PRAVARA INSTITUTE OF MEDICAL SCIENCES
(DEEMED TO BE UNIVERSITY)
Loni, Tal. Rahata, Dist. Ahmednagar 413736
NAAC Re-accrediated with 'A' Grade

SYLLABUS

M.Sc. Medical Radiological Imaging and Technology (M.Sc. MRIT)
(Department of Radiology)
(Academic Council Meeting Dated 20th March, 2019)

M.Sc. Medical Radiological Imaging and Technology

M.Sc. Medical Imaging Technology or Master of Science in Medical Imaging Technology is a postgraduate Medical Lab Technologist course. Medical imaging is a rapidly growing discipline within the healthcare sector. Involving clinicians. physicists. computer scientists and those in the IT sector. This is fuelled by the rapid development of 3D medical imaging systems over the last few decades, matched by an exponential rise in computing power. This has allowed the development of new methods for the acquisition, reconstruction, processing and display of digital medical image data with unprecedented speed. resolution and contrast: a trend which can only continue. Program provides a Masters-level postgraduate education in the knowledge. skills and understanding of engineering design of advanced medical and biotechnology products and systems. Students will also acquire a working knowledge of the clinical environment to influences their design philosophy. The M.Sc. Medical Imaging is aimed at training graduates for careers in this exciting multidisciplinary area and provides a judicious mix of theoretical and applied topics. The course is career orienting in nature that opens many jobs after its completion.

- **Eligibility criteria:**
    - Graduation in B.Sc. or any equivalent degree with minimum 50% marks
    - Intake Capacity : 5 Students per batch

- **DURATION: 2 YEARS**
- **LEVEL : POST GRADUATE**
- **TYPE : DEGREE**

M.Sc. Medical Imaging Technology Course Suitability

- Candidates should possess skills like learning strategies. Critical thinking skills. instructional skills. Active listening. Active learning, reading comprehension, and written/oral expression.
- They should be able to receive and interpret requests from medical practitioners for X-ray examinations to be performed on patients.
- They should be able to explain procedures to patients and address any concerns they have about radiation processes.
- They should be good hard worker, can work with team spirit and could be able to handle complex problems.

M.Sc. Medical Imaging Technology Course BENEFITS:

- Course is beneficial to provide core training in electrical. Microwave. Magnetic. Acoustic and optical techniques relevant to the life sciences interface and provide broad experience of analytical and imaging techniques relevant for biology. Biomolecular and clinical sciences.
- Course is suitable to enhance a student's analytical and critical abilities. competence in multi-disciplinary research & development
- Course is helpful to provide broad practical training in biology and biomolecular sciences sufficient for students to understand the biomedical nomenclature and to have an appreciation of the relevance and potential clinical impact of the research projects on offer.

M.Sc. Medical Imaging Technology Employment Areas

- Research & Medical Colleges/Universities
- Medical Labs
- Govt./Pvt. Hospitals
- Content Writing (medical)

M.Sc. Medical Imaging Technology Job Types

- MRI Technologist
- Radiographer
- Dialysis Technician & Therapist
- Lecturer & Professor
- Medical Imaging Technologist
- Consultant Medical Research Specialist
- Medical Physicist
- Application specialists in CT, MRI, Radiotherapy equipment
- Embryologists

EXAMINATIONS :

- SEMESTER END EXAMINATIONS: 4
- EACH SEMESTER HAS 3 PAPERS of 100 MARKS EACH and Practical examination of 100 marks
- TOTAL MARKS OF COURSE: 1200 marks (Theory) and 400 marks (Practical)= Total -1600 marks.
- Passing percentage is 50 % in Theory and Practical each.
- Subject wise passing cut off shall be 40 %
- Candidate must pass 50% of subjects to be promoted to the next semester.
- If total percentage acquired in Theory / Practical is <50 %, candidate shall be promoted to next semester and will appear for the repeat examination along with next semester examination in addition to subjects of the corresponding semester.

