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

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 (Computer Technology, Hospital practice and Patient Care).
- Anatomy.
- Physiology.
- Pathology.
- Basic Physics and Electronics.
- Nuclear Physics.
- Physics of Medical Imaging and Radiation safety
- Radiography including Dark room Techniques.
- 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 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

3 years plus 1 year of internship.

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2.6. Subjects

First Year.

		Total Hours of Instruction	
Subject	**Theory**	**Practical/ Clinics**	**Total**
Radiological Anatomy	**50**	**25**	**75**
Physiology	**50**	**25**	**75**
Pathology	**50**	**25**	**75**
Hospital practice and Patient Care and Medical Ethics	**25**	**25**	**50**
Computer	**25**	**25**	**50**
Darkroom Techniques/Medical Image processing	**60**	**200**	**260**
General Physics and Electronics	**60**	**60**	**120**
TOTAL			

Second Year.

		Total Hours of Instruction	
Subject	**Theory**	**Practical/ Clinics**	**Total**
Radiographic imaging	**120**	**300**	**420**
Darkroom Techniques/Medical Image Processing	**60**	**200**	**260**
Basic Physics and Electronics	**60**	**60**	**120**
Nuclear and Radiation Physics	**60**	**30**	**90**
Physics of Medical Imaging	**30**	**20**	**50**
TOTAL			

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Third Year.

		Total Hours of Instruction	
Subject	**Theory**	**Practical/ Clinics**	**Total**
Physics of Medical Imaging	**30**	**30**	**60**
Radiographic special procedures	**60**	**400**	**460**
Ultrasonography	**50**	**100**	**150**
CT	**50**	**100**	**150**
MRI	**50**	**100**	**150**
Interventions	**50**	**100**	**150**
Nuclear Medicine and PET Scan	**30**	**30**	**60**
TOTAL			

Fourth Year.

One year compulsory rotational postings during which students have to work under supervision of an experienced staff in the following areas:

	Postings	**Duration**
1	Conventional radiography	2months
2	Radiographic special procedures including diagnostic and Therapeutic Interventional Procedures	2 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

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2.7 Total number of hours

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.
- Organs of taste and smell.

ANATOMY (Paper I).

- General Anatomical Terms.

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- 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,

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

- **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).

PHYSIOLOGY (Paper II).

- **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,

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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 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.

1. Best and Taylor-The human body.
2. Dean, Basic Anatomy and Physiology for Radiographers.
3. King and Showers-Human Anatomy and Physiology.

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4. Best and Taylor: The Human Body-its Anatomy and Physiology (Chapman and Hall).

PATHOLOGY (Paper III).

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.

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- Pathogenic calcification and age related changes

7. Genetic diseases Down's syndrome Haemophilia.
8. Immunology.
9. Common terms used in connection with diseases of this system.
    - 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.

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- Peptic Ulcer.
- Carcinoma stomach.
- Malabsorption.
- Inflammatory Bowel diseases.
- Dysentery.
- Appendicitis.
- Peritonitis.
- Tumours.
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4. Gall bladder.
    - Stones.
    - Cholecystitis.
    - Tumours.
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5. Pancreas.
    - Pancreatitis.
    - Stones.
    - Diabetes mellitus.
    - Tumours.
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6. Male Reproductive system.
    - Hydrocele.
    - Orchitis & Epididymitis.
    - Benign prostate hypertrophy.
    - Brief mention of tumours.
7. Female Reproductive system.
    - Brief account of ovarian tumours.
    - Diseases of pregnancy.
    - Abruptio placenta.
    - Placental Tumours.
    - Ectopic gestation.
8. Breast.

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- Fibro adenoma.
- Carcinoma breast.

9. Blood.
    - Anaemias.
    - Leukaemia.
    - Bleeding disorders.
10. Lymphoreticular Systems.
    - Lymphadenitis.
    - Lymphomas.
11. Bones .
    - Congenital.
    - Osteomyelitis.
    - Rickets, osteomalacia.
    - Bone tumours.
    - 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).
15. Kidney.
    - Stones.
    - Glomerulonephritis.
    - Pyelonephritis.
    - Renal failure. Importance of Urea and Creatinine
    - Nephrotic syndrome.

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- Tumours.

GENERAL (PAPER IV)

A. COMPUTER TRAINING.

UNIT-I.

1. History of computers.
2. Type of computer generation.
3. Digital computer organization.
4. **Number systems:** Binary, octal, decimal and Hexa-decimal number systems, conversion from one number system to another one.
5. Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC).
6. **Computer fundamentals:** Central Processing Unit (CPU), Memory-Temporary and permanent-RAM (Random Access Memory) and ROM (Read Only Memory), Arithmetic Logic Unit (ALU), Display devices, Hard copy devices.
7. Input device (key board, mouse etc.).
8. Output devices.

