MAHATMA GANDHI UNIVERSITY
of
MEDICAL SCIENCES & TECHNOLOGY
JAIPUR

Mahatma Gandhi Institute of Allied Health Sciences

Syllabus

BACHELOR OF MEDICAL RADIOLOGY and IMAGING TECHNOLOGY (B. MRIT)

4 years

(3 Years + 1 Year Internship)

Program Code: BMRIT26

Duration- VIII Semesters (4 Years)

2026-2027

Recommended by the BOS in Allied Health Sciences at its meeting held on 8th April, 2026, the Faculty of Allied and Healthcare Professions at its meeting held on 28.7.2026 and approved by Academic Council at its meeting held on 03.08.2026

Principal
MG Institute of Allied Health Sciences
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NOTICE

1. The university reserves the right to make changes in the syllabus /books/ guidelines, fee-structure or any other information at any time without prior notice the decision of the university shall be binding on all.
2. The jurisdiction of all court cases shall be Jaipur Bench of Hon'ble Rajasthan High Court only.
3. This syllabus is aligned with the NCAHP Curriculum/Notice dated 24.04.2025 and Corrigendum dated 06.05.2026. Any subsequent amendments, revisions, or corrigenda issued by the NCAHP shall automatically apply to the Rules, Regulations, and Syllabus of MGUMST, Jaipur, and shall be implemented accordingly.

References:

1. https://ncahp.abdm.gov.in/Curriculum/MEDICAL%20RADIOLOGY%20AND%20IMAGING%20TECHNOLOGY.pdf
2. https://ncahp.abdm.gov.in/Curriculum/CurriculumCorrigendum/CORRIGENDUM%20-1_MRIT_06May2026.pdf

List of Abbreviations

Abbreviation	Full Form
2D	Two Dimensional
3D	Three Dimensional
AC	Alternate Current
ALARA	As Low As Reasonably Achievable
AEC	Automatic Exposure Control
AED	Automated External Defibrillator
AERB	Atomic Energy Regulatory Board
AHP	Allied and Healthcare Professional
BLS	Basic Life Support
BMW	Bio-Medical Waste
BVM	Bag-Valve-Mask
CATS	Credit Accumulation and Transfer System
CBCS	Choice-Based Credit System
CBD	Case-based Discussion
CBSE	Central Board of Secondary Education
CEX	Mini Case Evaluation Exercise
COPD	Chronic Obstructive Pulmonary Disease
CPR	Cardiopulmonary Resuscitation
CT	Computed Tomography
DC	Direct Current
DOPs	Direct Observation of Procedures
DRR	Digitally Reconstructed Radiographs
ECG	Electrocardiogram
ECTS	European Credit Transfer System
EEG	Electroencephalography
ERCP	Endoscopic Retrograde Cholangio Pancreatography
FW	Full Wave
GI	Gastrointestinal
HRCT	High-Resolution Computed Tomography
HSSC	Healthcare Sector Skill Council
HU	Hounsfield Unit
HVT	Half Value Thickness
HW	Half Wave
ICRP	International Commission on Radiological Protection
JCI	Joint Commission International
LDR	Low Dose Rate
MIP	Maximum Intensity Projection
MLC	Medico Legal Case
MLC	Multi Leaf Collimator
MSc. MRIT	Master of Science in Medical Radiology and Imaging Technology
MoHFW	Ministry of Health and Family Welfare
MPR	Multiplanar Reconstruction
MRI	Magnetic Resonance Imaging
MSc	Master of Science
NAAC	National Assessment and Accreditation Council

NABH	National Accreditation Board for Hospitals & Healthcare Providers
NCRC	National Curricula Review Committee
NIAHS	National Initiative for Allied Health Sciences
NSDA	National Skills Development Agency
NSQF	National Skills Qualification Framework
OSCE	Objective Structured Clinical Examination
OSLER	Objective Structured Long Examination Record
OSPE	Objective Structured Practical Examination
PACS	Picture Archiving and Communication System
PCA	Phase Contrast Angiography
PET	Positron Emission Tomography
PhD	Doctor of Philosophy
PPE	Personal Protective Equipment
PTBD	Percutaneous Transhepatic Biliary Drainage
QA	Quality Assurance
QC	Quality Control
RBC	Red Blood Cells
RPP	Radiation Protection Programme
SCA	Sudden Cardiac Arrest
SDL	Self-Directed Learning
SPECT	Single-Photon Emission Computed Tomography
TLD	Thermoluminescent Dosimeter
TSU	Technical Support Unit
TVT	Tenth Value Thickness
UGC	University Grants Commission
US	Ultrasonography
UHC	Universal Health Coverage
WBC	White Blood Cells
WHO	World Health Organization
WWW	World Wide Web

Rules and regulations of
Bachelor of Medical Radiology and Imaging Technology (B.MRIT)

Program Code: BMRIT26

1. **Title of the Program -** Bachelor of Medical Radiology and Imaging Technology (B.MRIT)

2. **Duration of the Program** –3 years (6 semesters) + 1 year (7th and 8th semester) internship. Total 4 years or VIII semesters programme.

3. **Medium of Instruction** – English

4. **Eligibility for Admissions**

- The candidate must have passed Senior Secondary (10+2) or equivalent with Physics, Chemistry & Biology.
- Admission on the basis of Senior Secondary (10+2) Merit.
- He/she has completed 17 years of age at the time of admission or will complete that age on or before 31 December of the year of his/her admission to the first of year the Undergraduate Allied and Healthcare Course.
- Lateral Entry to the candidates in second year (3rd semester) who have passed Diploma in same discipline.
- Medical fitness certificate is mandatory to submit and it is to be endorsed by a Government Medical Officer.

OR

- Candidates who have passed the Senior Secondary School Examination of National Open School with a minimum of 5 subjects with any of the following group subjects. English, Physics, Chemistry, Botany, Zoology English, Physics, Chemistry, Biology and any other language. Admission to Bachelor of Medical Radiology and Imaging Technology course shall be made based on eligibility and an entrance test to be conducted for the purpose. Medical fitness certificate is mandatory to submit and it is to be endorsed by a Government Medical Officer.
- **Foreign Students' Admission Process in Undergraduate (UG)**
    i. Foreign national students intending to study UG program in India, shall have to

take eligibility/equivalence certificate from respective State Allied and Healthcare Council.

ii. For admission of foreign national students in Undergraduate programs, merit list will be based on University Entrance Exam.

iii. Verification of valid Visa and valid Visa duration of foreign national students, to be verified by respective institution & University before enrolling students for program.

- The admission criteria shall be updated by the National Commission for Allied and Healthcare Professions from time to time.
- Admission process shall be conducted by State/Union Territory/University.

5. **Admission Process** – Selection shall be done by an admission board of the University/Rajasthan State Allied & Healthcare Council strictly on merit/written examination.

6. **Reservation Policy** – Reservation policy for admissions shall be as per the state/ Centre Government norms.
7. **Enrolment** @
    1. Every candidate who is admitted to the Bachelor of Medical Radiology and Imaging Technology program in Mahatma Gandhi Institute of Allied Health Sciences shall be required to get himself/herself enrolled with the Mahatma Gandhi University of Medical Sciences & Technology (MGUMST) after paying the prescribed eligibility and enrolment fees.
    2. A candidate shall deposit enrolment fee along with tuition fees at the time of his/her admission to the program. Such a candidate who fails to submit, to the college principal, duly filled enrolment form along with original documents including migration certificate required for enrolment within prescribed period then after he/she shall pay late fee applicable at that time. No student will be allowed to appear in the End of Semester Examination without his/her enrolment.

8. Introduction –A radiographer or medical imaging technologist is a trained health professional who performs medical imaging by producing high quality X-ray pictures or images used to diagnose and treat injury or disease. It is an important part of medicine and a patient's diagnosis and treatment is often

dependent on the X- ray images produced. They are responsible for producing high quality medical images that assist medical specialists and doctors to diagnose or monitor a patient's injury or illness treatment. They operate extremely technologically advanced equipment such as CT (computed tomography), MRI (magnetic resonance imaging) DSA, DEXA, mammography, CR, DR, fluoroscopy and digital mobile X-ray machines. Their roles are diverse and challenging, as radiographers are often trained in several specialist areas such as trauma radiography, mobile radiography, CT, MRI, Fluoroscopy, angiography, intervention and operation theatre mammography DEXA etc.

a) Objectives/ Aim of the Program

Learning Objectives:

- Bachelor of Medical Radiology and Imaging Technology (B.MRIT) program is to provide students with a high quality, well-rounded educational experience which results in graduates who possess the knowledge, skills and abilities to enter the field of diagnostic imaging as entry-level MRITs.
- Graduates of the B.MRIT program will be able to demonstrate the necessary skills to integrate the theoretical knowledge and essential clinical skills to perform radiography, radiological and imaging procedures including interventional procedures with utmost radiation safety measures as well as to provide exemplary patient care in a variety of healthcare settings with diverse patient populations.

The objectives of the program are to:

- Provide the profession and community with trained qualified MRITs.
- Provide education a comprehensive program that promotes problem solving, critical thinking and communication skills in the clinical environment.
- Students will demonstrate quality patient care skills including professionalism and ethical behaviors as specified in the code of ethics.
- Provide graduate students with specific skills necessary making them to be competent at entry level.

b) Programme Outcomes (POs)

Upon successful completion of the B. MRIT program, students will be able to:

PO Code	Program Outcome Description
PO1	Apply knowledge of anatomy, physiology, pathology, radiation physics, imaging principles, and radiographic procedures to perform diagnostic imaging effectively and accurately.
PO2	Operate and manage conventional and advanced imaging equipment including X-ray, CT, MRI, fluoroscopy, mammography, ultrasound, and interventional radiology systems safely and efficiently.
PO3	Produce high-quality diagnostic images through correct patient positioning, exposure selection, image processing, and technical quality assessment.
PO4	Implement ALARA principles, radiation protection measures, dose optimization techniques, and regulatory guidelines to ensure safety of patients, staff, and the public.
PO5	Demonstrate professional communication, patient preparation, counseling, empathy, informed consent procedures, and patient-centered care during imaging procedures.
PO6	Analyze clinical requirements, select appropriate imaging protocols, troubleshoot technical issues, and make informed decisions during routine and emergency situations
PO7	Practice ethical principles, maintain confidentiality, follow medico-legal regulations, respect patient rights, and uphold professional standards in healthcare settings.
PO8	Collaborate effectively with radiologists, clinicians, nurses, physicists, and other healthcare professionals while demonstrating leadership and managerial abilities when required.
PO9	Apply research methodology, evidence-based practice, scientific inquiry, and continuous professional development to improve imaging services and healthcare outcomes
PO10	Participate in quality control programs, equipment maintenance, accreditation requirements, departmental management, documentation, and healthcare informatics systems such as PACS and RIS.

c) Graduate Attributes

- Should be able to undertake all radiological and imaging procedures independently or as a key team member wherever required.
- Able to do the image processing.
- Should be able to handle all radiological and imaging equipment independently.
- Should ensure radiation protection and quality assurance.
- Undertake care and maintenance of all radiological and imaging equipment.
- Able to evaluate images for technical quality.
- Able to identify and manage emergency situations.
- Able to receive and document verbal, written and electronic orders in the patient's medical record.
- Should have computer skills.
- Should be able to provide empathetic professional patient care.
- Able to demonstrate professional growth, sense of professionalism and desire to learn.
- Able to demonstrate the core values of caring, integrity and discovery.
- To exhibit keen interest, initiative & drive in the overall development of the Department and 'Leadership Qualities' for others to follow.
- He / She is expected to be confident and to perform all the duties diligently with utmost sincerity and honesty.

9. **Attendance-**

A candidate shall study in concerned department of the Institute for the entire period as a full-time student.

- A candidate who has a minimum of 75% attendance in theory and practical separately and who has fulfilled other requirements of the course shall be permitted to appear for examination.
- A candidate having shortage of attendance shall repeat the exam when it is offered next.

Program Completion Timeline:

- The maximum period for completion of B. MRIT is 7 years.
- If a candidate does not complete within the 6years, he/she should re-register.

Note: Failure to do so will result in **exit** from the program.

10. **Minimum Instruction/ Teaching Days** – Each academic semester shall consist of minimum 120 working days, including examinations.

11. Programme Structure (Semester I, II, III, IV_____*Distribution of courses semester wise*)

Structure of the program Overview:

Foundation courses **(12 credits)**	1. Human Anatomy 2. Physiology 3. Pathology 4. Basics of Microbiology 5. Basics of Biochemistry
Core courses **(109 credits)**	**1.** Basics of Radiation Physics **2.** Conventional Radiography and Equipment **3.** Clinical Radiography Positioning (Part 1) **4.** Clinical Radiography Positioning (Part 2) **5.** Radiography and Image Processing Techniques **6.** Contrast Media and Special Radiological procedures **7.** Cross Sectional Anatomy **8.** Modern Radiological Imaging Equipment and Physics **9.** Interventional Radiology Techniques **10.** Patient Care in Radiology **11.** Basics Techniques in CT Technology **12.** Radiation safety in Diagnostic Radiology **13.** Quality Assurance in Diagnostic Radiology and Regulatory Requirements **14.** Basics Techniques in MRI Technology **15.** Introduction to Nuclear Medicine Techniques **16.** Ultrasound Techniques
Programme Course **s (09 Credits)**	1. Introduction to Healthcare 2. Medical Terminology and Record Keeping 3. Basic Computers and Information Science 4. Medical Law and Ethics 5. Professionalism and Values 6. Principals of Management 7. English and Communication Skills 8. Biostatistics and Research Methodology
40 Credits	Internship
Total credits: 170	

B.MRIT SEMESTER: FIRST

Course Code	Course Title	L (hrs/week)	T hr/unit	C/P (hrs/week)	Credits (L+T+P)
BMRIT-001	Human Anatomy	3	–	–	3
BMRIT-002	Physiology	3	–	–	3
BMRIT-003	Basics of Radiation Physics	2	–	6	5
BMRIT-004	Introduction to Healthcare*	1	–	–	1
BMRIT-005	Medical Terminology and Record keeping*	1	–	–	1
BMRIT-006	Basic Computers and Information science*	1	–	–	1
BMRIT-007	Medical Law and Ethics*	1	–	–	1
BMRIT-008	Professionalism and Values*	1	–	–	1
BMRIT-009	Principals of Management*	1	–	–	1
BMRIT-010	English & Communication skills*	1	–	–	1
–	BMRIT Radiology Clinical Education – Part I (studentship)*	–	–	15	5
	Total	15	-	21	23
*** Institute level exam only**					

B.MRIT SEMESTER: SECOND

Course Code	Course Title	L (hrs/week)	T hr/unit	C/P (hrs/week)	Credits (L+T+P)
BMRIT-011	Basics of Microbiology	2	–	–	2
BMRIT-012	Basics of Biochemistry	2	–	–	2
BMRIT-013	Conventional Radiography and Equipment	4	–	2	5
BMRIT-014	Clinical Radiography Positioning (Part I)	4	1	6	8
–	BMRIT Radiology Clinical Education – Part II (studentship)	–	–	15	5
	Total	12	1	23	22

B.MRIT SEMESTER: THIRD

Course Code	Course Title	L (hrs/week)	T hr/unit	C/P (hrs/week)	Credits (L+T+P)
BMRIT-015	Pathology	2	–	–	2
BMRIT-016	Clinical Radiography Positioning (Part II)	2	1	6	6
BMRIT-017	Radiography and Image Processing Techniques	2	–	2	3
BMRIT-018	Contrast Media & Special Radiological procedures	2	1	6	6
–	BMRIT Radiology Clinical Education – Part III (studentship)	–	–	12	4
	Total	8	2	26	21

B.MRIT SEMESTER: FOURTH

Course Code	Course Title	L (hrs/week)	T hr/unit	C/P (hrs/week)	Credits (L+T+P)
BMRIT-019	Cross sectional anatomy	2	–	6	5
BMRIT-020	Modern Radiological Imaging Equipment and Physics	2	1	2	5
BMRIT-021	Interventional Radiology Techniques	2	1	4	4
BMRIT-022	Patient Care in Radiology	1	1	4	4
	BMRIT Radiology Clinical Education – Part IV (studentship)	–	–	12	4
	Total	7	3	28	22

B.MRIT SEMESTER: FIFTH

Course Code	Course Title	Theory (hrs/week)	Tutorial hr/unit	Clinical / Practical (hrs/week)	Credits (L+T+P)
BMRIT-023	Basics Techniques in CT Technology	4	1	8	9
BMRIT-024	Radiation Safety in Diagnostic Radiology	2	1	4	5
BMRIT-025	Quality Assurance in Diagnostic Radiology and Regulatory Requirements	1	1	2	3
	BMRIT Radiology Clinical Education – Part V (studentship)	–	–	12	4
	Total	7	3	26	21

B.MRIT SEMESTER: SIXTH

Course Code	Course Title	T (hrs/week)	T hr/unit	C /P (hrs/week)	Credits (L+T+P)
BMRIT-026	Basics Techniques in MRI Technology	3	1	8	8
BMRIT-027	Introduction to Nuclear Medicine Techniques	1	1	2	3
BMRIT-028	Ultrasound Techniques	2	1	–	3
BMRIT-029	Biostatistics And Research Methodology	1	1	–	2
	BMRIT Radiology Clinical Education – Part VI (studentship)	–	–	15	5
	Total	7	4	25	21

B.MRIT SEVENTH & EIGHTH SEMESTER

Course Name	Credit	Contact Hours
INTERNSHIP (clinical lab posting/research dissertation)	20+20	2400
TOTAL	40	2400

Total credits = 170 credits

Credit Details:

- Lecture / Tutorial: 1 credit = 15 hours
- Practical: 1 credit = 30 hours
- Clinical Lab postings: 1 credit = 45 hours

Credit Includes: L – Lectures, T - Tutorials, P - Practical.

12. **Assessment and Evaluation**

Scheme of Evaluation

- The academic performance is assessed on the basis of both Continuous Internal Evaluation (CIE) assessment and End Semester Examination (ESE) in each semester.

- ESE weightage will be in the ratio of 30 % for CIE and 70 % for ESE.

Continuous Internal Evaluation (CIE)

- 30% of the total marks is allotted for CIE in each course.
- 50% of CIE shall be based on the average of marks obtained in two notified formative written tests. Absence without prior permission for a formative test shall result in scoring of the test as zero.
- The remaining 50% of CIE will be based on internal assessments in the form of evaluation seminars, journal club presentations, case presentations, completion of assignments etc. which will be specified in the individual course curricula.
- CIE will be conducted for theory and practical for each course wherever applicable.
- A Candidate must secure at least 40% of total marks fixed for CIE in the particular subject in order to be eligible to appear for the End Semester Examination (ESE) for that subject.

End semester examination (ESE)

- There shall be a University Examination at the end of each semester.
- To be eligible to appear for University examination a candidate should fulfill all the following conditions
    - Undergone satisfactorily the approved program of study in the course/courses the prescribed duration
    - 75% attendance separately in theory and in practical/hospital postings, in each course
    - Shall have the minimum attendance requirement in all courses of that semester for the first appearance
    - Secure at least 50% of total marks fixed for CIE in a particular course; and for
    - Fulfill any other requirement that may be prescribed by the University from time to time.
- The End semester examination will consist of Theory examination for all courses and in addition, Practical examination for specified courses.
- **Theory examination**
    - Written tests with question types, pattern, duration and weightage as specified in the Course-wise curricula
    - Setting of question papers and evaluation of answer scripts as per University regulations
- **Practical examination: -** Broad outline would be in the form of Spotters, Demonstration of equipment handling, Case based discussions.

13. Dissertation/ Internship/ Project/ Clinical Postings

Every candidate after passing all semesters examination is required to undergo compulsory internship to the satisfaction of the college authorities and University for a period of 1 year as to be eligible for the award of the degree. The internship is partial fulfillment of the requirements for the graduation and no candidate shall be declared to have completed the program otherwise. The internship shall be completed within 18 months of the date of passing final examination.

14. Scheme of Examination

MARKS DISTRIBUTION
B.MRIT 1st SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-001	Human Anatomy	70	30	-	-	100
BMRIT-002	Physiology	70	30	-	-	100
BMRIT-003	Basics of Radiation Physics	70	30	70#	30	200
BMRIT-004	Introduction to Healthcare	70*	30	-	-	
BMRIT-005	Medical Terminology and Record Keeping	70*	30	-		
BMRIT-006	Basic Computers and Information Science	70*	30	-	-	
BMRIT-007	Medical Law and Ethics	70*	30	-	-	
BMRIT-008	Professionalism and Values	70*	30	-	-	
BMRIT-009	Principles of Management	70*	30	-	-	
BMRIT-010	English & Communication Skills	70*	30	-	-	
	Radiology Clinical Education – Part I (Studentship)	-	-	-	-	
TOTAL	**11**	**700**	**300**	**140**	**60**	**400**
ESE- End Semester Exam,	CIE- Continuous Internal Evaluation,	*Internal Assessment	# External Assessment			

B.MRIT 2nd SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-011	Basics of Microbiology	70	30	-	-	100
BMRIT-012	Basics of Biochemistry	70	30	-	-	100
BMRIT-013	Conventional Radiography and Equipment	70	30	-	-	100
BMRIT-014	Clinical Radiography Positioning (Part I)	70	30	70#	30	200
	Radiology Clinical Education – Part II (Studentship)	-	-	-	-	-
TOTAL	5	280	120			500
ESE- End Semester Exam,	CIE- Continuous Internal Evaluation,		*Internal Assessment	# External Assessment		

B.MRIT 3rd SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-015	Pathology	70	30	-	-	100
BMRIT-016	Clinical Radiography Positioning (Part II)	70	30	70#	30	200
BMRIT-017	Radiography and Image Processing Techniques	70	30	-	-	100
BMRIT-018	Contrast Media & Special Radiological Procedures	70	30	70#	30	200
	Radiology Clinical Education – Part III (Studentship)	-		-	-	-
TOTAL	5	280	120	140	60	600
ESE- End Semester Exam	CIE- Continuous Internal Evaluation	*Internal Assessment		# External Assessment		

B.MRIT 4th SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-019	Cross Sectional Anatomy	-	-	70#	30	100
BMRIT-020	Modern Radiological Imaging Equipment and Physics	70	30	-	-	100
BMRIT-021	Interventional Radiology Techniques	70	30	70#	30	200
BMRIT-022	Patient Care in Radiology	70	30	70#	30	200
	Radiology Clinical Education – Part IV (Studentship)	-	-	-	-	-
TOTAL	5	210	90	210	90	600
ESE- End Semester Exam	CIE- Continuous Internal Evaluation			*Internal Assessment	# External Assessment	

B.MRIT 5th SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-023	Basics Techniques in CT Technology	70	30	70#	30	200
BMRIT-024	Radiation Safety in Diagnostic Radiology	70	30	70#	30	200
BMRIT-025	Quality Assurance in Diagnostic Radiology and Regulatory Requirements	-	-	70#	30	100
	Radiology Clinical Education – Part V (Studentship)	-	-	-	-	0
TOTAL	4	140	60	210	90	500
ESE- End Semester Exam	CIE- Continuous Internal Evaluation	*Internal Assessment	# External Assessment			

B.MRIT 6th SEMESTER

Course/Paper Code	Course/Paper Name	Theory ESE	Theory CIE	Practical ESE	Practical CIE	Total
BMRIT-026	Basics Techniques in MRI Technology	70	30	70#	30	200
BMRIT-027	Introduction to Nuclear Medicine Techniques	70	30	-	-	100
BMRIT-028	Ultrasound Techniques	70	30	-	-	100
BMRIT-029	Biostatistics and Research Methodology	70*	30	-	-	-
	Radiology Clinical Education – Part VI (Studentship)	-	-	-	-	-
TOTAL	5	280	120	70	30	400
ESE- End Semester Exam	CIE- Continuous Internal Evaluation	*Internal Assessment	# External Assessment			

B.MRIT 7th & 8th SEMESTER

ASSESSMENT SCHEME FOR CLINICAL EDUCATION (INTERNSHIP)

Training Duration	Continuous Internal Evaluation (Weekly Report of all 6 Months and Attendance)		End Semester Assessment (Practical and Oral)		Total Marks	
	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
6 Months	100	50	100	50	200	100

ESE will be conducted immediate after end of the 7th and 8th semester at the Institutional level.