COURSE SYLLABUS:

With reference to syllabus prescribed by various Universities and Colleges.

SEMESTER I :

PAPER I – Management and planning of Radiology and imaging department including national and international guidelines; Reporting formats. (100 marks)

PAPER 2- Radiological Imaging equipments and related softwares. (100 marks)

PAPER 3 - Basic Physics including Radiological Physics and Fluoroscopy physics (100 marks)

PRACTICAL (100 marks)

SEMESTER II

PAPER 1- Quality assurance and Quality control in Diagnostic radiology and imaging department (100 marks)

PAPER 2- Radiography positioning (100 marks)

PAPER 3-CT physics and Techniques (100 marks)

PRACTICAL (100 marks)

SEMESTER III

PAPER I - Radiation safety and protection (100 marks)

PAPER 2- Radiological and Imaging Procedures(100 marks)

PAPER 3- MR physics and Techniques(100 marks)

PRACTICAL (100 marks)

SEMESTER IV

PAPER 1- USG physics; Laws applicable to Radiology. (100 marks)

PAPER 2- Newer imaging developments and Nuclear medicine(100 marks)

PAPER 3- Interventional Radiological techniques and patient care. (100 marks)

PRACTICAL (100 marks)

DETAILED SYLLABUS

SEM I

PAPER 1 : MANAGEMENT AND PLANNING OF RADIOLOGY AND IMAGING DEPARTMENT INCLUDING NATIONAL AND INTERNATIONAL GUIDELINES; REPORTING FORMATS

1. Role of Radiographer in Planning & Radiation Protection: Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-Ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines – Planning of X-ray/CT rooms, Inspection of X-Ray installations - Registration of X-Ray equipment installation- Certification -Evaluation of workload versus radiation factors – Occupational exposure and protection Tools/devices.
2. Planning consideration for radiology, including Use factor, occupancy factors, and different shielding materials Protection for primary radiation, work load, protection from scatter radiation and leakage radiation, X-Ray/Fluoroscopy/Mammography/Intervention/DSA/CT room design, structural shielding, protective devices.
3. Regulatory Bodies & regulatory Requirements: International Commission on Radiation Protection (ICRP) / National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements. (ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection).
4. Surveys and regulations. Radiation protection survey: Need for survey. -

Performance standards for beam directing, beam defining and limiting devices in radiation protection equipment survey of the following. a. Radiographic equipment b. Fluoroscopic equipment c. CT and special equipment. Controlled and non-controlled areas and acceptable exposure levels. State and local regulations governing radiation protection practice.

5. Personal monitoring and occupational exposures: Personal monitoring for Radiation workers. Monitoring devices. Body badges and ring badges. Thermo-luminescent dosimeters, Pocket ionization chambers. Applications, advantages and limitations of each device, Values for dose equivalent limits for occupational radiation exposures.

6. NABH guidelines, AERB guidelines and code, Basic safety standard, PNDT /PCPNDT Act and guidelines.

Achievable safety through compliance on the regulations in India and recommendations of ICRT, IAEA.

7. Introduction to Management of a Radiology Department
   a. Strategic Management
   b. Decision Making, conflict and stress management
   c. Managing Change and Innovation
   d. Understanding Groups and Teams
   e. Leadership
   f. Time Management
   g. Cost and efficiency

8. <u>Reporting formats-</u>

- Reporting formats in Ultrasound- Abdomen and pelvis, Obstetrics- NT scan, Anomaly scan, growth scan, USG small parts- Thyroid, Neck, submandibular region etc, Doppler- Obstetric, Carotid, Peripheral arterial and venous Doppler, mammography.
- Reporting formats in CT - Brain, Face, Abdomen and pelvis, Thorax, 3D CT, Limbs, Joints, Angiography, HRCT Temporal bone.

- Reporting formats in MRI- Brain, PNS, Orbit, Joints, Spine, Abdomen and pelvis, Local swelling.