UNIT-II.

1. Computer Fundamentals and Operations.
    - MS-DOS.
    - DOS commands.
    - Introduction to Operating system.
    - Operating systems (Windows, UNIX, Linux).
2. Graphical user interface.
3. DBMS (dBASE, FoxBASE and newer softwares).
4. Common Word Processing softwares.
5. Spreadsheet applications like LOTUS 1-2-3/EXCEL.
6. Introduction to computer programming and application softwares.

UNIT-III.

Programming in BASIC .

- Constants and variables.

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- Arithmetic expression.
- Input/output statement.
- Array variables.
- Control statements.
- Functions and subroutines.
- File processing in BASIC.

UNIT-IV.

- Application of Computer in Health Education and Administration.
- Application of Computer in Medical Imaging**.**

B. HOSPITAL PRACTICE AND PATIENT CARE.

Modern hospital treatment is based on team work. 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 organisation; Department staffing and organisation; 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.

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.

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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; haemorrhage; 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: Sterilisation-methods of sterilisation; 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.

Additional emphasis to be given to the following aspects.

1. **Radiography as a profession**-professionalism, projecting professional image, professional and personal qualities (both essential and desirable) of the radiographer/Imaging techologist.
2. **Communication and Relational Skills**-development of appropriate communication skills with patients, verbal and non-verbal communication, appearance and behaviour of the radiographer.
3. **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.
4. **Communicable diseases** (special reference to HIV and 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.
5. **Patient vital signs**-temperature, pulse, respiration and blood pressure-normal values and methods of taking and recording them.

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6. **Medico-legal considerations**-radiographers' clinical and ethical responsibilities, misconduct and malpractice; handling female patients, practice in pregnancy.
7. **Radiological contrast media**-classification, need for radiological contrast media, relationship of X-ray transmission to density and atomic number of the elements of contrast medium. Types of Barium sulphate solutions, concentration and its particular uses, flavouring agents. Iodine preparation: Organic compounds, water-soluble group; significance of iodine content, proprietary preparations, iodised oil, Application of various systems of human body, Volume, contra-indications, methods of administration and route. Sensitivity test, side effects and management, elimination from the body; methods of administration, dosage, reactions to contrast media, role of the imaging department and the radiographer in management of patient with contrast reaction.Gases: Air, Oxygen and carbon di-oxide application and dangers.

8. **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 catheterisation and intubation, pre medication; its uses and methods; anaesthetised 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.
9. **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.
10. **Importance of documentation & alerting appropriate authorities regarding mishaps and accidents**.
11. **Department design and construction**

SUGGESTED BOOKS.

Text books.

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

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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.

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BASIC PHYSICS & ELECTRONICS

(PAPER V)

Areas covered include.

- Units.
- Mechanics.
- Electricity.
- Magnetism.
- Acoustics.
- Optics.
- Heat.
- Electronics.

A. BASIC PHYSICS.

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. Electricity and magnetism: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and Capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law. Varying currents-Growth and decay of current in LR circuit time constant, charge and discharge of a Capacitor through a resistance and inductance. 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.DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current.

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

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magnetisation-Magnetic susceptibility; B. H curve, magnetic hysteresis, Dia, para and ferromagnetism.

3. 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 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.

4. Electromagnetic waves: Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere.

4. 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.).

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

6. OPTICS.

1. **Interference**-Principle of superposition, coherent sources, conditions for brightness and darkness expression for bandwidth.
2. **Diffraction**-General Ideas, types of diffraction, plane transmission grating, determination of wavelength.
3. **Polarisation**-Polarisation by reflection and refraction, Brewster's Law, Double refraction: Ordinary/ and extraordinary/rays, Quarter and half wave plates.
4. **Scattering of Light:** Rayleigh scattering, Raman Effect: Explanation based on quantum theory. Relative intensities of Stokes and Antistokes lines.
5. **Fibre optics:** Principle and applications.

7. OSCILLATIONS.

Differential equation and solution of S. H. M. expressions for period, velocity and acceleration. Phase, initial phase, forced oscillations resonance.

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8. SOUND.

1. 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.
2. Doppler effect, Ultrasonic wave, production of ultrasonic waves (piezo-electric effect) in ultrasonography.
3. Use of principle of Doppler effect in Diagnostic Radiology (e.g. Echo, blood flow measurement).

9. 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).

