. Essay (2x15=30marks)

1. Describe briefly the various generations of CT scanners. Explain in detail the principle of multislice CT scanner with reference to the advantages over conventional CT scanners.

2. Explain nuclear magnetic resonance with it's application in diagnostic Radiology. Describe the spin echo and gradient echo sequences.

II. Write short notes on (8x5=40 marks)

3. MR spectroscopy

4. PACS

5. MRI contrast media

6. SPECT

7. Principles of DSA

8. Fluoroscopy guided procedures

9. HRCT

10. Doppler imaging

III. Answer briefly (10x3=30 marks)

11. Contrast enhanced ultrasound

12. CT guided biopsy

13. Advantages of digital Mammography

14. Ultrasound transducer

15. Two differences between Digital Radiography and Computerised Radiography

16. CT angiography

17. Functional MRI

18. Hepatobiliary interventions

19. Oral contrast media in CT

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20. CT protocol for hepatic lesions.

Internal assessment component

Sl.No	Items	Maximum. Marks	Splitup
1	Attendance	5	96%andabove- 5marks 92.1%–95.9% - 4marks 88.1%–92% - 3marks 84.1%–88% - 2marks 80%-84% - 1mark
2	Assignments	20	Must be hand written. Valuation is based on content, presentation, and originality. Plagiarism will not be accepted and treated seriously and those assignments will be rejected.
4	Class tests and viva	25	The affiliated colleges shall conduct at least three internal examinations/tests in each subject. Marks in best out of 2 examinations shall be taken for internal assessment. However, model examination is mandatory.
	TOTAL	50	

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