MAHATMA GANDHI UNIVERSITY
of
MEDICAL SCIENCES & TECHNOLOGY
JAIPUR

Syllabus

M.Sc. RADIO IMAGING TECHNOLOGY

(2 Years Degree Course)

Edition 2020-21

NOTICE

1. Amendments made by the Board of Management of the University in Rules / Regulations of Graduate Medical Courses shall automatically apply to the Rules/ Regulations of the Mahatma Gandhi University of Medical Sciences & Technology.

2. The University reserves the right to make changes in the syllabus/books/ guidelines, fee–structure or any other information at any time without prior notice. The decision of the University shall be binding on all.

3. The Jurisdiction of all court cases shall be Jaipur Bench of Hon'ble Rajasthan High Court only.

RULES & REGULATIONS

M.Sc. Radio Imaging Technology (RIT) ( )

(2 Years Degree Course)

DURATION OF COURSE:
The course shall be of 2 years duration from the date of commencement of academic session.

ELIGIBILITY FOR ADMISSION:
For admission a candidate should have passed the B.Sc. Radio Imaging Technology / Radiation Technology with at least 50% marks in the aggregate from any recognized University.

SELECTION OF CANDIDATES:
Selection for M. Sc. RIT Course shall be done by an Admission Board strictly on merit judged on the basis of University Entrance Examination conducted in the month of July / August every year.

TRAINING:
1. The period of training for M.Sc. (RIT) course shall be of 2years from the date of admission.
2. M.Sc. (RIT) Part – I and M.Sc. (RIT) Part – II shall be of 1 year each duration.
3. The candidate will undertake the post graduate training as a full time post graduate in the department concerned.
4. The students who have been registered late in the medical college will not be allowed to appear in the regular examination and they will be required to complete the period of study prescribed and fulfill the requirement of attendance.

ATTENDANCE:
1. A candidate is required to have at least 75% attendance in theory and practical separately.
2. A candidate lacking the prescribed attendance shall not be permitted to appear in the Examination.

EXAMINATION AND ASSESSMENT:
1. The examination in M.Sc. (RIT) Part I shall consists of three theory papers and
2. The examination in M.Sc (RIT) Part II shall consist of three theory papers and practical in the opted specialization.
3. A candidate shall be permitted a maximum of Four Attempts or 2 years to complete the part I examination from the year of admission.
5. Only those candidates will be allowed to appear at M.Sc. (RIT) Part II examination, who have passed M.Sc. (RIT) Part –I examination completely.

SCHEME OF EXAMINATION:

The Examination in **M.Sc. RIT Part I** shall consist of:

Paper I	Management of Radiology and Imaging Department	100 marks
Paper II	Modern Radiological and Imaging Equipment and Techniques	100marks
Paper III	Advance Physic of Radiology and Imaging	100 marks
	Internal assessment	100 marks
	Practical & Viva Voce Examination	300 marks
	Total Marks	**700 marks**

Notes:

1. Each theory paper shall be 3 hours duration.
2. Each paper will be set by the External Examiner of the subject concerned and will be assessed by the internal examiner of the subject concerned of the same institution.

   Pattern of questions to be set and answered shall be as follows:

Name of Paper	No. of questions to be set	No. of questions to be answered
Paper I	4	4
Paper II	4	4
Paper III	4	4

3. In order to pass the examination the candidate must secure a minimum of 50% marks in each theory paper.
4. A candidate who has failed in one or more theory paper of M.Sc.(RIT) Part-I Examination must appear in that theory paper in supplementary examination which will be conducted by university within 4 – 6 months.

The Examination in **M.Sc. RIT Part II** shall consist of:

Paper I	Quality Assurance and Quality Control in Radiology and Imaging Department	100 marks
Paper II	Newer Imaging Modalities and Intervention Radiological Techniques	100 marks
Paper III	Radiation Safety and Protection with Radiological Procedures	100 marks
	Internal assessment	100 marks
	Practical and viva voce	300 marks
	Dissertation/Project work	100 marks
	Total marks	**800 marks**

Notes:

1. Each theory paper shall be 3 hours duration.
2. All papers shall be set by the External Examiners.
3. Paper I will be assessed by the External Examiner and Paper II will be assessed by the Internal Examiner viz. Head of the Department of subject concerned. Paper III will be assessed by Professor / Associate professor / Assistant professor
4. Practical examination shall be conducted by one Internal, one External Examiner which will be appointed by the university.

