School of Health Sciences

CSJM University, Kanpur

Ordinance & Syllabus

for

Master in Medical Radiology and Imaging Technology (MMRIT)

Academic Programme

Ordinance according to

NEP-2020

Duration: 2 Years (04 Semesters)

Master in Medical Radiology and Imaging Technology (MMRIT)

ORDINANCE

Chapter

"A"

Preamble:
The Master in Medical Radiology and Imaging Technology (MMRIT) is a 2-year full-time program, structured into 4 semesters. The program equips students with advanced analytical, evidence-based, and hands-on learning skills in medical imaging technologies. It is designed to provide a broad understanding of imaging techniques while also allowing specialized learning in the chosen elective area. Psychosomatic aspects of patient care are integrated throughout the curriculum.

Title of the Programme: Master in Medical Radiology and Imaging Technology (MMRIT).

Objectives of the Programme:
At the completion of this course, the student should be able to:

1. Execute all routine and advanced imaging procedures with a strong foundation in evidence-based practice.
2. Function as a prominent member of a multidisciplinary radiology team, contributing to diagnostic and therapeutic imaging processes.
3. Provide comprehensive knowledge about imaging procedures, their indications, and benefits.
4. Transfer knowledge and skills to students and young professionals through teaching and mentorship.
5. Perform independent imaging assessments and interpret radiological findings.
6. Conduct independent research in the field of radiology and imaging technology.
7. Learn and apply multidisciplinary practices in clinical settings.
8. Assess, interpret, and diagnose patients independently using medical imaging technologies.
9. On successful completion of the MMRIT program, graduates will be able to undertake teaching assignments for undergraduate students in radiology and imaging.
10. Graduates will also be able to design and conduct research projects, analyze data using sound statistical techniques, and contribute to evidence-based radiology practices.

Program Outcome:

1. Comprehensive Knowledge: Students will gain in-depth knowledge of medical imaging technologies, including advanced modalities such as CT, MRI, Ultrasound, and Nuclear Medicine.
2. Practical Competence: Acquire the skills required to plan and manage imaging examinations, including patient preparation, scanning techniques, and safety protocols.
3. Clinical Diagnosis: Demonstrate expertise in functional diagnosis and the application of imaging technology to diagnose medical conditions.
4. Critical Appraisal: Develop the ability to critically evaluate recent literature in radiology and adopt the latest diagnostic and imaging procedures based on scientific evidence.

5. Independent Research: Engage in independent research, contributing to the development of advanced imaging technologies and methodologies within the department.
6. Specialization: MMRIT graduates are encouraged to pursue further qualifications or certifications to advance in their chosen imaging specialties, while also staying updated on technological advancements through continuous professional education.
7. Employment Opportunities: Graduates will have employment opportunities in hospitals (both public and private), diagnostic centers, research institutions, and academic institutions. They may also establish independent radiology practices.
8. Clinical Decision-Making: Demonstrate the ability to make informed clinical decisions regarding imaging strategies and choose appropriate diagnostic measures based on comprehensive knowledge of the specialty.
9. Evidence-Based Practice: Showcase expertise in the evidence-based management of diseases and disorders using medical imaging technology.
10. Professional Development: Graduates are prepared to take on leadership roles in medical imaging departments, teaching, or research, contributing to the advancement of radiology practices and patient care.

Program Specific Outcome

At the completion of this course, the student should be:

1. Able to execute all routine radiological imaging procedures with evidence-based practice. The student will be proficient in performing a wide range of diagnostic imaging techniques, ensuring high standards of safety and accuracy while adhering to evidence-based guidelines.
2. Able to be a prominent member of the multidisciplinary radiology team and contribute to the diagnosis and treatment of conditions requiring medical imaging. As part of a healthcare team, the student will work collaboratively with radiologists, physicians, and other healthcare professionals to provide comprehensive diagnostic services.
3. Able to provide adequate knowledge about the imaging procedures and their clinical benefits. The student will educate patients and fellow healthcare workers on the purposes, risks, and benefits of various radiological procedures, ensuring informed decision-making.
4. Able to transfer knowledge and skills to students as well as young professionals. Graduates will be capable of mentoring and teaching undergraduate students and junior professionals in the field of radiology and imaging technology, promoting growth and development in the field.
5. Able to perform independent radiological assessments and interpret imaging results for patient care. The student will be adept at independently conducting imaging examinations, analyzing the results, and contributing to the diagnosis and management of patient conditions.
6. Able to undertake independent research in the field of radiology and imaging technology. Graduates will have the skills to design and conduct research projects that advance the knowledge and practice of medical radiology and imaging technologies.

7. Learn multidisciplinary practice skills. The program equips students with the ability to integrate various diagnostic techniques from multiple imaging modalities, ensuring a comprehensive approach to patient care.
8. Able to practice and assess patients independently using imaging technologies. The student will be able to assess patient conditions, choose appropriate imaging procedures, and perform diagnostic examinations independently, ensuring the highest quality of patient care.
9. On successful completion of the MMRIT program, the radiology professional will be able to take up teaching assignments independently for undergraduate programs in radiology and imaging technology. Graduates will be qualified to teach at undergraduate levels, design research proposals with selected methodologies, and interpret results using sound statistical techniques and data processing methods.
10. He/she will be able to practice in his/her specialty area with advanced knowledge and skills. The graduate will be proficient in their chosen specialization within radiology (such as X-Ray, CT, MRI, Ultrasound and Nuclear medicine), contributing to high-quality clinical services and furthering expertise in advanced imaging technology.

Master in Medical Radiology and Imaging Technology (MMRIT)

1. The MMRIT degree will be offered under the Faculty of Medicine at C.S.J.M. University, Kanpur, in the department of Medical Radiology and Imaging Technology.

2. Duration of Course:

- MMRIT course will be a full-time course.
- Duration will be two years (Four Semesters).
  This course shall be divided into four semester examinations namely Master in Medical Radiology and Imaging Technology I & II Semester (First Academic Year), & III & IV Semester (Second Academic Year).

3. Seats:

30 (Thirty)

4. Admission:

Eligibility:

The students who have passed Bachelor's in Medical Radiology and Imaging Technology (BRT/BMRIT) or equivalent course from any recognized Institutions/University with minimum of 50% marks (45% for SC/ST)

Mode of Admission:
As per the University Norms.

5. Medium of Instruction:
English shall be the medium of instruction for all the subjects of study and for examination of the course.

6. Method of Teaching:
The method of teaching adopted shall be a combination of lectures, demonstrations and practical's by the full time faculty, visiting or part time or guest faculty.

7. Examination:
As per the University norms.

Duration of examination:
As per the University norms.

8. Attendance to appear in the end semester examination :
The permission to appear in end semester examination shall be granted to such candidate only who have fulfil the condition of 75% attendance in each subject separately in theory and practical as per the university rule.
Regarding attendance requirements students will have to fulfil the condition of 75% attendance. 15% relaxation in attendance, in exceptional circumstances can be made by the Vice Chancellor on the recommendation of the Director/Coordinator/Head of the Institute/Department.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: Master in Medical Radiology and Imaging Technology (MMRIT)

Name of BoS Convenors / BoS Members	Designation	Department	College/University
Prof. Sanjay Kala	Principal	Dean, Faculty of Medicine	GSVM. Medical College, Kanpur
Prof. Dolly Rastogi	Professor	Physiology	GSVM Medical College, Kanpur
Prof. Parvez Khan	Head	Ophthalmology	GSVM Medical College, Kanpur
Prof. Sanjay Kumar	Head	Orthopaedics	GSVM Medical College, Kanpur
Prof. MP Mishra	Ex. Director	JK Cancer Institute	GSVM Medical College, Kanpur
Dr. Chayanika Kala	Associate Professor	Pathology	GSVM Medical College, Kanpur
Dr. Ashok Verma	Head & Associate Professor	Radiology	GSVM Medical College, Kanpur
Dr. Digvijay Sharma	Director	School of Health Sciences	CSJM University, Kanpur
Dr. Munish Rastogi	Assistant Director	School of Health Sciences	CSJM University, Kanpur
Dr. Versha Prasad	Assistant Professor	School of Health Sciences	CSJM University, Kanpur
Dr. Ram Kishor	Assistant Professor	School of Health Sciences	CSJM University, Kanpur

Master in Medical Radiology and Imaging Technology (MMRIT)

I YEAR / I SEM						
COURSE CODE	TYPE	COURSE TITLE	CREDITS	CIA	ESE	MAX. MARKS
MRT25101	CORE	Planning & Management of a Radiology & Imaging Department	4	25	75	100
MRT25102	CORE	Review of Basic Imaging Techniques	4	25	75	100
MRT25103	CORE	Modern Imaging Techniques	4	25	75	100
MRT25104	CORE	Research Methodology in Radiology	4	25	75	100
MRT25105	PRACTICAL	Practical	8	25	75	100
	DISSERTATION	Dissertation	0	-	-	-
		TOTAL	24			500
I YEAR / II SEM						
MRT25201	CORE	Radiation safety and protection- AERB Guidelines	4	25	75	100
MRT25202	CORE	Imaging Anatomy and Physiology	4	25	75	100
MRT25203	CORE	Biostatistics in Radiology	4	25	75	100
MRT25204	MINOR ELECTIVE	Modern Radiological Imaging Equipment	4	25	75	100
MRT25205		Advanced Computed Tomography				
MRT25206	PRACTICAL	Practical	8	25	75	100
MRT25207	DISSERTATION	Dissertation	8	25	75	100
		TOTAL	32			600

II YEAR / III SEM						
COURSE CODE	TYPE	COURSE TITLE	CREDITS	CIA	ESE	MAX. MARKS
MRT25301	CORE	Quality Assurance and Quality Control in Diagnostic Radiology and Imaging	4	25	75	100
MRT25302	CORE	Pedagogy in Imaging Education	4	25	75	100
MRT25303	CORE	Radiological Imaging Procedure	4	25	75	100
MRT25304	CORE	Radiology Administration & Management	4	25	75	100
MRT25305	PRACTICAL	Practical	8	25	75	100
	DISSERTATION	Dissertation	0	-	-	-
		Teaching skills/seminars/symposia/ journal club etc. *	2	-	-	-
		Clinical training/ camps*	2	-	-	-
		TOTAL	28			500
II YEAR / IV SEM						
MRT25401	CORE	Newer Development in Advanced Imaging Technology	4	25	75	100
MRT25402	CORE	Interventional Radiology and Patient Care	4	25	75	100
MRT25403	CORE	Ultrasound Imaging	4	25	75	100
MRT25404	ELECTIVE	Nuclear Medicine Imaging Techniques	4	25	75	100
MRT25405		Advanced Magnetic Resonance Imaging				
MRT25406	PRACTICAL	Practical	8	25	75	100
MRT25407	DISSERTATION	Dissertation	8	25	75	100
		TOTAL	32	-	-	600
		Grand Total	116			2200

*** Not Included in University Exam.**

NOTE:

1. **Do not mark any Code/Information in Column-A, it will be endorsed by the University.**
2. **CIA** in Column-E stands for **'Continuous Internal Assessment'** and depicts the maximum internal marks. Respectiveexamination will be conducted by subject teacher. **ESE** in Column F stands for **'End Sem Examination/Evaluation'** and depicts the maximum external marks. Respective examination will be conducted by the University.
3. Column-B defines the nature of course/paper. The word **CORE** herein stands for **Compulsory Subject Paper**.
4. Column-D depicts the credits assigned for the corresponding course/paper.
5. **Elective:** It will be a Subject Elective. Students may accordingly select one or more subject papers under this category.
6. **Amongst the electives, one or two electives may be declared as Open (Generic) electives that shall be open as Minor Elective to students of other faculty in 2nd or 4th semester of a PG program.**
7. In both years of PG program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier.
8. Research project can be done in form of Internship/Survey/Field work/Research project/ Industrial training, for which report/dissertation shall have to be submitted. The evaluation for the same shall be done at the end of each year in form of seminar/presentation and viva voce.
9. The student straight away will be awarded 05 credits if he publishes a research paper on the topic of Research Project or Dissertation.

Internal Assessment

- It will be for theory and practical both.
- It will be done through the whole semester
- Candidate must obtain at least 40% marks in theory and practicals separately in internal assessment to be eligible for the semester university examination.

- Internal assessment (Theory) will be done as follows:

a)	Seminars/Symposia/Journal club/Assignment/ Clinical presentation	= 10 marks
b)	Mid-term examination	= 10 marks
c)	Attendance/Teaching Skills	= 05 marks
	Total	**= 25 marks**

- Internal assessment (Practical) will be done as follows:

a)	Lab work Presentation /Clinical Lab Practices/Clinical Training	= 10 marks
b)	Practical Training Skills/ Continuous evaluation	= 10 marks
c)	Laboratory Manual/Attendance	= 05 marks
		Total = 25 marks

- Internal assessment of subjects without practical will be done as:

a)	Assignments/ Projects/ class test/ Presentations	= 10 marks
b)	Mid Term examination	= 10 marks
c)	Attendance/Teaching Skills	= 05 marks
		Total = 25 marks

Criteria for Passing

- As per University norms.

Maximum duration for completion for course

- A candidate shall complete the course within four years from date of admission failing which the candidate will be discharged.

Division:

- As per the University norms.

Degree:

- The degree of MMRIT course of the University shall be conferred to the candidates who have pursued the prescribed course of study for not less than two academic years and have passed examinations as prescribed under the relevant scheme.

Monitoring Progress of Studies

It is essential to monitor the learning progress of each candidate through continuous appraisal and regular internal assessment. It also helps teachers to evaluate students, but also students to evaluate themselves. The monitoring is done by the faculty members of the department based on participation of students in various teaching / learning activities.

(a) Seminar

- Seminars /recent advance presentation will be held every week; however, its timings are subject to clinical schedule. Topics must be well researched and must include common knowledge, recent advances, analysis and references.
- PG students should present minimum of two seminars (One in general and one in elective area) and Internal Assessment marks will depend on better topic selection and presentation.

(b) Case Presentation

- PG students are expected to do at least one case presentation per month. They can choose the patient depending on the availability of cases. However, appropriateness should be confirmed with concern teacher.
- If the first presentation is unsatisfactory, students can do one more case presentation in the same posting for the improvement of the internal assessment.

(c) Clinical Practices

Postgraduate students must demonstrate competence in:

- Assessment, evaluation, and diagnosis techniques.
- Practice and application of radiological and imaging techniques in hospital/institutional settings.
- Application of advanced imaging techniques, diagnostic methods and imaging protocols.
- Clinical reasoning, decision-making Protocol, evidence-based practice, and maintaining a proper recording system.

(d) Teaching Skills

Candidates should be encouraged to teach undergraduate students if any. This performance will be based on assessment by the faculty members of the department and from feedback from the undergraduate students.

(e) Journal Review Meeting (Journal Club):

The ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting.

(f) Work diary / Log Book

Every student shall maintain a work diary and record his/her participation in the training programmes conducted by the department such as journal reviews, seminars, etc. Special mention may be made of the presentations by the candidate as well as details of clinical practice, if any conducted by the candidate by the student.

(g) Mid Term Examination/Class Test/Assignments

There will be mid-term examination/class tests/ assignments in every semester. Various class test may be taken by the department and assignments may be given to students on various topics. Marks of these will be included in every semester.

(h) Records

Records, log books and marks obtained in mid-term examination/class tests/ assignments will be maintained by the Head of the Department/Teacher of the concerned subject.