12. **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.

B. ELECTRONICS.

- **Semiconductors**; Conduction in crystals, Energy bands. Intrinsic and Extrinsic semiconductors n-type and p-type semiconductors, majority and minority carriers.
- **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.

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- **Transistors**-Symbols, 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.
- **Transistor Oscillators**-Hartley, Colpitt and phases, light: oscillators.
- **Transistor as a switch**-multivibrators-monostable, bistable multivibrators.

NUCLEAR AND RADIATION PHYSICS.

(PAPER VI).

A. NUCLEAR.PHYSICS.

1. 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.Thomson's model, Rutherford Nuclear atom model, Bohr's theory of hydrogen atom, critical potential Excitation-potential, limitations of Bohr's theory, Ritz combination principle, Somerfield's modification-elliptical orbits-relativistic correction.
2. Vector atom model-Quantum numbers, coupling schemes, Pauli's exclusion principle, Bohr magneton. Stern Gerlach experiment, Electronic configuration-periodic classification, Larmor precession, Seeman effect.
3. Discovery of Cathode rays, nature and properties, e/m-Thomson's method; charge on the electron, Millikan's experiment.
4. Positive rays, isotopic constitution of matter, Aston's mass spectrograph.
5. Quantum Physics-Photoelectric effect, Laws of photo-electric emission, Einstein's theory, Millikan's verification of Einstein's equation.
6. Matter waves-De Broglie's. Theory, phase and group velocities-uncertainty principle.
7. Atomic Nucleus-general properties, Binding energy, packing fraction, Nuclear forces, general ideas on meson theory.
8. 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,

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isomeric transitions, internal conversion, Naturally occurring radio-nuclides.

9. Radioactivity: natural and artificial radioactivity, nature of radioactivity, Law of radioactive disintegration, radioactive series. Law of successive disintegration, radioactive equilibrium unit of radioactive strength.
10. Radioactivity: Discovery of radioactivity, activity units-radium, thorium and uranium series-alpha, beta decay and gamma rays-radioactive disintegration-exponential decay, decay constant. Artificial radioactivity-production of radioisotopes-cyclotron-neutron-fission and fusion-chain reaction-atom bomb-nuclear reactor.
11. Range of alpha-particles, Geiger-Nuttall Law, theory of alpha-decay. Beta-ray spectrum, finite range of Beta-rays, Neutrino hypothesis.
12. Gamma-ray Spectra absorption by matter, pair production, conversion electrons, electron capture, Auger electron.
13. Nuclear reactions-(alpha, P), (alpha, n) reactions, proton bombardment, neutron bombardment, deuteron bombardment fission, fusion, Q values. Nuclear Reactors, production of isotopes, nuclear isomerism.
14. Qualitative ideas on elementary particles and Cosmic rays.

B. RADIATION PHYSICS.

1. **X-rays:** Discovery of x-rays-X-ray production and properties: Bremsstrahlung radiations-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.
2. **Interaction of ionizing radiation with matter**-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation.
3. **Interaction of X and gamma rays**: Transmission through matter, law of exponential attenuation, half value layer, linear attenuation coefficient-coherent scattering-photonuclear disintegration-Particle interactions. Interactions of X rays and Gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.

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4. Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number.
5. Radiation intensity and exposure, photon flux and energy flux density.
6. LET, range of energy relationship for alpha, beta particles with X-Rays.
7. **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-line focus principle-space charge effect, tube cooling-Modern X-ray tubes-stationary anode, rotating anode, grid controlled X-ray tubes, heel effect, off focus radiation, tube insert and housing-Tube rating-Quality and intensity of x-rays-factors influencing them.
    - 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 and maintenance and Q.A procedures.
8. 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-high frequency generators-falling load generators, Capacitors discharge and grid control systems.
9. **X-ray generator circuits**: Vacuum tube diodes-semi-conductor diodes-transistor-Rectification-half and full wave-self rectification-X-ray generator; filament circuit-kilo Voltage circuit-single phase generator-three phase generator-constant potential generator-Fuses, switches and interlocks-Exposure switching and timers-HT cables-earthing.

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10. **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).
11. **Radiation quantities and units**: Radiation intensity-exposure, roentgen, its limitations-kerma and absorbed dose-electronic equilibrium-rad, gray, conversion factor for roentgen to rad-quality factor-dose equivalent-rem, Sievert. Quality factor, dose equivalent, relationship between absorbed dose and equivalent dose.
12. **Radiation detection and measurements**: Principle of radiation detection-Basic principles of ionization chambers, proportional counters, G.M counters and scintillation detectors, semiconductor detector-Gamma ray spectrometer. Measuring system: free ionization chamber-thimble ion chamber-condenser chamber-secondary standard dosimeter-film dosimeter-chemical dosimeter-Thermo Luminescent Dosimeter-Pocket dosimeter. Radiation survey meter-zone monitor-contamination monitor, their function use and maintenance.