Pattern of questions to be set and answered shall be as follows:

Name of Paper	No. of questions to be set	No. of questions to be answered
Paper I	4	4
Paper II	4	4
Paper III	4	4

5. In order to pass the examination the candidate must secure a minimum of 50% marks in Theory papers including Viva and 50% marks in Practical separately.

6. In case a student passes either in Theory or in Practical only, the student shall be considered to fail in the whole examination and he will have to appear in both the Theory and Practical in the subsequent examination.
7. A candidate shall be permitted a Maximum of four attempts or four years from the date of admission in M.Sc. Part I.

ENROLMENT:

Every candidate who is admitted to M.Sc. RIT Courses in Mahatma Gandhi Medical College & Hospital shall be required to get himself/herself enrolled with the Mahatma Gandhi University of Medical Sciences & Technology after paying the prescribed eligibility/enrolment fees.

The candidate shall have to submit the application form duly filled in and forwarded to the University through Principal of the College for the enrolment/eligibility along with the original documents with the receipt of deposition of prescribed fees (up to November 30 of the year of admission or up to two months after the admission without late fees and then after with the prescribed late fees)

PAPER SETTER/EXAMINER

1. All the examiners, paper setters, theory examination answer books evaluators, Internal and External Examiners for Practical examinations shall be appointed by the President of the University.
2. Qualification of the Paper setter / Examiner: Assistant Professor and above.
3. Paper setter can be an examiner

REVALUATION

No Revaluation shall be permitted in M.Sc. Examination. However, the student can apply for scrutiny of the answer books

GRACE MARKS

No grace marks will be provided in M.Sc. Examination.

M.Sc. Radio Imaging Technology

DURATION OF COURSE Two years

COURSE DISTRIBUTION Course is divided into two parts.

Part - I: The candidates are imparted theoretical training in the subjects of:

1) Management of Radiology and Imaging Department.
2) Modern Radiological and Imaging Equipment and Techniques.
3) Advance Physic of Radiology and Imaging.

Practical training is given about the radiological equipment and of the radiographic techniques of specialized cases.

Part - II Theoretical training is imparted in the following subjects:

1. Quality Assurance and Quality Control in Radiology and Imaging Department.
2. Newer Imaging Modalities and Intervention Radiological Techniques.
3. Radiation Safety and Protection with Radiological Procedures.

Practical training is imparted in the specialized radiological and imaging procedures.

DISSERTATION:

Objectives:

1. The student should be able to demonstrate his/her capability in research by planning and conducting systematic scientific research and data analysis and deriving conclusion.
2. Communicate scientific information for health planning.

SUBMISSION OF DISSERTATION PROTOCOL

It should be submitted at the end of six months after admission to the course.

Protocol in essence should consist of :

a. Introduction and objectives of the research project
b. Brief review of literature
c. Suggested materials and methods
d. Bibliography

The protocol must be presented in the department of Radio-diagnosis & approved by the departmental research committee which will scrutinize the dissertation protocol in reference to its feasibility, statistical validity, ethical aspects etc.

SUBMISSION OF DISSERTATION

1. Dissertation will be submitted at the end of 1 ½ years.

The candidate shall submit the Dissertation / Project work as a printed copy to the Head of Department at least one month before commencement of University Theory paper examination otherwise permission to appear in the University examination shall not be granted.

2. Dissertationin essence should consist of
    a. Introduction
    b. Review of literature
    c. Aims and objectives
    d. Material and methods
    e. Results
    f. Discussion

The dissertation will be evaluated by the internal and external examiners at the time of viva voce examination of the candidate during the second year and 10% weightage will be given to the candidate for dissertation at the time of clinical/practical viva voce examination of second year. The candidate will be asked to make presentation before the external/internal examiners. The final dissertation duly approved by the External/Internal Examiners will be submitted to the Dean's Office along with the result. The Dean's office will send the dissertation to the library for record.