Dissertation

Every candidate pursing MMRIT degree course is required to carry out research work on a selected research project under the guidance of a recognized postgraduate teacher. The results of such a work shall be submitted in the form of dissertation. Topic for dissertation shall be assigned by the guide.
If the subject of Thesis entails collaboration with other departments or specialties, the collaborative portion of the work will be supervised by Co-Guide, designated by the School of Health Sciences in consultation with the Guide. Where a Co-Guide is involved, the Thesis will be certified jointly by the Guide & Co-guide.

Every candidate shall submit synopsis to the University in the prescribed Performa containing particulars of proposed dissertation work, within 6 months from the date of commencement of the course on or before the dates notified by the university. The synopsis shall be sent through the proper channel. Such synopsis will be reviewed and the university will register the dissertation topic.
No change in the dissertation topic or guide shall be made without prior approval of the university. Guide will be only a facilitator, advisor of the concept and hold responsible in correctly directing the candidate in the methodology and not responsible for the outcome and results.

The dissertation should be written under the following headings.

1. Introduction
2. Aims or objectives of study
3. Review of literature
4. Material and methods
5. Results
6. Discussion
7. Conclusion
8. References
9. Master and Chart & Table (If Applicable)
10. Annexure (If Applicable)

The written text of dissertation/ research project shall not be less than 50 pages and shall not exceed 120 pages excluding references, tables, questionnaires and other annexure. It should be neatly typed in double line spacing on one side of bond paper (A4 size, 8.27" x 11.69") and bound properly. Spiral binding should be avoided. A declaration by the candidate for having done the work himself should also be included, and the guide, head of the department and Director/Coordinator of the institute shall certify the dissertation/ research project.
Every candidate is required to give power point presentation before final submission of dissertation. Four copies of Dissertation/research project shall be submitted to the university, through proper channel, along with a soft copy (CD), 2 months before the final examination. It shall be assessed by two examiners appointed by the university, one internal and one external. There will be a power point open presentation of the submitted dissertation as per the schedule given by the university. This presentation shall be jointly evaluated by external and internal examiner.
If the student failed to secure the minimum passing marks he will resubmit the dissertation.

Guide

I. Eligibility for guide for each specialty
(a) Full time faculty involved in teaching in the same department/institute.
(b) Minimum MMRIT with 3 years teaching experience in related subject as a full time faculty.

The Director of the Institute can appoint a person as a guide whom he/she considers suitable.

II. Age of Guide
The age of guide should not exceed 62 years or as per university norms.

III. Guide student ratio

1: 10

A recognized guide shall supervise dissertation work of not more than 10 students per academic year.

IV. Change of Guide
In the event of registered guide leaving the department/institute or in the event of death of guide, guide may be change with prior permission from the university.

COURSE OF STUDY

Master in Medical Radiology and Imaging Technology (MMRIT)

First Semester University Examination

COURSE CODE	TYPE	COURSE TITLE	TEACHING HOURS
MRT25101	CORE	Planning & Management of a Radiology & Imaging Department	80
MRT25102	CORE	Review of Basic Imaging Techniques	80
MRT25103	CORE	Modern Imaging Techniques	80
MRT25104	CORE	Research Methodology in Radiology	80
MRT25105	PRACTICAL	Practical	160
	DISSERTATION	Dissertation	40
		TOTAL	520

Second Semester University Examination

COURSE CODE	TYPE	COURSE TITLE	TEACHING HOURS
MRT25201	CORE	Radiation safety and protection- AERB Guidelines	80
MRT25202	CORE	Imaging Anatomy and Physiology	80
MRT25203	CORE	Biostatistics in Radiology	80
MRT25204	MINOR ELECTIVE	Modern Radiological Imaging Equipment	80
MRT25205		Advanced Computed Tomography	
MRT25206	PRACTICAL	Practical	160
MRT25207	DISSERTATION	Dissertation	120
		TOTAL	600

Third Semester University Examination

COURSE CODE	TYPE	COURSE TITLE	TEACHING HOURS
MRT25301	CORE	Quality Assurance and Quality Control in Diagnostic Radiology and Imaging	80
MRT25302	CORE	Pedagogy in Imaging Education	80
MRT25303	CORE	Radiological Imaging Procedure	80
MRT25304	CORE	Radiology Administration & Management	80
MRT25305	PRACTICAL	Practical	160
	DISSERTATION	Dissertation	40
		Teaching skills/seminars/symposia/ journal club etc. *	40
		Clinical training/ camps*	40
		TOTAL	600

Fourth Semester University Examination

COURSE CODE	TYPE	COURSE TITLE	TEACHING HOURS
MRT25401	CORE	Newer Development in Advanced Imaging Technology	80
MRT25402	CORE	Interventional Radiology and Patient Care	80
MRT25403	CORE	Ultrasound Imaging	80
MRT25404	ELECTIVE	Nuclear Medicine Imaging Techniques	80
MRT25405		Advanced Magnetic Resonance Imaging	
MRT25406	PRACTICAL	Practical	160
MRT25407	DISSERTATION	Dissertation	120
		TOTAL	600

*** Not Included in University Exam.**

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I
PLANNING & MANAGEMENT OF A RADIOLOGY & IMAGING DEPARTMENT
Subject Code: MRT25101
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:
This course aims to equip students with the essential knowledge and skills required for effective planning, organization, and management of a Radiology and Imaging Department. The focus is on developing an understanding of administrative, technical, and operational aspects, along with the ability to handle day-to-day activities, optimize workflow, ensure quality control, and maintain compliance with safety standards in a healthcare setting.

COURSE OUTCOMES:
Upon completion of this subject, students should have the opportunity to:

- Understand the principles of planning and establishing a Radiology & Imaging Department in healthcare settings.
- Acquire knowledge about resource management, including equipment, personnel, and budgeting for radiology services.
- Apply effective management practices to ensure quality control, safety, and compliance with regulatory standards in the department.
- Learn and implement techniques for optimizing workflow and improving patient care outcomes in radiology.
- Understand and manage the legal, ethical, and administrative responsibilities associated with the operation of a radiology department.

COURSE CONTENT:

1. **Radiology Department Planning and Layout:**
   - Site selection and space requirements for radiology equipment.
   - Design considerations: Floor plans, workflow optimization, and zoning for various imaging modalities (X-ray, CT, MRI, Ultrasound, Mammography, Fluoroscopy, Dental Radiography Unit etc.).
   - Radiology room specifications and Layout: Shielding requirements, Primary, secondary protective barrier measurements, ventilation, lighting, and equipment positioning.
   - Safety considerations: Radiation protection measures, emergency exits, and infection control practices.
2. **Radiology Equipment and Technology Management:**
   - Selection criteria for radiology equipment: X-ray machines, CT scanners, MRI systems, Ultrasound, and other diagnostic tools.
   - Installation, calibration, and maintenance of radiology equipment.
   - Technological advancements in radiology: Digital radiography, PACS (Picture Archiving and Communication System), and teleradiology.
   - Cost-benefit analysis for procurement and upgrading of equipment.
   - Quality assurance (QA) and quality control (QC) programs for maintaining equipment performance and image quality.
3. **Human Resource Management in Radiology:**
   - Staff requirements: Radiologists, radiologic technologists, administrative staff, and support personnel.
   - Roles and responsibilities of department personnel.
   - Recruitment, training, and continuing education for radiology staff.
   - Leadership and communication skills for effective team management.
   - Workload management, shift planning, and ensuring optimal utilization of staff resources.
4. **Financial Management and Budgeting:**
   - Financial planning for a radiology department: Budgeting for equipment, personnel, consumables, and maintenance.
   - Cost management and revenue generation in radiology services.
   - Understanding the reimbursement policies and insurance claims for radiological procedures.
   - Cost-effectiveness of different imaging modalities.
   - Strategies for optimizing financial performance while ensuring high-quality patient care.

5. **Quality Management in Radiology:**
   - Introduction to quality assurance and quality improvement processes in radiology.
   - Implementation of image quality assessment protocols.
   - Patient safety protocols: Radiation dose management, infection control, and adverse event reporting.
   - Accreditation and certification standards: NABH (National Accreditation Board for Hospitals & Healthcare Providers) and JCI (Joint Commission International).
   - Legal and ethical issues related to radiology practices, including patient privacy, informed consent, and medico-legal considerations.
6. **Radiation Protection and Safety Management:**
   - Principles of radiation protection: ALARA (As Low As Reasonably Achievable), time, distance, and shielding.
   - Radiation safety protocols for staff and patients.
   - Regulatory bodies and standards governing radiation safety: AERB (Atomic Energy Regulatory Board) and ICRP (International Commission on Radiological Protection).
   - Emergency procedures and risk management in radiology, including handling radiation overexposure and equipment malfunction.
   - Radiation protection monitoring devices: Dosimeters and radiation badges for staff safety.
7. **Information Management in Radiology:**
   - Radiology Information System (RIS) and integration with Hospital Information System (HIS).
   - PACS (Picture Archiving and Communication System): Functionality, benefits, and challenges, DICOM.
   - Data storage, retrieval, and reporting in a digital radiology environment.
   - Teleradiology: Benefits, challenges, and implementation strategies.
   - Legal and ethical considerations in handling and sharing medical images and patient data.
8. **Patient Management and Care:**
   - Patient scheduling, registration, and coordination with other hospital departments.
   - Effective communication with patients: Ensuring informed consent, explaining procedures, and managing patient expectations.
   - Patient preparation for imaging procedures and post-procedural care.
   - Handling difficult or anxious patients and ensuring comfort during procedures.
   - Special considerations for pediatric, geriatric, and critically ill patients.

TEXTBOOKS:

1. "Radiology Administration: Principles and Practice" by Ronald L. Arenson, Saunders, 2nd Edition, 2020.
2. "Management of Radiology Services: A Practical Guide" by Judith V. Biggs, 3rd Edition, 2019.
3. "Radiation Protection in Diagnostic Radiology" by Euclid Seeram, 2nd Edition, 2021.

REFERENCE BOOKS:

1. "Radiology Business Practice: How to Succeed" by David M. Yousem and Norman J. Beauchamp, 2nd Edition, Elsevier, 2019.
2. "Principles of Radiographic Imaging: An Art and A Science" by Richard R. Carlton and Arlene M. Adler, 6th Edition, Cengage Learning, 2020.
3. "Leadership in Healthcare: Essential Values and Skills" by Carson F. Dye, 3rd Edition, Health Administration Press, 2017.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I
REVIEW OF BASIC IMAGING TECHNIQUES
Subject Code: MRT25102
Min. Hrs: 80 Hrs.

COURSE OBJECTIVES:

- To develop an in-depth understanding of radiographic techniques, including patient positioning and radiological anatomy.
- To understand the structure and function of tissues visualized using various radiological modalities.
- To evaluate and apply advanced radiological techniques for diagnostic accuracy.
- To understand the operating principles and uses of radiological instruments and equipment.

COURSE OUTCOMES:

- Students will gain knowledge of fundamental concepts and techniques in radiology and imaging.
- Students will be able to describe how anatomical structures are visualized in various imaging modalities.
- Demonstrate an understanding of radiographic physics, exposure parameters, and image processing techniques.
- Apply knowledge of radiology in practical settings, including the use of advanced imaging techniques.
- Safely and effectively operate imaging equipment and conduct diagnostic procedures. Record, extract, and analyze key diagnostic information using various radiological methods.

THEORY
RADIOGRAPHY

- General Radiography Techniques and Principles
- Patient Positioning: Methods and best practices for accurate imaging.
- Radiographic Anatomy: Visualization of bones, joints, and soft tissues.
- Radiation Physics: Interaction of X-rays with tissues, radiation protection, and safety protocols.
- Exposure Factors: Optimization of exposure parameters for image quality and dose reduction.
- Image Evaluation: Radiological interpretation and assessment of radiographs.
- Recent Advances in Radiography

ADVANCED IMAGING MODALITIES

- Computed Tomography (CT): General principles, slice thickness, reconstruction techniques, and contrast enhancement.
- Magnetic Resonance Imaging (MRI): Principles of MRI, tissue contrast, pulse sequences, and artifacts.
- Ultrasound Imaging: Physics of sound waves, Doppler effect, and common ultrasound techniques.
- Nuclear Medicine Imaging: Radioisotope techniques, PET and SPECT scanning, and radiation protection.
- Recent Advances in Advanced Imaging Modalities

IMAGING EQUIPMENT AND INSTRUMENTATION

- Radiographic Equipment: X-ray machines, fluoroscopy, and portable units.
- CT: Operating principles, Protocols usage, and safety measures.
- MRI Scanners: Operating principles, coil usage, and biological effect and safety measures.
- Ultrasound Equipment: Transducer technology, biological effect and safety protocols.
- Nuclear Medicine Equipment: Gamma cameras, PET/SPECT systems, and safety regulations.
- Radiation Safety and Protection: ALARA principles, dosimeters, and protective equipment.
- Recent Advances in Imaging Equipment

RADIATION BIOLOGY AND SAFETY

- Interaction of Radiation with Human Tissue
- Cellular Damage and Repair Mechanisms

- Radiation Dose Measurement and Monitoring
- Radiation Protection Protocols in Radiology
- Recent Advances in Radiation Safety

Text Books:

1. Frank H. Netter, Radiographic Anatomy, 4th Ed, Elsevier, 2010.
2. Stewart C. Bushong, Radiologic Science for Technologists: Physics, Biology, and Protection, 11th Ed, Elsevier, 2017.
3. Kathy McQuillen Martensen, Radiographic Image Analysis, Elsevier, 5th Ed, 2020.
4. Paul Suetens, Fundamentals of Medical Imaging, 2nd Ed, Cambridge University Press, 2009.
5. David Sutton, Radiology and Imaging for Medical Students, 7th Ed, Churchill Livingstone, 2014.

Reference Books:

1. William R. Hendee, Medical Imaging Physics, 4th Ed, Wiley-Liss, 2002.
2. Steve Webb, The Physics of Medical Imaging, CRC Press, 1988.
3. Jerrold T. Bushberg, The Essential Physics of Medical Imaging, 3rd Ed, Wolters Kluwer, 2012.
4. Richard L. Sutton, Practical Radiography, Springer, 6th Ed, 2015.
5. Euclid Seeram, Computed Tomography: Physical Principles, Clinical Applications, and Quality Control, 4th Ed, Saunders, 2021.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I
MODERN IMAGING TECHNIQUES
Subject Code: MRT25103
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- The objective of this course is to provide students with an in-depth understanding of the advanced imaging technologies currently utilized in medical diagnostics.
- This subject will focus on the principles, techniques, and applications of modern imaging modalities.
- Students will learn to integrate this knowledge into clinical practice, enabling them to choose appropriate imaging techniques based on clinical requirements, optimize image quality, and interpret diagnostic results effectively.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

- Understand the fundamental principles and technological advancements of modern imaging techniques in radiology.
- Analyze and apply the appropriate imaging modalities based on clinical indications and patient conditions.
- Enhance their knowledge of image acquisition, post-processing, and optimization for superior diagnostic accuracy.
- Critically evaluate and interpret images produced by advanced techniques to assist in clinical diagnosis.
- Understand safety measures, quality control, and ethical considerations in using modern imaging modalities.

COURSE CONTENT:

1. **Magnetic Resonance Imaging (MRI):**

- Physics of MRI: Basic principles, MR Instrumentations, MR Coil and its types, T1 and T2 relaxation, pulse sequences (spin echo, gradient echo, etc.), and image formation.
- Advanced MRI techniques: Diffusion-weighted imaging (DWI), perfusion imaging, functional MRI (fMRI), MR spectroscopy, and MR angiography.
- Clinical applications: Neurological, musculoskeletal, cardiovascular, and oncological imaging.
- MRI safety: Magnetic field strength, radiofrequency safety, and guidelines for preventing MRI accidents.
- MRI contrast agents: Types, mechanisms of action, and safety considerations.