EVALUATION SHEET FOR CONTINUOUS INTERNAL EVALUATION

Sr. No.	Enrollment t Number	Name of Student	Seminar/presentation in workshop or conference	Marks by Supervisor	Marks by Mentor Faculty	Total Marks
			Out of 40 (A)	Out of 30 (B)	Out of 30 (C)	Out of 100 (A+B+C)

Marking criteria for seminar/presentation at workshop/conference and marking criteria for supervisor/mentor faculty mentioned in the log book template.

DISTRIBUTION OF END-SEMESTER-EXAMINATION (ESE*) MARKS

Marks for Training Report	Marks for Practical's	Marks for Oral/Viva-voce	Total ESE marks
25	25	50	100

- Practical (25 marks) must include minimum two practical related demonstration Infront of the internal examiners.
- Board of examiners for 7th & 8th semester:
  - HOD of Radiology: Chairperson
  - Programme Co-Ordinator/Course Co-Ordinator/Chief of MRIT/Incharge of MRIT: Co-chairperson
  - Subject Experts: Internal examiners (two) members

15. Conduct of University Examination/ End of Semester Examination (As per MGUMST rules)

a) Appointment of Examiners and Paper Setters (Qualification of paper Setters and Examiners):

- All the examiners, paper setters, theory examination answer book evaluators, external and internal examiners for practical examinations shall be appointed by the respective university.
- Professor/Assoc. Professor/ Assistant Professor/Lecturer/Allied Health Professional having PG Qualification and 3 years professional /teaching experience after PG in respective fields or UG Qualification and 5 years professional industry/teaching experience after UG is eligible to act as an internal or external examiner of theory/practical examination.

b) Eligibility to appear for the Examination:

Candidates not possessing required attendance in a particular course as prescribed by University will not be allowed to take up examinations and has to appear for supplementary examination whenever board conducts exam for the particular course very next time.

Maximum attempt:

No more than three attempts shall be allowed for the candidate to pass the any subjects. If he/she fails to clear the any subjects within three attempts will be considered as withdrawal of the course.

c) Theory examination

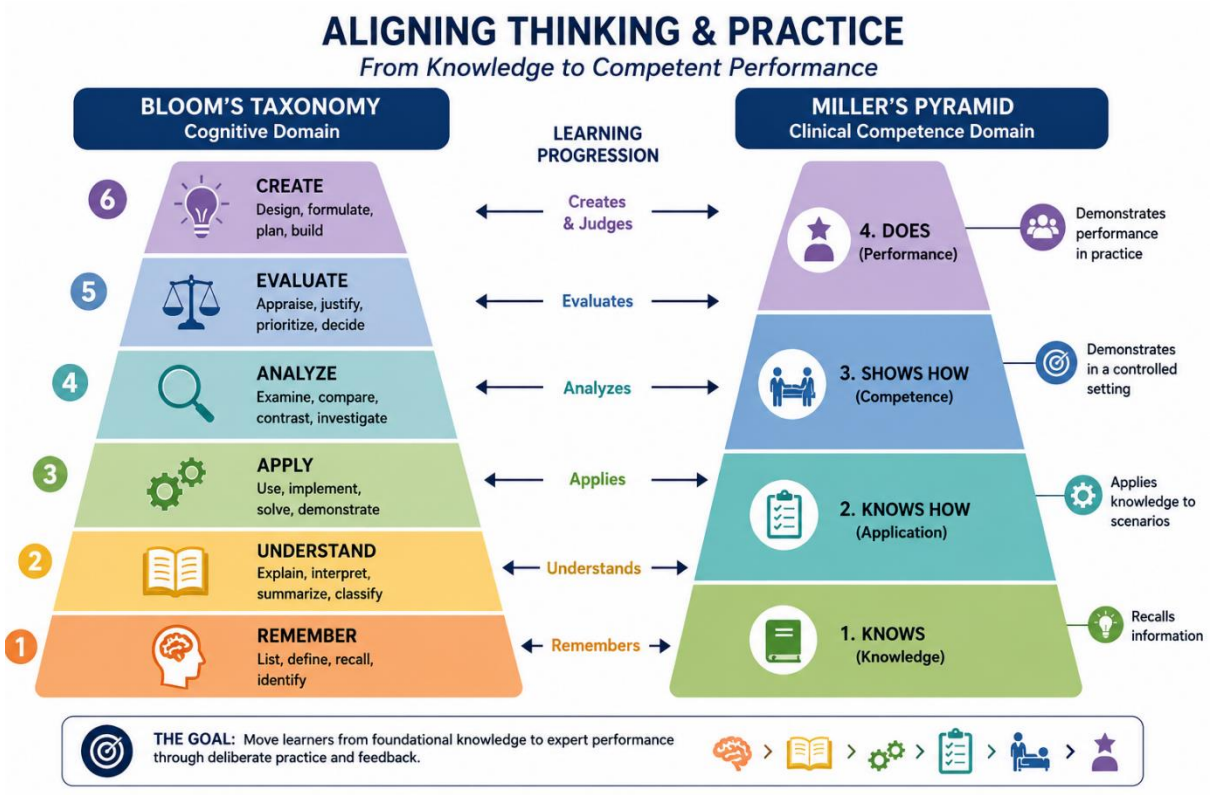
- There shall be Theory papers in each semester of study.
- Each Theory paper examination shall be of 3 hours duration and a maximum of 70 marks.
- Internal assessment (IA) shall be 30 marks for each Theory paper.
- The Paper Setter shall set the questions within the prescribed course of study of the concerned paper. There will be a set pattern of question papers duly approved by the Academic Council.

Proposed template of question papers –

MAXIMUM MARKS = 70		
TYPE OF QUESTION	NUMBER OF QUESTION	MARKS FOR EACH QUESTION
ESSAY TYPE	3 (to answer 2)	10
SHORT ESSAY TYPE	9 (to answer 7)	5
SHORT ANSWER TYPE	7 (to answer 5)	3

Bloom's Taxonomy: A blended approach—combining **didactic methods, experiential laboratory training, problem-solving, clinical immersion, and research exposure**—is essential in Medical Laboratory Sciences. When guided by educational frameworks such as **Bloom's Taxonomy,** these methodologies ensure that learners progress from acquiring foundational knowledge to demonstrating competence and ultimately practicing independently as professionals.

By weaving Bloom's Taxonomy (cognitive depth) the curriculum ensures that graduates not only master theoretical knowledge but also translate it into safe, accurate, and independent laboratory practice.



Double pyramid emphasizing cognitive progression and competence in practice

d) Practical Examinations and Viva Voce

- At the end of each semester there shall be the practical and viva-voce examination. It shall be conducted after the Theory examination is over. A candidate will have to obtain at least 50% marks in the practical and viva-voce examination.
- The university shall appoint the panel of examiners in such a manner that the complete syllabus of semester is taken care of by the internal/external practical examiner(s).
- The practical examinations shall be conducted by one external examiner and one internal examiner appointed by the president of the university

e) Criteria for pass/ Result: A Candidate must score 50% separately in theory and practical wherever applicable to be declared as pass. In case of fail, subsequently a candidate has to appear for both theory and practical examination of the university in that particular course.

f) Supplementary Examinations:

- Supplementary examination shall be conducted by the university for the benefit of unsuccessful candidates.
- Lower semester examinations shall be conducted by the University along with current semester examinations for the benefit of unsuccessful candidates.
- A Candidate detained for lack of attendance will be barred from appearing in any one or all course/s for the supplementary examination.
- A candidate permitted to appear for the supplementary examination can improve his internal assessment marks before he takes the supplementary examination by subjecting himself to internal assessment

Grace marks: The award of grace marks shall be as per the policy governed by the rules of Mahatma Gandhi University of Medical Sciences & Technology (MGUMST)

g) Re- Evaluation: (As per MGUMST Rules): Re-totaling/ Re- Evaluation of marks is permitted only for theory papers. The University/board, on application within the stipulated time and remittance of a prescribed fee, shall permit a re-totaling/ Re- evaluation of marks for the course/s applied. The marks obtained after re-totaling/ re- evaluation shall be the final marks awarded.

h) Promotion to the next Semester

Carry over benefit:

A candidate shall appear for all the subjects of that particular semester in the University examinations but failed in that semester can avail this benefit, provided:

- A candidate who fails in not more than 2 subjects in I semester is allowed to move to II semester. The candidate with back log subjects shall take both I semester backlog subjects as well as II semester subjects. The candidate with a backlog of not more than 2 subjects in II semester is allowed to go to the III semester till he/she clears all I semester subjects.
- The candidate with a backlog of not more than 2 subjects in III semester is allowed to go to the IV semester till he/she clears all II semester subjects.
- The candidate with a backlog of not more than 2 subjects in IV semester is allowed to go to the V semester till he/she clears all III semester subjects.
- The candidate with a backlog of not more than 2 subjects in V semester is allowed to go to the VI semester till he/she clears all IV semester subjects.
- Results of candidates will be declared at the end of VI semester only when the all backlog subjects are cleared by the candidates.

  Maximum attempt: No more than three attempts shall be allowed for the candidate to pass the any subjects. If he/she fails to clear the any subjects within three attempts will be considered as withdrawal of the course. (NCAHP)

- **Grading and Classification**

  Grading system

  Letter grades and CGPA

  The performance of a candidate shall be evaluated according to a Letter Grading System, based on the both CIE and ESE. The letter grades (O, S, A+,A, B, C , F and I) indicate the level of academic achievement assessed on a 10 point scale (0 to 10).

Marks Range(%)	Grade Point	Letter Grade	Descriptor	Classification	CGPA
90 & above	10	O	Outstanding	First Class with distinction	7.00 and Above
80 -89	9	S	Excellent		
70-79	8	A+	Very Good		
60-69	7	A	Good	First Class	6.00-6.99
55-59	6	B+	Average	Second Class	5.50-5.99
50-54	5	B	Pass	Pass Class	5.00-5.49
Below 50	0	F	Fails	Fail	Less than 4.0
Absent	0	I	Absent		

- For non-credit courses 'Satisfactory' (P) or 'Unsatisfactory' (F) shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA
- A candidate shall be considered to have completed a course successfully and earned the credits assigned, if he secures an acceptable letter grade in the range O-C. Letter grade 'F' in any course implies failure in that course and no credit is earned.
- A candidate having satisfactory attendance at classes and meeting the passing standard at CIE in a course, but remained absent from SEE shall be awarded 'I' grade in that course.

Grade Point Averages:

The overall performance of a candidate will be indicated by Grade Point Average (GPA).

For each course grade points will be awarded as per a letter grading system.

Semester Grade Point Average (SGPA) is computed as follows:

$\sum$ [(course credit) X (Grade point)] for all courses with Letter grades,

including F SGPA =…….

$\sum$ [(course credits)] for all courses with Letter grades,

including F **Cumulative Grade Point Average (CGPA) is computed as follows:**

$$\text{CGPA} = \frac{\sum [(\text{course credit}) \times (\text{Grade point})] \text{ for all courses for all semesters with, Letter grades excluding F}}{\sum [(\text{course credits})] \text{ for all courses for all semesters with Letter grades, excluding F}}$$

Conversion of Grades into Percentage

Formula for conversion of GPA into percentage: CGPA earned X10 = Percentage of marks scored Illustration: (CGPA Earned 8.18 X 10) = 81.80 %

Award of Class:

The candidate, who has passed all the courses prescribed, shall be declared to have passed the program. Class will be awarded only to those who pass the entire examination in the first attempt and on the basis of the aggregate of marks scored in individual semester.

- A candidate who secures GPA ≥ 7.00 and above in first attempt shall be declared to have passed in 'First Class with Distinction'.
- A candidate who secures GPA ≥ 6.00 or more but less than 7.00 in the first attempt shall be declared to have passed in 'First Class'.
- A candidate who secures GPA ≥ 5.00 or more but less than 6.00 in the first attempt shall be declared to have passed in 'Second Class'.
- A candidate who secures GPA ≥ 4.00 or more but less than 5.00 in the first attempt shall be declared to have passed in 'Pass Class'.
- Candidates who pass the examinations in more than one attempt shall be declared as passed in 'Pass' class irrespective of the percentage of marks secured.
- An attempt means the appearance of a candidate for one or more courses either in part or full in a particular examination. If a candidate submits application for appearing for the examination but does not appear for any of the courses either in full or part in the university examination, he can appear for supplementary examination provided other conditions such as attendance requirement, internal assessment marks, etc. are fulfilled and his appearing in the supplementary examination shall be considered as the first attempt.

16. **Award of Degree[@]:** The degree shall be awarded by the university only after receipt of course completion certificate and No Dues from the principal of the college.

Convocation: Degrees will be awarded in person to all eligible students who have graduated during preceding academic year at the annual convocation. (NCAHP)

17. **Authority to issue transcript:** The Controller of Examination of the University shall be the authority for issuing transcript after receiving the described fee from the candidate.

18. **Logbooks and Clinical Records**:
    Internship: minimum 2400 hours (calculated based on 8 hours per day for one year of internship)

19. **Any specific point/ rule/ regulation related to college/ institute**

20. **Course wise Syllabus with Recommended Text Books**

21. **Model Paper – Attached**

QUESTION PAPER TEMPLATE FOR B.MRIT SEMESTER I–IV

INSTRUCTIONS FOR PAPER SETTERS FOR B.MRIT SEMESTER I–IV

1. All questions must be framed in alignment with the NCAHP framework. Map each question to the relevant Course Outcome (CO) and Bloom's taxonomy.
2. Every question must carry two mandatory annotations:(a) Course Outcome (CO): e.g., CO2, CO5;(b) Highest Bloom's Level Attained: e.g., L3 – Application. These must be written in brackets after the question text.
3. The Bloom's Taxonomy ceiling for B.MRIT Semester I–IV is Level 3 – Application. No question in this paper shall exceed this level. The paper setter must self-audit using the Bloom's reference table provided in this template.
4. Question distribution across Bloom's levels [L1 – Knowledge; L2 – Comprehension; and L3 – Application] must be documented on the master copy. Recommended distribution for Semester I–IV:
   L1–L2: ~70–80%;
   L3: ~20– 30%;
   L4–L6: ~0% (not applicable).
5. Avoid repetition of topics across questions. Q1, Q2 and Q3 should collectively cover a minimum of 6–8 different topics/competencies to ensure adequate syllabus sampling.
6. All Long Answer Questions must carry sufficient internal scope. A 10-mark Long Answer Question should have 4–5 expected response components. These expected answers must be included in the model answer key submitted alongside the paper.
7. The paper setter must submit:
   (i) Question Paper with CO + Bloom's Level annotations;
   (ii) Model Answer Key with marking scheme.
   All documents are confidential and must be submitted in a sealed envelope to the Examination Cell.

B.MRIT Semester I–IV: Question-Level Mapping Table (70 Marks)

Q. No.	Question Type	Bloom's Range
Q1	Long Answer (Attempt any 2 out of 3)	L1 – L3
Q2	Short Essay (Attempt any 7)	L1 – L3
Q3	Short Answer (Attempt any 5)	L1 – L2 only

Question Paper Structure:

Subject Code: B.MRIT ……. **Subject Abb.**

Bachelor in Medical Radiology and Imaging Technology

Semester

Subject Name

Time: 3 Hours

Maximum Marks: 70

Q.1. Essay Questions ***(Attempt any 2)*** ***2 × 10 = 20 Marks***

a) …… *(CO- , L-)*
b)…… *(CO- , L-)*
c)…… *(CO- , L-)*

Q.2. Short Essay Questions ***(Attempt any 7)*** ***7 × 5 = 35 Marks***

a) …… *(CO- , L-)*
b) …… *(CO- , L-)*
c) …… *(CO- , L-)*
d) …… *(CO- , L-)*
e) …… *(CO- , L-)*
f) …… *(CO- , L-)*
g) …… *(CO- , L-)*
h) …… *(CO- , L-)*
i) …… *(CO- , L-)*

Q.3. Short Answer Questions ***(Attempt any 5)*** ***5 × 3 = 15 Marks***

(a) …… *(CO- , L-)*
(b) …… *((CO- , L-)*
(c) …… *(CO- , L-)*
(d) …… *(CO- , L-)*
(e) …… *((CO- , L-)*
(f) …… *(CO- , L-)*
(g) …… *(CO- , L-)*

QUESTION PAPER TEMPLATE FOR B.MRIT SEMESTER V–VI

INSTRUCTIONS FOR PAPER SETTERS FOR B.MRIT SEMESTER V–VI

1. All questions must be framed in alignment with the NCAHP framework. Map each question to the relevant Course Outcome (CO) and NCAHP and Bloom's Taxonomy.
2. Every question must carry two mandatory annotations:(a) Course Outcome (CO): e.g., CO2, CO5;(b) Highest Bloom's Level Attained: e.g., L5.These must be written in brackets after the question text.
3. The Bloom's Taxonomy ceiling for B.MLS Semester V–VI is Level 5 – Evaluation. No question in this paper shall exceed this level. The paper setter must self-audit using the Bloom's reference table provided in this template.
4. Question distribution across Bloom's levels [L2 – Comprehension; L3 – Application; L4 – Analysis; and L5 – Evaluation] must be documented on the master copy. Recommended distribution:
   L2-L3: ~70–80%;
   L4: ~10–15%;
   L5: 5-10%
5. Avoid repetition of topics across questions. Q1, Q2 and Q3 should collectively cover a minimum of 6–8 different topics/competencies to ensure adequate syllabus sampling.
6. All Long Answer Questions must carry sufficient internal scope. A 10-mark Long Answer Question should have 4–5 expected response components. Clinical scenarios or case-based questions should be included wherever appropriate. These expected answers must be included in the model answer key submitted alongside the paper.

The paper setter must submit:
(i) Question Paper with CO + Bloom's Level annotations;
(ii) Model Answer Key with marking scheme.
All documents are confidential and must be submitted in a sealed envelope to the Examination Cell.

B.MRIT Semester V–VI: Question-Level Mapping Table (70 Marks)

Q. No.	Question Type	Bloom's Range
Q1	Long Answer (Attempt any 2 out of 3)	L2 – L4
Q2	Short Essay (Attempt any 7)	L2 – L4
Q3	Short Answer (Attempt any 5)	L2 – L3 only

Question Paper Structure:

Subject Code: B.MRIT ……. **Subject Abb.**

Bachelor in Medical Radiology and Imaging Technology

Semester

Subject Name

Time: 3 Hours

Maximum Marks: 70

Q.1. Essay Questions ***(Attempt any 2)*** ***2 × 10 = 20 Marks***

a) …… *(CO- , L-)*
b)…… *(CO- , L-)*
c)…… *(CO- , L-)*

Q.2. Short Essay Questions ***(Attempt any 7)*** ***7 × 5 = 35 Marks***

(a) …… *(CO- , L-)*
(b) …… *(CO- , L-)*
(c) …… *(CO- , L-)*
(d) …… *(CO- , L-)*
(e) …… *(CO- , L-)*
(f) …… *(CO- , L-)*
(g) …… *(CO- , L-)*
(h) …… *(CO- , L-)*
(i) …… *(CO- , L-)*

Q.3. Short Answer Questions ***(Attempt any 5)*** ***5 × 3 = 15 Marks***

(a) …… *(CO- , L-)*
(b) …… *(CO- , L-)*
(c) …… *(CO- , L-)*
(d) …… *(CO- , L-)*
(e) …… *(CO- , L-)*
(f) …… *(CO- , L-)*
(g) …… *(CO- , L-)*

Semester: First

Teaching and Examination Scheme																	
Course Name : Bachelor in Medical Radiology and Imaging Technology																	
Duration of Program: Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks Semester : **First**																	
S.N.	**Course** Title	**Course Code**	**Teaching Scheme**				**Examination Scheme**										
							Theory					**Practical**					
			L	**T**	**C/P**	**Credits (L+T+P)**	**Exam Duration in Hrs.**	**CIE**	**ESE**	**Total**		**CIE**	**ESE**	**Total**		**Grand Total**
								Max Mark	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Human Anatomy	B.MRIT-001	3	--	--	3	2.5	30	70	100	50	--	--	--	--	**100**
2.	Physiology	B.MRIT-002	3	--	--	3	2.5	30	70	100	50	--	--	--	--	**100**
3.	Basics of Radiation Physics	B.MRIT-003	2	-	6	5	2.5	30	70	100	50	30	70#	100	50	**200**
4.	Introduction to Healthcare	B.MRIT-004	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
5.	Medical Terminology and Record keeping	B.MRIT-005	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
6.	Basic Computers and Information science	B.MRIT-006	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
7.	Medical Law and Ethics	B.MRIT-007	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
8.	Professionalism and Values	B.MRIT-008	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
9.	Principals of Management	BMRIT-00	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
10.	English & Communication skills	B.MRIT-010	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
11.	B.MRIT Radiology Clinical Education – part I (studentship)		--	--	15	5	--	--	--	--	--	--	--	--	--	--
	Total		**13**	**2**	**21**	**23**	**--**	**--**	**--**	**300**	**--**	**--**	**--**	**100**	**--**	**400**

Student Contact Hours Per Week: 36**Hrs.Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks: **400**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L – Lectures ((hrs/week), T - Tutorial, P – Practical {Clinical / Practicals (hrs/week)}

*Internal Assessment, # External Assessment.