TEACHING METHODS

Teaching methods include the help of audio-visual aids i.e. transparencies, slides, video cassettes as well as use of multimedia and computers etc.

TEACHING PROGRAMME:

Theory work : Departmental teaching, programme includes:

Regular class Lectures	5 days in a week
Journal clubs/seminars/discussions	Once in a week

Demonstration of equipment/ accessories	Once a week
Demonstration of special radiographic techniques	Once a week

PRACTICAL WORK:

i) Students are posted in various radiographic rooms to work independently and their day to day work is reviewed by senior staff members.
ii) Students are also given practical in physics pertaining to radiology as well as in checking and rectification of common faults in the x-ray equipments/accessories.
iii) Film discussions are also held to teach them the quality control and its importance in radio-diagnosis.

EVALUATION

a) Regular day to day work assessment i.e. checking by senior staff members.
b) Internal departmental examinations.

INTERNAL EXAMINATION

A candidates will be examined by internal departmental examinations and internal assessment will be based on the performance in these examinations as well as their day to day work report.

FINAL EXAMINATION

Appointment of Examiners:	M.Sc. Part I & II:	One external examiner with Ph.D. or MD qualification and one internal examiner who can be Head of the Deptt./ Professor Associate Professor/ Assistant Professor

MARKS DISTRIBUTION

Part - I

Theory Paper

Paper I	Management of Radiology and Imaging Department	100 marks
Paper II	Modern Radiological and Imaging Equipment and Techniques	100marks
Paper III	Advance Physic of Radiology and Imaging	100 marks
Internal assessment		100 marks
Practical & Viva Voce Examination		300 marks
	Total Marks	**700 marks**

(The theory paper will be set by the external examiner)

Candidates will be given two practical in physics as per list and will be cross examined by the examiners in the morning session. In the afternoon session a grand viva voce in all the three subjects with special emphasis on physics and newer imaging equipment will be taken.

Part - II Examination (Final Year)

Part - II examination will be held at the end of one academic year after the candidate has passed part I examination.

Marks distribution:

Paper I	Quality Assurance and Quality Control in Radiology and Imaging Department	100 marks
Paper II	Newer Imaging Modalities and Intervention Radiological Techniques	100 marks
Paper III	Radiation Safety and Protection with Radiological Procedures	100 marks
	Internal assessment	100 marks
	Practical and viva voce	300 marks
	Dissertation/Project work	100 marks
	Total marks	**800 marks**

The candidates will be given two special procedures to do one long and one short. This will be followed by grand viva on the special procedures as well as related topics.

RESULT

Final result will be declared after the candidate has passed both part I and part II examinations separately and it will be on the basis of aggregate marks obtained by the candidates in theory, practical, viva voce and internal assessment.

The marks obtained in part I examination will be added in part II examination before declaring the final result.

DETAILED SYLLABUS

Part - I

M.Sc RIT Part-I

Paper-I

Management of radiology and imaging department

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.

7. Achievable safety through compliance on the regulations in India and recommendations of ICRT, IAEA.
8. 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

M.Sc RIT Part-I

Paper-II

Modern Radiological and Imaging Equipment and Techniques

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

Modern radiological and Imaging equipment

1. 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 techniques and 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.

M.Sc RIT Part-I

Paper-III

Advanced Physics of Radiology & Imaging

1. Physics of Imaging including conventional radiography, fluoroscopy, computed radiography and flat panel DR imaging.

2. 2. 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.
3. 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 Index.
4. Mammography:- Digital mammography including cones compression device, biopsy system with all routine and digital mammography procedures.
5. MRI- Basic Principles: Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image.
   a. 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
   b. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers.
   c. Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP.
   d. MR Spectroscopy – functional MRI
6. Ultrasonography

   Production of ultrasound: Piezoelectricity, Medical ultrasound transducer: Principle, construction and working, characteristics of US beam.
   Basic Acoustics, Ultrasound terminologies: acoustic pressure, power, intensity, impedance, speed, frequency, dB notation: relative acoustic pressure and relative acoustic intensity.
   Interaction of US with matter: reflection, transmission, scattering, refraction and absorption, attenuation and attenuation coefficients, US machine controls, US focusing.
   Ultrasound display modes: A, B, M
   Real-time ultrasound: Doppler Ultrasound, Doppler artifacts, vascular sonography.