2. **Computed Tomography (CT):**

- Basic principles of CT: X-ray attenuation, image reconstruction, and Hounsfield units.
- Advances in CT technology: Multidetector CT (MDCT), dual-energy CT, and cone-beam CT.
- Clinical applications: Cardiovascular CT, CT angiography, virtual colonoscopy, CT in trauma, and oncology.
- Radiation dose management in CT: Dose optimization strategies, CTDI, ALARA principle, and the use of iterative reconstruction techniques.
- CT contrast agents: Types, administration protocols, and adverse reactions.

3. **Positron Emission Tomography (PET) and PET/CT:**

- Principles of PET imaging: Radioisotope production, annihilation reaction, and PET detectors.
- PET/CT technology: Hybrid imaging and its clinical significance.
- Clinical applications of PET: Oncology, cardiology, and neurology imaging.
- Radiopharmaceuticals used in PET: FDG (fluorodeoxyglucose) and other tracers.
- Radiation safety in PET: Handling radioactive substances, regulatory guidelines, and patient preparation.

4. **Ultrasound Imaging:**

- Physics of ultrasound: Sound wave propagation, interaction with tissues, and Doppler effect.
- Types of ultrasounds: Mode of Imaging, 2D, 3D, and 4D ultrasound, Tissue Harmonic Imaging, Doppler ultrasound (color, power, spectral), and elastography.

- Clinical applications: Obstetrics and gynecology, abdominal imaging, vascular studies, and musculoskeletal ultrasound.
- Ultrasound-guided procedures: Interventional techniques like biopsies, drainage, and injections.
- Safety and limitations: Tissue heating, mechanical index, and contrast-enhanced ultrasound (CEUS).

5. **Digital Radiography and Fluoroscopy:**

- Introduction to digital radiography: Computed Radiography (CR) and Direct Digital Radiography (DR).
- Flat panel detectors and image intensifiers in fluoroscopy.
- Advanced fluoroscopy techniques: Digital subtraction angiography (DSA) and cine fluoroscopy.
- Image processing techniques: Windowing, filtering, and digital image manipulation.
- Clinical applications: Gastrointestinal studies, angiography, and orthopedic imaging.

6. **Nuclear Medicine Imaging (SPECT/CT and Gamma Camera):**

- Principles of nuclear medicine: Radioactive decay, gamma ray detection, and collimation.
- Single Photon Emission Computed Tomography (SPECT): Principles, image reconstruction, and clinical uses.
- Hybrid imaging: SPECT/CT and its advantages in diagnostics.
- Radiopharmaceuticals: Technetium-99m, iodine-123, thallium-201, and others used in clinical practice.
- Radiation protection and safety in nuclear medicine.

7. **Interventional Radiology (IR):**

- Basics of interventional radiology: Imaging guidance (ultrasound, CT, fluoroscopy) and minimally invasive techniques.
- Clinical applications: Vascular interventions, biopsies, ablation therapies, and drainage procedures.
- Radiation safety in interventional procedures: Techniques for dose reduction and patient safety.
- Equipment and tools: Catheters, stents, guidewires, and embolic materials.
- Post-procedure care and management of complications.

8. **Teleradiology and PACS (Picture Archiving and Communication System):**

- Principles and functioning of PACS: Image storage, retrieval, and communication.
- Role of teleradiology in modern healthcare: Remote reporting and its challenges.
- Integration of PACS with Radiology Information Systems (RIS) and Hospital Information Systems (HIS).
- Data security, confidentiality, and regulatory standards in medical imaging.
- Future trends: AI in teleradiology, automated reporting, and cloud-based PACS solutions.

TEXTBOOKS:

1. "Fundamentals of Radiology" by William Herring, Elsevier, 3rd Edition, 2021.
2. "MRI in Practice" by Catherine Westbrook, Wiley-Blackwell, 5th Edition, 2019.
3. "Computed Tomography for Technologists: A Comprehensive Text" by Lois E. Romans, Lippincott Williams & Wilkins, 2020.

REFERENCE BOOKS:

1. "Diagnostic Imaging: Ultrasound" by Jeffrey A. Maidment, Elsevier, 3rd Edition, 2020.
2. "Principles of Nuclear Medicine" by Harvey A. Ziessman, MD, Mosby, 4th Edition, 2019.
3. "Interventional Radiology: A Survival Guide" by David G. McCarter, Elsevier, 5th Edition, 2022.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I
RESEARCH METHODOLOGY IN RADIOLOGY
Subject Code: MRT25104
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- To gain a thorough understanding of presenting supporting evidence and how to conduct research in radiology.
- To understand the models of research, statistical tools, and biostatistics applicable in medical imaging.
- To evaluate every radiological procedure based on evidence-based practices.
- To understand data analysis procedures and their significance in radiological research.

COURSE OUTCOMES:

- Students will be able to understand and apply concepts and terminology within the area of radiology research.
- Students will be able to describe research design and apply different methods to analyze data collected in radiological studies to conduct and complete research effectively.

RESEARCH METHODOLOGY IN RADIOLOGY

1. **Research in Radiology and Imaging**
- Introduction
- Research for Radiology: Why? How? And When?
- Research – Definition, concept, purpose, and approaches

2. **Research Fundamentals**
- Define measurement in radiological research
- Measurement framework
- Scales of measurement in radiology (e.g., CT, MRI signal intensity scaling)
- Pilot study in imaging research
- Types of variables in radiological studies
- Reliability & validity of imaging techniques
- Drawing tables, graphs, master chart, etc. for imaging data presentation

3. **Writing a Research Proposal, Critiquing a Research Article**
- Defining a research problem in radiology
- Review of literature specific to medical imaging
- Formulating a research question, operational definitions in radiology
- Inclusion & exclusion criteria in diagnostic studies
- Forming groups for radiological research studies
- Data collection & analysis from imaging techniques
- Results interpretation, conclusion, and discussion
- Ethical considerations and informed consent in radiological studies
- Limitations of imaging research

4. **Research Design**
- Principles of designing a radiological study
- Design, instrumentation, and analysis for qualitative research in radiology
- Design, instrumentation, and analysis for quantitative research (e.g., CT, MRI, USG data)
- Design, instrumentation, and analysis for quasi-experimental research in imaging
- Design models utilized in radiological studies

5. **Research Ethics**
- Importance of ethics in radiological research
- Main ethical issues in imaging research involving human subjects
- Main ethical principles governing research with human subjects in radiology
- Components of an ethically valid informed consent for radiological research

Text Book:

1. **B.L. Agarwal**, Basic Statistics, New Age International Publication, 2012.

Reference Books:

1. **Sundarrao**, Introduction to Biostatistics and Research Methodology, CBS, 1Ed, 2002.
2. **C.R. Kothari**, Research Methodology, New Age International Publication, 3Ed, 2014.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I
PRACTICAL
Subject Code: MRT25105
Min. Hrs: 160 Hrs.

PRACTICAL COURSE CONTENT:

1. **Assessment, Anatomical Evaluation, and Protocols:** Practical assessment and evaluation of patients using various imaging modalities (X-ray, CT, MRI, Ultrasound). Understanding of radiological diagnostic procedures and protocols for different clinical conditions.
2. **Practice and Application of Radiological Imaging Techniques in Hospital/Institution**: Hands-on training in the radiology department for applying imaging techniques like X-ray, CT, MRI, and Ultrasound. Application of appropriate imaging protocols and patient positioning for diagnostic accuracy.
3. **Application of Advanced Imaging Techniques**: Advanced techniques in interventional radiology (e.g., CT-guided biopsies, angiographies). Practice in image-guided procedures and therapeutic interventions under supervision. Introduction to hybrid imaging technologies (e.g., PET-CT, SPECT-CT).
4. **Clinical Reasoning, Decision Making, and Evidence-Based Practice:** Use of clinical reasoning and decision-making strategies in radiological imaging. Implementation of evidence-based practices in selecting imaging modalities and protocols. Record-keeping, patient safety, and quality assurance in radiology.
5. **Short Case Studies from Elective Area to Assess Investigative and Diagnostic Skills**: Real-time case discussions and investigations focusing on imaging methods and diagnostic evaluations. Analysis of cases involving contrast studies, interventional radiology, and radiation therapy planning.
6. **Short Case Studies from Elective Area to Assess Patient Management Skill:** Management of patients undergoing imaging procedures, including preparation, care during the procedure, and post-procedure care.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-I

DISSERTATION

Min. Hrs -: 40 Hrs.

- Every candidate pursing Master in Medical Radiology and Imaging Technology (MMRIT) degree course is required to carry out research work on a selected research project under the guidance of a recognized postgraduate teacher. The results of such a work shall be submitted in the form of dissertation. Topic for dissertation shall be assigned by the guide.
- If the subject of thesis requires collaboration with other departments or specialties, the collaborative portion of the work will be supervised by Co-Guide, designated by the School of Health Sciences in consultation with the Guide. Where a Co-Guide is involved, the thesis will be certified jointly by the Guide & Co-guide.
- The students will select various topics concerned with day to day recent trends in Radiology and Imaging Technology.
- Before selection of the topic the student must go through various Radiology journals and study them elaborately to understand the recent trends and scientific research.
- A minimum of at least 5 topics must be scrolled by each student and out of this the most appropriate topic may be selected for his further synopsis preparation with the consent of guide.
- After selection of topic the student has to discuss the various aspects of the selected topic with his guide and strategically plan how he will proceed in his research work.
- Importance should be given to legitimate data collection and handling, sample size and the recent trends in the field Radiology and Imaging Technology.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
RADIATION SAFETY AND PROTECTION - AERB GUIDELINES
Subject Code: MRT25201
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to familiarize students with radiation safety principles and the Atomic Energy Regulatory Board (AERB) guidelines that ensure the safe use of ionizing radiation in medical practices.
- The course will provide a comprehensive understanding of radiation protection protocols, dose limits, and safety standards. It emphasizes the importance of patient, personnel, and public safety in radiological practices, and students will learn the practical application of these guidelines in clinical settings.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Comprehend the basic principles of radiation physics, biological effects of radiation, and radiation hazards.
- Apply the AERB guidelines to ensure radiation safety for patients, healthcare workers, and the general public.
- Implement safety measures for minimizing radiation exposure and perform routine quality control checks on radiological equipment.
- Develop skills in assessing, monitoring, and managing radiation exposure in clinical practice.
- Understand the legal and regulatory framework governing radiation use in medical radiology and imaging departments.

COURSE CONTENT:

1. **Introduction to Radiation and Its Types**:

- Fundamentals of ionizing and non-ionizing radiation.
- Sources of radiation in the medical field: X-rays, gamma rays, and radioactive materials.
- Characteristics of radiation relevant to diagnostic radiology and nuclear medicine.
- Radiation interactions with matter and its clinical implications.

2. **Biological Effects of Radiation**:

- Tissue weighting factors and Radiation weighting factors.
- Direct and Indirect effect of radiation.
- Stochastic and deterministic effects of radiation exposure.
- Radiation dose-response relationships.
- Acute radiation syndrome (ARS) and delayed effects of radiation exposure.
- Radiation effects on tissues, organs, and systems (e.g., skin, reproductive organs, blood-forming organs).
- Radiation carcinogenesis and hereditary effects.

3. **Radiation Measurement and Units**:

- Units of radiation measurement: Gray (Gy), Sievert (Sv), Becquerel (Bq), and their clinical relevance.
- Methods of measuring radiation exposure: Dosimeters, Geiger counters, ionization chambers, and scintillation detectors.
- Dose limits and reference levels for occupational, patient, and public exposure.
- Calculation of effective dose and organ-specific dose.

4. **AERB Guidelines and Regulatory Framework**:

- Overview of the Atomic Energy Regulatory Board (AERB) and its role in radiation safety.
- AERB guidelines for diagnostic radiology, interventional radiology, and nuclear medicine.
- Legal requirements for radiation facilities: Licensing, registration, and compliance procedures.
- Roles and responsibilities of Radiological Safety Officers (RSO).
- International safety standards (ICRP, NCRP, IAEA) and their integration with AERB guidelines.

5. **Radiation Protection Principles**:

- Basic principles of radiation protection: Justification, optimization, and dose limitation (ALARA principle).

- Shielding: Types of shielding materials, structural shielding requirements for X-ray rooms, and operating theatres.
- Personal protective equipment (PPE) for radiation protection: Lead aprons, thyroid shields, and protective eyewear.
- Time, distance, and shielding as key factors in radiation protection strategies.
- Radiation protection for pregnant patients and healthcare workers.

6. **Radiation Protection of Patients**:

- Techniques for dose optimization in diagnostic radiology: Filtration, collimation, and proper beam alignment.
- Radiation protection during fluoroscopy and CT procedures.
- Use of contrast media and its impact on radiation dose.
- Pediatric radiology and the special considerations for reducing radiation exposure in children.
- Patient consent and education on radiation risks and benefits.

7. **Radiation Protection of Personnel**:

- Monitoring occupational exposure: Use of personal dosimeters, Pocket Dosimeter, TLDs, OSLD and electronic personal dosimeters (EPDs).
- Dose limits for radiation workers as per AERB guidelines.
- Radiation safety protocols for interventional radiology and nuclear medicine staff.
- Medical examinations and health surveillance for radiation workers.
- Safe handling and disposal of radioactive materials.

8. **Quality Assurance in Radiology**:

- Importance of quality assurance (QA) programs in radiation safety.
- Equipment calibration, maintenance, and performance evaluation.
- Routine quality control tests for radiographic, fluoroscopic, CT, and nuclear medicine equipment.
- Digital imaging quality assurance: Monitoring image quality, exposure index, and detector performance.
- Radiation incident management and emergency preparedness.

9. **Radiation Safety in Special Radiological Procedures**:

- Radiation protection in interventional procedures: Cardiac catheterization, angiography, and endoscopic retrograde cholangiopancreatography (ERCP).
- Protection measures in mobile radiography and operating room procedures.
- Radiation safety considerations in brachytherapy and external beam radiation therapy (EBRT).
- Use of radiation safety devices in high-dose radiological procedures.

10. **Environmental and Public Radiation Safety**:

- Environmental monitoring of radiation levels in and around radiological facilities.
- Public exposure from medical radiation sources and natural background radiation.
- Managing radiation waste: Classification, handling, and disposal of radioactive waste materials.
- Emergency procedures for radiation leaks or contamination in healthcare settings.

TEXTBOOKS:

1. "Radiation Protection in Medical Radiography" by Mary Alice Statkiewicz Sherer, 8th Edition, Elsevier, 2021.
2. "Principles of Radiological Health and Safety" by James E. Martin, Wiley-Interscience, 2020.

REFERENCE BOOKS:

1. "ICRP Publication 103: The 2007 Recommendations of the International Commission on Radiological Protection" by ICRP, Elsevier, 2007.
2. "Radiation Protection and Dosimetry: An Introduction to Health Physics" by Michael G. Stabin, Springer, 2018.
3. "Radiation Safety in Medical Practice: A Practical Guide" by M. Saeed Khan, Jaypee Brothers Medical Publishers, 2017

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
IMAGING ANATOMY AND PHYSIOLOGY
Subject Code: MRT25202
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to equip students with a comprehensive understanding of human anatomy and physiology from an imaging perspective.
- It focuses on the correlation between anatomical structures and their physiological functions, as well as their appearance in various imaging modalities.
- The objective is to enhance students' ability to interpret and analyze diagnostic images by understanding the normal anatomy and physiology of human organs and systems.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Demonstrate a thorough understanding of human anatomy and physiology as it relates to medical imaging techniques.
- Analyze and interpret radiological images by identifying normal anatomical structures and distinguishing them from pathological changes.
- Apply anatomical knowledge in evaluating different imaging modalities such as X-rays, CT, MRI, and ultrasound.
- Correlate physiological processes with anatomical imaging to assess organ function and detect abnormalities.
- Enhance their ability to work collaboratively with radiologists and other healthcare professionals in clinical decision-making based on imaging results.