Human Anatomy

RATIONALE

Anatomy is a key component of all education programmes for MRITs and should have a strong focus on organ position, orientation and relationships. The topics provide the student with an understanding of the structure and relationships of the systems and organs of the body which is essential in patient preparation and positioning. The radiographic anatomy component will enable MRITs to evaluate images prior to reporting by the radiologist.

Course Outcomes

CO	Course Outcome	Bloom′s Level
CO1	Describe the general anatomy of human body	**L2**
CO2	Explain normal disposition of various structures and organs in the body and its clinical correlation	**L2**
CO3	Describe the microscopic structure of various tissues	**L2**
CO4	Determine the topography of various structures on the surface of the body	**L3**
CO5	Identify and locate structures of the body	**L1**
CO6	Identify organs and tissues under microscope	**L1**
CO7	Point out various features of appearance of normal body in skiagrams	**L1**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
3	**--**	**--**	**3**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable tutorial assignments of minimum one hour per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency

Unit	Topic and contents	Hours	Marks
I	**Introduction: Human Body as a Whole** Definition of anatomy and its subdivisions, Terms of location, positions and planes, Cell and its organelles, Epithelium – definition, classification, describe with examples, functions, Glands – classification, describe serous and mucous glands with examples, Basic tissues – classification with examples	**08**	14
II	**Locomotion and Support** Cartilage – types, examples and histology Bone – classification, examples and histology. Parts of long bone, names of all bones, vertebral column and intervertebral disc. Fontanel's of fetal skull. Joints – classification of joints with examples, typical synovial joint (in detail). Muscular system – classification of muscular tissue and histology Important muscles of the body- Sternocleidomastoid, Trapezius, Muscles of tongue, Deltoid, Biceps brachii, Intercostal muscles, Thoracic diaphragm, Rectus abdominis, External oblique, Internal oblique, Transversus abdominis, Pelvic diaphragm, Gluteus maximus, Gluteus medius, Gluteus Minimus, Quadriceps femoris, Soleus.	**08**	14
III	**Cardiovascular System** Heart – size, location, chambers, exterior and interior, Blood supply of heart, Pericardium, Systemic and pulmonary circulation, Branches of aorta - common carotid artery, subclavian artery, Axillary artery, brachial artery, radial artery, superficial palmar arch, femoral artery, popliteal artery, dorsalis pedis artery., Peripheral pulse, Inferior venacava, portal vein, portosystemic anastomosis, Great saphenous vein, median cubital vein, Dural venous sinuses, Lymphatic system – cisterna chyli and thoracic duct, Lymphatic tissues and its histology, Regional lymph nodes – cervical, axillary and inguinal lymph nodes. **Respiratory System** Parts of RS – nose, nasal cavity, paranasal air sinuses, larynx, trachea, lungs, pleura, bronchopulmonary segments, Histology of trachea and lungs.	**08**	20

IV	**Gastro-Intestinal System Theory** Parts of GIT- oral cavity (lip, cheek, tongue, salivary glands, palate, dentition) pharynx (Waldeyer's ring) esophagus, stomach, small and large intestine and appendix, Liver, gall bladder, pancreas and spleen, Histology of esophagus, stomach, small and large intestine, liver, gall bladder and pancreas. **Peritoneum** Description of reflection, folds and pouches in brief.	**08**	14
V	**Urinary System** Kidney, ureter, urinary bladder, male and female urethra, Histology of kidney, ureter and urinary bladder. **Reproductive System** Parts of male reproductive system- testis, vas deferens, epididymis, prostate, Parts of female reproductive system- uterus, fallopian tubes, ovary, mammary gland, Histology of testis, vas deferens, epididymis, prostate, uterus, fallopian tube and ovary. **Endocrine Glands** Names of all endocrine glands, describe in detail on pituitary gland, thyroid gland and parathyroid gland, suprarenal gland, Histology of pituitary, thyroid, parathyroid, suprarenal gland.	**08**	20
VI	**Nervous System** Neuron, Classification of nervous system, Cerebrum, cerebellum, brain stem, spinal cord & spinal nerve, Meninges, ventricles and cerebrospinal fluid, Blood supply of the brain, Cranial nerves (in brief), Nerve plexus (Brachial & lumbar) **Sensory Organs** Skin and its appendages, Eye – parts of eye ball and lacrimal apparatus, Extra-ocular muscles, Histology of cornea and retina, Ear – parts of ear- external, middle and inner ear and contents Embryology Spermatogenesis and oogenesis, Ovulation, fertilization, Placenta	**08**	14
Total		**48**	96

SUGGESTED PRACTICALS/DEMONSTRATION

Course Outcomes

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Identify histology of epithelial and salivary glands and surface anatomy.	L1
CO2	Identify bones, joints, cartilage and muscles with their histological features.	L1
CO3	Identify cardiovascular, lymphatic and respiratory structures using specimens, histology and radiographs.	L1
CO4	Identify gastrointestinal structures using specimens, histology and radiographs.	L1
CO5	Identify urinary, reproductive and endocrine organs using specimens, histology and radiographs.	L1
CO6	Identify nervous system and special sense organs using specimens and histological sections.	L1

Sr. No		Hours
1.	Demonstration of Histology of types of epithelium, Histology of serous, mucous and mixed salivary gland, Surface marking of the body region wise.	1
2.	Demonstration of Histology of hyaline, elastic and fibrocartilage, Demonstration of all bones showing parts, radiographs of normal bones and joints, Histology of compact bone (TS and LS), Demonstration of all muscles of the body, Histology of skeletal, smooth and cardiac muscle.	1
3.	Demonstration of heart, pericardium and vessels of the body, Histology of large artery, medium sized artery and large vein, Histology of lymph node, spleen, tonsil and thymus, Normal chest radiograph showing heart shadows, Normal angiograms. Demonstration of parts of respiratory system, Normal radiographs of chest, Histology of lung and trachea.	1
4.	Demonstration of parts of GIT, liver, gall bladder, pancreas and spleen, Histology of tongue, salivary glands, esophagus, stomach, small and large intestine, liver, gall bladder, pancreas and spleen, Radiographs of abdomen plain and contrast. Demonstrations of reflections, folds and pouches.	1
5.	Demonstration of parts of urinary system, Histology of kidney, ureter, urinary bladder, Radiographs of abdomen – IVP, retrograde cystogram. Demonstration of section of male and female pelvis with organs in situ, Histology of testis, vas deferens, epididymis, prostate, uterus, fallopian tube and ovary, Radiographs of pelvis – Hysterosalpingogram. Demonstration of the glands, Histology of pituitary, thyroid, parathyroid, suprarenal glands.	1

6.	Demonstration of Histology of peripheral nerve and optic nerve, Demonstration of major nerves in the body, Demonstration of cranial cavity and parts of brain, Histology of cerebrum, cerebellum, spinal cord Demonstration of Histology of thin and thick skin, Demonstration of histology of cornea and retina.	1
	Total	**6**
Demonstration will be part of theory/tutorial classes. There is in separate credit for the practicals/demonstrations.		

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests Same pattern as Summative test Average of two to be considered Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit		Marks (± 5%)
1.	Introduction Human Body as a Whole	14
2.	Locomotion and Support	14
3.	Cardiovascular System, Respiratory System	20
4.	Gastro-Intestinal System, Peritoneum	14
5.	Urinary System, Reproductive System, Endocrine Glands	20
6.	Nervous System, Sensory Organs, Embryology	14
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Human Anatomy, Vol.1,2 &3, 5th edition, 2010,	B.D. Chaurasia	CBS publishers & distributors Pvt. Ltd.
2	Physiology & Anatomy with Practical Considerations	Ester. M. Grishcimer	J.P. Lippincott. Philadelphia
3	Manipal Manual of Anatomy, 2nd edition, 2012	Sampath Madhyastha	CBS publishers & distributors Pvt. Ltd
4	Text Book of General Anatomy, 2nd edition, 2013	Shobha Rawlani and Shivlal Rawlani	Jaypee brothers
5	Langman's Medical Embryology, 11th edition, 2009	T.W Sadler	Wolters Kluwer

PHYSIOLOGY

RATIONALE

Physiology provides the students with knowledge of the function of systems and organs and their relationships and underpins the understanding of how various imaging modalities are to be selected depending upon the clinical history.

COURSE OUTCOMES

CO	Course Outcome	Bloom's Level
CO1	Explain the normal functioning of organs and systems.	L2
CO2	Understand the interrelationships and interactions among various organs and systems for maintaining homeostasis.	L2
CO3	Assess the relative contribution of each organ systems toward the maintenance of constant internal environment.	L3
CO4	Differentiate between normal and abnormal functioning of organs and systems.	L3
CO5	Understand physiological basis of pathogenesis and treatment of diseases and disorders.	L2
CO6	Apply the physiological basis in the field of allied health care.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CIE	ESE	ESE	CIE	
3	--	--	3	30	70	--	--	100

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable tutorial assignments of minimum one hour per unit based on the curriculum.

THEORY COMPONENTS

Unit	Topic and contents	Hours	Marks
I	**General physiology** Introduction to Physiology, Concept of Homeostasis, cell – Morphology – Functions of organelles and Cell membrane, Transport mechanisms, Body fluid compartments. **Muscle nerve physiology** Neurons: Morphology, Action Potential, Neuroglia: Types & functions, Muscles: Types, structure of sarcomere. Neuromuscular junction, sliding filament mechanism of contraction. **Blood** Composition, properties, functions. Plasma proteins: Concentrations and functions, RBC: Morphology, functions, count, physiological variations and life span Erythropoiesis – stages, essential factors, regulation of Erythropoiesis, Hemoglobin: Functions, concentration, physiological variations. Fate of Hemoglobin – Jaundice, types, Color index, MCH, MCV, MCHC, PCV – normal values, WBC: Morphology, functions of all types including T & B lymphocytes, total and differential counts, physiological variations, Platelets: Morphology, count, functions, thrombocytopenia & bleeding time, Blood groups: Basis of blood grouping. Landsteiner's laws, ABO system, determination of blood groups, blood transfusion, complications of incompatible blood transfusion, Rh group, erythroblastosis foetalis, prevention and treatment, Blood bank. Haemostasis: Mechanisms. Clotting mechanism: factors, intrinsic and extrinsic pathways. Disorders of clotting – hemophilia, vitamin K deficiency. Anticoagulants – mechanism of action and their uses, Anemia: Classification – Morphological and Etiological, Blood volume: normal values.	**10**	**15**
II	**Cardiovascular system** Organization of cardiovascular system, greater and lesser circulation, Physiological anatomy of the heart, nerve supply, Junctional tissues of heart (pacemaker), Cardiac cycle: Mechanical events, Heart sounds, causes, characteristics and significance, Normal ECG, clinical significance of ECG, Heart rate – Physiological variations, Cardiac output: Definitions, normal values, physiological variations, Arterial blood pressure: Definitions, normal values, physiological variations, factors maintaining blood pressure. Role of baroreceptors in regulation of blood pressure.	**10**	**10**
III	**Respiratory system** Respiratory and Non-respiratory function of respiratory system. Physiological anatomy of respiratory system Functions of respiratory tract.	**8**	**10**

	Respiratory membrane. Respiratory muscles. Surfactant: functions, respiratory distress syndrome. Definitions of terms used in respiratory physiology: Eupnea, Hyperpnoea, Tachypnea, Apnea, Dyspnea. Mechanics of breathing – intrapulmonary and Intrapleural pressure changes during a respiratory cycle. Spirometry – Lung volumes and capacities. Vital capacity. Oxygen transport: Role of hemoglobin, factors affecting, oxygen carrying capacity. Carbon dioxide transport: forms, chloride shift (Hamburgers phenomenon). Respiratory centers. Role of chemo receptors in regulation of respiration. Pulmonary ventilation and alveolar ventilation. Partial pressure of gases, Calculation of partial pressure of gasses in mixture. Arterial and venous blood gas concentrations and contents. Hypoxia: Types and effects Cyanosis, Asphyxia, Periodic Breathing, Acclimatization. Hyperbaric O2 therapy, Artificial respiration and Ventilators.		
IV	**Excretory system** Functions of kidneys. Nephrons – Juxta glomerular apparatus – functions, Steps in Urine formation – Ultrafiltration, Tubular Reabsorption, Tubular Secretion, GFR. Definition, normal values, factors affecting GFR, measurement of GFR, Renal threshold for glucose, tubular load for glucose, Role of aldosterone and ADH in urine formation, Micturition, Innervation of bladder. Diuresis, Renal functions tests – Based on analysis of urine and analysis of blood, Skin: Functions of skin. Sweat glands.	**4**	**05**
V	**Digestive system** Introduction, structure of alimentary canal, Saliva: Composition, functions, Stomach: Functions. Gastric Juice: composition, functions, Pancreatic Juice: Composition and functions, Liver: Functions, Bile: composition, functions, Gall bladder: functions, Succusentericus: Composition, functions. Functions of large intestine, Movements of small intestines, Deglutition.	**4**	**05**

VI	**Endocrine system** Major endocrine glands- Hormone: Definition, Anterior pituitary: hormones and their functions, disorders – Giganitism, acromegaly, dwarfism, Posterior pituitary: Hormones – diabetes insipidus, Thyroid: Hormones, normal values, functions, role of TSH. Disorders: simple goitre, myxoedema, cretinism, Grave's disease, Adrenal cortex: hormones, functions of cortisol and aldosterone. Addison's disease, Cushing's syndrome, Adrenal medulla: actions of adrenaline and noradrenaline, Endocrine pancreas: Insulin & glucagon, functions, Regulation of blood glucose level, diabetes mellitus, Parathyroid: Functions of PTH. **Nervous system** Synapse: Types, Transmission, Sensory receptors: Definition, Classification Organization of spinal cord, Functions of Dorsal column and Spinothalamic tract, Functions of Corticospinal tract, Reflex Action: Definition, reflex arc, Functions of Cerebellum, Basal ganglia, Thalamus, Hypothalamus, Cerebral cortex: Lobes & functions. EEG – Definition and uses, Autonomic nervous system: Organization & functions, Cerebrospinal fluid: Composition and function.	**8**	**15**
VII	**Special senses** Vision: Physiological anatomy of eye ball, rods & cones, Refractive errors: Myopia, hypermetropia, presbyopia & astigmatism, Audition: Functions of outer, middle & inner ear, cochlea, Deafness – types, Taste: Taste buds, primary taste sensation, Smell: Receptors, modalities of smell **Reproductive system** Male reproductive system: functions of testes, puberty, spermatogenesis functions of testosterone, semen, Female reproductive system: Ovarian hormones functions – Menstrual cycle, Hormonal basis of changes in menstrual cycle, Family Planning.	**10**	**10**
Total		**54**	**70**

Suggested Practicals/Demonstration

Suggested Practicals/Demonstration

CO	Course Outcome	Bloom's Level
CO1	Demonstrate the operation of laboratory instruments such as the microscope, hemocytometer, and hemoglobinometer, and perform basic hematological investigations including RBC count, WBC count, blood grouping, bleeding time, and clotting time determination.	L3
CO2	Perform and interpret physiological assessments including arterial blood pressure measurement, radial pulse examination, spirogram recording, and determination of vital capacity using standard clinical procedures.	L3
CO3	Demonstrate emergency and diagnostic procedures such as artificial respiration, cardiopulmonary resuscitation (CPR), and ECG recording while explaining their clinical significance in patient care.	L3

	SUGGESTED PRACTICALS/DEMONSTRATION	Hours
	Study of Microscope and its uses Collection of blood and study of hemocytometer Hemoglobinometry Determination of RBC count Determination of WBC count Determination of blood groups Determination of bleeding time Determination of clotting time Recording of Arterial Blood Pressure, Clinical examination of Radial pulse Recording of spirogram and determination of vital capacity Artificial respiration, CPR Demonstration of ECG recording	8
	Total	8
Demonstration will be part of theory/tutorial classes. There is in separate credit for the practicals/demonstrations.		

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests Same pattern as Summative test Average of two to be considered Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

Question Paper Blueprint

Unit		Marks (± 5%)
1.	General physiology, Muscle nerve physiology, Blood	18
2.	Cardiovascular system	14
3.	Respiratory system	14
4.	Excretory system	9
5.	Digestive system	9
6.	Endocrine system, Nervous system	18
7.	Special senses, Reproductive system	14
	Total Marks (including optional questions)	**96**

Suggested Learning Resources

S.No.	Title of Book	Author	Publication
1	Foundation of Anatomy and Physiology	Ross Wilson	Churchill Livingstone.
2	Physiology & Anatomy with Practical Considerations	Ester. M. Grishcimer	J.P. Lippincott. Philadelphia
3	Text Book of Physiology	A. P. Krishna	Suman Publication
4	Text Book of Physiology	A.K. Jain	Avichal Publishing Company;

Basics of Radiation Physics

RATIONALE

Radiation physics is one of the primary pillars underlying the practice of radiology technology and understanding the principles of radiation physics helps BMRIT become better technologist

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Taxonomy
CO1	Describe general physics related to imaging.	**L1**
CO2	Differentiate between various types of radiation.	**L4**
CO3	Identify the construction of radiology equipment.	**L3**
CO4	Interpret quality control of radiology equipment.	**L4**
CO5	Differentiate between X-ray equipment and other radiology-related equipment.	**L4**
CO6	Describe the production of X-rays.	**L1**
CO7	Describe the circuit system of radiology equipment.	**L2**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**--**	**6**	**5**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable tutorial assignments of minimum one hour per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours
I	**Basic concepts**: Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table-Isotopes-Ionization- excitation-Binding energy-electron volt-Electromagnetic radiation-Quantum nature of radiation-mass energy equivalence-Fluorescence-electromagnetic spectrum.	5
II	**Electricity and magnetism**: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and Capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law. Varying currents-Growth and decay of current in LR circuit time constant, charge and discharge of a Capacitor through a resistance and inductance. Oscillations in an LC circuit. Alternating currents: Peak and RMS values and current and voltage, circuit containing LR, CR and LCR-Power factor, series and parallel LCR circuits, DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current. **Electromagnetic waves**: Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere.	6
III	**Electronics** Semiconductors; Conduction in crystals, Energy bands. Intrinsic and Extrinsic semiconductors n-type and p-type semiconductors, majority and minority carriers. Semiconductor diodes: p-n junction-properties forward and reverse bias, characteristics of p-n junction Rectifiers-Half-wave and full wave, ripple factor, Efficiency of HW and FW rectifiers. Filter circuits; Zener diode, regulated power supply. Transistors-Symbols, Transistor connections and characteristics, Transistor as an amplifier, load line analysis, operating point, types of amplifiers-voltage and power amplifiers. Feedback-negative feedback in amplifiers.	5
IV	**Discovery of x-rays-X-ray production and properties**: Bremsstrahlung radiations-Characteristics X-Rays, factors affecting X-ray emission spectra, X-ray quality and quantity, HVL measurements, heel effect, soft and hard X-Rays, added and inherent filtration, reflection and transmission targets.	5
V	**Heat** Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transfer-conduction, convection, radiation, thermal conductivity, equation for thermal conductivity (k), the value of k of various material of interest in radiology, thermal expansion, Newton's law of cooling, Heat radiation, perfect black body, Stefan law, application in Diagnostic Radiology (Heat dissipation in both stationary and rotating X-ray tubes).	4

VI	**Interaction of ionizing radiation with matter**-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation. Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, and linear attenuation coefficient-coherent scattering-photonuclear disintegration-Particle interactions. Interactions of X rays and Gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.	**5**
VII	**Exponential attenuation** (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number. Radiation intensity and exposure, photon flux and energy flux density. LET, range of energy relationship for alpha, beta particles with X-Rays. **Physical quantity, its unit and measurement**: Fundamental and derived quantity, SI unit, various physical/radiation quantity used in Diagnostic Radiology and its unit (for example, KVp, mA, mAS, Heat unit.	**6**
Total		**36**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Explain the basic concepts of physics, electricity, magnetism, electromagnetic waves, and electronics relevant to medical imaging.	L2
CO2	Describe the discovery, production, and properties of X-rays and their applications in radiology.	L2
CO3	Analyze the interaction of ionizing radiation with matter, exponential attenuation, and related physical principles.	L4
CO4	Apply the concepts of physical quantities, units, measurements, heat, and radiation physics in radiological practice.	L3

Sr. No		**Hours**
1.	Basic concepts	
2.	Electricity and magnetism, Electromagnetic waves	
3.	Electronics	
4.	Discovery of x-rays-X-ray production and properties	