PAPER 2: RADIOLOGICAL AND IMAGING EQUIPMENTS AND RELATED SOFTWARES

1. High Frequency X-Ray Generators and their types and applications.
2. Modern x-ray tubes-their types and advancements.
3. Special radiological equipment: Computed radiography: its principle, physics & equipment. Digital Radiography, Direct and indirect digital radiography Digital Fluoroscopy , Digital Mammography; including cones compression devices Stereotactic Biopsy system including Prone Table Biopsy system.
4. Image Receptors: Flat Panel Detectors, Image Processing Workstation and Imaging Cameras.
5. Tomography: Body section radiography, basic principle and equipment, multi section tomography, various types of topographic movements,
6. Tomosynthesis, Stitch radiography
7. Dual energy x-ray absorptionometry (DEXA) scan.
8. Vascular Imaging Equipment: Introduction, historical developments DSA Equipment- Principle, applications and definition of terms, Single Plane, Biplane, Hybrid DSA Lab- digital subtraction techniques.
9. Scatter radiation its formation and control: beam centering devices, collimators, cone diaphragms and grids.
10. Fluoroscopy and IITV systems including cine radiography with various recording devices.

11. Computed Tomography -Principle, data acquisition concepts, image reconstruction, instrumentations, image manipulation Historical developments - Various generations, spiral/helical, single slice/multislice CT, Electron beam CT, mobile CT, Advances in volume scanning, continuous, sub-second scanning. Real time CT fluoroscopy, interventional guidance tool, 3D CT, CT angiography. Virtual reality imaging, including image quality and quality control in CT Scanners.
12. Ultrasonography: :Basic principle of U.S., various types of transducers, mechanism of image formation, various advancements including Doppler, Elastography, HIFU,ABVS and image artifacts.
13. MRI: Basic principle of MRI, complete imaging equipment and various requirements, T1 and T2 Relaxation behaviors of tissues, T1, T2 and proton density images, spatial localization of images. Types of imaging sequences (spin echo, fast spin echo, flash, inversion recovery, gradient echo etc. MR spectroscopy, principle and techniques, Contrast Agents in MRI, Image quality, Image artifacts and its compensators, NMR hazard and safety. Advances in MRI.
14. Radionuclide scanning including rectilinear scanner, gamma camera, PET, SPECT, their principles, working, applications and advancements.
15. Care and maintenance of radiological equipments
16. Interventional Radiography: Basic angiography and DSA:
    a. History , technique, patient care
    b. Percutaneous catherisation, catheterization sites, Asepsis
    c. Guidewire, catheters, pressure injectors, accessories
    d. Use of digital substraction- single plane and bi-plane

    All forms of diagnostic procedures including angiography, angioplasty, bilary examination, renal evaluation and drainage procedure.

2. Central Nervous System:
    a. Myelography.

b. Cerebral studies.
c. Ventriculography

3. Arthrography: Shoulder, Hip, Knee, Elbow
4. Angiography:
   a. Carotid Angiography (4 Vessel angiography).
   b. Thoracic and Arch Aortography.
   c. Selective studies: Renal, SMA, Coeliac axis.
   d. Vertebral angiography.
   e. Femoral arteriography.
   f. Angiocardiography.
5. Venography:
   a. Peripheral venography.
   b. Cerebral venography.
   c. Inferior and superior venocavography.
   d. Relevant visceral phlebography.
6. Cardiac catheterization procedures: PTCA, BMV, CAG, Pacemaker, Electrophyiology
7. Ultrasonography/ Doppler studies: Techniques of sonography-selection-Preparations - instructions and positioning of patient for TAS, TVS, TRUS, neck USG and extremities- patient care and maintenance protocols clinical applications display methods –quality image reproducible extend – biopsy procedures, assurance to patients.
8. CT scan studies acquisition/ protocols /techniques: CT of head and neck – thorax – abdomen – pelvis – musculo skeletal system – spine – PNS. Anatomy – clinical indications and contraindications – patient preparation

– technique – contrast media-types, dose, injection technique; timing, sequence -

image display – patient care – utilization of available techniques & image processing facilities to guide the clinician- CT anatomy and pathology of different organ systems.