COURSE CONTENT:

1. **Introduction to Imaging Anatomy and Physiology**:

- Basic principles of anatomy and physiology in the context of medical imaging.
- Cross-sectional anatomy and its relevance in diagnostic imaging.
- Radiological anatomy: Key landmarks and features visible in various imaging techniques.

2. **Musculoskeletal System**:

- Anatomy of bones, joints, and muscles as seen in plain radiography, CT, MRI, and ultrasound.
- Imaging of the axial skeleton (skull, vertebral column) and appendicular skeleton (limbs).
- Physiological processes such as bone remodeling, muscle contraction, and joint movement in imaging.
- Pathological conditions of the musculoskeletal system (e.g., fractures, arthritis, soft tissue injuries) and their imaging presentation.

3. **Cardiovascular System**:

- Anatomy of the heart, major blood vessels, and vascular structures as visualized through echocardiography, CT angiography, and MRI.
- Physiology of blood circulation and cardiac function.
- Imaging techniques used to assess the cardiovascular system (e.g., Doppler ultrasound, cardiac MRI, and CT angiography).
- Imaging of common cardiovascular conditions: coronary artery disease, aneurysms, and congenital heart defects.

4. **Respiratory System**:

- Anatomy of the respiratory system: Lungs, airways, diaphragm, and thoracic cavity.
- Imaging of the lungs and airways using chest X-rays, CT, MRI, and PET scans.
- Physiological aspects of respiration and gas exchange in relation to imaging findings.
- Common respiratory pathologies (e.g., pneumonia, tuberculosis, lung cancer) and their radiological features.

5. **Gastrointestinal System**:

- Anatomy of the digestive tract: Oesophagus, stomach, small and large intestines, liver, pancreas, and gallbladder.
- Imaging techniques for the GI tract: Barium studies, abdominal ultrasound, CT, and MRI.

- Physiology of digestion and absorption, and how these processes appear on imaging.
- Identification of GI diseases (e.g., ulcers, tumors, inflammatory bowel disease) through imaging modalities.

6. **Urinary and Reproductive Systems**:

- Anatomy of the kidneys, ureters, bladder, and reproductive organs in males and females.
- Imaging modalities: Intravenous pyelogram (IVP), renal ultrasound, MRI, and CT.
- Physiological functions of the urinary system (e.g., filtration, reabsorption, excretion) in imaging studies.
- Reproductive imaging (e.g., hysterosalpingography, pelvic ultrasound) and conditions such as tumors, cysts, and congenital abnormalities.

7. **Nervous System**:

- Central and peripheral nervous system anatomy: Brain, spinal cord, cranial nerves, and peripheral nerves.
- Imaging of the brain and spinal cord using MRI, CT, and functional imaging techniques.
- Correlation of physiological brain functions (e.g., motor control, sensory perception, cognition) with imaging studies.
- Detection of neurological conditions (e.g., stroke, brain tumors, multiple sclerosis) through imaging.

8. **Endocrine System**:

- Anatomy of endocrine glands: Pituitary, thyroid, parathyroid, adrenal, and pancreas.
- Imaging of the endocrine system using nuclear medicine, ultrasound, and MRI.
- Physiological aspects of hormone secretion and regulation, and their reflection in imaging studies.
- Imaging findings of endocrine disorders such as thyroid nodules, adrenal tumors, and diabetes-related changes.

9. **Breast Imaging**:

- Anatomy of the breast and surrounding tissues.
- Mammography, breast ultrasound, and MRI techniques in imaging breast tissues.
- Physiological changes in the breast (e.g., during the menstrual cycle, pregnancy, and lactation) as observed in imaging studies.
- Diagnosis of breast conditions such as fibrocystic changes, benign tumors, and breast cancer through imaging.

10. **Pediatric Imaging**:

- Anatomical and physiological differences between pediatric and adult patients in imaging.
- Imaging techniques suited for children: Pediatric X-rays, ultrasound, and low-dose CT.
- Common pediatric conditions (e.g., congenital abnormalities, growth plate injuries) and their appearance on imaging.
- Special considerations for pediatric radiation protection and safety in imaging practices.

TEXTBOOKS:

1. "Imaging Anatomy: Head and Neck" by Philip R. Chapman, Elsevier, 2019.
2. "Imaging Anatomy of the Human Spine" by Scott E. Forseen, Cambridge University Press, 2016.

REFERENCE BOOKS:

1. "Netter's Atlas of Human Anatomy" by Frank H. Netter, 7th Edition, Elsevier, 2019.
2. "Human Anatomy and Physiology" by Elaine N. Marieb, 10th Edition, Pearson, 2015.
3. "Clinical Imaging: An Atlas of Differential Diagnosis" by Ronald L. Eisenberg, 6th Edition, Elsevier, 2020.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Second Semester
BIOSTATISTICS FOR RADIOLOGICAL RESEARCH
Subject Code: MRT25203
Min. Hrs: 80 Hrs.

COURSE OBJECTIVES:

- To provide a thorough understanding of how to present supporting evidence and conduct statistical analysis in radiological research.
- To comprehend the models and methodologies used in biostatistics relevant to medical imaging.
- To evaluate diagnostic procedures and treatments based on evidence and statistical methods.
- To understand data analysis techniques and their significance in medical radiology research.

COURSE OUTCOMES:

- Students will gain the ability to understand and apply statistical concepts and terminology within the realm of radiological research.
- Students will be able to design research studies and apply statistical methods to analyze data collected from imaging modalities and radiological assessments.
- Students will learn to record, extract, and analyze key data related to patient diagnosis and imaging studies.

COURSE CONTENT:

1. Biostatistics in Radiology

- Introduction: Definition of biostatistics in medical radiology and imaging. Importance of statistical methods in radiological research and diagnostics.
- Types of Data in Radiology: Categorical and continuous data relevant to medical imaging. Applications of biostatistics in various imaging techniques (X-ray, CT, MRI, Ultrasound).

2. Data Collection and Presentation in Radiology

- Data Definition: Types of data encountered in radiological research.
- Methods of Data Collection: Techniques for gathering quantitative and qualitative data from imaging studies.
- Data Presentation: Use of charts, graphs, and tables to present imaging data for analysis.

3. Measures of Central Tendency

- Arithmetic Mean, Median, Mode: Application of these measures in radiological research data (e.g., average radiation doses, average imaging times).
- Partitioned Values: Quartiles, deciles, and percentiles in diagnostic radiology (e.g., patient size distribution in imaging studies).

4. Measures of Dispersion

- Range, Mean Deviation, Standard Deviation: Interpretation of variability in radiological data (e.g., radiation dose variation in CT scans).

5. Normal Distribution Curve in Radiology

- Properties of Normal Distribution: Application of the normal distribution in radiological image quality control and patient dose measurements.
- Standard Normal Distribution: Transformation of radiological data into a normal distribution.

6. Correlation Analysis in Radiology

- Bivariate Distribution: Application in radiology (e.g., correlation between age and incidence of certain diseases visible on imaging).
- Scatter Diagram and Coefficient of Correlation: Use in diagnostic accuracy studies (e.g., correlation between image quality and diagnostic accuracy).
- Statistical Tests: T-test, Z-test, and P-values for hypothesis testing in radiology research.

7. Regression Analysis in Radiology

- Lines of Regression and Regression Coefficient: Use of regression analysis to predict radiological outcomes (e.g., predicting disease progression based on imaging data).

- Standard Error and Types I & II Errors: Importance of understanding errors in radiological test results and research.

8. Probability in Radiology (Brief Overview)

- Application of Probability: Use of probability in diagnostic radiology and determining the likelihood of conditions based on imaging findings.

9. Hypothesis Testing in Radiology Research

- Null and Alternative Hypotheses: Developing and testing hypotheses in radiological studies (e.g., efficacy of a new imaging technique).
- Level of Significance: Deciding statistical significance in radiological research results.

10. Parametric and Non-Parametric Tests in Radiology

- Chi-Square Test: Use in evaluating categorical imaging data (e.g., disease classification from imaging results).
- Mann-Whitney U Test, Wilcoxon Signed-Rank Test: Application in comparing imaging modalities or techniques.
- Kruskal-Wallis Test, Friedman Test: Use in non-parametric data analysis for radiology studies.
- T-Test and Analysis of Variance (ANOVA): Comparing means in clinical trials involving radiological techniques.

Text Books:

1. **B.L Agarwal, Basic Statistics**, New Age International Publication, 2012.

Reference Books:

1. **Sundarrao, Introduction to Biostatistics and Research Methodology**, CBS, 1st Edn, 2002.
2. **C.R Kothari, Research Methodology**, New Age International Publication, 3rd Edn, 2014.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
MODERN RADIOLOGICAL IMAGING EQUIPMENT
Subject Code: MRT25204
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to provide students with an in-depth understanding of the modern radiological imaging equipment used in diagnostic and therapeutic radiology.
- The objective is to familiarize students with the working principles, technical aspects, and operational protocols of various advanced imaging machines.
- It also aims to develop competency in the use and maintenance of these machines in a clinical setting, ensuring patient safety and image quality.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Understand the working principles, construction, and operation of modern radiological imaging equipment.
- Apply knowledge of imaging equipment for optimal image acquisition and diagnosis in clinical settings.
- Ensure radiation safety and quality control measures while using different radiological equipment.
- Troubleshoot and perform basic maintenance of imaging equipment.
- Stay updated with technological advancements in medical imaging for better clinical outcomes.

COURSE CONTENT:

1. **X-Ray Machines**:

- Principle of transformer its types, and losses of transformer.
- X-ray generator, x-ray circuit components.
- Components of X-ray machines: Different types of X-ray tube, collimators, filters, generators.
- Image acquisition techniques and factors affecting image quality.
- Maintenance, calibration, and troubleshooting of X-ray machines.

2. **Computed Tomography (CT) Scanners**:

- Principles of MDCT imaging: X-ray attenuation, slice acquisition, and reconstruction algorithms, Post processing algorithm, Maximum Intensity Projection, Minimum Intensity Projection, Shaded Surface Display, Volume Rendering Technique.
- Components of CT scanners: Gantry, detectors, rotating X-ray source, Flying Focus X-ray Tube (Straton tube).
- Types of CT scanners: Single-slice, multi-slice, and cone-beam CT scanners.
- Advanced CT techniques: 3D imaging, dual-energy CT, and dynamic imaging.
- Applications of CT in radiology and troubleshooting of common errors.

3. **Magnetic Resonance Imaging (MRI) Scanners**:

- Basic physics of MRI: Magnetic fields, radiofrequency pulses, and resonance.
- MRI system components: Magnet, gradient coils, RF coils, and control console.
- Imaging sequences: T1-weighted, T2-weighted, FLAIR, STIR and diffusion imaging.
- Advanced MRI techniques: Functional MRI (fMRI), MR spectroscopy, and diffusion tensor imaging (DTI).
- MRI safety, contrast media in MRI, and handling equipment malfunctions.

4. **Ultrasound Machines**:

- Principles of ultrasound imaging: Piezoelectric effect, sound wave propagation, and echo generation.
- Types of ultrasound machines: 2D, 3D, 4D ultrasound, Doppler ultrasound.
- Components of an ultrasound machine: Transducer, display, control panel.
- Doppler imaging: Color Doppler, spectral Doppler, and power Doppler.
- Applications in obstetrics, cardiology, musculoskeletal imaging, and troubleshooting image artifacts.

5. **Digital Radiography (DR) and Computed Radiography (CR)**:

- Comparison between analog and digital imaging.
- Components of CR and DR systems: Imaging plates, detectors, processing units.

- Digital image acquisition, storage, and retrieval techniques (PACS).
- Advantages of DR and CR over traditional radiography.
- Quality control in digital imaging systems and maintenance of equipment.

6. **Fluoroscopy Machines**:

- Principles of real-time imaging using fluoroscopy.
- Components of fluoroscopy machines: Image intensifier, C-arm, and flat panel detectors.
- Applications of fluoroscopy in interventional radiology and barium studies.
- Radiation safety in fluoroscopy and reduction of patient dose.
- Troubleshooting and maintenance of fluoroscopy equipment.

7. **Mammography Equipment**:

- Principles of breast imaging using low-dose X-rays.
- Components of mammography machines: X-ray tube, X-ray generator, Grid ratio, Filter, target material, compression paddle, detector.
- Screen film mammography system.
- Image acquisition techniques and quality assurance in mammography.
- Troubleshooting common equipment issues and ensuring patient safety.

8. **Nuclear Medicine Equipment (Gamma Cameras and PET Scanners)**:

- Principles of nuclear medicine imaging: Radioisotope decay, gamma ray detection.
- Components of gamma cameras and PET scanners: Detectors, collimators, scintillation crystals.
- Hybrid imaging systems: PET-CT and SPECT-CT.
- Applications of nuclear medicine in oncology, cardiology, and neurology.
- Radiation protection in nuclear medicine and troubleshooting of imaging equipment.

9. **Angiography Equipment**:

- Principles of angiographic imaging using contrast media.
- Components of angiography systems: Catheter, injector, image intensifier, and C-arm.
- Digital subtraction angiography (DSA) and its clinical applications.
- Safety protocols for contrast injection and radiation exposure reduction.
- Equipment maintenance and error troubleshooting in angiographic procedures.

10. **Hybrid Imaging Systems**:

- Overview of hybrid imaging techniques: PET-CT, SPECT-CT, PET-MRI.
- Integration of functional and anatomical imaging for enhanced diagnosis.
- Applications of hybrid imaging in oncology, cardiology, and neurology.
- Radiation safety and optimization of hybrid imaging systems.
- Basic maintenance and troubleshooting of hybrid imaging equipment.

TEXTBOOKS:

1. "Physics for Diagnostic Radiology" by P.P. Dendy and B. Heaton, 3rd Edition, CRC Press, 2011.
2. "MRI: The Basics" by Ray H. Hashemi and William G. Bradley, 4th Edition, Lippincott Williams & Wilkins, 2019.

REFERENCE BOOKS:

1. "Radiographic Imaging and Exposure" by Terri L. Fauber, 5th Edition, Elsevier, 2016.
2. "CT and MRI of the Whole Body" by John R. Haaga, 6th Edition, Elsevier, 2017.
3. "Ultrasound in Obstetrics and Gynecology" by Peter W. Callen, 6th Edition, Elsevier, 2017.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
ADVANCED COMPUTED TOMOGRAPHY
Subject Code: MRT25205
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to provide students with advanced knowledge and skills in computed tomography (CT) technology.
- Students will gain a thorough understanding of CT imaging techniques, instrumentation, image acquisition protocols, and post-processing methods.
- Emphasis is placed on patient care, radiation safety, and the application of specialized CT procedures in clinical practice.
- This course also covers contrast media administration and strategies for optimizing image quality while minimizing radiation dose.

COURSE OUTCOMES:

- Demonstrate an understanding of CT imaging principles, including physics, instrumentation, and image reconstruction.
- Apply appropriate CT protocols for a variety of clinical indications, ensuring optimized image quality and patient safety.
- Perform CT imaging procedures with competence in patient positioning, contrast media administration, and radiation pr+otection.
- Analyze and interpret CT images, identifying common artifacts and techniques for artifact reduction.
- Demonstrate knowledge of advanced CT applications such as CT angiography, cardiac CT, and virtual colonoscopy.