5.	Heat	**108**
6.	Interaction of ionizing radiation with matter-	
7.	Exponential attenuation, Physical quantity, its unit and measurement	
Total		**108**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit	**Marks (± 5%)**
Basic concepts	10
Electricity and magnetism, Electromagnetic waves	10
Electronics	06
Discovery of x-rays-X-ray production and properties	25
Heat	06
Interaction of ionizing radiation with matter-	25
Exponential attenuation, Physical quantity, its unit and measurement	14
Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Basic radiological physics	K. Thayalan	Jaypee BrothersMedical Publishers (P) Limited, 2003
2	Christensen's physics of diagnostic radiology	Curry and Dowdey	Wolters Kluwer
3	X-Ray Equipment for Student	D.N. And M.O. Chesney	Blackwell Science Ltd
4	A Textbook Of Radiation Physics For Radiologic Technology	Surendra Maharjan, Suraj Sah	Samiksha Publications
5	A Concise Guide on Basic Radiographic Physics Darkroom Procedures, Radiographic Positioning & Techniques	Lalit Agarwal	JBD Publications

Introduction to Healthcare

RATIONALE

The course provides the students a basic insight into the main features of Indian health care delivery system and how it compares with the other systems of the world.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the concept of health, determinants of health, health indicators of India, and the role of the health team.	L2
CO2	Describe the National Health Policy, National Health Programs, and Family Welfare Programs in India.	L1
CO3	Understand basic nursing concepts, principles, and develop effective interpersonal relationships in patient care.	L2
CO4	Demonstrate nursing procedures such as bandaging techniques and proper patient positioning for comfort and treatment.	L3
CO5	Apply safe methods of lifting, transferring, and transporting patients along with effective bedside management.	L3
CO6	Perform basic nursing care procedures including feeding methods, tube feeding, administration of drips and transfusion, and elimination care (bedpan, catheter, enema).	L3

<table>
<tr><td colspan="3">Teaching Scheme (In Hours)</td><td>Total Credits (L+T+P)</td><td>Examination Scheme</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Institute level exam only:
The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.</td></tr>
<tr><td>1</td><td>--</td><td>--</td><td>1</td></tr>
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THEORY COMPONENTS:

Topic and contents	Hours
• Introduction to Health: • Definition of Health, Determinants of Health, Health indicators of India, Health team concept • National Health Policy • National Health Programs (Brief objectives and scope) Family welfare programs in India • Introduction to Nursing: • Nursing and Nursing principles, Interpersonal relationships, Bandaging basic turns, Bandaging extremities, Triangular bandages and their applications • Nursing position, bed making, prone, lateral, dorsal, dorsal re-cumbent, Fowler's position, comfort measures, Aids, rest and sleep • Lifting and transporting patients, Transferring patients to wheel chair, transferring from bed to stretcher • Bedside Management: Proper usage of bed pan, Observation of stools, urine, sputum. Understand the use and care of catheters. Enema procedures • Method of giving nourishment: Feeding, tube feeding, drips, transfusion • Monitoring and recording of vitals • Simple aseptic techniques, sterilization and disinfection Observation of surgical dressings • Concepts of First Aid	**18**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Principles and Practice of Nursing Management and Administration	Jogindra Vati	Jaypee Brothers Ltd
2	Textbook of Preventive and Social Medicine	K Park	Banarsidas Bhanot Publishers
3	Introduction to Healthcare	Dakota Mitchell and Lee Haroun	Delmar
4	Introduction to Healthcare and Careers	Roxann Delaet	Joanes and Bartlett Learning

Medical Terminologies and Record Keeping

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	Institute level exam only: The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	**--**	**--**	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	**Hours**
Topics include: origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student's field of study. Spelling is critical and will be counted when grading tests. Topics to be covered under the subject are as follows: 1. Derivation of medical terms. 2. Define word roots, prefixes, and suffixes. 3. Conventions for combined morphemes and the formation of plurals. 4. Basic medical terms. 5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots. 6. Interpret basic medical abbreviations/symbols. 7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system. 8. Interpret medical orders/reports. 9. Data entry and management on electronic health record system.	**18**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Medical Terminology, Documentation, and Coding	Anne P. Stich	Routledge Publisher
2	Medical Terminology for Health Professions	Ann Ehrlich, Carol L. Schroeder	Cengage Learning
3	Medical Terminology	M. Mastenbjörk M.D. S. Meloni M.D. Medical Creation David Andersson	Medical Creations
4	Medical Records: Organization and Management	GD Mogli (Author)	Jaypee Brothers Medical Publishers

Basic Computers and Information Science

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating system and software, and MS windows, Word processing, Excel data worksheet and PowerPoint presentation.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	**Institute level exam only:** The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	**--**	**--**	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	**Hours**
Topics to be covered under the subject are as follows: 1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages. 2. Input output devices: Input devices(keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices(monitors, pointers, plotters, screen image projector, voice response systems). 3. Processor and memory: The Central Processing Unit (CPU), main memory. 4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices. 5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.). 6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge. 7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.	**18**

8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs. 9. Introduction of Operating System: introduction, operating system concepts, types of operating system. 10. Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network. 11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet. 12. Application of Computers in clinical settings. Practical on fundamentals of computers - 1. Learning to use MS office: MS word, MS PowerPoint, MS Excel. 2. To install different software. 3. Data entry efficiency	

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Basic of Computer and Information Technology	Ashok Arora	Vikas
2	Computer and Information Science	Roger Lee (editor)	Springer
3	Computer and Information Sciences	Tadeusz Czachórski , Erol Gelenbe, Krzysztof Grochla, Ricardo Lent (Editor	Springer
4	Information science and computer basics: An introduction	Mitchell, Ruth K	Clive Bingley

Medical law and ethics

RATIONALE

Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical sciences, growing sophistication of the modern society's legal framework, increasing awareness of human rights and changing moral principles of the community at large, now result in frequent occurrences of healthcare professionals being caught in dilemmas over aspects arising from daily practice.

Medical ethics has developed into a well based discipline which acts as a "bridge" between theoretical bioethics and the bedside. The goal is "to improve the quality of patient care by identifying, analyzing, and attempting to resolve the ethical problems that arise in practice. Doctors are bound by, not just moral obligations, but also by laws and official regulations that form the legal framework to regulate medical practice. Hence, it is now a universal consensus that legal and ethical considerations are inherent and inseparable parts of good medical practice across the whole spectrum.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	Institute level exam only: The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	--	--	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	**Hours**
The important and relevant topics that need to focus on are as follows: 1. Medical ethics - Definition - Goal - Scope 2. Introduction to Code of conduct 3. Basic principles of medical ethics – Confidentiality 4. Malpractice and negligence - Rational and irrational drug therapy 5. Autonomy and informed consent - Right of patients 6. Care of the terminally ill- Euthanasia 7. Organ transplantation 8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.	**18**

9. Professional Indemnity insurance policy 10. Development of standardized protocol to avoid near miss or sentinel events 11. Obtaining an informed consent. 12. Medical ethics - Definition - Goal - Scope 13. Introduction to Code of conduct 14. Basic principles of medical ethics – Confidentiality 15. Malpractice and negligence - Rational and irrational drug therapy 16. Autonomy and informed consent - Right of patients 17. Care of the terminally ill- Euthanasia 18. Organ transplantation 19. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects. 20. Professional Indemnity insurance policy 21. Development of standardized protocol to avoid near miss or sentinel events 22. Obtaining an informed consent.	

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Medical Law and Ethics	Bonnie F. Fremgen	Pearson
2	Medical Law and Ethics	Jonathan Herring	OUP UK
3	Medical Law and Ethics	Purosottam Behera	Mittal Publications
4	Reflections on Medical Law and Ethics in India	Bismi Gopalakrishnan, Mercy Khaute, B. Sandeepa Bhat	Eastern Law House

Professionalism and Values

RATIONALE

The module on professionalism will deliver the concept of what it means to be a professional and how a specialized profession is different from a usual vocation. It also explains how relevant is professionalism in terms of healthcare system and how it affects the overall patient environment.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	Institute level exam only: The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	--	--	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	Hours
1. Professional values- Integrity, Objectivity, Professional competence and due care, Confidentiality 2. Personal values- ethical or moral values 3. Attitude and behavior- professional behavior, treating people equally 4. Code of conduct, professional accountability and responsibility, misconduct 5. Differences between professions and importance of team efforts 6. Cultural issues in the healthcare environment	**18**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Textbook of Medical Ethics	Erich H Loewy	Springer
2	Professionalism, Professional Values and Ethics in Nursing	Suresh K Sharma, Asha P Shetty	Jaypee Brothers Medical Publishers
3	Essentials of Professionalism, Professional Values & Ethics for BSc Nursing Students	Varinder Kaur	CBS Publishers and Distributors Pvt. Ltd
4	Textbook of Professional Ethics and Human Values	R S Naagarazan	New age International Publishers

Principles of Management

RATIONALE

The course is intended to provide a knowledge about the basic principles of Management.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	**Institute level exam only:** The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	**--**	**--**	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	**Hours**
1. Introduction to management 2. Strategic Management 3. Foundations of Planning 4. Planning Tools and Techniques 5. Decision Making, conflict and stress management 6. Managing Change and Innovation 7. Understanding Groups and Teams 8. Leadership 9. Time Management 10. Cost and efficiency	**18**

SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Essentials of Professionalism, Professional Values & Ethics for BSc Nursing Students	Varinder Kaur	CBS Publishers and Distributors Pvt. Ltd
2	Professionalism Professional Values and Ethics in Nursing	Suresh K Sharma	Jaypee Brothers
3	Professionalism, Professional Values & Ethics	Shama Lohumi and Rakesh Lohumi	CBS publishers and Distributers PVT Ltd

English and Communication skills

RATIONALE

Patients need to feel safe enough to communicate honestly and openly with their care providers to receive effective treatments. Providers need to convey treatment plans and health education clearly, accessibly, and empathetically so that patients can receive optimal care.

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	Institute level exam only: The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.
1	**--**	**--**	**1**	

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Topic and contents	Hours
Language-Basic Content: Review of grammar, Remedial study of grammar, building vocabulary Introduction Parts of speech Exercise on use of grammar Tense, Number, Gender **Assessment methods:** Objective type, Fill in the blanks. Content: Read and comprehend prescribed course books Reading, Summarizing, Comprehension **Assessment methods:** Fill in the blanks and one-mark questions Content: Various Forms of Composition Letter writing Note taking Precise	**18**

writings Diary writing Reports on health problem etc. Official correspondence: Outgoing correspondence, replying incoming correspondence, writing circulars, notices, charge memos, note taking, writing summaries, observation reports. Teaching learning activities: Exercise on writing: Letter writing, resume/CV Essay writing. **Assessment methods**: Applications, short reports to be written. Content: English- Spoken mode, Debates, Telephonic conversion, formal & informal conversation: Agreeing emphasizing, interrupting, politely, opinions, interviews, visual presentation. Teaching learning activities: Participating in seminar, Telephonic conversion, conversation in different situations, practice in public speaking **Assessment methods:** Assessment of the skills based on the checklist. Content: Listening to comprehension media, audio, video, speeches, definition of listening, types of listening, purposes of listening, obstacles for listening, contexts of listening, to be a good listener, listening to a lecture etc. Teaching learning activities: Listening to audio, video tapes and identify the key points. **Assessment methods:** Practical test of listening and filling out the blanks, essay type.	

Suggested Books

S.No.	Title of Book	Author	Publication
1	Communicative English for General Nursing Students	Tom Koorkkakala	K.J. Publications
3	How to write and speak Better, Reader's	John Ellison Kahn	Reader's Digest Association
4	Communication and Soft Skill Development	Ashwini Deshpande	Career Publications

B.MRIT Radiology Clinical Education – part I (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in every semester.
- Provide simulation and skill labs for practicing skills specific to the program in the initial years of observership/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
- All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship.

Second Semester

BACHELOR OF MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (B.MRIT)

Teaching and Examination Scheme

Course Name : Bachelor in Medical Radiology and Imaging Technology

Duration of Program: Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks
Semester : **Second**

S. N.	Course Title	Course Code	Teaching Scheme				Examination Scheme									
							Theory					Practical				
								CIE	ESE	Total		CIE	ESE	Total		Grand Total
			L (hrs/ week)	T	C/ P (hrs/week)	Credits (L+T+P)	Exam Durati in Hrs.	Max Marks	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Basics of Microbiology	B.MRIT -011	2	--	--	2	2.5	30	70	100	50	--	--	--	--	100
2.	Basics of Biochemistry	B.MRIT -012	2	--	--	2	2.5	30	70	100	50	--	--	--	--	100
3.	Conventional Radiography and Equipment	B.MRIT -013	4	--	2	5	2.5	30	70	100	50	--	--	--	--	100
4.	Clinical Radiography Positioning (Part I)	B.MRIT -014	4	1	6	8	--	30	70	100	50	30	70#	100	50	200
5.	B.MRIT Radiology Clinical Education – part II (studentship)		--	--	15	5	--	--	--	--	--	--	--	--	--	--
	Total		**12**	**1**	**23**	**22**	--	--	--	400	--	--	--	100	--	500

Student Contact Hours Per Week: 36**Hrs.Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks **: 500**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L - Lectures, T - Tutorial, P - Practical
*Internal Assessment, # External Assessment.

Basics of Microbiology

RATIONALE

Basics of Microbiology helps students to gain information about structure, metabolism reproduction,function and diseases caused by bacteria, viruses, bacterial viruses, animal viruses, archaea, mycoplasma and Phytoplasma. It also makes students aware of the nature and other important aspects of the microorganisms.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Describe the structure, classification, morphology and growth of bacteria.	L1
CO2	Describe the methods of sterilization and disinfection and their applications.	L2
CO3	Explain the concepts of immunity, hypersensitivity and immunization.	L2
CO4	Describe nosocomial infections and methods for prevention of hospital-acquired infections.	L2
CO5	Describe the management of biomedical waste.	L3
CO6	List the common fungi and viruses and explain their importance.	L1

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	**100**
2	**--**	**--**	**2**	**70**	**30**	**--**	**--**	

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours
I	Morphology of Bacteria: (Structure, size, shape, arrangement cell wall, flagella, spore, capsule, fimbria) Physiology of Bacteria: (Bacterial growth curve, Temp, O2, Co2, micro and macro nutrient growth requirements) Culture Media Culture Methods Antimicrobial sensitivity tests Sterilization and Disinfections: Definition, Dry heat Sterilization, Moist heat Sterilization, Chemical disinfectants, Gaseous disinfection, Test for disinfection / Sterilization control	**9**
II	Infection: Classification, Sources of infection, Modes of transmission Nosocomial infection including biomedical waste management:Definition, Classification, Significance, Prevention and control Biomedical waste management	**8**
III	Immunology: Immunity, Antigen, Antibody, Hypersensitivity	**5**
IV	General Properties of fungi. (General characters, classification, Morphology, Reproduction) General Properties of Viruses. (General character, classification based on Genome, Capsid, Envelope & replication and cultivation of virus).	**7**
V	Applied Microbiology: Pyrexia of unknown origin, Meningitis, Zoonotic infections, Hepatitis, HIV infection and AIDS, Food poisoning, Diarrhea, Urinary tract infections, Pulmonary Tuberculosis	**7**
Total		**36**

Evaluation system
Continuous internal evaluation

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit	Marks (± 5%)
Unit I	26
Unit II	20
Unit III	13
Unit IV	22
Unit V	15
Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Text book of Microbiology	Ananthnarayana&Panikar	University Press
2	Text book of Microbiology	Baveja	Arya Publications
3	Text book of Microbiology	Sathish Gupte	JPB
4	Textbook of Microbiology	Dr Arora	CBS Publishers & Distributors Pvt. Ltd

Basics of Biochemistry

RATIONALE

Biochemistry is a key component of all education programmes for MRITs and should have a strong focus on

laboratory investigation with radiological procedures. The topics provide the student with an understanding of the blood investigation and relationships of the systems which are essential in patient preparation and procedures.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Understand the responsibility of healthcare personnel and hazards faced in the clinical laboratory.	L2
CO2	Explain the different types, uses, care and maintenance of laboratory apparatus and instruments.	L2
CO3	Understand the fundamental chemistry and knowledge of different solutions.	L2
CO4	Understand what acids, bases, salts and indicators are and also know about acid-base balance.	L2
CO5	Describe the sample collection procedure to analyze various biochemical parameters.	L3
CO6	Describe assimilation of nutrients and consequences of malnutrition.	L2
CO7	Understand the different functional tests like LFT (Liver Function Test) and RFT (Renal Function Test).	L2
CO8	Understand the overview of tumor markers, cardiac markers, blood sugar and GTT, lipid profile and diagnostic enzymology.	L2
CO9	Describe the applications of radioisotopes.	L1

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**--**	**--**	**2**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours
I	**Nutrition** Calorific value Nitrogen Balance Respiratory quotient BMR Nutritional importance of carbohydrate, lipids, proteins, vitamins and minerals Emphasis on parenteral nutrition	9
II	**Acid–Base Balance** Henderson Hassel Bach equation Buffers of the body fluids Ph regulation Disturbance in acid base balance Anion gap Basic principles & estimation of blood gases and ph. **Water & Electrolyte balance** Over view of water and electrolyte balance Basic principles in estimation of Electrolyte Normal values and interpretation	9
III	**Clinical chemistry** **Brief over view of normal values and interpretation of results** Renal function tests Liver function tests Tumor markers Cardiac markers Diagnostic Enzymology Lipid profile	9

	Blood sugar and GTT Normal & Abnormal urine analysis	
IV	Radioisotopes: Definition, Application &Hazards Normal and abnormal urine analysis Clinical charts on LFT, RFT, and diagnostic enzymology	**9**
	Total	**36**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70

Duration (minutes)	180

Question Paper Blueprint

Unit		Marks (± 5%)
1.	Introduction to Clinical Biochemistry, Chemicals & Reagents, Preparation of solution, Specimen collection and handling	25
2.	Nutrition	20
3.	Acid–Base Balance; Water & Electrolyte balance	22
4.	Clinical chemistry; Brief over view of normal values and interpretation of results	14
5.	Radioisotopes: Definition, Application & Hazards	15
6.		
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Text Book of biochemistry for dental students	Vasudevan, Sreekumari, Kannan Vaidyanathan	Jaypee Brothers
2	Biochemistry for Physiotherapy and allied health sciences students.	Nandini M, Beena V Shetty, Vinitha Ramanath Rai	Jaypee Brothers Medical Publisher (India)
3	Clinical chemistry	Varley	CBS Publishers & Distributors
4	Textbook of biochemistry for paramedical students	P Ramamoorthy	Jaypee Brothers Medical Publishers

Conventional Radiography and Equipment

RATIONALE

Conventional Radiography and Equipment provide the students' knowledge about the x-ray equipment working and also about how x-rays are produced.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Describe the structure and working of X-ray tube and production of X-rays.	L2
CO2	Describe the types of X-ray tubes and heat dissipation methods.	L1
CO3	Explain the X-ray generator circuits.	L2
CO4	Describe the different circuit types.	L1
CO5	Describe the meters and exposure timers.	L1
CO6	List the control methods of scattered radiation.	L1
CO7	Describe fluoroscopy.	L2
CO8	Explain the care and maintenance of X-ray equipment.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
4	**--**	**2**	**5**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable tutorial assignments of minimum one hour per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours
I	**X-ray tube:** historical aspects, construction of X-ray tubes, requirements for X-ray production(Electron source, target and anode material), tube voltage, current, space charge, early X-ray tubes(Coolidge tubes, tube envelop and housing) cathode assembly, X-ray production efficiency, advances in X-ray tubes, anode angulation and rotating tubes-line focus principle-space charge effect, tube cooling-Modern X-ray tubes-stationary anode, rotating anode, grid controlled X-ray tubes, heel effect, off focus radiation, tube insert and housing-Tube rating-Quality and intensity of x-rays-factors influencing them. **Production of x-rays:** X-ray tube, gas filled x-ray tube, construction working and limitations; stationary anode x - ray tube; construction, working, methods of cooling the anode, rating chart and cooling chart;	**10**
II	**Rotating anode x - ray tube:** construction, working rating chart, speed of anode rotation, angle of anode inclination, dual focus and practical consideration in choice of focus, anode heel effect, grid controlled x - ray tube; effect of variation of anode voltage and filament temperature; continuous and characteristics spectrum of x - rays, inherent filter and added filter, their effect on quality of the spectrum. **Grid controlled and high speed tubes**, focal spot size, speed of anode rotation, target angle, inherent filtration, radiation leakage and scattered radiation).Interlocking and X-ray tube overload protection. **Heat dissipation methods**, tube rating, heat units, operating conditions and maintenance and Q.A procedures.	**10**
III	**Filament current and voltage**, X-ray circuits (primary circuit, auto transformer), types of exposure switch and timers, principle of automatic exposure control (AEC) and practical operation, filament circuit, high voltage circuits, half wave, full wave rectification, three phase circuits. Types of generators, 3 phase, 6 and 12 pulse circuits-high frequency generators-falling load generators, Capacitors discharge and grid control systems. **X-ray generator circuits:** Vacuum tube diodes-semi-conductor diodes-transistor-Rectification-half and full wave-self rectification-X-ray generator; filament circuit-kilo Voltage circuit-single phase generator-three phase generator-constant potential generator-Fuses, switches and interlocks-Exposure switching and timers-HT cables-earthing.	**10**
IV	**High tension circuits:** H.T. generator for x-ray machines, three phase rectifier circuits, three phase six rectifier circuit, three phase 12 rectifier circuit, high and medium frequency circuits; capacitance filter control and stabilizing equipment;	**10**

	mains voltage compensator, mains resistance compensator, compensation for frequency variation, control of tube voltage, kV compensator; high tension selector switch, filament circuit, control of tube current, space charge compensation. **Interlocking circuits: Relays:** description and working, use of relays in diagnostic machines for over load protection, circuit diagram; simplified circuit and block diagrams illustrating sequence of events from mains supply to controlled emission of x-rays.	
V	**Meters and exposure timers:** Moving coil galvanometer: construction and working/conversion to millimeter, ammeter and voltmeter, meters commonly used in diagnostic x-ray machines, pre reading kV meter and millimeter, digital panel meters. Clockwork timers, synchronous motor timer, electronic timers, photo metric timers (fluorescent and photoelectric effect as applied in timers), ion chamber-based timers, integrated timer.	**10**
VI	**Control of scattered radiation: Beam limiting devices:** cones, diaphragms, light beam collimator, beam centering device, methods to verify beam centering and field alignment; Filters- inherent filters, added filters, heavy metal filters, grids; design and control of scattered radiation, grid ratio, grid cut-off, parallel grid, focused grid, crossed grid, grided cassettes, stationary and moving grid potter bucky diaphragms, various types of grid movements; single stroke movement, oscillatory movement and reciprocatory movement.	**8**
VII	**Fluoroscopy:** Fluorescence and phosphorescence - description, fluorescent materials used in fluoroscopic screens, construction of fluoroscopic screen and related accessories, tilting table, dark adaptation. Image intensifier - Construction and working, advantages over fluoroscopic device, principles and methods of visualising intensified image, basic principles of closed circuit television camera and picture tube. Vidicon camera, CCD. Automatic brightness control, automatic exposure control, chamber selection during fluoroscopy. Serial radiography: Manual cassette changer, rapid automatic film changer, basic principles of cine fluoroscopy and angiography use of grid controlled x-ray tube.	**8**
VIII	**Care and Maintenance of X-ray equipment;** General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot of an x-ray tube, testing the light beam diaphragm, practical precautions pertaining to Brakes and locks, H.T. cables, meters and controls, tube stands and tracks as well as accessory equipment.	**6**
Total		**72**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the structure and working of X-ray tubes, X-ray production, and heat dissipation methods used in radiological equipment.	L2
CO2	Describe the principles and functions of X-ray generator circuits, high-tension circuits, interlocking circuits, relays, meters, and exposure timers.	L2
CO3	Apply the concepts of beam limiting devices and scattered radiation control techniques in radiographic procedures.	L3
CO4	Demonstrate knowledge of fluoroscopy and the care and maintenance of X-ray equipment for safe and efficient operation.	L3