C. RADIATION HAZARDS, CONTROL & SAFETY.

1. **Radiation protection**: principle, history& development-National & international agencies; AERB, BARC, ICRP, WHO and their role. Equivalent dose-effective dose-Sievert-REM. Sources of radiation-natural-man made & internal exposures.
2. **Radiation protection**: time-distance and shielding, shielding calculation and radiation survey, personnel dosimeters (TLD and film badges), occupational exposure, radiation protection of self and patient, ICRP and WHO guidelines for radiation protection, pregnancy and radiation protection.
3. **Somatic and genetic effect of ionising radiation**: need for protection, principle of radiation protection, ALARA, radiation monitoring devices-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).
4. **Natural and background radiation**: Cosmic, terrestrial.
5. **Biological effects of radiation**: effects on cell-stochastic & deterministic effects-radiation risk-tissues at risk-genetic, somatic & foetus risk-risk at other industries. Dose equivalent limits-philosophy-ICRP-concepts-AERB guidelines.Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell, DNA, RNA, chromosome, tissue and organ radio-sensitivity, cytoplasm, cellular membranes, effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on

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each of major organ system including foetus stochastic and non-stochastic effects, mean and lethal dose, direct and indirect effects, multi target and multi hit theory, factors affecting radio-sensitivity, RBE, survival curves.

6. Biological effects of non-ionizing radiation (ultrasound, sound lasers, IR, UV and magnetic fields).
7. **Planning of radiation installation:** protection from primary, leakage and scattered radiation. Concepts of workload use factor, occupancy factor & distance. Barrier design-barrier materials-concrete, brick& lead. Primary & secondary barrier design calculations. Design of doors. Control of radiation-effects of time, distance and shielding.

8. Personnel monitoring systems: principle and objective-film badge-guidelines for use-thermo luminescent dosimeter badge-pocket dosimeter. Area monitoring and radiation survey, practical use of survey meter, zone monitors and phantoms. Survey in x-ray, fluoroscopy and CT scan units.

9.AERB safety code and ethics; Built in safety specification for diagnostic X-ray, fluoroscopy and CT units. Specification for radiation protection devices-room layout. Operational safety-Radiation protection programme-Personnel requirements and responsibilities-regulatory controls.

10. Patient protection: Safe work practice in Diagnostic Radiology-Radiation absorbed dose from general, dental, fluoroscopy X-ray and CT examinations-X-ray examinations during pregnancy-X-ray examinations associated with illness, not associated with illness-medico-legal or insurance purpose X-ray examinations-X-ray-avoidance of unnecessary radiation dose. Radiation emergencies-situation preparedness, safety and prevention-legal requirements. Recent developments in radiation safety related topics. Special issues and management of pediatric patients, eg:-restraining the child, methods for dose reduction, justification of radiological studies, taking consent.

SUGGESTED BOOKS.

Text books.

1. First year Physics for Radiographers-Hay & Hughes.

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2. Quality assurance in Diagnostic Radiology By: J.M. Mclemore (Year books of Medical publishers).
3. Radiation Protection in Hospitals. Richard F.Mould.

Reference books.

1. Fundamental of X-ray and Radium Physics-Joseph Selman.
2. Basic Medical Radiation Physics-Stanton.
3. Christensen's Physics of Diagnostic Radiology-Christensen.
4. Quality Control in diagnostic imaging By: J.E. GRAY (University Park Press).
5. Processing and Quality Control By: William, E.J. McKinney (J.B. Lippincott Company).
6. Concepts in Medical Radiographic imaging By: Marianne Tortoise (W.B.Saunders Company).
7. Quality assurance Management By: G.E. Hayes (Charger production).
8. Diagnostic Imaging: Quality Assurance By: M.M. Rehani (Jaypee Bros Medical Publishers).
9. Basic radiological physics. Jaypee bothers pvt ltd, New Delhi.
10. An Introduction to Radiation Protection. Allen Martin & Samuel.
11. Radiation safety in Medical practice. M.M. Rchami.
12. Radiation Protection. Ronald L. Kathren.
13. AERB safety code and manuals.

RADIOGRAPHIC TECHNIQUES.

(PAPER VII).