9. MRI imaging – Head and Neck ,Thorax, Abdomen, Musculoskeletal System imaging - Clinical indications and contraindications- types of common sequences effects of sequence on imaging - Protocols for various studies- slice section- patient preparation-positioning of the patient -patient care-calibration - paramagnetic agents and dose, additional techniquesand recent advances in MRI - image acquisition-modification of procedures in an unconscious or un co-operative patient - plain studies- contrast studies

-special procedures- reconstructions- 3D images- MRS blood flow imaging, diffusion/perfusion scans - strength and limitations of MRI- role of radiographer.

10. Techniques of Fusion and hybrid Imaging Technology including PET CT,PET MRI, PET Ultrasound, MRI, CT, Fluoroscopy, Hybrid Imaging as well as Advanced Interventional suite.

11. <u>Softwares related to Radiology department:</u>

- PACS
- HIMS
- FOCUS

PAPER 3: BASIC PHYSICS INCLUDING RADIOLOGICAL PHYSICS AND FLUOROSCOPY 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, series and parallel LCR circuits, DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current.
3. **Electromagnetic waves**: Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere.
4. **Sound.**

    a. 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.
    b. Doppler's effect, Ultrasonic wave, production of ultrasonic waves (piezo-electric effect) in ultrasonography.
    c. Use of principle of Doppler's effect in Diagnostic Radiology (e.g. Echo, blood flow measurement).

5. **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).

6. Electronics.

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

7. Basic Radiological Physics including Xrays and Fluoroscopy

d. 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.
e. Interaction of ionizing radiation with matter-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation.
f. Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, and 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.

g. Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number.

h. Radiation intensity and exposure, photon flux and energy flux density.

i. LET, range of energy relationship for alpha, beta particles with X- Rays.

j. 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.

k. 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.

l. Heat dissipation methods, tube rating, heat units, operating conditions and maintenance and Q.A procedures.

m. 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.

n. 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.

o. 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.

p. 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.

q. Radiation detection and measurements: Principle of radiation detection-Basic principles of ionization chambers, proportional counters, G.M counters and scintillation detectors. Measuring system: free ionization chamber-thimble ion chamber-condenser chamber- secondary standard dosimeter-film dosimeter-chemical dosimeter- Thermo Luminescent Dosimeter-Pocket

dosimeter.

SEM II

PAPER 1: QUALITY ASSURANCE AND QUALITY CONTROL IN RADIOLOGY AND IMAGING DEPARTMENT

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

5. Quality assurance of film and image recording devices: Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution; Distortion; Artifacts of films and image recording. Monitor calibration. SMPTE pattern.
6. Maintenance and care of equipment: Safe operation of equipment; Routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipments; Record keeping and log book maintenance; Reject analysis and objectives of reject analysis programme.
7. Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.
8. Quality Assurance and quality control of Modern Radiological and Imaging Equipment which includes Digital Radiography, Computed Radiography, CT scan, MRI Scan, Ultrasonography and PACS related. Image artifacts their different types, causes and remedies

PAPER 2: RADIOGRAPHY POSITIONING

1. Skeletal system:

a) 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.

b) Lower limb: Technique for foot, toes, great toe, tarsal bones, calcaneum, ankle joint, lower leg, knee, patella & femur. Supplementary techniques: Stress view for torn ligaments,

- Subtalar joint and talo calcaneal joint.