Sr. No		Hours
1.	X-ray tube; Production of x-rays	5
2.	Rotating anode x - ray tube; Grid controlled and high speed tubes; Heat dissipation methods	4
3.	Filament current and voltage; X-ray generator circuits	5
4.	High tension circuits; Interlocking circuits; Relays	5
5.	Meters and exposure timers	5
6.	Control of scattered radiation: Beam limiting devices	4
7.	Fluoroscopy	4
8.	Care and Maintenance of X-ray equipment	4
	Total	36

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

Question Paper Blueprint

Unit	TOPICS	Marks (± 5%)
1.	X-ray tube; Production of x-rays	16
2.	Rotating anode x - ray tube; Grid controlled and high speed tubes; Heat dissipation methods	15

3.	Filament current and voltage; X-ray generator circuits	10
4.	High tension circuits; Interlocking circuits; Relays	10
5.	Meters and exposure timers	9
6.	Control of scattered radiation: Beam limiting devices	16
7.	Fluoroscopy	10
8.	Care and Maintenance of X-ray equipment	10
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Radiographic Imaging (Cbs)I.C.R.P.	D.N. Chesney & M.O Chesney	CBS Publishers & Distributors
2	An Introduction Of Physics to Diagnostic Radiography	Christensen, Curry & Dowdey	Lea & Febiger
3	Radiological Science for technologists	Stewart C Bushong	Mosby
4	Equipment for Diagnostic Radiography	E. Forster	Springer Dordrecht
5	The Physics Of Radiology And Imaging	K Thayalan	Jaypee

Clinical Radiography Positioning (part I)

RATIONALE

Clinical Radiography Positioning Part- 1 provides the students with knowledge of x-ray imaging, positioning and all the care that should be taken.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Understand the basic patient positioning during radiographic investigation.	L2
CO2	Apply special positioning skills for different pathological and physical conditions.	L3
CO3	Apply equipment while working in radiology departments.	L3
CO4	Choose the proper position during radiography.	L3
CO5	Explain the relative positions of the X-ray tube and patient, and relevant exposure factors during radiography.	L2
CO6	Explain the use of accessories.	L2
CO7	Explain the anatomical and physiological basis of the procedure to be undertaken.	L2
CO8	Explain the radiographic appearances of both normal and common abnormal conditions.	L4

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
4	**1**	**6**	**8**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable tutorial assignments of minimum one hour per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified

competency.

Unit	Topic and contents	Hours
I	**Principles of Radiography:** Preparation of the Room, Apparatus and Instruments Positions of the Patient: Erect, Sitting, Supine, Prone, Lateral, Oblique, Decubitus Etc. Relative position of X-Ray tube and patient, relevant exposure factors. Use of accessories such as radiographic cones, grid and positioning aids. Anatomic and Physiological basis of the procedure, Association with theory with practical work. Radiographic appearances, both normal and common abnormal conditions where elementary knowledge of the pathology involved will ensure the application of the appropriate radiographic technique. Modifications in technique for various disabilities and types of subject. Radiation protection, use of gonad shield, practical methods of reducing radiation dose to the patient.	**8**
II	**Upper limb:** Routine projections for the whole hand, fingers, wrist joint, forearm, elbow joint and humerus. Supplementary projections for Scaphoid, Carpal tunnel, Ball Catchers projections, Head of the Radius, Supracondylar fracture and Olecranon process	**10**
III	**Lower limb:** Routine projections for the whole foot, toes, calcaneum, ankle joint, leg, knee-joint, patella and femurs. Supplementary projections for Talo-Calcaneal joint, Forced projections for torn ligaments, Flat Feet, Club Feet, Intercondylar projections for loose bodies in the knee, Axial projection for Patella.	**10**
IV	**Shoulder Girdle and Thorax:** Routine projections for the shoulder joint, Scapula, Acromio-Clavicular joint, Clavicle, Sternoclavicular joint, Sternum and Ribs. Supplementary projections for the axial projection of Clavicle, Bicipital groove, Coracoid process.	**10**

V	**Vertebral Column:** Routine projections for Atlanto -Occipital joint, cervical spine, Cervico- thoracic Junction, thoracic Spine, lumbar Spine, Lumbo Sacral Region, Sacrum and Coccyx. Supplementary projections for the intervertebral foramina, posterior arch of Atlas, Flexion and Extension of Cervical Spine, Scoleosis and Kyphosis, Sacro Ileac Joint.	**12**
VI	**Skull:** Routine projections for cranium and facial bones; Supplementary projections for trauma, Towne's method, Sellaturcica, Optic foramina, Jugular foramina, Temporal bones, Mastoids, Petrous bone, Zygomatic arches, Orbits, Maxillae, Nasal bones, Mandible, Temporomandibular joints. Nasal Sinuses: Techniques for Frontal, Maxillary, Ethmoidal and Sphenoid Sinuses, erect and horizontal projections for fluid levels.	**12**
VII	**Pelvic girdle and hip region:** Routine projections for the whole pelvis, Sacro-Ileac joints, hip joint and Neck of Femur. Supplementary projections for the greater and lesser trochanters of Femur. Frog leg projection, Ischeum, Symphysis Pubis, Ileum, Acetabulum and Congenital Dislocation of Hip, Arthrodesis. **Skeletal survey:** Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders.	**10**
Total		**72**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Demonstrate the principles of radiography and perform appropriate patient positioning for routine radiographic examinations.	L3
CO2	Apply radiographic positioning techniques for the upper limb, lower limb, shoulder girdle, thorax, vertebral column, skull, pelvic girdle, and hip region.	L3
CO3	Analyze radiographic images and perform skeletal survey examinations to obtain diagnostically acceptable radiographs.	L4

Sr. No		Hours
1.	Principles of Radiography	15
2.	Upper limb	17
3.	Lower limb	17
4.	Shoulder Girdle and Thorax	14
5.	Vertebral Column	15
6.	Skull	15
7.	Pelvic girdle and hip region, Skeletal survey	15
	Total	**108**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit	TOPICS	Marks (± 5%)
1.	Principles of Radiography	13
2.	Upper limb	15
3.	Lower limb	13
4.	Shoulder Girdle and Thorax	13
5.	Vertebral Column	15
6.	Skull	13
7.	Pelvic girdle and hip region, Skeletal survey	14
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Atlas of Radiographic Positioning and Radiological Procedures	Philip W Ballinger, Eugene D. Frank	Mosby
2	Clarks Positioning In Radiography	Ra Swallow, E Naylor	Lippincott Williams and Wilkins
3	Merrill's Atlas of Radiographic Positioning and Procedures	Bruce W. Long &Jeannean Hall Rollins & Barbara J. Smith	Mosby
4	Bontrager's Textbook Of Radiographic Positioning And Related Anatomy	John Lampignano and Leslie E Kendrick	Elsevier Science
5	Radiology Of Positioning And Applied Anatomy For Students And Practitioners	Garkal Gs	Jaypee Brothers Medical Publishers
6	A Guide on Special Radiographic Investigations & Techniques	Lalit Agarwal	JBD Publications

B.MRIT Radiology Clinical Education – part II (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in every semester.
- Provide simulation and skill labs for practicing skills specific to the program in the initial years of observership/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
- All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship.

Third Semester

BACHELOR OF MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY

(B.MRIT)

Teaching and Examination Scheme

Course Name: Bachelor in Medical Radiology and Imaging Technology

Duration of Program: Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks
Semester : **Third**

S.N.	Course Title	Course Code	Teaching Scheme				Examination Scheme									
							Theory					Practical				Grand Total
			L (hrs/week)	T	C/ (hrs/week)	Credits (L+T+P)	Exam Duration in Hrs.	CIE	ESE	Total		CIE	ESE	Total		
								Max Marks	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Pathology	BMRIT -015	2	--	--	2	2.5	30	70	100	50	--	--	--	--	**100**
2.	Clinical Radiography Positioning (Part II)	BMRIT-016	2	1	6	6	2.5	30	70	100	50	30	70#	100	50	**200**
3.	Radiography and Image Processing Techniques	BMRIT-017	2	--	2	3	2.5	30	70	100	50	--	--	--	--	**100**
4.	Contrast Media& Special Radiological procedures	BMRIT-018	2	1	6	6	2.5	30	70	100	50	30	70#	100	50	**200**
5.	B.MRIT Radiology Clinical Education – part III (studentship)		--	--	12	4	--	--	--	--	--	--	--	--	--	--
	Total		**6**	**4**	**26**	**21**	**--**	**--**	**--**	**400**	**--**	**--**	**--**	**200**	**--**	**600**

Student Contact Hours Per Week: 36**Hrs.Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks **: 600**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L - Lectures, T - Tutorial, P - Practical

*Internal Assessment, # External Assessment.

*Internal Assessment (Institutional Level examination) marks are not to be counted for the grade at the end of the semester.

Pathology

RATIONALE

Pathology helps students to learn about the advances in basic science and clinical pathology. And help students learn and classify the type of diseases, to help learn about the mechanism of action of various diseases and to gain knowledge on lab tests

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Define the term "Disease" and the concepts of disease.	L1
CO2	Define and classify diseases and the medical terms used.	L1
CO3	Describe the causes and mechanisms of common diseases encountered during routine work.	L2
CO4	Describe common changes seen in diseased persons in different organs, tissues, and body fluids.	L2
CO5	List the common laboratory tests used to diagnose diseases through examination of urine, blood, other body fluids, and tissues.	L1
CO6	Enumerate the proper methods of collection, preservation, and delivery of samples to the respective laboratories.	L2
CO7	Describe the procedures of procuring whole blood or blood components from a blood bank and the complications of blood transfusion.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**--**	**--**	**2**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Introduction to Pathology, Cell membrane, Cytoplasm, contents and nucleus Various injuries – Cell changes – Reversible changes, fatty liver, hydropic changes and Irreversible changes Irreversible changes – Necrosis. Types with examples. Apoptosis Pigments – Classification. Bilirubin, melanin, pathological calcification Inflammation – Definition, classification, signs, vascular & cellular events in acute inflammation Repair and wound healing, fracture healing, complications, factors influencing healing Infectious diseases – Tuberculosis, leprosy, fungal diseases, malaria	**7**	**10**
II	Oedema – Definition, classification, causes, pathogenesis. Pulmonary oedema, cardiac oedema, Renal oedema, Lymphedema Thrombosis – Definition, classification, pathogenesis, venous and arterial thrombosis, fate of thrombus Embolism – Definition, classification and clinical manifestations – Infarction, gangrene Cellular adaptations and Growth disorders: Atrophy, hypertrophy, hyperplasia, metaplasia, dysplasia and neoplasia Neoplasia (Tumors) – Definition, nomenclature, differences between benign and malignant tumors metastasis Causes (carcinogens), clinical features and lab diagnosis of cancers Genetics – Genetic diseases, cause, Common cytogenic diseases – Klinefelter, Downs and Turners syndrome. Complete urine examination – physical, chemical, microscopy of sediment Liver function tests, Renal function tests Cytology, FNAC, Surgical pathology, biopsy, resected specimen preservation, fixation and filling of request forms	**8**	**15**

III	Blood collection for investigations, anticoagulant. Sample collection, labeling, transportation to labs Common hematological tests – Peripheral blood smear, Haemoglobin, Packed cell volume, WBC count – variation of total and differential leukocyte count, Platelet count Bone marrow Aspiration and biopsy; Indications, procedure, contraindications and complications Anemias – Definition, classification, Iron deficiency anemia, causes, clinical features and lab diagnosis Megaloblastic anemia – cause, classification, diagnosis. Briefly hemolytic anemia Leukemia – Definition, classification, lab diagnosis of Acute Leukemias (AML & ALL) and Chronic Leukemias (CML & CLL) Bleeding disorders – Classification, Vascular, Platelet and coagulation factors contribution in clotting. Common Platelet disorders Common coagulation disorders (Hemophilia, DIC). BT, CT, Prothrombin time and APTT for diagnosis Blood grouping, cross matching, collection of blood from blood donors. Mandatory tests done in blood bank, blood components, complications of blood transfusion and its evaluation	**7**	**15**
IV	Osteomyelitis – Acute and chronic, Tubercular, causes, pathology & its complications Diseases of joints – Osteoarthritis and Rheumatoid arthritis – causes, aetiopathogenesis, pathology, complications Metabolic disease of bones – Osteoporosis, Osteomalacia, Rickets Cardiovascular diseases – Introduction, Atherosclerosis – definition, risk factors, sites/ organs, pathology manifestations, complications. Aneurysms – types, causes and complications Ischemic heart disease (IHD) – Types, Pathogenesis of Angina, Myocardial infarctions and its complications Rheumatic heart disease – etiology, pathogenesis and morphology of the heart Hypertension – definition, causes, complications Heart failure – Causes, pathophysiology, clinical manifestations and complications	**7**	**15**
V	Respiratory diseases – Chronic obstructive pulmonary	**7**	**15**

	airway diseases – causes, pathology and complications of each (asthma, chronic bronchitis, emphysema, Broncheictasis in brief). Pneumonia – classification, clinical features and morphology Pulmonary tuberculosis – classification/ types, primary, complex, miliary TB and cavitatory TB, complications Pleural effusion – definition, causes, clinical features and diagnosis Renal system; Glomerulonephritis, nephritic and nephrotic syndrome. Tubulointerstitial diseases, Renal failure – Acute and chronic Pyelonephritis – Types, causes, organ changes and complications. Renal stones – Causes, pathogenesis, clinical features. Hydronephrosis – causes, clinical features and diagnosis		
Total		**36**	**70**

Practical

Course Outcome (CO)

Sr. No.	Course Outcome (CO)	Bloom's Level
CO1	Describe and identify gross and microscopic features of common pathological conditions including fatty liver, tuberculosis lymphadenitis, acute appendicitis, granulation tissue, atherosclerosis, myocardial infarction, rheumatic valvular lesions, renal and pulmonary diseases.	L2
CO2	Differentiate benign and malignant tumors based on gross morphology, microscopic appearance, patterns of metastasis, and explain mechanisms of thrombosis, atrophy, hypertrophy, and neoplastic progression.	L4
CO3	Demonstrate laboratory procedures including blood collection techniques, anticoagulant selection, hematological investigations (Hb%, PCV, ESR, peripheral smear, bone marrow aspiration), blood grouping, cytology, histopathology specimen handling, fixation, biopsy processing, and request form preparation.	L3
CO4	Interpret hematological and pathological findings in anemia, leukemia, transfusion medicine, renal disorders, cardiovascular diseases, and respiratory diseases for clinical correlation and diagnosis.	L4

SUGGESTED PRACTICALS/DEMONSTRATION

Sr.No		Hours
	• Fatty liver – Gross & Microscopy • T.B. Lymphadenitis – Gross & Microscopy • Acute Appendicitis – Gross & Microscopy • Granulation tissue – Microscopy • Mechanism of thrombosis, Sites & complications and clinical features (effects) • Atrophy & Hypertrophy (Heart). • Benign tumors - Squamous papilloma – Gross & Microscopy, Adenoma Colon o Gross & Microscopy, Leiomyoma uterus – Gross & Microscopy; • Malignant tumors - Squamous cell carcinoma – Gross & Microscopy, Adenocarcinoma colon – Gross & Microscopy, Malignant melanoma skin – Gross & Microscopy, Osteosarcoma bone – Gross & Microscopy • Metastasis – Lung, liver, lymph nodes (specimens) • Blood collections – Containers, Anticoagulants Hb%, PCV, ESR, Peripheral smear and Bone marrow aspiration • Cytology – Body fluids, FNAC. • Histopathology – Specimens, biopsies, fixatives. Request form writing.	6
	• Blood grouping, Transfusion complications, components. • Anemias – Microcytic hypochromic, Megaloblastic (slides) • Leukemia – AML & CML (Slides) • Atherosclerosis, MI, Rheumatic valvular lesions • Renal stones, hydronephrosis, chronic pyelonephritis (specimens) • 18. Lung – Pneumonias, pulmonary tuberculosis cavitatory lung abscess (specimens).	
	Total	6

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		

	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit	Marks (± 5%)
Unit I	16
Unit II	20
Unit III	20
Unit IV	20
Unit V	20
Total Marks (including optional questions)	96

SUGGESTED LEARNING R RESOURCES

S.No.	Title of Book	Author	Publication
1	Textbook of Pathology with Pathology	Harsh Mohan	Jaypee Brothers Medical Publishers (P) Ltd
2	Pathology Basis of Disease	Robbins and Cotran	Saunders Elsevier
3	Text book on Pathology for DMLT & Paramedical Courses	Dr. I Clement	Emmess medical publishers
4	Text book of Pathology & Microbiology for Paramedical Students	Aruna Singh	Notion Press

Clinical Radiography Positioning (Part- II)

RATIONALE

Clinical Radiography Positioning Part-2provides the students with knowledge of x-ray imaging, positioning and all the care that should be taken. To improve skills and knowledge on patient positioning for students' MRIT and to identify radiological pathologies and to gain knowledge on radiographic anatomy. They also gain knowledge of image quality in radiological images and management of patients in emergency situations.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Prepare management and positioning of patients.	L3
CO2	Correlate the indications and contraindications of the patient.	L4
CO3	Understand the patient preparations needed before any radiological examination.	L2
CO4	Generalize knowledge of post-procedural care.	L2
CO5	Position patients for radiological procedures.	L3
CO6	Understand image quality in radiological images.	L2
CO7	Manage patients in the radiology department for various procedures.	L3
CO8	Handle emergency situations in the radiology department.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**1**	**6**	**6**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Dental Radiography** Technique for intra oral full mouth. - Occlusal projections. - Extra oral projections including orthopantomography. - Supplementary techniques. **Upper respiratory system** Technique for postnasal airways, larynx, trachea, thoracic inlet, Valsalva maneuver. - Phonation.	5	10
II	**Lung and Mediastinum:** Supplementary projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated postero-anterior projection. - Expiration technique. - Technique for pleural fluid levels and adhesions. **Abdominal viscera-** Technique for plain film examination. - Projection for acute abdomen patients. - Technique to demonstrate: Foreign bodies, Imperforate anus.	6	10
III	**Radiography using mobile X-ray equipment- Radiography in the ward:** Radiography in the specialized unit, such as: Intensive care unit, Coronary care, Neonatal unit Radiography in the operating theatre**.** **Mammography:** Basic views, special views, wire localization. **Localization of foreign bodies.** Various techniques	5	10
IV	**Ward /mobile radiography –** electrical supply, radiation protection, equipment and instructions to be followed for portable/ward radiography. **Operation theatre techniques:** General precautions, Asepsis in techniques - Checking of mains supply and functions of equipment, selection of exposure factors, explosion risk, radiation protection and rapid processing techniques. **Trauma radiography/Emergency radiography**	**5**	**10**
V	**Neonatal and Pediatric Radiography, Forensic Radiography Microradiography:** General principles, Requirement, Equipment, Technique.	**5**	**10**

VI	**Soft Tissue Radiography:** High and low kilo voltage technique; differential filtration. Non - screen technique - simultaneous screen and non -screen technique. **Multiple radiography.** Uses of soft tissue radiography. **High kV Radiography:** General principles Relation to patient dose Change in radiographic contrast. **Scatter elimination; beam collimation; grid ratio. Speed and type of grid movement.** **Radiographic factor; application and uses.**	**5**	**10**
VII	**Localization of foreign bodies:** General location principles. Ingested; inhaled; inserted; embedded foreign bodies. Foreign bodies in eye. Preparation of the area to be investigated. Appropriate projection for all Techniques to locate non-opaque foreign body.	**5**	**10**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Demonstrate radiographic techniques and positioning for dental, upper respiratory system, chest, mediastinum, abdominal, and soft tissue examinations.	L3
CO2	Apply radiographic procedures in specialized areas including ward radiography, mammography, operation theatre imaging, and C-arm examinations.	L3
CO3	Perform radiographic examinations in neonatal, pediatric, forensic, micro-radiography, and multiple radiography procedures.	L3
CO4	Analyze the effects of scatter radiation, beam collimation, grid ratio, grid movement, and radiographic factors on image quality.	L4
CO5	Apply localization techniques for foreign bodies and select appropriate exposure factors to obtain diagnostically acceptable images.	L3

Sr. No		Hours
1.	Dental Radiography; Upper respiratory system	20
2.	Lungs and Mediastinum; Abdominal viscera	20
3.	Radiography in the ward; Mammography	20
4.	Operation theatre techniques; C-arm	20
5.	Neonatal and Paediatric Radiography; Forensic Radiography Microradiography	10
6.	Soft Tissue Radiography Multiple radiography High kV Radiography Scatter elimination; beam collimation; grid ratio Speed and type of grid movement Radiographic factor; application and uses	10
7.	Localization of foreign bodies	8
	Total	108