The term Radiographic technique in implies a full knowledge of the procedure for X-ray examination; preparation of the room, apparatus and instruments; position of the patient for at least two projections, at right angles, relative to positions of the X-ray tube and patients; relevant exposure factors; use of accessories, such as radiographic cones, grids and position aids. 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 radiographic technique which may be necessary for various disabilities. The need for radiation precautions to be emphasised, to both patients and all hospital staff and general public.

For each area studied, emphasis will be given to.

- Anatomy (review).

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- 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 include.

1. Upper extremity-basic views and special views.
2. Lower extremity (including pelvis)-basic views and special views.
3. Chest including thoracic cage and sternum.
4. Spine-Cervical, dorsal, lumbar, lumbo-sacral (including functional views).

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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.

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- 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.

14. Mammography: Review of Anatomy, Physiology and Pathology of female breast-knowledge about the nature of X-ray beam and equipment suitable for breast imaging-image recording devices-accessories for immobilisation and identification, positioning, techniques for various projections; exposure factors, radiation protection-technique of

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biopsy procedure-characteristics of benign and malignant lesions-patient care-female attendant.

CONVENTIONAL 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. Technologist's role in the management in adverse reactions.

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.

Gastrointestinal tract imaging: Fluoroscopy, general considerations, responsibility of radiographers, 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.

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.

Biliary system: Plain film radiography-Oral cholecystography-Intravenous cholangiography-Percutaneous cholangiography-Endoscopic retrograde Cholangio-

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Pancreatography(ERCP)-Operative cholangiography-Post-Operative cholangiography (T-tube Cholangiography)-Technique of PTC, ERCP, T-Tube cholangiography, per-operative cholangiography.

Revision of Anatomy and Physiology-clinical indications and contraindications-contrast media-patient preparation-film series-radiation protection-patient care.

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.

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

Mammography: Mammography: cyst puncture, mammary duct injection.

Respiratory system: Nasopharyngography-Laryngography-Bronchography.

Central nervous system-Myelography-Cerebral studies-Ventriculography-Encephalography.

Arthrography-Shoulder, hip, knee, elbow.

Discography-Technique and procedures.

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.

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

Lymphatic system: Techniques for routine projection-Soft tissues differentiation for region concerned-Lymphangiography.

Dacryocystography-Techniques and procedures.

Sinusography-Routine Technique and procedure.

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Procedures which are obsolete or rarely used: Myelography-indications and contraindications-contrast used-patient preparation-injection technique-film sequence-projections-patient care-

Others are.

- Pelvimetry.
- Oral cholecystography.
- Intravenous cholangiography.
- Dacryocystography.
- Conventional Arthrography.
- Discography.

Conventional--special situations.

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.
- Oesophageal 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.

Geriatric radiography.

Understanding patient profile-possible difficulties during radiography-Technical considerations-need to carry out standardised projections in unconventional positions-

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equipment and accessories-exposure factor considerations in view of variations in skeletal tissue-special care.

Trauma/Emergency Radiography: Limb fractures-Fracture of thoracic cage, spine, and 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.

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.

Macroradiography: General principles-Requirement-Equipment-Technique-use.

Tomography: General Principles-Estimation, selection of depth of layer-Layer thickness required for different examination-Spacing of layers-Types and advantages of various movements- Choice of tomographic movement-exposure factor-Sequential, Horizontal and multi section tomography-Application of Tomography to specific regions.

Stereography: Principles involved-tube shift in relation to patient-Technique-Stereoscopic apparatus for viewing and orientation of films-Correct marking of stereographs-Application to specific regions.

Subtraction: Photographic subtraction-Colour subtraction-Digital subtraction.

Soft tissue radiography: High and low kilo voltage technique; differential filtration-Non-screen technique-simultaneous screen and non-screen technique-Multiple radiography-Uses of soft tissue radiography.

High KV radiography: General principles-Relation to patient dose-Change in radiographic contrast-Scatter elimination; beam collimation-Radiographic factor; application and uses.

Localization of foreign bodies: General location principles-Ingested; inhaled; inserted; embedded foreign bodies-Foreign bodies in eye-Preparation of the area to be investigated-Appropriate projection for all regions-Techniques to locate non-opaque foreign body.

SUGGESTED BOOKS.

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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).
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.

PHYSICS OF MEDICAL IMAGING AND RADIATION SAFETY.

(PAPER VIII).