M.Sc RIT Part-II

Paper-I

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

M.Sc RIT Part-II

Paper-II

Newer Imaging Modalities and interventional radiological techniques

1. 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
2. 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.
3. Advanced technique & instrumentation of MRI
4. Basic Principle: Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image.
5. 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.
6. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers.
7. Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP.
8. MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functional MRI Ultrasonography
9. Production of ultrasound: Piezoelectricity, Medical ultrasound transducer: Principle, construction and working, characteristics of US beam.
10. Ultrasound display modes: A, B, M

    Basic Acoustics, Ultrasound terminologies: acoustic pressure, power, intensity, impedance, speed, frequency, dB notation: relative acoustic pressure and relative acoustic intensity.

Interaction of US with matter: reflection, transmission, scattering, refraction and absorption, attenuation and attenuation coefficients, US machine controls, US focusing.

11. Real-time ultrasound: Line density and frame rate, Real-time ultrasound transducers: mechanical and electronic arrays, ultrasound artifacts, ultrasound recording devices, and Distance, area & volume measurements.
12. Techniques for imaging different anatomic areas, ultrasound artifacts, biological effects and safety.
13. Doppler Ultrasound- Patient preparation for Doppler, Doppler artifacts, vascular sonography,
14. Elastography, HIFU, ABVS etc.
15. Fusion Imaging -PET CT & PET MRI

Intervention Radiological Techniques

1. Basic Angiography and DSA:

History , technique, patient care, Percutaneous catherisation, catheterization sites, Asepsis ,Guide wire, catheters, pressure 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

Newer Developments in Advanced Imaging Technology

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.

M.Sc RIT Part-II
Paper-III

Radiation Safety and Protection with radiological procedures

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.

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.

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.

EVALUATION OF DISSERTATION

The dissertation will be evaluated by the External / Internal Examiners at the time of viva voce examination and the marks allotted is 50 marks during the 2nd year examinations. The candidate will be asked to make presentation before the External / Internal Examiners.

The final dissertation duly approved by the External / Internal Examiners will be submitted to the Dean's office along with the result. The Dean's office will send the dissertation to the Library for record.

M.SC Part I

Theory	:	300marks
Clinical / practical, Viva Voce Examination	:	300marks
Internal assessment	:	100marks
Total marks		**700 marks**

M.SC Part II

Theory	:	300marks
Clinical / practical, Viva Voce Examination	:	300marks
Internal assessment	:	100marks
Dissertation	:	100marks
Total marks		**800 marks**

APPOINTMENT OF EXAMINERS

M. Sc Part I & II : One external examiner with Ph.D or MD Qualification

: Internal Examiner which can be Head of the department or Professor or Associate Professor, Assistant Professor.

COMPARTMENT

Candidates who fails only in one subject will be placed in the compartment provided he or she secures at least 50% marks in theory as well as in practical individually.

Such candidates will be given only two chances to clear the compartment examination which will be held every six months. The candidate placed in compartment will be required to appear both in theory & practical. If a candidates fails to appear in the supplementary examination for any reason it will be considered that he/she has availed a chance. However, the candidate who is placed in the compartment in Part I

will be allowed to attend the classes of 2nd Year. The candidates who is taking compartment examination of part I along with 2nd year examination, his /her result of Part II will be declared only if he/she passes part –I examination. In case he/she fails to clear the compartment examination in two subsequent attempts, he/she would deem to have failed & her name will be struck off from the rolls.

COMPARTMENT IN 2ND YEAR

A candidate of Part II also will be eligible to avail 2 chances to clear the compartment examination held every six months. However if he /she fails to clear the compartment examination, in two attempts, he/ she will be required to reappear in the whole examination of Part II.