COURSE CONTENT:

1. **Introduction to Computed Tomography:**

- Overview of CT technology: history, evolution, and current advancements.
- Basic principles of CT: image formation, attenuation, and Hounsfield units.
- CT instrumentation: gantry, X-ray tube, detectors, and data acquisition systems.
- Image reconstruction methods: filtered back projection, iterative reconstruction, and artificial intelligence applications.

2. **Patient Preparation and Safety in CT Procedures:**

- Pre-scan patient assessment: medical history, allergies, and contraindications for contrast media.
- Patient positioning and immobilization techniques in CT.
- Radiation safety principles in CT: dose optimization, shielding, and ALARA principles.
- Contrast media safety: administration protocols, adverse reactions, and emergency procedures.

3. **CT Imaging Protocols for Different Anatomical Regions:**

- CT protocols for head and neck imaging: brain, facial bones, sinuses, and angiography.
- Chest CT protocols: pulmonary embolism, lung nodule assessment, and thoracic aorta imaging.
- Abdomen and pelvis CT protocols: liver, pancreas, kidneys, and GI tract imaging.
- Musculoskeletal CT protocols: bone fractures, joint assessments, and tumor evaluation.

4. **Advanced CT Procedures:**

- CT angiography: principles, techniques, and clinical applications in vascular imaging.
- Cardiac CT: coronary artery imaging, calcium scoring, and cardiac function analysis.
- Virtual colonoscopy: indications, procedure, and interpretation.
- Perfusion CT and functional imaging techniques.

5. **Image Quality and Artifact Reduction in CT:**

- Factors affecting image quality in CT: contrast, spatial resolution, noise, and slice thickness.
- Common CT artifacts: beam hardening, motion artifacts, metal artifacts, and techniques to reduce them.

- Image post-processing techniques: multi-planar reconstruction (MPR), maximum intensity projection (MIP), and volume rendering.
- Use of dual-energy CT for enhanced imaging capabilities.

6. **Contrast Media and Pharmacology in CT:**

- Types of contrast media used in CT: iodinated contrast and its properties.
- Techniques for intravenous contrast administration: dosage, injection protocols, and timing.
- Pharmacology of contrast agents: mechanism of action, distribution, and metabolism.
- Management of contrast reactions and guidelines for patient monitoring post-contrast administration.

7. **Radiation Dose Management in CT:**

- CT dose measurement and units: CTDI, DLP, and effective dose.
- Techniques to reduce radiation dose: automated exposure control, tube current modulation, and dose optimization strategies.
- Pediatric dose considerations and protocols for minimizing exposure.
- Role of the technologist in dose documentation and patient education on radiation risks.

8. **Emerging Trends in CT Imaging Technology:**

- Technological advancements in CT scanners: multi-slice CT, spectral CT, and photon-counting detectors.
- Hybrid imaging: PET-CT and SPECT-CT for enhanced diagnostic capabilities.
- Role of artificial intelligence in CT imaging: automated image analysis, reconstruction, and diagnostic assistance.
- Future directions in CT imaging, including precision medicine and personalized imaging protocols.

9. **Troubleshooting in CT Procedures:**

- Identifying and managing technical issues during CT scanning.
- Approaches to challenging cases: pediatric, elderly, and trauma patients.
- Communication with patients during procedures and addressing patient concerns.
- Professional development and continuous learning in CT technology.

TEXTBOOKS:

1. "Computed Tomography: Physical Principles, Clinical Applications, and Quality Control" by Euclid Seeram, 4th Edition, Saunders, 2015.
2. "Essentials of Radiologic Science" by Robert A. Fosbinder and Denise Orth, 2nd Edition, Wolters Kluwer Health, 2017.

REFERENCE BOOKS:

1. "Computed Tomography for Technologists: A Comprehensive Text" by Lois E. Romans, 2nd Edition, Lippincott Williams & Wilkins, 2010.
2. "MDCT Physics: The Basics – Technology, Image Quality, and Radiation Dose" by Mahadevappa Mahesh, 1st Edition, Lippincott Williams & Wilkins, 2009.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
PRACTICAL
Subject Code: MRT25206
Min. Hrs: 160 Hrs.

1. Assessment, Anatomical Evaluation,
- Thorough understanding of patient assessment and diagnostic evaluation through various radiological techniques.
- Ability to accurately diagnose conditions using imaging modalities such as X-ray, CT, MRI, Ultrasound, and Nuclear Medicine.
2. Practice and Application of Radiological Techniques in Hospital/Institution
- Hands-on training in performing radiological procedures and operating advanced imaging equipment.
- Application of imaging protocols in a clinical environment, ensuring adherence to safety standards and patient care guidelines.
3. Application of Advanced Imaging Techniques and Interventional Procedures
- Proficiency in using advanced imaging technologies, including CT-guided interventions, MRI spectroscopy, and fluoroscopy for diagnostic and therapeutic purposes.
- Exposure to interventional radiology techniques such as angiography, biopsies, and drainage procedures.
4. Clinical Reasoning, Decision Making, Evidence-Based Practice, and Recording System
- Development of clinical reasoning and decision-making skills specific to radiological practice, with a focus on case management and outcome-based decision-making.
- Understanding and applying evidence-based practices in radiology, ensuring high-quality patient care.
- Efficient use of digital imaging systems, PACS (Picture Archiving and Communication System), and proper documentation for radiological records.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-II
DISSERTATION
Subject Code: MRT25207
Min. Hrs: 120 Hrs.

- Every candidate shall submit synopsis to the University in the prescribed Performa containing particulars of proposed dissertation work, within 6 months from the date of commencement of the course on or before the dates notified by the university.
- The synopsis shall be sent through the proper channel. Such synopsis will be reviewed and the university will register the dissertation topic.

Students will prepare their synopsis for dissertation in consultation with their guides.

Performa for synopsis:

1. Introduction
2. Aims and Objectives
3. Review of Literature
4. Methodology or Material and Methods
5. References

Note:

1. The copies of synopsis must be in bound properly.
2. The candidate have to submit 4 copies of synopsis.
3. Colour scheme for synopsis will be white.
4. Text writing
   Paper to be used – A4 size (Bond Paper)
   Printing – One side
   Font - Title – 18 Pt. Bold
   Heading – 16 Pt. Bold.
   Sub Heading – 14 Pt. Bold
   Running text (English) -12 Pt. – Times New Roman
   Running Text (Hindi) 14 Pt. (CG12, Krutidev 10)
   Spacing : Double
   Margin : Left – 4 Cm, Top, Bottom, Right – 2.5 Cm.
   Page Numbering– Properly numbered

Writing Reference

Should be numbered consecutively in the order in which they are first mentioned in the text (not in alphabetic order). Identify references in text, tables and legends by Arabic numerals in superscript. References cited only in tables or figure legends should be numbered in accordance with the sequence established by the first identification in the text of the particular table or figure.

Journal Articles
Shashi A, Jain SK and Pandey M: *In-vitro* evaluation of anti lthiatic activity of seeds of *Dolichos biflorus* and roots of *Asparagus racemosus* . International Journal of Plant Sciences 2008; 1:67-71.

A Book
Kalia AN: A Text Book of Industrial Pharmacognosy. CBS Publishers & Distributors, First Edition 2005.

A Chapter in a Book
Nadkarni KM: Indian Materia Medica. Popular Prakashan, Mumbai, Edition 3, Vol. I, 2000: 242-246.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
QUALITY ASSURANCE AND QUALITY CONTROL IN DIAGNOSTIC RADIOLOGY AND IMAGING
Subject Code: **MRT25301**
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to provide students with a comprehensive understanding of quality assurance (QA) and quality control (QC) protocols in diagnostic radiology and imaging.
- The objective is to ensure that students gain the necessary skills to assess, monitor, and maintain high standards in radiological procedures.
- It aims to enhance the accuracy of imaging results, optimize radiation doses, improve patient safety, and extend the longevity of radiological equipment.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Understand the principles of quality assurance and quality control in diagnostic radiology.
- Implement QA/QC protocols to maintain consistency and reliability in imaging results.
- Analyze and evaluate the performance of radiological equipment to ensure optimal functionality.
- Minimize radiation exposure to patients and personnel by adhering to safety guidelines.
- Conduct regular audits and quality checks on equipment and imaging procedures to ensure compliance with regulatory standards.

COURSE CONTENT:

1. **Introduction to Quality Assurance (QA) and Quality Control (QC)**:
- Definitions and importance of QA and QC in diagnostic radiology.
- Differences between quality assurance and quality control.
- Objectives and benefits of QA/QC programs in radiology.
- Regulatory and accreditation bodies: AERB, NABH, and international standards.

2. **Quality Assurance in Diagnostic Radiology**:
- Components of a QA program: equipment, personnel, and procedures.
- Establishing a QA protocol in diagnostic imaging departments.
- Routine monitoring and maintenance of radiology equipment.
- Documentation, record-keeping, and reporting in QA programs.
- QA guidelines for radiology departments by regulatory bodies (AERB, ICRP, etc.).

3. **Quality Control in Diagnostic Imaging Systems**:
- QC tests for X-ray machines: kVp accuracy, exposure time, and mA linearity.
- QC protocols for computed tomography (CT) scanners: image uniformity, noise, and slice thickness accuracy.
- QC tests for MRI machines: magnetic field homogeneity, RF calibration, and image artifact detection.
- QC in ultrasound systems: beam alignment, axial and lateral resolution, depth of penetration.
- QC in digital radiography (DR) and computed radiography (CR) systems.

4. **Radiation Dose Optimization and Patient Safety**:
- Principles of radiation protection in diagnostic radiology.
- ALARA (As Low As Reasonably Achievable) concept in imaging.
- Dose optimization strategies: shielding, collimation, and exposure settings.
- Monitoring radiation doses for patients and personnel: use of dosimeters, TLDs, and film badges.
- Regulatory dose limits and recommendations by ICRP and AERB.

5. **Image Quality Assessment and Improvement**:
- Factors affecting image quality: resolution, contrast, noise, and artifacts.
- Methods for assessing image quality: visual inspection, contrast-detail phantoms, and modulation transfer function (MTF).
- Strategies for improving image quality in different imaging modalities.
- Identifying and troubleshooting common imaging artifacts.
- Role of digital image processing in enhancing image quality.

6. **Equipment Calibration and Preventive Maintenance**:

- Importance of equipment calibration and performance verification.
- Calibration procedures for X-ray, CT, MRI, and ultrasound machines.
- Preventive maintenance schedules and protocols for radiological equipment.
- Troubleshooting common equipment issues and ensuring consistent performance.
- Role of medical physicists in equipment calibration and maintenance.

7. **Audit and Review of Quality Control Programs**:

- Conducting internal and external audits of QA/QC programs.
- Steps involved in performing a quality audit in a radiology department.
- Evaluation and review of imaging protocols and QC results.
- Implementation of corrective actions based on audit findings.
- Continuous improvement of QA/QC programs: feedback, updates, and revisions.

8. **Regulatory Compliance and Accreditation**:

- Overview of legal and regulatory requirements for QA/QC in diagnostic radiology.
- AERB guidelines for radiation safety and equipment standards.
- Accreditation process by NABH and other international bodies.
- Preparing for external audits and inspections by regulatory authorities.
- Ensuring compliance with national and international standards in radiology departments.

9. **Radiation Safety and Protection in Quality Assurance**:

- Radiation safety standards for patients, personnel, and the environment.
- Implementing radiation protection measures in the radiology department.
- Use of personal protective equipment (PPE) and lead shields.
- Importance of radiation monitoring devices and regular safety audits.
- Compliance with radiation safety protocols and guidelines by AERB.

10. **Advances in Quality Assurance and Control**:

- Latest technologies and innovations in QA/QC systems.
- Automated QC systems for digital radiography and advanced imaging modalities.
- Role of artificial intelligence (AI) in quality assurance and control.
- Emerging trends in radiation safety and quality management.
- Future directions for QA/QC in diagnostic radiology.

TEXTBOOKS:

1. "Quality Management in the Imaging Sciences" by Jeffrey Papp, 6th Edition, Elsevier, 2019.
2. "Quality Assurance and Quality Control in Diagnostic Radiology" by William R. Hendee and E. Russell Ritenour, 3rd Edition, CRC Press, 2001.

REFERENCE BOOKS:

1. "Principles of Radiographic Imaging: An Art and A Science" by Richard Carlton and Arlene Adler, 6th Edition, Cengage Learning, 2019.
2. "Radiation Protection in Medical Radiography" by Mary Alice Statkiewicz Sherer and Paula J. Visconti, 8th Edition, Elsevier, 2018.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
PEDAGOGY IN RADIOLOGICAL EDUCATION
Subject Code: MRT25302
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to introduce students to the principles and methodologies of teaching and learning within the field of radiological sciences.
- It aims to equip students with the necessary pedagogical skills to educate future professionals in radiology and imaging technology.
- The course focuses on understanding educational theories, teaching methods, curriculum development, and assessment strategies that are critical for effective teaching in the radiological domain.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Demonstrate knowledge of the fundamental principles of pedagogy and its application in radiological education.
- Develop effective teaching strategies tailored to the needs of students in radiology and imaging technology.
- Design curriculum, learning objectives, and instructional materials suitable for radiology education.
- Apply appropriate assessment methods to evaluate student performance and learning outcomes.
- Integrate modern teaching technologies and tools to enhance the learning experience in radiology education.

COURSE CONTENT:

1. **Introduction to Pedagogy in Radiological Sciences**:

- Definitions and concepts of pedagogy and its relevance to radiological education.
- Overview of educational theories: behaviourism, cognitivism, and constructivism.
- Role of the teacher as a facilitator in radiology education.
- Understanding student learning styles and adapting teaching techniques accordingly.

2. **Curriculum Design and Development**:

- Principles of curriculum design in radiology and imaging technology.
- Structuring learning outcomes and objectives based on educational goals.
- Selecting content, learning materials, and resources for radiology programs.
- Integration of clinical practice into the curriculum for radiology students.
- Strategies for updating and revising curriculum to meet industry standards and technological advancements.

3. **Teaching and Learning Methods in Radiology Education**:

- Traditional teaching methods: lectures, tutorials, and demonstrations.
- Innovative teaching techniques: problem-based learning (PBL), flipped classroom, and team-based learning (TBL).
- Use of clinical case studies and simulations to enhance practical learning.
- Incorporating interdisciplinary approaches in radiology education.
- Engaging students through interactive and student-centered learning activities.

4. **Instructional Design and Lesson Planning**:

- Developing instructional plans that align with learning objectives.
- Structuring lectures, tutorials, and practical sessions for radiology topics.
- Use of multimedia and visual aids to enhance teaching (e.g., radiographic images, videos).
- Techniques for managing large and small groups in clinical and classroom settings.
- Effective time management and pacing of lessons in radiology education.

5. **Use of Technology in Radiology Education**:

- Integration of e-learning tools and online resources in teaching.
- Use of virtual simulation and radiographic imaging software in education.
- Role of digital platforms for assessment, communication, and feedback.
- Impact of artificial intelligence and machine learning on radiology education.
- Emerging trends in educational technology for radiological training.

6. **Assessment and Evaluation of Student Learning**:

- Principles and types of assessments: formative and summative.
- Designing effective assessments for radiological knowledge and clinical skills.
- Objective Structured Clinical Examination (OSCE) and its application in radiology education.
- Rubrics and marking schemes for evaluating practical and theoretical knowledge.
- Providing constructive feedback to students for academic and clinical improvement.