- Inter condylar projection of the knee.
- Tibial tubercle.
- Length measurement technique.

c) Shoulder girdle and thorax: Technique for shoulder joint, scapular, clavicle, acromio clavicular joints, sternum, ribs, sterno-clavicular joint. Supplementary projections and techniques

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

d) Vertebral column: Technique for atlanto-occipital joint, cervical spine, cervico thoracic spine, thoracic spine, thoraco- lumber spine, lumbo sacral spine, sacrum and coccyx. Supplementary techniques to demonstrate:

- Scoliosis
- Kyphosis
- Spondylolisthesis
- disc lesion
- Union of spinal graft.

e) 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 techniques-

- Congenital dislocation of hips
- Epiphysis of femur
- Lateral projections for hip joints to show femoral head and neck relationship.

f) Skeletal survey: Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders.

g) Skull: Basic projections for cranium, facial bones, nasal bones and mandible. Technique for

- Petrous temporal for mastoids. Internal auditory canal. - Accessory nasal sinuses.
- Tempero - mandibular joint. –Orbits and optic foramen.- Zygomatic arches.
- Styloid process. - Pituitary fossa. - Jugular foramen.

2. Dental Radiography- Technique for intra oral full mouth.- Occlusal projections.- Extra oral projections including orthopantomography.- Supplementary techniques.
3. Upper respiratory system- Technique for post nasal airways, larynx, trachea, thoracic inlet, Valsalva manoeuvre. - Phonation.
4. Lungs and Mediastinum: Technique for routine projections- Supplementary projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated postero-anterior projection. - Expiration technique. - Technique for pleural fluid levels and adhesions.
5. Abdominal viscera- Technique for plain film examination. - Projection for acute abdomen patients. - Technique to demonstrate: Foreign bodies, Imperforate anus.
6. Radiography using mobile X-ray equipment- Radiography in the ward: Radiography in the specialized unit, such as: Intensive care unit, Coronary care, Neonatal unit.- Radiography in the operating theatre.

PAPER 3 : CT PHYSICS AND TECHNIQUES

- Basic Computed Tomography- Basic principles of CT, generations of CT, CT instrumentation, image formation in CT, CT image reconstruction, Hounsfield unit, CT image quality, CT image display
- Advanced Computed Tomography

Helical CT scan: Slip ring technology, advantages, multi detector array helical CT, cone – beam geometry, reconstruction of helical CT images, CT artifact, CT angiography, CT fluoroscopy, HRCT, post processing

techniques: MPR, MIP, Min IP, 3D rendering: SSD and VR, CT Dose, patient preparation, Imaging techniques and protocols for various parts of body, CT contrast enhanced protocols – CT angiography – (Aortogram, selective angiogram head, neck and peripheral) image documentation and Filing, maintenance of equipment and accessories.

- **CT Technique** in view of planning, FOV, Slice thickness and other parameters specific to CT Brain, Face, PNS, Temporal bone, Thorax, Abdomen and Pelvis, 3D CT limbs and joints, Angiography.
- CT scan studies acquisition/ protocols/techniques: CT of head and neck – thorax – abdomen – pelvis – musculo skeletal system – spine – PNS. Anatomy – clinical indications and contraindications – patient preparation – technique – contrast media-types, dose, injection technique; timing, sequence - image display – patient care – utilization of available techniques & image processing facilities to guide the clinician

SEM III

PAPER 1: RADIATION SAFETY AND PROTECTION – AERB GUIDELINES

Radiation safety in diagnostic Radiology

1. Introduction to Radiation protection-Need for protection, Aim of radiation protection.
2. Limits for radiation exposure: Concept of ALARA, maximum permissible dose, exposure in pregnancy, children. Occupational Exposure Limits - Dose limits to public
3. Radiation Protection in: Radiography, Fluoroscopy, Mammography, Mobile Radiography, CT scan, DSA and Interventional Radiology.
4. Radiation measuring instruments: survey meters, area monitor, personnel dosimeters, film badge, thermo luminescent dosimeter, pocket dosimeter.
5. Radiation Quantities and Units: Radiation, Radioactivity, Sources of radiation - natural radioactive sources, cosmic rays, terrestrial radiation, manmade radiation sources. Kerma, Exposure, Absorbed dose, Equivalent Dose, Weighting Factors, Effective Dose
6. Biological Effects of radiation: Direct & Indirect actions of radiation, concept of detriment ,Deterministic & stochastic effect of radiation, somatic and genetic effects, dose relationship, effects of antenatal exposure Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell-Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus -Somatic effects and hereditary effects- stochastic and deterministic effects-Acute exposure and chronic exposure-LD50 - factors affecting radio sensitivity. Biological effects of non-ionizing

radiation like ultrasound, lasers, IR, UV and magnetic fields.