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit		Marks (±5%)
1.	Dental Radiography; Upper respiratory system	14
2.	Lungs and Mediastinum; Abdominal viscera	14
3.	Radiography in the ward; Mammography	14
4.	Operation theatre techniques; C-arm	14
5.	Neonatal and Paediatric Radiography; Forensic Radiography; Macroradiography	14
6.	Soft Tissue Radiography Multiple radiography High kV Radiography Scatter elimination; beam collimation; grid ratio Speed and type of grid movement Radiographic factor; application and uses	14
7.	Localization of foreign bodies	12
SUGGESTED LEARNING RESOURCES	**Total Marks (including optional questions)**	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Radiological positioning	Merils	Mosby
2	A guide to radiological positioning	Clarks	CBS publishers and distributors pvt. Ltd
3	Radiology Of Positioning And Applied Anatomy For Students And Practitioners	GarkalGs	Jaypee Brothers Medical Publishers

4	Bontrager's Textbook of Radiographic Positioning and Related Anatomy	John Lampignano), Leslie E. Kendrick	Mosby
5	A concise Guide on Basic Radiographic Physics Darkroom Procedures, Radiographic Positioning & Techniques	Lalit Agarwal	JBD Publications

Radiography and Image Processing Techniques

RATIONALE

Radiography and Image processing techniques provides construction and working of film, intensifying screen, cassette, dark room and automatic processor.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Know the basic physics of the radiographic processing system.	L1
CO2	Describe the construction and working of film, intensifying screen, cassette, dark room, and automatic processor.	L2
CO3	Explain radiographic film processing chemistry.	L2
CO4	Discuss the factors affecting image quality in radiographic images and their application.	L2
CO5	Operate the workflow in X-ray imaging.	L3
CO6	Apply knowledge for the use of radiation factors.	L3
CO7	Demonstrate processing of radiographic films in different systems.	L3
CO8	Prepare and perform care and maintenance of radiographic films, cassettes, intensifying screens, darkroom accessories, and X-ray equipment.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**--**	**2**	**3**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Photographic Principles:** Radiographic film- construction and types; Photographic effect and latent image formation; Film density and log relative exposure; Characteristic curve – its formation and features; Spectral response; Film faults and Artifacts Intensifying Screens: Luminescence-fluorescence and phosphorescence; Construction and types of Intensifying Screens; Intensification Factor, quantum detection and conversion efficiency; Film screen matching; Resolving power of Intensifying Screens; Speed of intensifying screen; Screen film contact tests; Advantages and limitations of Intensifying Screens X-ray Cassette: Construction of X-ray cassettes; Types of cassettes; Mounting Intensifying Screens on cassettes; Care and maintenance of cassettes	**9**	**20**
II	**Dark Room – Planning & Construction:** Planning for a small & large Hospital; Location of Dark Room; Construction of Dark Room; Ventilation; Wall Protection; Entrance to Dark Room - Single Door, Double Door, Labyrinth Dark Room Accessories: Dry bench; Hopper, Drawer, Cupboard; Loading and unloading cassettes; Hangers, types of hangers and storage of hangers; Wet bench; Cleanliness, control of dust, dark room sinks; Hatches; Drier; Safe Lights-types and uses, factors affecting safelight performance, safelight Tests; Viewing room, Film dispensing	**7**	**15**
III	**Film Processing: Photochemistry;** Developer; Rinsing; Fixer; Washing and drying; Preparation of processing solutions; Manual processing apparatus; Effect of temperature in processing; Rapid processing Automatic processor: Principle of working and features, thermal regulation and replenishment system; Care and maintenance of automatic processor; Advantages and limitations of automatic processor	**7**	**15**
IV	Day Light Film handling; Xeroradiography, Stereoscopy	**5**	**5**

V	**The Radiographic Image:** The emergent beam related to densities on film contrast – objective and subjective Radiation contrast, film contrast and Radiographic contrast- Density, Sharpness, Unsharpness Resolution: Factors affecting resolution, choice of Kilovolt age and Mill amperage, Choice of Short Focus and Broad Focus, selection of Focus to Film Distance and Object to Film Distance selection of cassettes, Avoiding scatter radiation, magnification, distortion, penumbra Reproduction of Radiographs: Copying Radiographs, Magnification and Minification Radiography Imaging Communication: Hospital Information System, Radiology Information System, PACS, DICOM	**8**	**15**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Describe the structure, functions, and handling of radiographic films, intensifying screens, X-ray cassettes, and darkroom facilities.	L2
CO2	Demonstrate radiographic film processing techniques and apply the principles of photochemistry in image production.	L3
CO3	Analyze factors affecting radiographic image quality, including density, contrast, sharpness, unsharpness, resolution, and radiograph reproduction.	L4

Sr. No		**Hours**
1.	Radiographic film; IntensifyingScreens; X-ray Cassette	20
2.	Dark Room – Planning & Construction	6
3.	Film Processing; Photochemistry;	5
4.	The emergent beam related to densities on film contrast – objective and subjective Radiation contrast, film contrast and Radiographic contrast- Density, Sharpness, Unsharpness; Factors affecting resolution; Reproduction of Radiographs	5
	Total	36

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Radiographic film; IntensifyingScreens; X-ray Cassette	25
2.	Dark Room – Planning & Construction	20
3.	Film Processing; Photochemistry;	20
4.	Day Light Film handling; Xeroradiography, Stereoscopy	10
5.	The emergent beam related to densities on film contrast – objective and subjective Radiation contrast, film contrast and Radiographic contrast-Density, Sharpness, Unsharpness; Factors affecting resolution; Reproduction of Radiographs	21
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Radiographic Imaging (Cbs)I.C.R.P.	D.N. Chesney & M.O Chesney	Blackwell Scientific
2	An Introduction Of Physics to Diagnostic Radiography	Christensen, Curry & Dowdey	Lea & Febiger
3	Radiological Science for technologists	Stewart C. Bushong	Mosby
4	A Concise Guide on Basic Radiographic Physics Darkroom Procedures, Radiographic Positioning & Techniques	Lalit Agarwal	JBD Publications

Contrast and Special Radiological Procedures

RATIONALE

Contrast & Special Radiological Procedures are diagnostic procedures usually performed by giving contrast through oral or intravenous to diagnose the disease. These imaging procedures are done under the guided of fluoroscopy or c-ram equipment.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Prepare management and positioning of patients while performing radiological procedures.	L3
CO2	Correlate indications, contraindications, contrast media, radiation dose, exposure timing, and radiation safety measures for different radiological procedures.	L4
CO3	Understand the patient preparations needed before any radiological examination.	L2
CO4	Generalize knowledge of post-procedural care.	L2
CO5	Position patients for radiological procedures.	L3
CO6	Understand image quality in radiological images.	L2
CO7	Manage patients in the radiology department for various procedures.	L3
CO8	Ability to Handle emergency situations in the radiology department.	L3
CO9	Precautions and care required in interventional suits.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**1**	**6**	**6**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Introduction: General approach to Special Radiographic procedures, Responsibility of Radiology Technologist during radiological procedures, Preparation of patient for different procedures, Room layout in interventional radiology and fluoroscopy. Contrast Media: Positive and Negative, Ionic & Non Ionic, Adverse Reactions to contrast media and patient management. Emergency Equipment in the Radiology Department	**8**	**10**
II	Gastro Intestinal Tract: Barium Swallow; Barium Meal - Single and Double Contrast; Barium Meal Follow Through; Small Bowel Enema (Enteroclysis); Barium Enema - Gastrograffin Enema; Loopogram Biliary Tract: Oral & Intravenous Cholecystography; Percutaneous Transhepatic Cholengiography; Percutaneous Transhepatic Biliary Drainage; Endoscopic Retrograde Cholengiopancreatography	**10**	**20**
III	Urinary System: IVU (Intravenous Urography), Retrograde Pyeloureterography (RGU), Micturating Cysto Urethrography, Ascending Urethrography Reproductive System: HysteroSalpingogram, FTR (Fallopian Tube Recanalization)	**8**	**20**
IV	Central Nervous System: Cervical Myelography – Cisternal Puncture and Lateral Cervical Puncture, Lumbar Myelography, Myelography with water soluble and oily contrast media Respiratory System: Bronchography, Percutaneous Lung Biopsy Other procedures in radiology: Arthrography, Sialography, Lymphography, Sinography & Fistulography, Dacryocystography, Embolization & embolic agents	**10**	**20**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the general approach to special radiographic procedures and the responsibilities of the radiology technologist during these examinations.	L2
CO2	Apply knowledge of contrast media, recognize adverse reactions, and demonstrate appropriate patient management during radiological procedures.	L3
CO3	Perform and assist in radiographic procedures of the gastrointestinal and biliary systems using appropriate contrast techniques.	L3
CO4	Demonstrate radiographic procedures of the urinary, reproductive, central nervous, and respiratory systems following standard protocols.	L3
CO5	Analyze procedural requirements and radiographic outcomes to ensure safe and effective special radiological investigations.	L4

Sr. No		Hours
1.	General approach to special radiographic procedures, responsibility of radiology technologist during radiological procedures Contrast media and their adverse reactions to contrast media and patient management	25
2.	Procedures for gastrointestinal tract including barium studies Procedures for biliary tract	29
3.	Procedures for urinary system and reproductive system	29
4.	Procedures for central nervous system and respiratory system	25
	Total	108

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			

	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		Marks (± 5%)
1.	General approach to special radiographic procedures, responsibility of radiology technologist during radiological procedures Contrast media and their adverse reactions to contrast media and patient management	15

2.	Procedures for gastrointestinal tract including barium studies Procedures for biliary tract	27
3.	Procedures for urinary system and reproductive system	27
4.	Procedures for central nervous system and respiratory system	27
	Total Marks (including optional questions)	**96**

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1	Radiographic Imaging (Cbs)I.C.R.P.	Bhushan and Lakkhar	Arya Publications
2	A guide to radiological procedures	Chapman	Elsevier

B.MRIT Radiology Clinical Education – Part III (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in every semesters.
- Provide simulation and skill labs for practising skills specific to the program in the initial years of observership/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
- All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship.

Fourth Semester

BACHELOR OF MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (B.MRIT)

Teaching and Examination Scheme

Course Name : Bachelor in Medical Radiology and Imaging Technology

Duration of Program :Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks
Semester : **Fourth**

S.N	Course Title	Course Code	Teaching Scheme				Examination Scheme									
							Theory					Practical				
			L (hrs/week)	T	C/P (hrs/week)	L (hrs/week)	Exam Duration in Hrs.	CIE	ESE	Total		CIE	ESE	Total		Grand Total
								Max Marks	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Cross sectional anatomy	B.MRIT -019	2	--	6	5	--	--	--	--	--	70#	30	100	50	**100**
2.	Modern Radiological Imaging Equipment and Physics	B.MRIT-020	2	1	2	3	2.5	70	30	100	50	--	--	--	--	**100**
3.	Interventional Radiology Techniques	B.MRIT -021	2	1	4	4	2.5	70	30	100	50	70#	30	100	50	**200**
4.	Patient Care in Radiology	B.MRIT -022	1	1	4	4	2.5	70	30	100	50	70#	30	100	50	**200**
5.	B.MRIT Radiology Clinical Education – part IV (studentship)		--	--	12	4	--	--	--	--	--	--	--	--	--	--
		Total	**7**	**3**	**26**	**22**	**--**	**--**	**--**	**300**	**--**	**--**	**--**	**300**	**--**	**600**

Student Contact Hours Per Week: 36**Hrs.Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks: **600**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L - Lectures, T - Tutorial, P - Practical

*Internal Assessment, # External Assessment. *

Internal Assessment (Institutional Level examination) marks are not to be counted for the grade at the end of the semester.

Cross Sectional Anatomy

RATIONALE

Cross sectional anatomy provides the students with Skills that are important to help the technologist in MRI and CT to identify the anatomy being imaged and to communicate effectively with the radiologist and physicians.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Identify cross-sectional anatomy in the sagittal, coronal, and axial planes on CT and MR images.	L3
CO2	Describe anatomical structural relationships.	L2
CO3	Recognize normal anatomy and build a personal resource system for future study.	L2
CO4	Locate and identify pertinent cerebral, upper thorax, mid-thorax, and abdominal anatomy.	L3
CO5	On CT and MR images, identify anatomical structures of the body and head.	L3
CO6	Distinguish between arterial and venous anatomy of the entire body's vascular system.	L2
CO7	Classify the various sections of anatomical regions and their associated parts.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**--**	**6**	**5**	**--**	**--**	**30**	**70**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Introduction to Sectional Anatomy & Terminology-** Sectional planes, Anatomical relationships/terminology Anatomy of the upper thorax-Surface anatomy relationships, Bony structures and muscles, Blood vessels. Divisions of the mid-thorax, heart and great vessels-Lungs, heart and great vessels, Esophagus	12	--

II	**CT/MRI Images of the Thorax -** Normal and abnormal imaging **Anatomy of the Abdomen-** Major organs and their accessories, Abdominal blood vessels **CT/MR Images of Abdomen –** Normal and pathologic anatomy of the Pelvis- Bony structures and associated muscles, Digestive and urinary systems **Reproductive Organs -** Normal and abnormal imaging	12	--
III	**CT/MR Images of the Male/Female Pelvis- Normal and pathologic** **Neuro Anatomy**-Scan planes **Brain –**Cerebral hemispheres, Sinuses, Ventricles, Brainstem and associated parts, Arterial/venous systems, Basal ganglia, Cranial nerves **Spine-** Vertebra and disc, Spinal cord and meninges **Neck-**Arterial/venous systems, Muscles, Glands and pharynx	12	--
Total		**36**	--

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Describe sectional anatomy, anatomical terminology, and anatomical relationships in different imaging planes used in CT and MRI.	L2
CO2	Identify and correlate the cross-sectional anatomy of the thorax, including lungs, heart, great vessels, esophagus, and associated structures on CT/MR images.	L3
CO3	Recognize and interpret the normal and pathological anatomy of the abdomen and pelvis on CT/MR images.	L4
CO4	Identify and analyze neuroanatomical structures including the brain, ventricles, sinuses, cranial nerves, spinal cord, and meninges on CT/MR images.	L4
CO5	Correlate the sectional anatomy of the neck, vascular systems, muscles, glands, and pharynx with their appearance on CT and MRI examinations.	L3

Sr. No		Hours
1.	**Introduction to Sectional Anatomy & Terminology-** Sectional planes, Anatomical relationships/terminology Anatomy of the upper thorax-Surface anatomy relationships, Bony structures and muscles, Blood vessels. Divisions of the mid-thorax, heart and great vessels-Lungs, heart and great vessels, Esophagus	36
2.	**CT/MRI Images of the Thorax -** Normal and abnormal imaging **Anatomy of the Abdomen-** Major organs and their accessories, Abdominal blood vessels **CT/MR Images of Abdomen –** Normal and pathologic anatomy of the Pelvis- Bony structures and associated muscles, Digestive and urinary systems **Reproductive Organs -** Normal and abnormal imaging	36
3.	**CT/MR Images of the Male/Female Pelvis- Normal and Pathologic** **Neuro Anatomy-**Scan planes **Brain –**Cerebral hemispheres, Sinuses, Ventricles, Brainstem and associated parts, Arterial/venous systems, Basal ganglia, Cranial nerves **Spine-** Vertebra and disc, Spinal cord and meninges **Neck-**Arterial/venous systems, Muscles, Glands and pharynx	36
	Total	108

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			

	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

End Semester Evaluation (ESE)
There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Cross Sectional Anatomy CT & MR	G Bhavin Jhankaria	Jaypee Brothers Medical Publishers;
2	Step by step Cross-sectional Anatomy	D Karthikeyan	Jaypee brother medical publishers
3	Atlas of Cross Sectional Anatomy and Radiological Imaging	Dr David J. Jackowe	Anshan Ltd
4	Fundamentals of Sectional Anatomy: An Imaging Approach	Denise L. Lazo	Cengage Learning

Modern Radiological Imaging Equipment and Physics

RATIONALE

Modern radiological Imaging Equipment and Physics provides the students knowledge about the modern x-ray equipment and working principle. Modern imaging techniques – including X-rays, ultrasound, CT scans and MRI – can show structures inside your body in great detail. Radiologic Physics is the study of medical imaging components, technology, and parameters in an effort to produce optimal imaging results. The goal with studying radiologic physics is to ensure you get clear images while ensuring the patient is safe from radiation.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Describe the special radiological equipment.	L1
CO2	Describe digital and computed radiography.	L2
CO3	Describe PACS, RIS, and HIS.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**ESE**	**CIE**	
2	**1**	**2**	**3**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Modern x-ray tube. Digital Mammography and Tomosynthesis, Stitch radiography, Dual energy x-ray absorptionometry (DEXA) scan	**9**	**20**

II	Computed radiography: its principle, physics & equipment. Digital Radiography: its principle, physics & equipment. Flat panel digital fluoroscopy and radiography system, Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages and applications. Digital Portable and mobile x-ray units.	**9**	**20**
III	Modern dental equipments. Cone beam dental CT.	**9**	**20**
IV	Picture archiving and communication system (PACS), RIS and HIS.	**9**	**10**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Describe the principles, construction, and applications of modern X-ray tubes, digital mammography, tomosynthesis, stitch radiography, and DEXA scanning.	L2
CO2	Explain the principles, physics, equipment, advantages, disadvantages, and applications of computed radiography and digital radiography systems.	L2
CO3	Differentiate between direct and indirect digital radiography and fluoroscopy systems, including flat-panel detector technology.	L3
CO4	Demonstrate knowledge of modern portable/mobile X-ray units, digital fluoroscopy systems, and cone beam dental CT equipment.	L3
CO5	Explain the role and functioning of PACS, RIS, and HIS in the management, storage, and communication of radiological data.	L2

Sr. No		**Hours**
1.	Modern x-ray tube. Digital Mammography and Tomosynthesis, Stich radiography, Dual energy x-ray absorptionometry (DEXA) scan.	**9**
2.	Computed radiography: its principle, physics & equipment. Digital Radiography: its principle, physics & equipment. Flat panel digital fluoroscopy and radiography system, Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages and applications. Digital Portable and mobile x-ray units.	**9**
3.	Modern dental equipments. Cone beam dental CT.	**9**

4.	Picture archiving and communication system (PACS), RIS and HIS.	**9**
Total		**36**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Modern x-ray tube. Digital Mammography and Tomosynthesis, Stich radiography, Dual energy x-ray absorptionometry (DEXA) scan.	25
2.	Computed radiography: its principle, physics & equipment. Digital Radiography: its principle, physics & equipment. Flat panel digital fluoroscopy and radiography system, Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages and applications. Digital Portable and mobile x-ray units.	25
3.	Modern dental equipments. Cone beam dental CT.	25
4.	Picture archiving and communication system (PACS), RIS and HIS.	21
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Textbook of Radiology: Physics	Amol Sasane, Hariqbal Singh , Roshan Lodha	Jaypee Brothers Medical Publishers
2	The Physics Of Radiology And Imaging	THAYALAN K	Jaypee Brothers Medical Publishers
3	Christensen's Physics of Diagnostic Radiology	Thomas S. Curry, James E. Dowdey, Robert E. Murry	Lea & Febiger,U.S
4	Textbook Of Radiology For Residents And Technicians	BHARGAVA S. K (Author	CBS; publishers
5	Concise Text Book on Imaging Modalities & Recent Advances In Diagnostic Radiology	Lalit Agarwal, Dr. K.B. Gehlot	JBD Publications

Interventional Radiology Techniques

RATIONALE

Interventional radiology (IR) helps student MRIT to gain about the basics diagnostics and interventional procedures and to learn procedures in modalities like digital radiography CT and MRI and nuclear medicine and to increase the level of understandings and knowledge required to meet current radiologic procedures and to understand the physical principles of radiography and basic radiography positioning to perform the procedures. it a medical specialty that performs various minimally-invasive procedures using medical imaging guidance, such as x-ray fluoroscopy, computed tomography, magnetic resonance imaging, or ultrasound. IR performs both diagnostic and therapeutic procedures through very small incisions or body orifices

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Know the basic principles and physics of interventional equipment.	L2
CO2	Know the management and positioning of patients while performing interventional radiological procedures.	L3
CO3	Have knowledge about the indications, contraindications, contrast media, radiation dose, exposure timing, and radiation safety measures for different interventional radiological procedures.	L2
CO4	Understand the patient preparation needed before any interventional radiological procedures.	L2
CO5	Have knowledge about post-procedural care and safety.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**1**	**4**	**4**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Introduction to interventional procedures **DSA:** basic principles and types **Equipment:** Basics of angiographic equipment, single and biplane angiographic equipments, angiographic table, image intensifier, flat panel detectors, recording systems, pulse oximetry, cardiac resuscitation measure-ECG, pressure injector, catheters, needle and other tools, 3D rotational angiography, image processing, patient monitor, CO2 angiography	6	15
II	Interventional procedures: Catheter- classification, types and applications, Guide wire- classification, types and applications, Pressure Injector and Accessories, Percutaneous catheterization, Digital Subtraction Angiography, Catheterization Sites, Asepsis	9	20
III	Arteriography: Head and Neck Arteriography, Pulmonary Arteriography, Coronary Arteriography, Ascending Aortography, Trans Lumbar Aortography, Renal Arteriography, Trans Femoral Arteriography Venography: Peripheral Venography- Lower Limb, Upper Limb, Central Venography, Superior Venacavography, Inferior Venacavography, Pelvic Venography	9	20
IV	**Safety considerations in angiography room**; room design, protective devices, radiation monitoring	6	10
V	**Care and maintenance tests:** General care, functional test **Quality assurance program:** Acceptable limits of variation, corrective action	6	05
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the basic principles, components, and operation of angiographic equipment used in interventional radiology.	L2
CO2	Identify and apply the use of catheters and guide wires in arteriography and venography procedures.	L3

CO3	Demonstrate knowledge of arteriography, venography procedures, and safety considerations in the angiography room.	L3

Sr. No		**Hours**
1.	Basics of angiographic equipments	18
2.	Catheter and guide wires	18
3.	Arteriography and venography procedures	18
4.	Safety considerations in angiography room	18
	Total	72