FAILURE:

Candidate who fails in Part I or Part II examination will be given only two chances to clear the examinations & in case he/she fails to appear in the subsequent examination it would be considered that he/she has availed a chance.

MODEL PAPER

M.Sc. RIT Part – I **MangtRad**

M.Sc. (RIT) Part – I (Main) Examination month year

Paper – I

Management of Radiology and Imaging Department

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1. Describe radiation hazards. How you protect patient from this [25]

Q.2. Describe planning of radiology department of 100 bedded hospital [25]

Q.3. Short notes-

(a) AREB guidelines [$12^1/_2$]

(b) ICRP guidelines [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Mammography tube
B) Protective device
C) Grid
D) Generators
E) TLD Badge
F) Time management
G) Leakage radiation

MODEL PAPER

M.Sc. RIT Part – I **ModRed**

M.Sc. (RIT) Part – I (Main) Examination month year

Paper – II

Modern Radiological and Imaging Equipment and Techniques

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1. Describe principal of computed tomography [25]

Q.2. Describe basic principle of MRI [25]

Q.3. Short notes-

(a) PET [$12^1/_2$]

(b) CT angiography of lower limb [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Fusion imaging
B) Fluoroscopy
C) Principle of ultrasound
D) DSA
E) Patient care
F) Gamma camera
G) Types of Transducer

MODEL PAPER

M.Sc. RIT Part – I **AdvPhy**

M.Sc. (RIT) Part – I (Main) Examination month year

Paper – III

Advanced Physics of Radiology & Imaging

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1. Describe flat panel DR imaging [25]

Q.2. Describe MR Spectroscopy [25]

Q.3. Short notes-

(a) Shim coil [$12^1/_2$]

(b) FLAIR sequence [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Image formation in CT
B) 3D Reconstruction
C) Artefacts in MRI
D) Types of magnets in MRI
E) Piezoelectric Effect
F) Doppler ultrasound
G) CT fluoroscopy

MODEL PAPER

M.Sc. RIT Part – II **QuaAssu**

M.Sc. (RIT) Part – II (Main) Examination month year

Paper – I

Quality Assurance and Quality Control in Radiology and Imaging Department

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1.Quality assurance programme in radiology department [25]

Q.2. Measures to improve quality of imaging [25]

Q.3. Short notes-

(a) Maintenance of equipment [$12^1/_2$]

(b) Laser printer [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Digital radiography
B) Mammography
C) DEXA
D) PACS
E) Film contrast
F) Artefacts in film
G) Safe light test

MODEL PAPER

M.Sc. RIT Part – II **SpecInvTech**

M.Sc. (RIT) Part – II (Main) Examination month year

Paper – II

Newer Imaging Modalities and interventional radiological techniques

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1. Describe MR angiography [25]

Q.2. Describe principle of HRCT [25]

Q.3. Short notes -

(a) STIR images [$12^1/_2$]

(b) CT contrast enhancement protocol [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Real time ultrasound
B) Elastpgraphy
C) Fusion Imaging
D) Ultrasound transducer
E) Arthrography Procedure
F) Carotid Angiography
G) Treatment of contrast reaction

MODEL PAPER

M.Sc. RIT Part – II **RadSaf**

M.Sc. (RIT) Part – II (Main) Examination month year

Paper – III

Radiation Safety and Protection with radiological procedures

Time: Three Hours
Maximum Marks: 100

Attempt all Questions.

All the parts of one question should be answered at one place in sequential order.
Illustrate your answers with suitable diagrams, wherever necessary.

Q.1. Describe aims of radiation protection [25]

Q.2. Describe direct and indirect hazards of radiation [25]

Q.3. Short notes -

(a) Ionization chamber [$12^1/_2$]

(b) Radioactivity [$12^1/_2$]

Q.4. Short notes (Any 5 out of 7) [5x5=25]

A) Cosmic rays
B) Survey meter
C) DSA
D) Dosimeter
E) Hazards of ultrasound
F) KERMA
G) NABH Guideline