7. Radiation detection and Measurements: Ionization of gases, Fluorescence and Phosphorescence, Effects on photographic emulsion. Ionization Chambers, proportional counters, G.M counters, scintillation detectors, liquid semiconductor detectors, Gamma ray spectrometer. Measuring systems: free air ionization chamber, thimble ion chamber, condenser chamber, Secondary standard dosimeters, film dosimeter, chemical dosimeter- thermo luminescent Dosimeter, Pocket dosimeter, Radiation survey meter- wide range survey meter, zone monitor, contamination monitor -their principle function and uses. Advantages & disadvantages of various detectors & appropriateness of different detectors for different type of radiation measurement.
8. Dose and Dosimetry, CT Dose Index (CTDI, etc.), Multiple Scan Average Dose (MSAD), Dose Length Product (DLP), Dose Profile, Effective Dose, Phantom Measurement Methods, Dose for Different Application Protocols, Technique Optimization. Dose area product in fluoroscopy and angiography systems, AGD in mammography.
9. Radiation protection, Hazard evaluation and control:: Philosophy of Radiation protection Radiation protection of self and patient and General Public, Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey, Calculation of Work load, weekly calculated dose to radiation worker & General public Good work practice in Diagnostic Radiology.
10. Planning consideration for radiology, including Use factor, occupancy factors, and different shielding materials Protection for primary radiation, work load, use factor, occupancy factor, protection from scatter radiation and leakage radiation, X-Ray/ Fluoroscopy/ Mammography/ Intervention/ DSA/CT room design, structural shielding, protective devices.
11. Regulatory Bodies & regulatory Requirements: International Commission on Radiation Protection (ICRP) / National Regularity body (AERB - Atomic Energy

Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements. (ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection).

12. NABH guidelines, AERB guidelines, PNDT Act and guidelines.
13. Procedural safety
14. Achievable safety through compliance on the regulations in India and recommendations of ICRT, IAEA.
15. Newer Radiation safety protocols and recent advances in radiation safety. Role of Radiographer in Planning & Radiation Protection: Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-Ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines – Planning of X-ray/CT rooms, Inspection of X-Ray installations - Registration of X-Ray equipment installation- Certification -Evaluation of workload versus radiation factors – Occupational exposure and protection Tools/devices.

PAPER 2 : RADIOLOGICAL AND IMAGING PROCEDURES

1. Special Radiographic/Radiological procedures
2. Selection of Fluoroscopy Equipment, general considerations, responsibility of radiographers. Patient Preparation, Indications Contraindications Technique Post Care and Preparation of Drug Trolley/Tray, Radiation Safety. Contrast Media - Positive and Negative, Ionic & Non – Ionic, Adverse Reactions To Contrast Media and Patient Management, Emergency Drugs in the Radiology Department ,Aseptic technique for the following procedures.
3. Gastrointestinal Tract: Barium swallow, pharynx and oesophagus. Barium meal and follow through. Hypotonic duodenography. Small bowel enema. Barium Enema routine projections for colon and rectum, colonic activators; double contrast studies; colostomy. Special techniques for specific disease to be examined. Including

water soluble contrast media - e.g. gastrograffin studies. Including CT, US and MRI Special Imaging Techniques.