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15

Total marks	70
Duration (minutes)	180

End Semester Evaluation (ESE)
There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Basics of angiographic equipments	13
2.	Catheter and guide wires	20
3.	Arteriography and venography procedures	20
4.	Safety considerations in angiography room	10
5.	Care and maintenance tests and quality assurance program	20
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1	The practice of interventional radiology	Karim valji	
2	Interventional radiology: a survival guide	EBIR Kessel, David, Robertson, Iain	Elsevier Health Sciences
3	Handbook of Interventional Radiologic Procedures	Krishna kandarpa, lindsay machan, janettedurham	Lippincott Williams and Wilkins
4	Interventional Radiology: A Survival Guide	David Kessel , Iain Robertson	sevier Health Sciences

Patient Care in radiology

RATIONALE

Patient management is based on team work, it is essential that the student should appreciate the technologist's role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Understand the responsibility of the imaging technologist and other healthcare personnel.	L2
CO2	Understand the management and care of patients during different procedures and emergency situations.	L2
CO3	Know different patient transfer techniques and methods to restrain uncooperative patients during radiological examinations.	L3
CO4	Differentiate the types of consent forms.	L3
CO5	Know about infection control, sources of infection, and isolation techniques.	L2
CO6	Describe sterilization techniques.	L1
CO7	Understand radiation safety and protection.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
1	**1**	**4**	**4**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Introduction to Patient Care:** Responsibilities of Medical Imaging Technologist, Obtaining Consents and history for different radiological examinations, Patient transfer and Restraining techniques, Obtaining vital signs, Ergonomics and body mechanism **Communication:** Patient education, Communication with the patient, Professional role and behavior	**2**	**10**
II	**Hospital procedure:** Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico- legal aspects; accidents in the departments, appointments, organization; minimizing waiting time; out-patient and follow-up clinics; stock-taking and stock keeping.	**2**	**10**
III	**Care of the patient :** FIRST contact with patients in the department; management of chair and stretcher patients and aids for this, management of the unconscious patient; elementary hygiene; personal cleanliness; hygiene in relation to patients.	**3**	**10**
IV	**Nursing procedures in Radiology:** Injection- methods and their routes of administration, Clothing of patient, Administering rectal enema. **First aid:** Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock; insensibility; asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions; prophylactic measures; administration of oxygen; electric shock; burns; scalds; hemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies; poisons.	**3**	**10**
V	**Infection:** Bacteria, their nature and appearance; spread of infections; auto-infection or cross-infection; the inflammatory process; local tissue reaction, general body reaction; ulceration; asepsis and antisepsis. Universal precautions, hospital acquired infections- HIV, Hepatitis B, C, and MRSA etc. **Principles of asepsis:** Sterilization - methods of sterilization; use of central sterile supply department; care of identification of instruments, surgical dressings in common use, including filamented swabs, elementary operating theatre procedure; setting of trays and trolleys in the radio imaging department (for study by radio imaging students only)	**3**	**10**

VI	**Patient care in following investigations:** GIT, Respiratory system, Cardiovascular system, CNS; Sterilization; Infection control **Departmental procedures:** Department staffing and organizations; records relating to patients and departmental statistics; professional attitudes of the technologist to patients and other members of the staff, medico-legal aspects accidents in the department; appointments; organisations; minimizing waiting time; out-patient and follow-up clinics; stock taking and stock keeping.	**2**	**10**
VII	**Drugs in the department and Storage:** classification; labelling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti-depressive, anti- hypertensive etc. crash cart. **Medical ethics and records:** Medico legal implication of MLC cases, Importance of consent, Consent in detail, Precaution while dealing with female patient, Medical records	**3**	**10**
Total		**18**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Explain the principles of patient care, communication, hospital organization, departmental records, and medico-legal aspects in radiology practice.	L2
CO2	Apply nursing procedures, first aid measures, and patient care techniques during various radiological investigations.	L3
CO3	Demonstrate infection control practices, sterilization procedures, aseptic techniques, and safe handling of drugs and medical records in the radiology department.	L3

Sr. No		**Hours**
1.	Introduction to Patient Car and Communication	10
2.	Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico- legal aspects; accidents in the departments, appointments, organization; minimizing waiting time; out- patient and follow-up clinics; stock-taking and stock keeping.	11
3.	Care of the patient	10

4.	Nursing procedures in Radiology and first aid	11
5.	Infection and Principles of asepsis	10
6.	Patient care in following investigations: GIT, Respiratory system, Cardiovascular system, CNS; Sterilization; Infection control.	10
7.	Drugs in the department and Storage and medical ethics and records	10
	Total	72

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Introduction to Patient Car and Communication	10
2.	Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico- legal aspects; accidents in the departments, appointments, organization; minimizing waiting time; out-patient and follow-up clinics; stock- taking and stock keeping.	14
3.	Care of the patient	10
4.	Nursing procedures in Radiology and first aid	14
5.	Infection and Principles of asepsis	14
6.	Patient care in following investigations: GIT, Respiratory system, Cardiovascular system, CNS; Sterilization; Infection control.	20
7.	Drugs in the department and Storage and medical ethics and records	14
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S.No.	**Title of Book**	**Author**	**Publication**
1	Patient care in radiography	Ruth Ann Ehrlich, Dawn M Coakes	Mosby
2	Concise Textbook on Hospital Management & Patient Care in Diagnostic Radiology	N.K.Kardam,, Lalit Agarwal	JBD Publications
3	Patient care in radiography: with an introduction to medical imaging	Ruth Ann Ehrlich and Joan A. daly	St. Louis, Mo. : Mosby Elsevier
4	Introduction To Radiologic And Imaging Sciences And Patient Care	Adler A M	Elsevier
5	Concise Text Book on Hospital Management & Patient Care In Diagnostic Radiology	Lalit Agarwal , Dr. N.K. Kardam	JBD Publications

B.MRIT Radiology Clinical Education – part IV (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in every semesters.
- Provide simulation and skill labs for practising skills specific to the program in the initial years of observership/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
- All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship.

Fifth Semester

Bachelor of Medical Radiology and Imaging Technology

(B.MRIT)

Teaching and Examination Scheme

Course Name : Bachelor in Medical Radiology and Imaging Technology

Duration of Program :Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks Semester : **Fifth**

S.N.	Course Title	Course Code	Teaching Scheme				Examination Scheme								
							Theory				Practical				Grand Total
							Exam Duration in Hrs.	CIE	ESE	Total		CIE	ESE	Total		
			Theory (hrs/week)	Tutorial	Clinical / Practicals (hrs/week)	Credits (L+T+P)		Max Marks	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Basics Techniques in CT Technology	B.MRIT -023	4	1	8	9	2.5	30	70	100	50	30	70#	100	50	**200**
2.	Radiation Safety in Diagnostic Radiology	B.MRIT -024	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
3.	Quality Assurance in Diagnostic Radiology and Regulatory Requirements	B.MRIT-025	1	1	2	3	--	--	--	--	--	30	70#	100	50	**100**
4.	B.MRIT Radiology Clinical Education – part V (studentship**)**		--	--	12	4	--	--	--	--	--	--	--	--	--	--
	Total		**7**	**3**	**26**	**21**	--	--	--	**200**	--	--	--	**300**	--	**500**

Student Contact Hours Per Week: 36 **Hrs. Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks **: 500**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L - Lectures, T - Tutorial, P - Practical

*Internal Assessment, # External Assessment.

*Internal Assessment (Institutional Level examination) marks are not to be counted for the grade at the end of the semester.

Basics Techniques in CT Technology

RATIONALE

Basics techniques in CT Technology provide the students with knowledge of the basic physics of CT. It creates relationship between scan and patient with various CT protocols for better representation of images.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Define the basic principles and physics of Computed Tomography (CT) scanning.	L1
CO2	Recognize protocols needed for Computed Tomography examinations.	L2
CO3	Prepare and position patients for Computed Tomography examinations.	L3
CO4	Interpret post-processing of raw Computed Tomography images.	L4
CO5	Prepare and position patients for Computed Tomography examinations.	L3
CO6	Manage patients for post-contrast reactions.	L3
CO7	Plan scanning using various Computed Tomography protocols for better image representation.	L5
CO8	Systematize post-processing for Computed Tomography Scan.	L4
CO9	Management of patient for any post contrast reaction.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
4	**1**	**8**	**9**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Introduction and history,** CT principle, CT generations, CT Instrumentation, CT detectors, Axial & Helical CT – Slip ring technology	15	20
II	**Data acquisition, Image pre-processing/reconstruction techniques,** Algorithms for image reconstruction, Image display, Image post-processing techniques, CT artifacts, Image quality	14	10
III	**CT Protocols for different body parts & Dental scan,** CT Protocols for Angiography & Perfusion, CT contrast media and administration, CT guided interventional procedures	14	15
IV	**Multi-detector CT** Isotropic imaging, Cardiac CT, Flash CT, Advanced CT scanners, Dual energy & Dual Source Scanners, CT- fluoroscopy	15	15
V	**Safety consideration,** Documentation in CT, Role of Medical Imaging technologist in CT scan procedures, Quality assurance in CT	14	10
Total		**72**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the history, principles, generations, instrumentation, detectors, and operating technologies of Computed Tomography (CT), including axial and helical CT.	L2
CO2	Analyze CT image reconstruction, post-processing techniques, artifacts, and quality assurance measures to optimize image quality.	L4
CO3	Apply appropriate CT protocols, contrast administration techniques, angiography, perfusion studies, and CT-guided interventional procedures for different clinical applications.	L3
CO4	Demonstrate knowledge of multidetector CT, safety considerations, documentation, and the professional role of the Medical Imaging Technologist in CT procedures.	L3

Sr. No		Hours
1.	Introduction and history, CT principle, CT generations, CT Instrumentation, CT detectors, Axial & Helical CT – Slip ring technology	30
2.	Image post-processing techniques, CT artifacts	20
3.	CT Protocols for different body parts & Dental scan, CT Protocols for Angiography & Perfusion, CT contrast media and administration, CT guided interventional procedures	54
4.	Multi-detector CT	20
5.	Safety consideration, Documentation in CT, Role of Medical Imaging technologist in CT scan procedures, Quality assurance in CT	20
	Total	**144**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35

Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

End Semester Evaluation (ESE)
There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Introduction and history, CT principle, CT generations, CT Instrumentation, CT detectors, Axial & Helical CT – Slip ring technology	20
2.	Image post-processing techniques, CT artifacts	19
3.	CT Protocols for different body parts & Dental scan, CT Protocols for Angiography & Perfusion, CT contrast media and administration, CT guided interventional procedures	19
4.	Multi-detector CT	19
5.	Safety consideration, Documentation in CT, Role of Medical Imaging technologist in CT scan procedures, Quality assurance in CT	19
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1	Computed Tomography: Physical Principles, Clinical Applications, and Quality Control	Euclid Seeram RT(R) BSc MSc FCAMRT (Author)	Saunders
2	Computed Tomography for Technologists: A Comprehensive Text	Lois Romans	Lippincott Williams and Wilkins;

3	Computed Tomography: Physics and Technology. A Self Assessment Guide	Euclid Seeram	Wiley-Blackwell
4	The CT Handbook: Optimizing Protocols for Today's Feature-Rich Scanners	Timothy P. Szczykutowicz	Medical Physics Publishing Corporation
5	CT PROTOCOLS	Manjot Kaur, Maajid Mohi Ud Din Malik	JBD Publications

Radiation Safety in Diagnostic Radiology

RATIONALE

Radiation protection aims to reduce unnecessary radiation exposure with a goal to minimize the harmful effects of ionizing radiation. In the medical field, ionizing radiation has become an inescapable tool used for the diagnosis and treatment of a variety of medical conditions .to study radiation physics relevant to radiation protection to gain information on radiation types and does receive to study the molecular and cellular effects of radiations and to know the radiation quantities units dose limits and regulatory bodies to know about equipment design for radiation protection and to implement patient and personnel radiation protection practices for radiological procedures

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Understand the aim and need of radiation protection.	L2
CO2	Describe radiation units and quantities.	L1
CO3	Understand various radiation protection regulations and dose limits.	L2
CO4	Explain radiation protection for patients, occupational workers,and the general public in diagnostic radiology.	L2
CO5	Describe the layout of a radiology department.	L1
CO6	Use protective devices and demonstrate awareness of radiation signages.	L3
CO7	Apply dose reduction measures with technical protective considerations during radiological procedures.	L3
CO8	Describe different radiation measuring devices.	L1
CO9	Explain the effects of radiation on biological tissues.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**1**	**4**	**5**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Radiation Quantities and Units: Radiation- Radioactivity- Sources of radiation - natural radioactive sources -cosmic rays terrestrial radiation - - man made radiation sources. Units of radiation - Quality factor - Flux- Fluence-Kerma-Exposure- Absorbed dose- Equivalent Dose- Weighting Factors-Effective Dose - Occupational Exposure Limits - Dose limits to public.	**7**	**15**
II	Biological Effects of radiation: Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell-Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus -Somatic effects and hereditary effects- stochastic and deterministic effects-Acute exposure and chronic exposure-LD50 - factors affecting radio sensitivity. Biological effects of non-ionizing radiation like ultrasound, lasers, IR, UV and magnetic fields.	**8**	**15**
III	Radiation detection and Measurements: Ionization of gases- Fluorescence and Phosphorescence -Effects on photographic emulsion. Ionization Chambers – proportional counters- G.M counters- scintillation detectors – liquid semiconductor detectors – Gamma ray spectrometer. Measuring systems – free air ionization chamber – thimble ion chamber – condenser chamber – Secondary standard dosimeters – film dosimeter – chemical dosimeter- Thermoluminescent Dosimeter. -Pocket dosimeter-Radiation survey meter- wide range survey meter -zone monitor-contamination monitor -their principle function and uses. Advantages & disadvantages of various detectors &its appropriateness of different detectors for different type of radiation measurement. Dose and Dosimetry, CT Dose Index (CTDI, etc.), Multiple Scan Average Dose (MSAD), Dose Length Product (DLP), Dose Profile, Effective Dose, Phantom Measurement Methods, Dose for Different Application Protocols, Technique Optimization. Dose area product in fluoroscopy and angiography systems, AGD in mammography Artificial Intelligence in Radiation Safety	**7**	**15**
IV	Radiation protection: Radiation protection of self and patient- Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey –ALARA- personnel dosimeters (TLD and film batches) - occupational exposure.	**7**	**10**

V	Radiation Hazard evaluation and control: Philosophy of Radiation protection, effects of time, Distance & Shielding. Calculation of Work load, weekly calculated dose to radiation worker & General public Good work practice in Diagnostic Radiology. Planning consideration for radiology, including Use factor, occupancy factors, and different shielding material.	**7**	**15**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Describe radiation quantities, units, biological effects of radiation, and the principles of radiation protection.	L2
CO2	Demonstrate the use of radiation detection and measurement devices, including survey meters and personal dosimeters.	L3
CO3	Explain the application of Artificial Intelligence in radiation safety and radiation monitoring practices.	L2
CO4	Apply ALARA principles and evaluate radiation hazards to implement appropriate radiation control measures.	L4

Sr. No		**Hours**
1.	Radiation Quantities and Units	15
2.	Biological Effects of radiation	15
3.	Radiation detection and Measurements Survey meter and personal dosimeter Artificial Intelligence in Radiation Safety	15
4.	Radiation protection; Principles of radiation protection; ALARA	15
5.	Radiation Hazard evaluation and control	12
		72

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Radiation Quantities and Units	18
2.	Biological Effects of radiation	20
3.	Radiation detection and Measurements Survey meter	20

	and personal dosimeter	
4.	Radiation protection; Principles of radiation protection; ALARA	19
5.	Radiation Hazard evaluation and control	19
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1	Radiation Protection In Diagnostic X-Ray Imaging	Euclid Seeram, Patrick C. Brennan	Jones and Bartlett Publishers
2	Development of Radiation Protection in Diagnostic Radiology	Stewart C. Bushong	CRC Press Inc.,U.S.
3	Textbook of adiological Safety	Thayalan K	Jaypee Brothers Medical Publishers
4	Radiation Protection in Medical Radiography	Statkiewicz Sherer	Elsevier Health - US;
5	Basics of Radiation, Hazards and Prevention In Diagnostic Radiology	Prashant Kumar Jha	JBD Publications

Quality Assurance in Diagnostic Radiology and Regulatory Requirements

RATIONALE

Quality assurance testing includes the monitoring, evaluation and maintenance of equipment for optimal performance and stability. It is essential that radiological technologists recognize, record and report, according to policy, when a significant increase or underexposure in radiation exposure occurs.

COURSE OUTCOMES

CO	Course Learning Outcomes: The student will be able to	Bloom's Level
CO1	Aim and need of radiation protection	L1
CO2	Introduction to quality assurance	L2
CO3	Understanding of regulatory requirements	L2
CO4	Follow radiation protection regulations and apply practically	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
1	**1**	**2**	**3**	**--**	**--**	**30**	**70**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Objectives of quality Control: Improve the quality of imaging thereby increasing the diagnostic value; to reduce the radiation exposure; Reduction of film wastage and repeat examination; to maintain the various diagnostic and imaging units at their optimal performance. Quality assurance activities: Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance. Quality assurance programme at the radiological faculty level: Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Quality assurance practical	**4**	**--**

	exercise in the X ray generator and tube; Image receptors from processing; Radiographic equipment; Fluoroscopic equipment; Mammographic equipment; Conventional tomography; Computed tomography; Film processing, manual and automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration		
II	**QA in Diagnostic Radiology** filtration Contact between film and intensifying screen Contrast Verification of Optical and Radiation field congruence Beam alignment Focal spot size Linearity of tube current mA and Timer Applied potential HVT and total tube Resolution Grid alignment QA in mammography QA in CT QA in Digital Radiography	**4**	--
III	**Regulatory requirements in Diagnostic Radiology** National Regulatory Body Responsibilities and organization Safety Standards Codes and Guides Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment	**4**	--
IV	Responsibilities of licensees, registrants and employers Enforcement of Regulatory requirements Role of technologist in radiology department Maintenance and care of equipment: Safe operation of equipment; Routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipments; Record keeping and log book maintenance; Reject analysis and objectives of reject analysis programme.	**3**	

V	Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.	**3**	--
Total		**18**	--

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom ' s Level**
CO1	Explain the principles, components, and procedures of quality assurance (QA) programs in diagnostic radiology, including acceptance testing, routine testing, and evaluation of radiological equipment.	L2
CO2	Perform quality assurance tests for radiographic, fluoroscopic, mammographic, computed tomography, and digital radiography systems to assess equipment performance and image quality.	L3
CO3	Analyze quality control parameters such as filtration, beam alignment, focal spot size, tube current linearity, timer accuracy, HVL, grid alignment, image distortion, and laser printer calibration.	L4
CO4	Apply regulatory requirements, radiation safety standards, and responsibilities of licensees, registrants, and employers in diagnostic radiology practice.	L3
CO5	Demonstrate preventive maintenance, fault tracing, and care of diagnostic imaging equipment, including mobile radiographic systems.	L3

Sr. No		**Hours**
1.	Quality assurance programme at the radiological faculty level: Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Quality assurance practical exercise in the X ray generator and tube; Image receptors from processing; Radiographic equipment; Fluoroscopic equipment; Mammographic equipment; Conventional tomography; Computed tomography; Film processing, manual and automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration	7

2.	**QA in Diagnostic Radiology** filtration Contact between film and intensifying screen Contrast Verification of Optical and Radiation field congruence Beam alignment Focal spot size Linearity of tube current mA and Timer Applied potential HVT and total tube Resolution Grid alignment QA in mammography QA in CT QA in Digital Radiography	8
3.	Regulatory requirements in Diagnostic Radiology	7
4.	Responsibilities of licensees, registrants and employers Enforcement of Regulatory requirements	7
5.	Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.	7
	Total	**36**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

There is no theory examination for this subject.

End Semester Evaluation (ESE)
There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1	Quality Assurance and Control in Diagnostic Radiology and Imaging	Bhargava	CBS Publishers and Distributors
2	Quality Assurance	Dr. R. Sundhararajan, M.V.Kumudhavalli, Minal T. Harde	Thakur Publications Pvt Ltd
3	Quality Assurance in Diagnostic Radiology	J. McLemore (Author	Imprint unknown
4	An Introduction to Quality Assurance in Radiology	Zafar Neyaz	JBD Publications

B.MRIT Radiology Clinical Education – part V (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in every semesters.
- Provide simulation and skill labs for practising skills specific to the program in the initial years of observership/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.

All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship

Sixth Semester

Bachelor of Medical Radiology and Imaging Technology

(B.MRIT)

Teaching and Examination Scheme

Course Name: Bachelor in Medical Radiology and Imaging Technology

Duration of Program: Four Years (Eight Semesters) Pattern : Full Time Duration : 18 Weeks

Semester : **Sixth**

S.N.	Course Title	Course Code	Teaching Scheme				Examination Scheme									
							Theory					Practical				Grand Total
								CIE	ESE	Total		CIE	ESE	Total		
			Theory (hrs/week)	Tutorial	C/P (hrs/week)	Credits (L+T+P)	Exam Duration in Hrs.	Max Marks	Max Marks	Max Marks	Min Marks	Max Marks	Max Marks	Max Marks	Min Marks	
1.	Basics Techniques In MRI Technology	B.MRIT-026	3	1	8	8	2.5	30	70	100	50	30	70#	100	50	**200**
2.	Introduction to Nuclear Medicine Techniques	B.MRIT-027	1	1	2	3	2.5	30	70	100	50	--	--	--	--	**100**
3.	Ultrasound Techniques	B.MRIT -028	2	1	--	3	2.5	30	70	100	50	--	--	--	--	**100**
4.	Biostatistics And Research Methodology	B.MRIT-029	1	1	--	2	--	30	70*	100	50	--	--	--	--	--
5.	B.MRIT Radiology Clinical Education – part VI (studentship)		--	--	15	5	--	--	--	--	--	--	--	--	--	--
	Total		**7**	**4**	**25**	**21**	**--**	**--**	**--**	**300**	**--**	**--**	**--**	**100**	**--**	**400**

Student Contact Hours Per Week: 36**Hrs.Theory and practical periods of 60 minutes each.** Medium of Instruction: **English** Total Marks **: 400**

Abbreviations: ESE- End Semester Exam, CIE- Continuous Internal Evaluation, L - Lectures, T - Tutorial, P - Practical

*Internal Assessment, # External Assessment.