2. **Radiography**: Primary radiological image-Image produced by contrast media-Attenuation-Linear and mass attenuation coefficient-Factors affecting attenuation-application in radiology-Filters-inherent and added filters-Heavy metal filters-X-ray beam restrictors-aperture diaphragm-cones and cylinders-collimators-function of restrictor.
3. **Scattered radiation**: significance of scatter-Grid, principle, design and type-evaluation of grid performance-lead content-Grid cut off-moving girds-Grid selection-air gap technique.
4. **Fluoroscopy:** 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, types of

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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, 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.
8. **Mammography:** Technical aspects of Mammography, generator, X-ray tubes, Accessories, Resolution, quality control. Application and role in medicine.
9. **Xeroradiography:** principles-xeroradiography plate powder development-image development- image quality-liquid toner xeroradiography.
10. **Ultrasound**: Physical characteristics of sound-characteristics of ultrasound beam-interaction of ultrasound and matter-quarter wave matching-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 impedance).Ultrasound image formation and storage/documentation devices-ultrasonic display-imaging principles-Doppler techniques-real time ultrasound-Tissue harmonic Imaging-Elastography-ultrasound instrumentation-bio effects and safety considerations.
11. **COMPUTERIZED TOMOGRAPHY (CT):** Historical background, various generations of scanners, advancement in CT technology (helical/spiral and multi slice), ultra-fast scanners. CT fluoroscopy-System components, CT performance parameters, image quality and methods of image reconstruction, radiation dose measurements and technical aspects of Q.A. (quality assurance).

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12. **DIGITAL RADIOGRAPHY AND PACS:** Direct and Indirect Digital Imaging, Computer Radiography**.** 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.
13. **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.
    - Basis of MRI, 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.
    - MRI in Practice, Image Artefacts.
    - Safety Considerations.
    - Introduction to in vivo MR Spectroscopy, Single and multi-voxel MRS.
    - Introduction to Spectroscopy Imaging (CSI).
    - Processing MRS Data.
    - Flow and Angiography, Advanced Pulse Sequences and Techniques.
14. **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.
15. **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.

EQUIPMENTS IN CONVETIONAL RADIOLOGY.

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

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- 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.
    - X-ray tube overload protection circuits.
    - Percentage tube overload indication.
3. **Specialised X-ray generators.**
    - High Frequency.
    - Shared generators.
4. **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.
5. **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.

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- Heat path.
- Anode, tube housing cooling chart.

6.X-ray tube supports.

- Floor stands.
- Floor to ceiling stands.
- 'C' arm supports.
- Advantages of ceiling suspend tubes.

7. **X-ray tables/Bucky.**

- Floating top table.
- Variable height table.
- The vertical Bucky.
- The versatile Bucky.
- Limitations of the primary beam/the light beam diaphragm.

8. **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.

9. **Equipment for mobile radiography.**

- Portable/Mobile X-ray unit.
- Capacitor discharge unit.
- Cordless mobiles.
- Mobile image intensifier, limitations.
- Mobile Digital Radiography

10. **Equipment for MMR (Mass Miniature Radiography).**

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- Design and construction and function.
- Film loading, care.

11. **Equipment for Dental Radiography.**
    - Intra oral radiography unit.
    - The orthopantomography unit (OPG).
    - The cephalostat.
12. **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 and tube movement pattern.
13. **Equipment for Skull Radiography.**
    - Types and principles.
    - Basic requirements in control and design.
    - Types of movements.
    - Accessories, application.

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.).

RADIOGRAPHIC IMAGING.

(PAPER IX).

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Appreciation and application of all the factors listed below will enable the 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, interpretation of characteristics curve-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. Types, applications, advantages/limitations of different types, safe light requirements.

   Sensitometry: Photographic density-characteristic curve-information from the characteristic curve-speed Vs definition. Storage of X-ray film.
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.
3. **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.
4. **Cassettes:** Structure and function-Types-single, gridded, film holder-Design features and consideration with loading/unloading-Care and maintenance (cleaning).
5. **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 development-constitution of developer-development time-factors in the use of developer. Fixers-constitution of fixing solution-factors affecting the fixer-replenishment of fixer-silver conservation-Drying-developer and fixer for automatic film processor-rinsing-washing

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and drying. Replenishment rates in manual and automatic processing-Silver recovery-Auto and manual chemicals**.**

6. **Processing:** manual processing-care of processing equipment-automatic processor-manual VS automatic processing-principles and typical equipment Microprocessor controlled-Cine processing-Daylight systems-Processing faults-maintenance.
7. **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).
8. **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.

    Dark Room.