4. Salivary glands: Routine technique, procedure - sialography.
5. Biliary system: Plain film radiography. Intravenous cholangiography. Percutaneous cholangiography, Endoscopic retrograde cholangio-pancreatography (ERCP). Operative cholangiography, Post-Operative cholangiography (T-tube Cholangiography). Including CT, US and MRI Special Imaging Techniques.
6. Urinary system: Intravenous urography, retrograde pyelography. Antegrade pyelography. Cystography and micturating cystouresthrography. Urethrography (ascending) renal puncture. Including CT, US and MRI Special Imaging Techniques.
7. Reproductive system: All the Techniques relating to Male and Female reproductive system including Hysterosalpingography.
8. Breast Imaging: Mammography: Basic views, special views, wire localization. Ductography, Tomosynthesis, ABVS, Various Biopsy Techniques including Prone Table Biopsy, CT, US and MRI Special Imaging Techniques
9. Respiratory system: - Bronchography: Including CT, US and MRI Special Imaging Techniques.
10. Sinography: Routine technique and procedure.
11. Central Nervous System: Myelography. Cerebral studies. Ventriculography etc. including CT, US and MRI Special Imaging Techniques.
12. Arthrography: Shoulder, Hip, Knee, Elbow joints etc. including CT, US and MRI Special Imaging Techniques.
13. Angiographic Studies: Carotid Angiography (4 Vessel angiography). Thoracic and Arch Aortography. Selective studies: Renal, SMA, Coeliac axis. Vertebral angiography. Femoral arteriography. Angiocardiography, Peripheral angiography
14. Venography: Peripheral venography. Cerebral venography. Inferior and superior venocavography. Relevant visceral phlebography.

PAPER 3: MR PHYSICS AND TECHNIQUES

Advanced technique & instrumentation of MRI

a. Basic Principles: Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image.
b. Pulse sequence : Spin echo pulse sequence – turbo spin echo pulse sequence - Gradient echo sequence – Turbo gradient echo pulse sequence - Inversion recovery sequence – STIR sequence – SPIR sequence – FLAIR sequence – Echo planar imaging – Advanced pulse sequences.
c. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers.
d. Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP.
e. MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functional MRI

MR Techniques: Preparation, planning, protocols, image reconstruction, post processing for – MRI Brain, MR Angiography, MR Venography, MR Spine, Abdomen, Pelvis, Joints, Local swelling, MRCP, Mammography.

SEM IV

PAPER 1: ULTRASOUND PHYSICS AND LAWS APPLICABLE TO RADIOLOGY

1. Ultrasonography/ Doppler studies: Techniques of sonography- selection- Preparations - instructions and positioning of patient for TAS, TVS, TRUS, neck USG and extremities- patient care and maintenance protocols clinical applications display methods –quality image reproducible extend – biopsy procedures, assurance to patients.
2. Laws applicable to Radiology:

- PC PNDT
- Consumer Protection Act, 1986
- Case in medical council
- Cas of criminal negligence- Sec 304 A , Sec 337, Sec 338
- Vicarious responsibility

PAPER 2: NEWER IMAGING DEVELOPMENTS AND NUCLEAR MEDICINE

1. In addition to existing Radiological and Imaging Modalities -Newer Developments in Digital Imaging CT,MRI,US and any other modality.
2. Newer Radiological and Imaging Equipment: including Computed radiography: Digital Radiography, Digital Fluoroscopy, Digital Mammography and DSA - Introduction to Newer Technology innovations, software and its applications.
3. Computed Tomography Introduction to Newer Developments/ Newer Technology innovations, software and its applications.
4. MRI Introduction to Newer Developments/Newer Technology innovations, software and its applications.
5. Advanced Ultrasonography Newer Developments/Newer, Technology innovations, software and its applications. Elastography, HIFU, ABVS etc.
6. Maxillo-facial imaging, dental radiology including RGV, OPG, CBCT and other advanced modalities

7. Tele-radiology, HIS, RIS, PACS, Imaging processing and archiving.

PAPER 3 : INTERVENTIONAL RADIOLOGICAL TECHNIQUES AND PATIENT CARE

Intervention Radiological Techniques

1. Basic Angiography and DSA:
   History , technique, patient care, Percutaneous catherisation, catheterization sites, Asepsis ,Guide wire, catheters, pres+6sure injectors, accessories, Use of digital substraction- single plane and bi-plane.