7. **Clinical Teaching and Mentorship in Radiology**:

- Methods for teaching clinical skills in radiology departments and labs.
- Role of the educator as a mentor for students in clinical practice.
- Supervising and guiding students during clinical rotations and radiographic procedures.
- Evaluating student performance in clinical settings and providing support for skill development.
- Ethical and professional responsibilities of educators in clinical radiology teaching.

8. **Research and Scholarship in Radiology Education**:

- Importance of research in improving radiology teaching methods and outcomes.
- Conducting educational research and scholarship in radiology education.
- Evidence-based teaching practices and their application in radiological sciences.
- Preparing radiology educators for lifelong learning and professional development.
- Publishing and presenting educational research in radiology conferences and journals.

9. **Challenges and Solutions in Radiology Education**:

- Addressing the challenges of teaching in technologically evolving fields like radiology.
- Overcoming common difficulties faced in clinical education and training.
- Managing diverse learner needs and creating an inclusive learning environment.
- Balancing theoretical knowledge with practical and clinical training.
- Solutions to improve student engagement, motivation, and participation in radiology courses.

10. **Regulatory and Accreditation Standards in Radiology Education**:

- Overview of regulatory bodies and accreditation processes for radiology programs.
- AERB guidelines and international standards for radiology education.
- Ensuring compliance with educational standards and maintaining quality assurance in teaching.
- Preparing radiology programs for accreditation and external reviews.
- Role of accreditation in improving radiology education and clinical outcomes.

TEXTBOOKS:

1. "Medical Education: Theory and Practice" by Tim Dornan, Karen Mann, Albert Scherpbier, and John Spencer, 1st Edition, Churchill Livingstone, 2010.
2. "Principles of Medical Education" by Tejinder Singh, Piyush Gupta, Daljit Singh, 5th Edition, Jaypee Brothers Medical Publishers, 2021.

REFERENCE BOOKS:

1. "Teaching and Learning in Medicine: A Practical Guide" by Shobhna Ganguli and Margaret Lloyd, 1st Edition, Radcliffe Publishing, 2013.
2. "Developing Teaching and Learning in Medical Education" by Helen O'Sullivan, 1st Edition, SAGE Publications, 2014.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
RADIOLOGICAL IMAGING PROCEDURE
Subject Code: **MRT25303**
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:
- This course is designed to provide students with in-depth knowledge and understanding of various radiological imaging procedures.
- The primary focus is to equip students with both theoretical and practical skills necessary for performing and managing advanced radiological procedures in a clinical setting.
- The course emphasizes accurate patient positioning, proper use of imaging equipment, selection of appropriate imaging protocols, and interpretation of imaging results while ensuring patient safety and adherence to radiation protection guidelines.

COURSE OUTCOMES:
- Demonstrate proficiency in performing a wide range of radiological imaging procedures, including conventional radiography, CT, MRI, ultrasound, and nuclear medicine.
- Apply knowledge of patient positioning, beam alignment, and radiation protection principles in clinical practice.
- Analyze and select appropriate imaging protocols based on clinical indications and patient conditions.
- Identify and troubleshoot common challenges encountered during imaging procedures.
- Ensure compliance with radiation safety standards and optimize image quality while minimizing patient exposure.

COURSE CONTENT:
1. **Introduction to Radiological Imaging Procedures**:
- Overview of various radiological imaging modalities: X-ray, fluoroscopy, CT, MRI, ultrasound, and nuclear medicine.
- Indications and contraindications for specific imaging procedures.
- Patient preparation and consent for radiological examinations.
- Principles of image acquisition, processing, and interpretation.
- Quality assurance in imaging procedures.

2. **Conventional Radiography Procedures**:
- Techniques for performing chest, abdomen, and musculoskeletal radiographs.
- Special procedures: Barium studies (Barium Swallow, Barium Enema), Intravenous Pyelogram (IVP), and Hysterosalpingography (HSG).
- Patient positioning for routine and special radiographic examinations.
- Image quality assessment and optimization in conventional radiography.
- Troubleshooting common artifacts and technical issues.

3. **Computed Tomography (CT) Imaging Procedures**:
- CT protocols for head, chest, abdomen, and musculoskeletal imaging.
- Advanced CT procedures: CT angiography, cardiac CT, and CT colonography.
- Contrast media administration in CT: types, doses, and patient safety.

4. **Magnetic Resonance Imaging (MRI) Procedures**:
- MRI protocols for brain, spine, musculoskeletal, and abdominal imaging.
- Advanced MRI techniques: MR angiography, diffusion-weighted imaging, and functional MRI.
- Safety considerations in MRI: contraindications, use of contrast agents, and patient screening.
- Image artifact reduction and quality improvement in MRI.

5. **Ultrasound Imaging Procedures**:
- Doppler techniques.
- Ultrasound protocols for abdominal, obstetric, gynecological, and vascular imaging.
- Real-time ultrasound-guided interventions: biopsy, drainage, and catheter placement.
- Artifacts in ultrasound and techniques for minimizing them.
- Role of 3D and 4D ultrasound in diagnostic imaging.

6. **Nuclear Medicine Imaging Procedures**:
- Common nuclear medicine procedures: bone scan, thyroid scan, PET-CT, and SPECT imaging.

- Patient preparation and radiation safety in nuclear medicine.
- Interpretation of nuclear medicine images: qualitative and quantitative assessment.
- Fusion imaging techniques: PET-CT, SPECT-CT, and their clinical applications.

7. **Interventional Radiology Procedures**:

- Common interventional procedures: angiography, stent placement, embolization, and biopsy.
- Patient preparation, sedation, and monitoring during interventional procedures.
- Radiation safety considerations in interventional radiology.
- Post-procedure care and management of complications.

8. **Radiation Safety and Patient Care in Imaging Procedures**:

- Techniques for minimizing patient exposure during imaging procedures.
- Use of protective devices: lead aprons, shields, and collimation.
- Patient care and communication during imaging procedures: addressing patient concerns and providing instructions.
- Legal and ethical considerations in radiological practice: informed consent, patient confidentiality, and professional conduct.

9. **Advanced Imaging Techniques and Emerging Trends**:

- Introduction to dual-energy CT, dynamic contrast-enhanced MRI, and molecular imaging.
- Role of artificial intelligence and machine learning in radiological imaging.
- Hybrid imaging modalities and their clinical applications.
- Trends in personalized imaging protocols and precision medicine.
- Future directions in radiological imaging technology and innovations.

10. **Troubleshooting and Problem-Solving in Radiological Procedures**:

- Managing imaging artifacts and ensuring optimal image quality.
- Strategies for handling challenging patient cases: pediatric, elderly, and uncooperative patients.
- Working with multi-disciplinary teams for complex diagnostic and interventional cases.
- Continuous learning and professional development in radiology.

TEXTBOOKS:

1. "Clark’s Positioning in Radiography" by A. Stewart Whitley, 13th Edition, CRC Press, 2020.
2. "Essentials of Radiologic Science" by Robert A. Fosbinder and Denise Orth, 2nd Edition, Wolters Kluwer Health, 2017.

REFERENCE BOOKS:

1. "Computed Tomography for Technologists: A Comprehensive Text" by Lois E. Romans, 2nd Edition, Lippincott Williams & Wilkins, 2010.
2. "MRI in Practice" by Catherine Westbrook, John Talbot, and Carolyn Kaut Roth, 5th Edition, Wiley-Blackwell, 2018.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
RADIOLOGY ADMINISTRATION & MANAGEMENT
Subject Code: MRT25304
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course is designed to provide students with comprehensive knowledge and skills in the administration and management of radiology departments and imaging center.
- The focus is on developing leadership, operational, and financial management expertise necessary for running a radiology department effectively.
- Students will learn about healthcare regulations, quality control, team management, resource allocation, and implementation of safety standards in line with industry best practices.

COURSE OUTCOMES:

Upon completion of this subject, students will be able to:

- Understand the principles of radiology department administration and the management of daily operations.
- Apply strategies for budgeting, financial planning, and resource management within a radiology setting.
- Implement effective communication, team leadership, and decision-making processes in clinical and non-clinical scenarios.
- Ensure compliance with healthcare regulations and standards such as AERB (Atomic Energy Regulatory Board) guidelines for radiology.
- Develop and execute quality control measures and ensure safety protocols are adhered to in the radiology department.

COURSE CONTENT:

1. **Introduction to Radiology Administration and Management**:

- Overview of roles and responsibilities of a radiology administrator.
- Key functions in managing a radiology department: leadership, operations, finance, human resources.
- Organizational structure and hierarchy in healthcare institutions.
- Core principles of healthcare management in radiology.
- Strategic planning for radiology services.

2. **Financial Management in Radiology**:

- Budgeting for radiology departments: operating budget, capital budget, and financial forecasting.
- Revenue generation models for radiology services: fee-for-service, bundled payments, and value-based care.
- Cost management: managing equipment costs, staffing, and consumables.
- Financial reporting and analysis for radiology administrators.
- Developing and implementing pricing strategies for imaging procedures.

3. **Human Resource Management in Radiology**:

- Staffing models for radiology departments: radiologists, technologists, nurses, and administrative staff.
- Recruitment, training, and development of staff.
- Performance management and appraisals in radiology.
- Conflict resolution, team dynamics, and fostering a collaborative work environment.
- Managing workloads, schedules, and staff burnout in a high-pressure environment.

4. **Healthcare Regulations and Legal Aspects**:

- Understanding healthcare regulations in radiology, including HIPAA (Health Insurance Portability and Accountability Act) and AERB guidelines.
- Legal considerations in radiology: patient consent, confidentiality, and record keeping.
- Medical ethics in radiology administration.
- Compliance with safety regulations: radiation protection, patient safety, and occupational safety standards.
- Risk management and dealing with medical malpractice and negligence claims.

5. **Quality Assurance and Quality Control in Radiology Management**:
- Importance of quality control programs in radiology.
- Implementing quality assurance (QA) protocols in imaging departments.
- Continuous improvement processes: workflow optimization and process mapping.
- Measuring and monitoring patient satisfaction and outcomes.
- Tools for managing quality: audits, accreditation, and certifications.

6. **Operations Management in Radiology**:
- Workflow design and optimization in radiology departments.
- Patient scheduling, triaging, and appointment management.
- Equipment maintenance and procurement: managing imaging machines, PACS (Picture Archiving and Communication System), and IT infrastructure.
- Inventory management: stock control of radiology supplies and contrast media.
- Emergency preparedness and disaster management in radiology.

7. **Communication and Leadership Skills**:
- Effective communication strategies with staff, patients, and other healthcare professionals.
- Leadership styles in healthcare: transactional, transformational, and servant leadership.
- Decision-making processes in clinical and administrative settings.
- Building inter-departmental relationships and collaboration within healthcare facilities.
- Leading change and innovation in radiology practice.

8. **Radiology Information Systems and Technology**:
- Role of Radiology Information Systems (RIS) in department management.
- Integration of PACS, RIS, and HIS (Hospital Information System) for seamless data flow.
- Use of electronic health records (EHR) and teleradiology in modern radiology practice.
- Data security, privacy, and protection of patient health information.
- Emerging technologies in radiology management: artificial intelligence, cloud computing, and telemedicine.

9. **Patient Care and Satisfaction in Radiology**:
- Enhancing patient care and experience in radiology departments.
- Managing patient flow, waiting times, and optimizing patient communication.
- Patient safety: implementing safety standards and infection control measures.
- Handling patient complaints and feedback to improve services.
- Measuring and enhancing patient satisfaction with radiological services.

10. **Risk Management and Safety in Radiology**:
- Identifying and mitigating risks in radiology practice.
- Ensuring radiation safety: adherence to ALARA (As Low As Reasonably Achievable) principles.
- Radiology department safety protocols: fire safety, electrical safety, and infection control.
- Preparing for and managing radiation accidents or hazardous situations.
- Documentation and reporting of adverse events in radiology.

TEXTBOOKS:

1. "Radiology Business Practice: How to Succeed" by David M. Yousem and Norman J. Beauchamp, 2nd Edition, Saunders, 2010.
2. "Medical Imaging Management" by Anthony B. Wolbarst, Richard G. Jones, and Patricia H. Wald, 1st Edition, Wiley-Blackwell, 2013.

REFERENCE BOOKS:

1. "Quality Management in the Imaging Sciences" by Jeffrey Papp, 6th Edition, Elsevier, 2018.
2. "Healthcare Management: Challenges and Opportunities" by Buchbinder, S. B., and Shanks, N. H., 2nd Edition, Jones & Bartlett Learning, 2011.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
PRACTICAL
Subject Code: MRT25305
Min. Hrs: 160 Hrs.

Objectives:

- To provide hands-on experience in the management of radiology departments, focusing on operational efficiency and patient safety.
- To in still skills in leadership, financial planning, and compliance with regulations.

Practical Content:

- Department Workflow Optimization: Conducting time-motion studies to optimize patient flow, reduce wait times, and improve staff utilization. Proposing workflow improvements based on practical observations and data analysis.
- Staff Scheduling and Team Management: Practicing real-life scenarios in creating staff schedules, managing workloads, and maintaining staff satisfaction. Conducting role-play for conflict resolution and effective team communication.
- Compliance and Safety Audits: Conducting mock audits to ensure compliance with AERB safety standards, patient safety regulations, and accreditation requirements. Generating compliance reports and safety protocols for radiology departments.
- Special Radiographic Procedures: Practice and perform specialized radiological techniques.
- Fluoroscopy Equipment Selection: Equipment handling, patient preparation, and post-care procedures. Learn about contrast media, emergency drugs, and radiation safety.
- Gastrointestinal Tract: Perform procedures like barium swallow, barium meal, and enema using CT, US, MRI techniques.
- Salivary Glands: Practice routine sialography procedures.
- Biliary System: Conduct cholangiography and ERCP procedures, including CT, US, and MRI techniques.
- Urinary System: Perform urography, cystography, and pyelography using advanced imaging.
- Reproductive System: Learn techniques related to male and female reproductive system imaging.
- Breast Imaging: Perform mammography, ductography, and biopsy techniques.
- Respiratory System: Practice bronchography and related imaging techniques.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) Semester-III
DISSERTATION
Min. Hrs: 40 Hrs.

- Students will continue research work as per the synopsis.
- Data should be collected as per the ethical norms and the sample size.
- Day to day discussions and presentation of the collected data before the guide needs to be done periodically.
- After discussion the concerned changes may be made in the research work to improve its quality.
  Care should be taken to avoid plagiarism and the research work should be genuine.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT)
Semester-III
TEACHING SKILLS/ SEMINARS/SYMPOSIA/JOURNAL CLUB ETC.
Min. Hrs -: 40 Hrs.

(a) Teaching Skills

Candidates should be encouraged to teach undergraduate students if any. This performance will be based on assessment by the faculty members of the department and from feedback from the undergraduate students.

(b) Seminar/Symposia

- Seminars /recent advance presentation will be held every week, however, its timings are subject to clinical schedule. Topics must be well researched and must include common knowledge, recent advances, analysis and references.
- PG students should present minimum of two seminars (One in general and one in elective area) and Internal Assessment marks with depend on better topic selection and presentation.

(c) Journal Review Meeting (Journal Club):

The ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting.

(d) Work diary / Log Book

Every student shall maintain a work diary and record his/her participation in the training programmes conducted by the department such as journal reviews, seminars, etc. Special mention may be made of the presentations by the candidate as well as details of clinical practice, if any conducted by the candidate by the student.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT)
Semester-III
CLINICAL TRAINING/CAMPS
Min. Hrs -: 40 Hrs.