    - The processing area.
    - Dark room design, construction, illumination, entrance, safe lighting-types.
    - Storage, shelving of films.
    - Cleaning and maintenance.
9. **Radiographic image-**components of image quality-unsharpness in radiographic image-contrast of the radiographic image-distinctness of the radiographic image-size, shape and spatial relationships.
10. **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.
11. Presentation of radiographs-opaque letters and markers-Identification of dental films-preparation of stereo radiographs-viewing conditions.
12. **Monitor images-**Characteristics of the video image-television camera-imaging camera. Laser-light and laser-laser imaging-laser imagers-imaging plates-Dry cameras.

QUALITY ASSURANCE IN DIAGNOSTIC RADIOLOGY.

Diagnostic Radiology provides a valuable input into health care delivery system. Efficient utilization of the technology can be assured only through planned systematic

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and organized quality assurance procedures. Good diagnostic images would lead to accurate diagnosis and better management of health problem.

Objectives: 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.

1. **Quality assurance and quality control tests:** Meaning of the term and aspects of a QA programme, equipment and staff requirements, benefits of QA procedures in an imaging department.
2. **QA activities**. Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance.
3. **QA programme at radiological faculty level:** Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Record keeping; 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.
4. **QA Programmed tests**: 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. **QA of film and image recording devices**: Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution, distortion, artefacts of films and image recording.
6. **Maintenance and care of equipment**. Safe operation of equipment-Routine cleaning of equipment and instruments-Cassette, screen, maintenance of automatic processor and manual processing units. Routine

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maintenance of equipment's, record keeping and log book; maintenance; Reject analysis and objectives of reject analysis programme.

7. **X-ray room specifications:** Setting up of a new X-ray unit, staff requirement, AERB (Atomic Energy Regulatory Board) specifications for site planning and mandatory guidelines.

SUGGESTED BOOKS.

Text books.

Radiographic Imaging-Chesney & Chesney, Blakwell scientific publications, oxford (1981).

Reference books.

- Radiographic imaging-Derrick P. Roberts and Nigel L. Smith. Churchill. Livingstone, Edinburgh (1994).
- Radiographic Latent image processing-W.E.J. Mckinney.
- Photographic processing, quality control and evaluation of photographic material-J.E. Gray.
- Photographic processing Chemistry-L.F.A. Mason.
- Physical and photography principles of Medical Radiography- Seeman & Herman.

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MODERN IMAGING AND RECENT ADVANCES.

(PAPER X).

This subject enables the student/technologist to learn and understand the advancement in Radio Diagnostic Technology, Imaging equipment and imaging modalities and its clinical applications, developed more towards the recent years. This subject also enables the student to learn and understand the basic concept of computer applications in Diagnostic Radiology and imaging.

(A). EQUIPMENTS.

1. **Ultra Sound Scanning (U/S):** 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. **Computed tomography:** Historical information, fundamentals, computer hardware and software. Scanner types, technologic considerations of sequential/spiral volume zoom-CT advantages and limitations-Basic data acquisition concepts. CT-detector 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.

   Basic principle-data accumulation-image reconstruction-storing the image-viewing the image-evaluation of image-equipment for tomography-table-gantry-X-ray generator-different generations-image quality-patient exposure-artefacts.
3. **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.

   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-safety considerations. Newer sequences and emphasis on,

   - Relaxation Parameters and Spin Echoes.
   - Magnetic Field Gradients, Slice selection and Frequency Encoding.

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- 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.

4. **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.
5. **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.
6. **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.
7. **Mammography systems:** Background, diagnosis and screening. Imaging requirements-Equipment-tube, compression, grids and Image receptor requirements. Radiation dose, Image quality-Interventional accessories-Biopsy equipment attachments.

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8. **Gamma Camera, PET etc.:** Basic principle-Instrumentation-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).

(B). IMAGING.

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.

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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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.

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.

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.

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 B.Sc (MIT) examination unless he/she has a minimum of 80% attendance with the provision for one time condonation up to 10% on medical grounds (condonable limit 70%). 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.
- Those who obtain 50% of aggregate in each paper towards internal assessment will be eligible for appearing the university examinations.

3.2 Schedule of Regular/Supplementary exams

- Every year there shall be an examination to examine the students.
- Each examination may be held twice a year. The first examination in a year shall be the annual examination and the second examination shall be supplementary examination.
- The examinations shall be of written and practical (including viva voce) carrying maximum marks for each part of a subject

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**.	

.