All forms of diagnostic procedures including angiography, angioplasty, biliary examination, renal evaluation and drainage procedure and aspiration cytology under flouro, CT, US, MRI guidance.

2. Central Nervous System: Myelography. Cerebral studies,Ventriculography.
3. Arthrography: Shoulder, Hip, Knee, Elbow
4. Angiography: Carotid Angiography (4 Vessel angiography).Thoracic and Arch Aortography. Vertebral angiography, femoral arteriography. Selective studies: Renal, SMA, Coeliac axis. Angiocardiography.
5. Venography: Peripheral venography, Cerebral venography, Inferior and superior venocavography. Relevant visceral phlebography.
6. Cardiac catheterization procedures: PTCA, BMV, CAG, Pacemaker.

Care of Patient in Interventional Radiology

1. Introduction to patient care: responsibilities of healthcare facility- responsibilities of the imaging technologist.
2. General patient care, patient transfer technique-restraint techniques-aspects of patient comfort-specific patient conditions-security of patient property- obtaining vital signs-laying up a sterile trolley-assisting in IV injection.
3. Surgical Asepsis: The Environment and Surgical Asepsis, Methods of Sterilization, Disinfection, Opening Sterile Packs, Changing Dressing.
4. Nursing procedure in radiology- general abdominal preparation, clothing of the patient-giving an enema-handling the emergencies in radiology- first aid in the X-ray department
5. Patient care during investigation: GI tract, biliary tract, respiratory tract, Gynecology, cardiovascular lymphatic system, CNS etc.

6. Infection control: definitions- isolation techniques-infection sources- transmission modes- procedures-psychological considerations – sterilization & sterile techniques.
7. Patient education: communication – patient communication problems – explanation of examinations-radiation safety/protection – interacting with terminally ill patient.
8. Medical Emergencies: Shock, Pulmonary Embolus, Diabetic Emergencies, Respiratory Failure, Cardiac Failure, Airway Obstruction, Stroke, Fainting, Seizures.
9. Drug Administration: System of Drug Administration, Medication Error and Documentation, Equipment for Drug Administration, Methods of Drug Administration, Care of patient with Intravenous Infusions

BOOKS TO REFER:

1. Clark's Positioning in Radiography 13E
2. Weir & Abrahams' Imaging Atlas of Human Anatomy
3. Farr's Physics for Medical Imaging
4. Christensen's Physics of Diagnostic Radiology\
5. MRI made easy Govind Chavhan
6. Radiological Procedures by Bhushan N Lakhkar.
7. Chapman & Nakielny's Guide to Radiological Procedures
8. Handbook of Interventional Radiologic Procedures Kandrappa
9. Nuclear Medicine: The Requisites (Requisites in Radiology) by Ziessman MD
10. Netter's Guide to radiological anatomy

MSc MRIT PRACTICAL EXAMINATION

		MARKS
1. PRACTICAL WORK	A	20
	B	20
2. SPOTS	5 spots x 4 marks	20
3. VIVA		40
TOTAL MARKS		100 marks

MSc MRIT QUESTION PAPER PATTERN

		Marks
SECTION I	**Multiple choice questions (MCQ)- 10 x 1 mark each**	**10**
SECTION II	**Short answer question (SAQ)- All questions are compulsory**	**30**
	SAQ 1.	**5**
	SAQ 2.	**5**
	SAQ 3.	**5**
	SAQ 4.	**5**
	SAQ 5.	**5**
	SAQ 6.	**5**
SECTION III	**Long Answer question (LAQ) – All questions are compulsory**	**60**
	LAQ 1.	**15**
	LAQ 2.	**15**
	LAQ 3.	**15**
	LAQ 4.	**15**
TOTAL MARKS		**100 MARKS**