Newer Developments in Advanced Imaging Technology

- To understand and demonstrate the use of the latest advancements in imaging technologies such as 3D and 4D imaging, dual-energy CT, and AI-assisted MRI techniques.
- Review the setup and operation of advanced imaging systems.
- Conduct scans using dual-energy CT and compare image quality with traditional CT.
- Demonstrate AI-assisted image processing for MRI and evaluate the results.
- Students will gain hands-on experience with state-of-the-art imaging technology and understand their clinical applications.

Interventional Radiology and Patient Care

- To perform basic interventional radiology procedures under guidance and learn about patient care protocols.
- Observe and participate in procedures like angiography, biopsies, and catheter placements.
- Practice patient preparation and post-procedure care, ensuring safety and comfort.
- Apply radiation safety protocols during procedures.
- Students will develop skills in interventional radiology techniques and patient management during such procedures.

Nuclear Medicine Imaging Techniques

- To familiarize students with nuclear medicine equipment and imaging procedures, including SPECT and PET scans.
- Prepare and administer radiopharmaceuticals to patients.
- Operate nuclear medicine imaging systems, perform PET and SPECT scans, and interpret the results.
- Review safety protocols in handling radiopharmaceuticals and equipment calibration.
- Students will acquire practical knowledge of nuclear medicine imaging, including patient preparation and radiation safety.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
NEWER DEVELOPMENT IN ADVANCED IMAGING TECHNOLOGY
Subject Code: MRT25401
Min. Hrs: 80 Hrs.

Course Objective:
- The objective of this course is to familiarize students with cutting-edge advancements in medical imaging technology.
- Upon completion, students will gain an understanding of emerging trends and innovations in the field of radiology, enabling them to apply these technologies in clinical practice to enhance diagnostic accuracy and patient outcomes.

Course Outcomes:
- Understand and explain the latest developments in advanced imaging modalities.
- Critically analyze the role of newer technologies in improving diagnostic imaging.
- Apply modern imaging techniques in clinical settings with an emphasis on safety and efficacy.
- Evaluate the limitations and advantages of each advanced imaging modality.
- Keep up with ongoing research and future trends in imaging technology.

Course Content:
1. Digital Radiography and Tomosynthesis:
Principles and Applications:
- Fundamentals of digital radiography (DR) and its advantages over conventional radiography.
- Overview of tomosynthesis, Digital Breast Tomosynthesis, Stereotactic biopsy, Duel energy subtraction mammography, its operational principles, and clinical applications in detecting breast cancer and other conditions
- Real-life clinical cases highlighting the use of digital radiography in diagnosis.
- Interpretation of tomosynthesis images and its advantages in detecting lesions.
- AEC

2. Dual-Energy CT (DECT) and Photon-Counting CT:
Principles and Applications:
- Working principles of dual-energy CT scanners and photon-counting detectors.
- Spiral CT, Helical CT, Slip Ring technology, Multislice detector, Area Detector
- Clinical applications of DECT in detecting bone marrow edema, urolithiasis, and differentiating soft tissue types.
- Introduction to photon-counting technology for higher resolution imaging and reduced radiation dose.
- Virtual non-contrast imaging, Iodine quantification, material decomposing

Image Acquisition and Processing:
- CT Image Quality
- Techniques for acquiring and processing dual-energy images.
- Practical demonstration of DECT for specific diagnostic applications.

3. Functional MRI (fMRI) and Diffusion Tensor Imaging (DTI):
Functional MRI:
- Basics of functional MRI, BOLD signal, and its applications in mapping brain activity.
- Applications in neuroimaging, including the detection of tumors, epilepsy foci, and pre-surgical planning.

Diffusion Tensor Imaging (DTI):
- Techniques for visualizing white matter tracts in the brain.
- Applications of DTI in diagnosing stroke, multiple sclerosis, and traumatic brain injury.

4. Positron Emission Tomography - Magnetic Resonance Imaging (PET-MRI):
Hybrid Imaging:
- Overview of hybrid PET-MRI technology and its advantages over PET-CT.
- Clinical applications in oncology, cardiology, and neurology.

Integration of Molecular and Functional Imaging:
- Benefits of combining metabolic imaging (PET) with high-resolution anatomical imaging (MRI).
- Case studies demonstrating the use of PET-MRI in the detection and staging of cancers.

5. Artificial Intelligence (AI) in Imaging:

AI Algorithms and Deep Learning:

- Introduction to the role of AI, Machine Learning (ML): Supervised Learning, Unsupervised Learning, Reinforcement Learning, and
- Deep Learning (DL): Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) in medical imaging.
- Overview of AI-based tools for image reconstruction, segmentation, and diagnosis.

Clinical Applications:

- Case studies of AI-enhanced imaging systems in radiology for detecting lung nodules, breast cancer, and other pathologies.
- Ethical considerations and challenges in AI implementation in medical imaging.

6. 3D and 4D Imaging Techniques:

3D Imaging:

- Techniques for 3D reconstruction from MRI, CT, and ultrasound data.
- Applications of 3D imaging in surgery planning, virtual colonoscopy, and 3D printing for medical models.

4D Imaging:

- Introduction to 4D imaging, capturing motion (e.g., 4D ultrasound in cardiac imaging).
- Application of 4D CT in respiratory and cardiac studies.

7. Contrast-Enhanced Ultrasound (CEUS) and Elastography:

Contrast-Enhanced Ultrasound:

- Overview of microbubble contrast agents in ultrasound imaging.
- Applications of CEUS in liver, kidney, and vascular imaging.

Elastography:

- Techniques in measuring tissue stiffness with ultrasound and MRI elastography.
- Applications in diagnosing liver fibrosis, thyroid nodules, and breast lesions.

8. Image-Guided Interventions:

Technological Advances:

- Integration of advanced imaging techniques (e.g., 3D, fluoroscopy, CT, MRI) in interventional procedures.
- Real-time navigation for biopsies, tumor ablation, and vascular interventions.
- Role of modern imaging in minimally invasive treatments, improving accuracy and patient safety.

9. Future Trends in Imaging:

Quantum Imaging and Terahertz Imaging:

- Introduction to quantum imaging and terahertz imaging techniques.
- Potential future applications in medical imaging and diagnostics.

Radiomics:

- Overview of radiomics, extracting quantitative data from medical images.
- Applications in personalized medicine and oncology.

10. Fusion Imaging:

- PET-CT, PET-MRI

Textbooks and Reference Materials:

Textbooks:

- "Diagnostic Radiology and Imaging: Recent Advances" by Bhavik Patel
- "Advanced Imaging Techniques in Clinical Practice" by Gregory G. Brown

Reference Books:

- "New Horizons in Medical Imaging" by Thomas C. Errington
- "Artificial Intelligence and Machine Learning in Medical Imaging" by Daniel Rubin

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
INTERVENTIONAL RADIOLOGY AND PATIENT CARE
Subject Code: MRT25402
Min. Hrs: 80 Hrs.

Course Objective:

- The objective of this course is to provide students with a comprehensive understanding of interventional radiology (IR) techniques and their applications in diagnostic and therapeutic procedures.
- Students will gain in-depth knowledge of patient care principles, safety protocols, and the role of the radiologic technologist in assisting during interventional procedures.
- By the end of the course, students should be able to effectively contribute to patient management and handle interventional radiology equipment proficiently.

Course Outcomes:

Upon completing this course, students will be able to:

- Understand the fundamentals of interventional radiology procedures and techniques.
- Assist effectively in various image-guided diagnostic and therapeutic interventions.
- Demonstrate proficiency in the use and maintenance of interventional radiology equipment.
- Apply radiation safety measures and understand guidelines for minimizing patient and staff exposure.
- Provide optimal patient care before, during, and after interventional procedures.
- Manage patient-related complications and emergencies associated with interventional procedures.

Course Content:

1. Introduction to Interventional Radiology (IR):
Overview of Interventional Radiology:

- Definition, scope, and evolution of IR.
- Types of interventional radiology procedures.
- Role of IR in diagnostic and therapeutic medicine.

Imaging Modalities Used in IR:

- Fluoroscopy, ultrasound, CT, and MRI-guided interventions.
- Real-time imaging techniques for interventional procedures.

2. Vascular Interventions:
Angiography and Angioplasty:

- Techniques and clinical applications of angiography and angioplasty.
- Endovascular treatments for arterial and venous diseases.

Embolization Procedures:

- Principles and techniques of embolization for tumor, aneurysm, and hemorrhage control.
- Uterine artery embolization and its role in fibroid treatment.

3. Non-Vascular Interventions:
Biopsies and Drainage Procedures:

- Percutaneous biopsies of liver, kidney, lung, and bone lesions.
- Techniques for abscess drainage, nephrostomy, and biliary drainage.

Tumor Ablation:

- Radiofrequency ablation (RFA), microwave ablation, and cryoablation techniques.
- Applications in the treatment of liver, lung, and renal cancers.

4. Interventional Oncology:
Chemoembolization and Radioembolization:

- Procedures for delivering chemotherapy or radioactive materials to tumors.
- Clinical applications in hepatocellular carcinoma and metastases.

Tumor Imaging and Monitoring:

- Role of interventional radiology in cancer diagnosis and treatment monitoring.

5. Neurointerventional Procedures:
Stroke Intervention:
- Techniques for mechanical thrombectomy and intra-arterial thrombolysis.
- Role of neurointerventional radiology in acute stroke management.

Aneurysm Coiling and Stenting:
- Endovascular treatment of brain aneurysms and arteriovenous malformations (AVMs).

6. Interventional Procedures in Gastrointestinal and Hepatobiliary Systems:
Biliary Interventions:
- Techniques for percutaneous biliary drainage and stent placement.
- Clinical management of obstructive jaundice.

Gastrointestinal Interventions:
- Techniques for treating gastrointestinal bleeding, bowel obstruction, and perforation.
- Percutaneous gastrostomy tube placement.

7. Patient Care in Interventional Radiology:
Pre-procedural Patient Assessment:
- History taking, consent process, and preparation of patients for IR procedures.
- Risk assessment and contraindications for various IR procedures.

Intra-procedural Patient Monitoring:
- Vital signs monitoring and management of sedation during IR procedures.
- Managing patient anxiety and pain during interventions.

Post-procedural Care and Complication Management:
- Post-procedural care, observation, and patient discharge protocols.
- Identifying and managing complications such as bleeding, infection, and contrast reactions.

8. Radiation Safety in Interventional Radiology:
Radiation Protection Principles:
- Radiation safety protocols for patients, staff, and the environment.
- Use of protective equipment (e.g., lead aprons, shields) and dose monitoring.

Radiation Dose Optimization:
- Techniques to minimize radiation exposure during fluoroscopy-guided interventions.
- Importance of ALARA (As Low As Reasonably Achievable) principles in IR.

9. Interventional Radiology Equipment:
Fluoroscopy and Angiography Suites:
- Overview of IR equipment, including C-arms, catheters, guidewires, and stents.
- Equipment maintenance and quality assurance practices.

Advanced Imaging Technology:
- Use of hybrid imaging systems (CT/Fluoroscopy, PET/CT) in interventional procedures.
- Role of robotic-assisted interventions in IR.

10. Emerging Trends in Interventional Radiology:
- **Innovative Techniques and Future Directions:**
- 3D printing for pre-procedural planning.
- Use of artificial intelligence (AI) in image-guided interventions.

Research and Development:
- Ongoing advancements in interventional radiology and their potential impact on patient care.

Textbooks and Reference Materials
- **Textbooks:**
- "Interventional Radiology: A Practical Guide" by Anthony F. Watkinson
- "Vascular and Interventional Radiology" by John A. Kaufman and Michael J. Lee

Reference Books:
- "Atlas of Interventional Radiology" by Michael Grey
- "Textbook of Interventional Radiology" by K. D. Vaswani

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
ULTRASOUND IMAGING
Subject Code: MRT25403
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course aims to provide students with a comprehensive understanding of ultrasound imaging technology, focusing on the physics, instrumentation, and clinical applications of ultrasound in various fields.
- It emphasizes technical proficiency, patient safety, and diagnostic accuracy.
- Students will learn proper patient preparation, image acquisition techniques, and the interpretation of ultrasound findings to support diagnostic decisions in clinical practice.

COURSE OUTCOMES:

- Demonstrate understanding of ultrasound physics, including wave propagation, sound-tissue interactions, and Doppler principles.
- Apply proper scanning techniques, patient positioning, and protocol selection for different anatomical regions.
- Perform high-quality ultrasound imaging procedures while ensuring patient comfort and safety.
- Interpret ultrasound images accurately and identify common artifacts, applying techniques to minimize them.
- Exhibit knowledge of advanced ultrasound applications and recognize emerging trends in ultrasound technology.

COURSE CONTENT:

1. **Introduction to Ultrasound Imaging:**
   - Overview of ultrasound technology: history, evolution, and applications in medical imaging.
   - Basic principles of ultrasound physics: sound waves, frequency, wavelength, and velocity.
   - Sound-tissue interactions: reflection, refraction, absorption, and scattering.
   - Types of ultrasound transducers: linear, curvilinear, phased array, and specialty probes.
   - Ultrasound imaging modes: A-mode, B-mode, M-mode, Doppler, and real-time imaging.
2. **Patient Preparation and Safety in Ultrasound Procedures:**
   - Pre-scan patient assessment and preparation protocols.
   - Patient positioning techniques for abdominal, obstetric, vascular, and musculoskeletal ultrasound.
   - Infection control and hygiene in ultrasound, including transducer cleaning and disinfection.
   - Patient communication and comfort during ultrasound exams.
   - Safety considerations: thermal and mechanical index, bioeffects, and guidelines for safe ultrasound use.
3. **Ultrasound Imaging Protocols for Different Anatomical Regions:**
   - Abdominal ultrasound: liver, gallbladder, kidneys, pancreas, and spleen imaging.
   - Obstetric and gynecological ultrasound: fetal imaging, placenta, uterus, and ovaries.
   - Vascular ultrasound: carotid, peripheral arterial, venous, and abdominal vascular assessments.
   - Musculoskeletal ultrasound: joint, tendon, and soft tissue imaging.
   - Small parts ultrasound: thyroid, breast, scrotum, and other superficial structures.
4. **Doppler Ultrasound Techniques:**
   - Principles of Doppler ultrasound: continuous wave, pulsed wave, color, and power Doppler.
   - Doppler applications in vascular studies: blood flow analysis, velocity measurements, and waveform interpretation.
   - Advanced Doppler techniques: spectral analysis, duplex, and triplex imaging.
   - Artifacts in Doppler imaging and methods for artifact reduction.
5. **Image Quality and Artifact Reduction in Ultrasound:**

- Factors affecting image quality: gain, depth, focus, time-gain compensation (TGC), and transducer selection.
- Common ultrasound artifacts: acoustic shadowing, enhancement, reverberation, mirror image, and techniques to minimize them.
- Optimization of image quality based on clinical requirements.
- Post-processing techniques in ultrasound imaging.