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 shows maximum mark and minimum marks

FIRST YEAR EXAMINATION

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

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva voce		Total			
	Max	Min	Max	Min	Max	Min	Max						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) Only internal examination no University examination			50	25	50	25							50	25
Total Marks	300	150	200	100	500	250							500	250

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Second YEAR EXAMINATION

(Max-Maximum and Min-Minimum for a pass)

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva voce		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 Marks	300	150	150	75	450	225	100	50	50	25	150	75	600	300

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Third YEAR EXAMINATION

(Max-Maximum and Min-Minimum for a pass)

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva voce		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
PAPER VIII Physics of Medical Imaging	100	50	50	25	150	75							150	75
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 Marks	300	150	150	75	450	225	200	100	100	50	300	150	750	375

Model question paper for each subject with question paper pattern

All the question papers should be 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.

MODEL QUESTIAN PAPER
QP CODE:

Rreg No:.....
Nane:.....

FIRST YEAR B.Sc (MRT)DEGREE EXAMINATION.....22

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

(10x3=30)

Answer briefly

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

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MODEL QUESTIAN PAPER
QP CODE:

Rreg No:.....
Nane:.....

FIRST YEAR B.Sc (MRT)DEGREE EXAMINATION.....22

Paper II
PHYSIOLOGY

Time 3 Hours

Max Marks: 100

Answer all Questions.
Draw Diagrams wherever necessary.

Essay (2x15=30)

1. Describe the Sstaging of red blood cell formation.

2. Name the 12 cranial nerve. Describe the function of any two of them in detail
. (8x5=40)

Short notes:

3.

4.

5.

6.

7. Leukopenia and its clinical significance.

8. Menstrual cycle

(10x3=30)

9. Non-respiratory functions of lungs.

10.Composition of semen.

Answer briefly

11. Function of throbocytes
12. Functions of mineralocorticoids
13. Ovulation
14. Anti-diuretic hormone
15. Function of gall Bladder
16. Functions of progesterone
17. Cretinism
18. Cryptorchidism
19. Functions of kidney
20. Primary taste sensations

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MODEL QUESTIAN PAPER
QP CODE:

Rreg No:.....
Nane:.....

FIRST YEAR B.Sc (MRT)DEGREE EXAMINATION.....22

Paper III
PATHOLOGY

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?

Short notes: (8x5=40)

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 (10x3=30)

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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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 transistor, Draw input and output characteristics X5

Short Notes 8x5 40

4 Explain the principle of transformer

5 define electromagnetic induction

6 Explain self bias

7 Faithfull amplification

8 Draw the circuit of an op-amp, which employs negative feedback with a resistor. Show the voltage polarities and direction of currents through the input and output.

9. What is total internal reflection and refractive index

10 What are super conductors and its use

11 Distinguish between single and three phase circuits.

Answer briefly: 10x3 30

13. Define current and voltage. Give its SI units.
13. What is total internal reflection and refractive index.
14. Mention one assumption of de Broglie's relation.
15 Three capacitors are connected in parallel and derive the expression for equivalent capacitor.
16 What are super conductors and its use?
17. Obtain the expression for self-induced e.m.f and hence define its SI unit.

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18 Distinguish between single and three phase circuits.
19. A 100Hz AC is flowing in 15mH coil. Find its reactance.
20. Define conductor and insulator on the basis of electrical conductivity. Give its examples
21. Define time constant for growth of charge in R-C circuit

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. What is nuclear reactor? Explain in details of construction and working
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. Energy to mass conversion interaction
20. Mass defect

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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.Enumerate the factors affecting the radiographic quality. What are the methods to improve radiographic quality.

Short notes (10x5=50)

3. Automatic film processor
4. Digital subtraction Angiography
5. Stationary grid
6. Image intensifier
7. Artefacts in radiographic film
8. Anode heel effect
9. Imaging plate in CR
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. Detectors in DR

18.Mammography X-ray tube

19.Bucky

.

20. Grid ratio

21. Auto transformer

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..

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20. Effective dose.

Reg.No. ……

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

Paper IX Radiographic Imaging

Time: 3 hours Total Marks:100

Answer all questions

Draw diagrams wherever necessary

Essay (2x10=20)

1.Write in detail the technique, indications and contraindications of Double contrast Barium enema.

2. What is Positron Emission Tomography ?Describe briefly the physical principles and indications.

Write short notes on (10x5=50)

3.ERCP

4.Clinical applications of MRI

5. Radiographic views for calcaneum

6.Hysterosalpingography

7.Myelography

8.Dental Radiography

9.MR contrast agents

10.Barium swallow

11.Sialography

12. MCU

Answer briefly (10x3=30)

13.High kV technique

14.High density Barium

.

15.Open mouth view

16.Mammographic views

17.Decubitus lateral view

18.Low osmolar contrast media

19.Preparation for IVU

20.Radiographic view for patella

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)

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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

20. CT protocol for hepatic lesions.

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