6. **Advanced Ultrasound Applications:**
   - Real-time ultrasound-guided procedures: biopsies, drainages, and catheter placements.
   - 3D and 4D ultrasound imaging: principles, applications, and clinical relevance.
   - Contrast-enhanced ultrasound (CEUS): uses, patient safety, and interpretation.
   - Elastography: principles, techniques, and clinical applications in liver and soft tissue evaluation.
   - Fusion imaging in ultrasound and its role in diagnostic accuracy.
7. **Ultrasound Physics and Instrumentation:**
   - Ultrasound machine components: transducer, beamformer, receiver, and display.
   - Signal processing in ultrasound: dynamic range, filtering, and compression.
   - Physics of ultrasound image formation: beam focusing, lateral and axial resolution.
   - Calibration and quality control in ultrasound equipment.
8. **Emerging Trends in Ultrasound Imaging Technology:**
   - Technological advancements in ultrasound: portable and point-of-care ultrasound devices.
   - Role of artificial intelligence in ultrasound image analysis and interpretation.
   - Applications of handheld ultrasound devices in emergency and primary care settings.
   - Future directions in ultrasound, including AI-assisted diagnostics and wearable ultrasound technology.
9. **Troubleshooting in Ultrasound Procedures:**
   - Identifying and resolving common technical issues in ultrasound imaging.
   - Strategies for managing challenging cases: pediatric, elderly, and uncooperative patients.
   - Communication with multidisciplinary teams for comprehensive patient care.
   - Ongoing professional development in ultrasound imaging.

TEXTBOOKS:

1. "Diagnostic Ultrasound" by Carol M. Rumack, Stephanie R. Wilson, J. William Charboneau, and Deborah Levine, 5th Edition, Elsevier, 2017.
2. "Fundamentals of Musculoskeletal Ultrasound" by Jon A. Jacobson, 3rd Edition, Elsevier, 2017.

REFERENCE BOOKS:

1. "Essentials of Ultrasound Physics" by James A. Zagzebski, 2nd Edition, Elsevier, 2010.
2. "Clinical Sonography: A Practical Guide" by Roger C. Sanders and Thomas C. Winter, 5th Edition, Lippincott Williams & Wilkins, 2016.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
NUCLEAR MEDICINE IMAGING TECHNIQUES
Subject Code: MRT25404
Min. Hrs: 80 Hrs.

Course Objective:
- The primary goal of this course is to provide students with a thorough understanding of nuclear medicine imaging techniques, including the principles of radiopharmaceuticals, imaging instrumentation, and clinical applications.
- Students will develop competencies in performing and interpreting nuclear medicine scans for a variety of clinical conditions and gain expertise in patient preparation, radiation safety, and quality control.

Course Outcomes:
- Understand the fundamental principles of nuclear medicine and radiopharmaceuticals.
- Operate nuclear medicine imaging equipment and perform various nuclear medicine scans.
- Interpret nuclear medicine images for diagnostic and therapeutic purposes.
- Apply radiation safety protocols specific to nuclear medicine.
- Demonstrate competence in patient care and preparation for nuclear medicine procedures.
- Integrate nuclear medicine techniques with other imaging modalities for comprehensive patient diagnosis.

Course Content:
1. Introduction to Nuclear Medicine:
Basic Principles of Nuclear Medicine:
- Overview of nuclear medicine and its role in diagnostic and therapeutic imaging.
- History and evolution of nuclear medicine imaging techniques.

Radiopharmaceuticals:
- Principles of radiopharmaceuticals used in nuclear medicine.
- Technetium generator, parent half-life, daughter half-life, physical half-life, secular equilibrium and transient equilibrium.
- Preparation, administration, and pharmacokinetics of commonly used radiopharmaceuticals.
- Mechanisms of localization in target tissues.

2. Imaging Techniques in Nuclear Medicine:
Gamma Camera and SPECT (Single Photon Emission Computed Tomography):
- Principles of gamma camera operation.
- SPECT imaging technique, instrumentation, and clinical applications.
- Reconstruction algorithms and image processing in SPECT.

PET (Positron Emission Tomography):
- Radiopharmaceuticals used in PET, including FDG (Fluorodeoxyglucose).
- PET/CT hybrid imaging and its clinical applications.
- Quantitative PET imaging and image fusion techniques.

3. Clinical Applications of Nuclear Medicine:
Cardiac Imaging:
- Myocardial perfusion imaging (MPI) using SPECT and PET.
- Assessment of cardiac function using MUGA (Multigated Acquisition) scans.
- Clinical indications and interpretation of nuclear cardiology studies.

Oncological Imaging:
- Role of PET/CT in oncology for cancer diagnosis, staging, and treatment monitoring.
- Tumor detection, response assessment, and follow-up in cancer patients.
- Applications of SPECT and radionuclide therapy in oncology.

Neurological Imaging:
- Brain SPECT and PET imaging for diagnosing conditions like Alzheimer's disease, epilepsy, and brain tumors.
- Imaging cerebral blood flow and glucose metabolism.

4. Renal and Hepatobiliary Imaging:
Renal Imaging Techniques:
- Principles of nuclear medicine imaging for evaluating renal function and anatomy.
- Dynamic and static renal imaging (e.g., renal scintigraphy, MAG3 scans, DMSA sscans).

Hepatobiliary Imaging:

- Nuclear medicine techniques for assessing liver function, biliary system, and gallbladder.
- Hepatobiliary iminodiacetic acid (HIDA) scans for gallbladder dysfunction.

5. Bone and Thyroid Imaging:

Bone Scintigraphy:

- Techniques for detecting bone metastases, fractures, and infections using bone scintigraphy.
- Whole-body bone scans and three-phase bone scans.

Thyroid Imaging:

- Principles of thyroid scintigraphy using iodine-based radiopharmaceuticals.
- Evaluation of thyroid nodules and function (e.g., hyperthyroidism, hypothyroidism).
- Role of radioiodine therapy for thyroid disorders.

6. Hybrid Imaging Techniques:

PET/CT and SPECT/CT:

- Principles of hybrid imaging and its advantages in clinical practice.
- Workflow for performing PET/CT and SPECT/CT studies.
- Applications of hybrid imaging in oncology, neurology, and cardiology.

PET/MRI:

- Introduction to PET/MRI hybrid technology and its clinical utility.
- Applications in neuroimaging, oncology, and pediatric imaging.

7. Patient Care in Nuclear Medicine:

Patient Preparation and Safety:

- Guidelines for patient preparation before nuclear medicine procedures.
- Management of claustrophobia, anxiety, and other patient concerns.
- Monitoring and follow-up care after administration of radiopharmaceuticals.

Emergency Protocols in Nuclear Medicine:

- Identification and management of adverse reactions to radiopharmaceuticals.
- Handling medical emergencies during nuclear medicine procedures.

8. Emerging Trends in Nuclear Medicine:

Theranostics:

- Role of nuclear medicine in combining diagnostics with targeted therapy (e.g., radionuclide therapy).
- Future developments in theranostics for personalized treatment.

Artificial Intelligence in Nuclear Medicine:

- Applications of AI and machine learning for improving image reconstruction, diagnosis, and decision-making.
- Potential of AI in dose reduction and workflow optimization.

Textbooks and Reference Materials:

Textbooks:

- "Nuclear Medicine: The Requisites" by Harvey A. Ziessman and Janis P. O'Malley.
- "Essentials of Nuclear Medicine Imaging" by Fred A. Mettler and Milton J. Guiberteau.

Reference Books:

- "Clinical Nuclear Medicine" by C. Richard Goldfarb.
- "Nuclear Medicine Physics: The Basics" by Ramesh Chandra.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
ADVANCED MAGNETIC RESONANCE IMAGING
Subject Code: MRT25405
Min. Hrs: 80 Hrs.

COURSE OBJECTIVE:

- This course provides an advanced understanding of magnetic resonance imaging (MRI) technology, focusing on its physical principles, instrumentation, and clinical applications.
- Emphasis is placed on MR safety, patient preparation, protocol selection, and artifact management.
- Students will gain proficiency in advanced MRI techniques, including functional MRI, diffusion imaging, and MR angiography, to enhance their diagnostic capabilities in a clinical setting.

COURSE OUTCOMES:

- Understand the principles of MRI physics, including signal generation, relaxation, and image contrast mechanisms.
- Select and implement appropriate MRI protocols tailored to specific anatomical regions and clinical indications.
- Perform MRI procedures while ensuring patient safety, comfort, and adherence to MR safety protocols.
- Recognize and minimize artifacts to optimize image quality and diagnostic accuracy.
- Apply advanced MRI techniques for specialized clinical applications, including neuroimaging, musculoskeletal imaging, and cardiovascular imaging.

COURSE CONTENT:

1. **Introduction to MRI Technology:**

- History and evolution of MRI technology in medical imaging.
- Basic principles of MRI: magnetic fields, radiofrequency pulses, and nuclear magnetic resonance.
- Components of an MRI system: magnets, gradient coils, RF coils, and computer systems.
- Understanding of relaxation times (T1, T2) and image contrast.

2. **MRI Physics and Image Formation:**

- Nuclear magnetic resonance principles: precession, resonance, and signal generation.
- Image contrast mechanisms: T1-weighted, T2-weighted, and proton density imaging.
- Pulse sequences: spin echo, gradient echo, fast spin echo, and inversion recovery.
- K-space and its role in image formation and resolution.

3. **MRI Safety and Patient Preparation:**

- MR safety protocols: screening for contraindications, managing metallic implants, and patient safety checks.
- Managing claustrophobia and patient anxiety during MRI exams.
- Specific safety considerations for MRI contrast agents: gadolinium-based agents, indications, and safety concerns.
- MR environment and safety zones: staff training and emergency procedures.

4. **MRI Protocols for Different Anatomical Regions:**

- Neuroimaging protocols: brain, spine, and cranial nerve imaging.
- Musculoskeletal MRI: joints, cartilage, and soft tissue assessment.
- Cardiovascular MRI: cardiac function, myocardial perfusion, and vascular imaging.
- Abdominal and pelvic MRI: liver, pancreas, kidneys, and reproductive organs.

5. **Advanced MRI Techniques:**

- MR angiography (MRA): principles, techniques, and applications in vascular imaging.
- Diffusion-weighted imaging (DWI) and diffusion tensor imaging (DTI): techniques and clinical relevance, especially in neuroimaging.
- Functional MRI (fMRI): principles, BOLD contrast, and applications in brain mapping.
- Perfusion MRI: dynamic contrast-enhanced (DCE) and arterial spin labeling (ASL) techniques.
- Spectroscopy: MR spectroscopy (MRS) principles and applications in tissue analysis.

6. **Image Quality and Artifact Reduction in MRI:**

- Factors affecting MRI image quality: signal-to-noise ratio (SNR), spatial resolution, and contrast.
- Common MRI artifacts: motion, chemical shift, susceptibility, and aliasing.
- Techniques for artifact reduction and optimization of image quality.
- Importance of patient cooperation and positioning in artifact management.

7. **Contrast Media and Pharmacology in MRI:**

- Gadolinium-based contrast agents (GBCAs): types, mechanisms, and safety considerations.
- Contrast administration protocols: dosage, timing, and patient monitoring.
- Nephrogenic systemic fibrosis (NSF) and risk management in patients with renal impairment.
- Emerging contrast agents and research on non-gadolinium-based alternatives.

8. **Emerging Trends in MRI Technology:**

- Developments in MRI hardware: high-field (3T, 7T) and ultra-high-field imaging systems.
- Hybrid imaging techniques: PET-MRI and their clinical applications.
- Role of artificial intelligence in MRI: automated analysis, protocol optimization, and diagnostic support.
- Future trends in MRI, including wearable and portable MRI devices.

9. **Troubleshooting in MRI Procedures:**

- Identifying and resolving common technical issues in MRI imaging.
- Managing challenging cases, including pediatric, geriatric, and uncooperative patients.
- Communication with patients to enhance cooperation and comfort during MRI procedures.
- Continued professional development in MRI technology and protocol advancements.

TEXTBOOKS:

1. "MRI in Practice" by Catherine Westbrook, John Talbot, and Carolyn Kaut Roth, 5th Edition, Wiley-Blackwell, 2018.
2. "Essentials of MRI Safety" by Donald W. McRobbie, 1st Edition, Wiley-Blackwell, 2011.

REFERENCE BOOKS:

1. "Magnetic Resonance Imaging: Physical Principles and Sequence Design" by Robert W. Brown, E. Mark Haacke, Michael R. Thompson, and Ramesh Venkatesan, 2nd Edition, Wiley-Blackwell, 2014.
2. "Clinical MR Imaging: A Practical Approach" by Peter Reimer and Paul M. Parizel, 1st Edition, Springer, 2006.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
PRACTICAL
Subject Code: MRT25406
Min. Hrs: 160 Hrs.

Newer Developments in Advanced Imaging Technology

- To understand and demonstrate the use of the latest advancements in imaging technologies such as 3D and 4D imaging, dual-energy CT, and AI-assisted MRI techniques.
- Review the setup and operation of advanced imaging systems.
- Conduct scans using dual-energy CT and compare image quality with traditional CT.
- Demonstrate AI-assisted image processing for MRI and evaluate the results.
- Students will gain hands-on experience with state-of-the-art imaging technology and understand their clinical applications.

Interventional Radiology and Patient Care

- To perform basic interventional radiology procedures under guidance and learn about patient care protocols.
- Observe and participate in procedures like angiography, biopsies, and catheter placements.
- Practice patient preparation and post-procedure care, ensuring safety and comfort.
- Apply radiation safety protocols during procedures.
- Students will develop skills in interventional radiology techniques and patient management during such procedures.

Nuclear Medicine Imaging Techniques

- To familiarize students with nuclear medicine equipment and imaging procedures, including SPECT and PET scans.
- Prepare and administer radiopharmaceuticals to patients.
- Operate nuclear medicine imaging systems, perform PET and SPECT scans, and interpret the results.
- Review safety protocols in handling radiopharmaceuticals and equipment calibration.
- Students will acquire practical knowledge of nuclear medicine imaging, including patient preparation and radiation safety.

MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (MMRIT) - Semester IV
DISSERTATION
Subject Code: MRT25407
Min. Hrs.: 120 Hrs.

Every candidate pursing MMRIT degree course is required to carry out research work on a selected research project under the guidance of a recognized postgraduate teacher. The results of such a work shall be submitted in the form of dissertation. Topic for dissertation shall be assigned by the guide.
If the subject of Thesis entails collaboration with other departments or specialties, the collaborative portion of the work will be supervised by Co-Guide, designated by the School of Health Sciences in consultation with the Guide. Where a Co-Guide is involved, the Thesis will be certified jointly by the Guide & Co-guide.

Every candidate shall submit synopsis to the University in the prescribed Performa containing particulars of proposed dissertation work, within 6 months from the date of commencement of the course on or before the dates notified by the university. The synopsis shall be sent through the proper channel. Such synopsis will be reviewed and the university will register the dissertation topic.
No change in the dissertation topic or guide shall be made without prior approval of the university. Guide will be only a facilitator, advisor of the concept and hold responsible in correctly directing the candidate in the methodology and not responsible for the outcome and results.

The dissertation should be written under the following headings.

1. Introduction
2. Aims or objectives of study
3. Review of literature
4. Material and methods
5. Results
6. Discussion
7. Conclusion
8. References
9. Master and Chart & Table (If Applicable)
10. Annexure (If Applicable)

The written text of dissertation/ research project shall not be less than 50 pages and shall not exceed 120 pages excluding references, tables, questionnaires and other annexure. It should be neatly typed in double line spacing on one side of bond paper (A4 size, 8.27" x 11.69") and bound properly. Spiral binding should be avoided. A declaration by the candidate for having done the work himself should also be included, and the guide, head of the department and Director/Coordinator of the institute shall certify the dissertation/ research project.
Every candidate is required to give power point presentation before final submission of dissertation. Four copies of Dissertation/research project shall be submitted to the university, through proper channel, along with a soft copy (CD), 2 months before the final examination. It shall be assessed by two examiners appointed by the university, one internal and one external. There will be a power point open presentation of the submitted dissertation as per the schedule given by the university. This presentation shall be jointly evaluated by external and internal examiner.
If the student failed to secure the minimum passing marks he will resubmit the dissertation.