*Internal Assessment (Institutional Level examination) marks are not to be counted for the grade at the end of the semester.

Basics Techniques in MRI Technology

RATIONALE

Magnetic Resonance Imaging (MRI) is a non-invasive imaging technology that produces three dimensional detailed anatomical images. It is often used for disease detection, diagnosis, and treatment monitoring. It is based on sophisticated technology that excites and detects the change in the direction of the rotational axis of protons found in the water that makes up living tissue. The student learn to Recognize and planning different protocols and prepare and position patients for MRI examination. To gain knowledge on Management of patients, contrast reactions MRI Safety.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Define the basic principles and physics of Magnetic Resonance Imaging (MRI).	L1
CO2	Recognize protocols needed for Magnetic Resonance Imaging examinations.	L2
CO3	Interpret post-processing of Magnetic Resonance Imaging images.	L4
CO4	Interpret post-processing of Magnetic Resonance Imaging images.	L4
CO5	Prepare and position patients for Magnetic Resonance Imaging examinations.	L3
CO6	Categorize knowledge for improving image quality in Magnetic Resonance Imaging.	L4
CO7	Perform scanning of patients using various Magnetic Resonance Imaging protocols for better image representation.	L3
CO8	Plan post-processing of Magnetic Resonance Imaging data.	L5
CO9	Manage patients for post-contrast reactions.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
3	**1**	**8**	**8**	**30**	**70**	**30**	**70**	**200**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	Introduction to MRI; Basic principle; Image weighting and contrast in MRI; Instrumentation of MRI-Magnets- classification, types, advantages, disadvantages, Gradient & Body Coils, RF coils, Shim coils, Ramping, Cryogen, RF shielding	**12**	**15**
II	Encoding and Image formation-Encoding, K-Space; Parameters and Trade-offs; MRI Pulse sequences-Spin Echo pulse sequence, Gradient Echo pulse sequence; Fast imaging sequences	**12**	**15**
III	Flow phenomena; Flow phenomena compensation; Vascular Imaging- Digital Subtraction MRA, TOF-MRA, PC-MRA, Velocity Encoding, MR-Angiogram, MR- Venogram	**10**	**10**
IV	Cardiac Imaging; Whole body MRI Protocols; MRI Artifacts and their compensation; MRI contrast agents-T1 contrast agent, T2 contrast agent	**10**	**15**
V	MRI safety- Implants and pace-makers, Electrical safety, Metallic safety, Instrumental safety, Bio-effects of MRI; Documentation; Quality assurance in MRI	**10**	**15**
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the instrumentation of MRI, including magnets, gradient coils, body coils, RF coils, shim coils, cryogens, ramping, and RF shielding.	L2
CO2	Describe MRI pulse sequences, including spin echo, gradient echo, and fast imaging sequences, along with their clinical applications.	L2
CO3	Analyze flow phenomena, MRI artifacts, and artifact compensation techniques to optimize image quality.	L4
CO4	Apply whole-body MRI protocols and demonstrate knowledge of MRI safety measures during imaging procedures.	L3
CO5	Demonstrate quality assurance procedures in MRI for maintaining equipment performance and diagnostic image quality.	L3

Sr. No		Hours
1.	Instrumentation of MRI-Magnets- classification, types, advantages, disadvantages, Gradient & Body Coils, RF coils, Shim coils, Ramping, Cryogen, RF shielding	30
2.	MRI Pulse sequences-Spin Echo pulse sequence, Gradient Echo pulse sequence; Fast imaging sequences	30
3.	Flow phenomena; Flow phenomena compensation	24
4.	Whole body MRI Protocols; MRI Artifacts and their compensation	30
5.	MRI safety and Quality assurance in MRI	30
Total		**144**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

End Semester Evaluation (ESE)
There shall be practical examination for 70 marks in the subject.

Distribution of marks for ESE practical exams:

ESE		CIE		**Grand total**
Practical	Viva		Sub Total	
50	20	30	100	100

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	Instrumentation of MRI-Magnets- classification, types, advantages, disadvantages, Gradient & Body Coils, RF coils, Shim coils, Ramping, Cryogen, RF shielding	19
2.	MRI Pulse sequences-Spin Echo pulse sequence, Gradient Echo pulse sequence; Fast imaging sequences	20
3.	Flow phenomena; Flow phenomena compensation	19
4.	Whole body MRI Protocols; MRI Artifacts and their compensation	19
5.	MRI safety and Quality assurance in MRI	19
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S.No.	**Title of Book**	**Author**	**Publication**
1	Tomography and Magnetic Resonance Imaging of the Whole Body (Vol.1& II) (Saunders).	John R. Haaga, Daniel Boll	Elsevier
2	MRI inPractice	Catherine Westbrook& Caralyn Kaut	Wiley–Blackwell
3	Protocols inMRI	Catherine Westbrook	Wiley-Blackwell
4	An Introduction to the Physics and Function of Magnetic Resonance Imaging	Dominik Weishaupt , Victor D. Koechli , Borut Marincek , J.M. Froehlich	Springer;
5	Concise Textbook of MRI Physics & Protocols	Maajid Mohi Ud Din Malik, Manjot Kaur	JBD Publications

Introduction to Nuclear Medicine Techniques

RATIONALE

It is thebranch of medicine that deals with the use of radioactive substances in research, diagnosis, and treatment disease. In this student will learn about the fundamentals of radioactivity and various interactions of radiation with matter, radiopharmaceuticals, instrumentations measuring radioactivity, PET imaging and patients care and safety.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Define the basic principles and physics of Nuclear Medicine.	L1
CO2	Apply precautions while handling radiopharmaceuticals.	L3
CO3	Recognize the artefacts associated with Nuclear Medicine.	L2
CO4	Assess methods for improving image quality in Nuclear Medicine.	L4
CO5	Manage patients for any late reactions associated with radiotracers in Nuclear Medicine.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
1	**1**	**2**	**3**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	History; Isotopes and Radionuclides- Production of Radionuclides, Transport of Radionuclides; Radio Activity- Radio Active transformations, Specific Activity; Radiopharmaceuticals- Preparation, Precautions while handling	**7**	**25**
II	Gamma Camera instrumentation - Collimator- classification and types; Single Photon Emission Computed Tomography (SPECT); Positron Emission Tomography (PET); Advanced techniques in NM - SPECT-CT, PET-CT, PET-MRI	**7**	**25**
III	Safety Considerations & Radiation Dose in Nuclear Medicine; Room layout in nuclear medicine	**4**	**20**
Total		**18**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Explain the history of Nuclear Medicine, radionuclides, radioactivity, radioactive transformations, and the preparation and handling of radiopharmaceuticals.	L2
CO2	Describe the instrumentation of gamma cameras, collimators, and their role in Nuclear Medicine imaging.	L2
CO3	Differentiate between SPECT, PET, SPECT-CT, PET-CT, and PET-MRI techniques and their clinical applications.	L3
CO4	Apply radiation safety principles, dose optimization measures, and precautions while handling radiopharmaceuticals in Nuclear Medicine.	L3
CO5	Demonstrate knowledge of Nuclear Medicine department layout and operational requirements for safe and efficient patient management.	L3

Sr.No		Hours
1.	History; Isotopes and Radionuclides- Production of Radionuclides, Transport of Radionuclides; Radio Activity- Radio Active transformations, Specific Activity; Radiopharmaceuticals- Preparation, Precautions while handling	12
2.	Gamma Camera instrumentation - Collimator- classification and types; Single Photon Emission Computed Tomography (SPECT); Positron Emission Tomography (PET); Advanced techniques in NM - SPECT-CT, PET-CT, PET-MRI	12

3.	Safety Considerations & Radiation Dose in Nuclear Medicine; Room layout in nuclear medicine	12
Total		**36**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)

Written Paper

Type of question	**No. of questions**	**Marks per question**	**Total**
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			150

Question Paper Blueprint

Unit		**Marks (± 5%)**
1.	History; Isotopes and Radionuclides- Production of Radionuclides, Transport of Radionuclides; Radio Activity- Radio Active transformations, Specific Activity; Radiopharmaceuticals- Preparation, Precautions while handling	32

2.	Gamma Camera instrumentation - Collimator- classification and types; Single Photon Emission Computed Tomography (SPECT); Positron Emission Tomography (PET); Advanced techniques in NM - SPECT-CT, PET-CT, PET- MRI	32
3.	Safety Considerations & Radiation Dose in Nuclear Medicine; Room layout in nuclear medicine	32
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Nuclear Medicine Textbook: Methodology and Clinical Applications	DuccioVolterrani , Paola Anna Erba , IgnasiCarrió , H. William Strauss	Springer;
2	Nuclear Medicine Instrumentation	Jennifer Prekeges (Author)	Jones and Bartlett Publishers
3	Nuclear Medicine Physics: The Basics	Ramesh Chandra & Arman Rahmim	Wolters Kluwer
4	Nuclear Medicine Technology: Procedures and Quick Reference	Pete Shackett BA CNMT ARRT(N) (Author)	LWW;
5	A Concise Guide on Basic Radiation Physics, radiotherapy Physics & Nuclear Medicine	Lalit Agarwal, Dr. Arvind Shukla	JBD Publications

Ultrasound Techniques

RATIONALE

Ultrasound techniques provide students knowledge on the basic principles of ultrasonography and how to prepare the patients for the scan and also to identify any artefacts. To learn about the physics behind ultrasound and to gain knowledge regarding various ultrasound procedures equipment used in ultrasoundand patient care during ultrasound procedures.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Describe the ultrasound properties and interaction of ultrasound with matter.	L2
CO2	Describe the transducer and its types.	L1
CO3	Explain the concepts of image display.	L2
CO4	Describe Doppler imaging and ultrasound contrast agents.	L2
CO5	Describe image characteristics and artifacts.	L2
CO6	Explain the safety considerations and protocols in ultrasound.	L2

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**CIE**	**ESE**	**CIE**	**ESE**	
2	**1**	**--**	**3**	**30**	**70**	**--**	**--**	**100**

CIE, Continuous Internal Evaluation; ESE, End Semester Evaluation; L, lecture; T, Tutorial; P, Practical

TUTORIAL ASSIGNMENTS

Tutorials should be planned to enhance learning. The faculty shall decide suitable assignments minimum one per unit based on the curriculum.

THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to attain the identified competency.

Unit	Topic and contents	Hours	Marks
I	**Ultrasound:** Properties of ultrasound, interaction of ultrasound with matter	**6**	**10**

II	**Transducers:** Types of transducers, advances in the design of modern ultrasound transducers	**6**	**15**
III	**Image display:** Display modes, ultrasound instrumentation, controls, image storage, scan converter memory, photographic film, multi format camera,laser imager, colour and video thermal printer, computer storage, pre and post processing techniques	**6**	**10**
IV	**Doppler Imaging:** Doppler principles, continuous wave Doppler and pulsed Doppler, duplex scanning, colour flow imaging, power doppler, harmonic imaging, extended field of view Ultrasound contrast agents	**6**	**15**
V	**Image characteristics and artefacts:** vascular, interventional, intraoperative and ophthalmic ultrasonography, 3D and 4D ultrasound imaging Artificial Intelligence in Ultrasound	**6**	**10**
Vl	**Bio-effects and safety considerations in ultrasound**, ultrasound system performance measurements, ultrasound equipments quality assurance – conventional Doppler system testing and documentation	**6**	**10**
Total		**36**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

CO No.	**Course Learning Outcomes**	**Bloom's Level**
CO1	Explain the interaction of ultrasound with matter, principles of ultrasound imaging, and the design of modern ultrasound transducers.	L2
CO2	Describe ultrasound instrumentation, image display modes, system controls, and image formation processes.	L2
CO3	Apply the principles of Doppler imaging, including continuous wave, pulsed Doppler, duplex scanning, colour flow imaging, power Doppler, harmonic imaging, and extended field-of-view techniques.	L3
CO4	Analyze image characteristics, artefacts, and the role of ultrasound contrast agents in improving diagnostic imaging.	L4
CO5	Demonstrate knowledge of bio-effects, safety considerations, system performance measurements, and quality assurance procedures in ultrasound imaging.	L3

Sr. No		Hours
1.	**Ultrasound** interaction of ultrasound with matter	6
2.	Types of transducers, advances in the design of modern ultrasound transducers	6
3.	**Image display:** Display modes, ultrasound instrumentation, controls	6
4.	**Doppler Imaging:** Doppler principles, continuous wave Doppler and pulsed Doppler, duplex scanning, colour flow imaging, power doppler, harmonic imaging, extended field of view Ultrasound contrast agents	6
5.	**Image characteristics and artefacts**	6
6.	**Bio-effects and safety considerations in ultrasound**, ultrasound system performance measurements, ultrasound equipments quality assurance	6
	Total	**36**

Evaluation System

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Written tests • Same pattern as Summative test • Average of two to be considered • Absence without prior permission to be marked as 0	50		
	Total	***50***	***0.3***	***15***
2.	Continuous assessment			
	Seminars/Case presentations/ Logbook/ Case records/Record book/assignment			
	Total	***50***	***0.3***	***15***
	Total CIE marks			***30***

End Semester Evaluation (ESE)
Written Paper

Type of question	No. of questions	Marks per question	Total
Essay Question (EQ)	3 (to answer 2)	10	20
Short Essay Question (SEQ)	9 (to answer 7)	5	35
Short Answer Question (SAQ)	7 (to answer 5)	3	15
Total marks			70
Duration (minutes)			180

Question Paper Blueprint

Unit		Marks (± 5%)
	Ultrasound: Properties of ultrasound, interaction of ultrasound with matter	14
	Transducers: Types of transducers, advances in the design of modern ultrasound transducers	20
	Image display: Display modes, ultrasound instrumentation, controls, image storage, scan converter memory, photographic film, multi format camera,laser imager, colour and video thermal printer, computer storage, pre and post processing techniques	14
	Doppler Imaging: Doppler principles, continuous wave Doppler and pulsed Doppler, duplex scanning, colour flow imaging, power doppler, harmonic imaging, extended field of view Ultrasound contrast agents	20
	Image characteristics and artefacts: vascular, interventional, intraoperative and ophthalmic ultrasonography, 3D and 4D ultrasound imaging	14
	Bio-effects and safety considerations in ultrasound, ultrasound system performance measurements, ultrasound equipments quality assurance – conventional Doppler system testing and documentation	14
	Total Marks (including optional questions)	96

SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Ultrasound physics and technology	Vivien gibbs, davidcole, Antonio sassano	Churchill Livingstone;
2	Manual of Diagnostic Ultrasound	Philip E. S. Palmer (Author)	WorldHealth Organization
3	Physics and Technical Aspects Diagnostic Ultrasound	DINESH K BAGHEL (Author	AITBS PUBLISHERS

4	Diagnostic Ultrasound	Carol M. Rumack (Author), Deborah Levine (Author)	Elsevier;
5	Ultrasound Imaging (1000 Multiple Choice Questions)	Yadav	JBD Publications

Biostatistics and Research Methodology

RATIONALE:

The application of statistical techniques to scientific research in health-related fields, including medicine, biology, and public health, and the development of new tools to study these areas.

COURSE OUTCOMES

CO No.	Course Learning Outcomes	Bloom's Level
CO1	Understand the importance of statistics in the curriculum.	L2
CO2	Understand statistical terms.	L1
CO3	Possess knowledge and skill in the use of basic statistics for the analysis and interpretation of data.	L3

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme
L	**T**	**P**	**C**	**Institute level exam only:** The Institute level examination will be held before the commencement of the University examinations. A Pass in the subject with a minimum of 50 marks (50% of the total 100 marks) is compulsory in order to be eligible for the award of degree. These marks will not be considered for the award of class. Supplementary examination shall be conducted by the Institute for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six
1	**1**	**--**	**2**	

Unit	Topic and contents	Hours
I	Introduction: Meaning, Definition, Characteristics of Statistics; Importance of the Study of Statistics. Branches of Statistics; Descriptive and Inferential Statistics; Variables and Their Types. Measurement Scales.	**3**
II	Tabulation of Data: Raw Data, the Array, Frequency Distribution. Basic Principles of Graphical Representation; Types of Diagrams - Histograms, Frequency Polygons, Smooth Frequency Polygon, Commutative Frequency Curve, O give; Normal ProbabilityCurve.	**3**
III	Measure of Central Tendency: Need For Measures of Central Tendency; Definition and Calculation of Mean; Ungrouped and Grouped Meaning, Interpretation and Calculation of Median Ungrouped and Grouped; Meaning	**3**

	and Calculation of Mode; Comparison of the Mean, and Mode; Guidelines for the Use of Various Measures of Central Tendency.	
IV	Measure of Variability: Need For Measure of Dispersion. The Range, the Average Deviation, The Variance and Standard Deviation; Calculation of Variance and Standard Deviation, Ungrouped and Grouped.	**3**
V	Probability and Standard Distributions: Meaning of Probability of Standard Distribution, The Binominal Distribution. The Normal Distribution; Divergence from Normality - Skewness,Kurtosis	**3**
VI	Sampling Techniques: Need For Sampling - Criteria for Good Samples. Application of Sampling in Community, Procedures of Sampling and Sampling Designs Errors. Sampling Variation and Tests of Significance.	**3**
Total		**18**

Suggested Learning Resources

S. No.	Title of Book	Author	Publication
1	Elements of Health Statistics	Rao. N.S	
2	An introduction of Biostatistics	Sunder Rao	
3	Methods in Bio-Statistics	B.K. Mahajan	
4	Elementary Statistics in Medical Workers	Inderbir Singh	
5	An Introduction to. Statistical Methods, Ram Prasad &Sons	Gupta C.B	

B.MRIT Radiology Clinical Education – part VI (studentship)

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a senior technologist. Students are tested on intermediate clinical radio diagnosis skills.

Studentship or observer ship must include:

- A minimum of 14 hours per week is considered as studentship in every semester.
- Provide simulation and skill labs for practicing skills specific to the program in the initial years of observer ship/studentship.
- Every semester must have seminars/workshops on new developments/ technologies. Check annexure for marking criteria.
- If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
- All practical skills must be supervised and recorded in a Logbook and skills to be evaluated after the completion of the internship.

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Skills based outcomes and monitorable indicators for Medical Radiology and Imaging Technologist during internship:

S. no.	Learning outcomes	Knowledge/comprehension	Applications / synthesis /evaluation	Hours
1	Be able to interpret and evaluate a prescription	Identify the area for treatment.	Determining x-ray, CT scan or MRI scan needs of patient	200
		Quantify the practical problems associated with machine and accessory equipment limitations	Understand and interpret instructions and requirements documented by the physician in the patient's prescription	
2	Operate and oversee operation of radiologic equipment	Selecting and performing basic views (projections) and conventional contrast studies using appropriate radiographic parameters and equipment	Reliably perform all non-contrast plain Radiography, conventional contrast studies and non-contrast plain radiography in special situations	200
		Carrying out routine procedures for troubleshooting and maintenance of imaging and processing systems	Control and manipulate parameters associated with exposure and processing to produce a required image of desirable quality	
			Apply quality control procedures for all radiologic equipment	
3	Be able to transfer all relevant information and complete accurate documentation	Recognize the importance of accurate transfer of information to allow for accurate treatment set-up according to the treatment plan and prescription	Construct the most appropriate device for the individual patient within the context of the protocol	100
		Know what should be included	Apply the necessary precautions in production	
		Know to whom or where the documentation and information should be sent	Implement correct QC, storage and handling procedures for shielding devices	
		Be aware of the legal issues relating to documentation		

4		Know the shielding devices/methods available	Construct the most appropriate device for the individual patient within the context of the protocol	100
	Be able to prepare the diagnostic machinery	Know how to use these devices	Apply the necessary precautions in production	
		Recognize the associated health and safety issues	Implement correct QC, storage and handling procedures for immobilization devices	
5	Be able to carry out the daily organization of the treatment unit	Recognize the importance of team interactions	Participate in the organization of the daily work schedule to maximize efficiency	100
		Explain the principles of effective communication	Inform the patient about the procedure	
		Review the individual patient requirements		
6	Be able to accurately and consistently set-up and produce a good quality radiological image	Able to interpret the set-up information	Interpret the diagnostic plan and set-up the patient accordingly	200
		Apply knowledge of radiographic imaging to the production of radiographs and the assessment of image quality	Carrying out quality control tests on images obtained	
7	Be able to prepare and position the patient for the procedure	Be familiar with the treatment plan	Explain the anatomic and physiological basis of the procedure to be undertaken	200
		Identify preparatory procedures	Identify and explain the possible side effects to each patient	
			Check all preparatory procedures have been completed	
		Be familiar with the diagnostic plans for all patients on the treatment unit	Identify the patient in accordance with recognized procedures and consistent with the department protocol	

		Recognize the signs and symptoms associated with treatment in different sites	Analyze the information and integrate to define the optimal patient position	
		Discuss the importance of patient identification and how it should be carried out	Interpret the diagnostic plan and use the equipment accordingly	
8	Be able to complete accurate treatment documentation	Recognize the importance of accurate documentation	Complete the treatment documentation accurately	50
		Know what should be included	Ensure all legal requirements have been met	
		Be aware of the legal issues relating to treatment documentation		
		List support groups that might benefit patients		
9	Advise patient on appropriate nutrition, sexual function, rest, skin care, nausea and other symptoms	Explain the impact of nutritional status on patient tolerance of treatment	Assess the patient's nutritional status	50
10	Monitor and assure quality	Monitor treatment process/outcomes	Identify needs and expectations of patient/health care professionals	50
		Identify problems in treatment process/outcomes	Solve treatment process/outcome problems	
		Know what patient care is relevant for the procedure	Evaluate potential solutions thoroughly	
11	Be able to carry out the necessary data transfer checks	Define and explain the data that must be transferred	Check and verify all parameters	100
			Confirm approval and signatures	
12	Be able to process radiographic images	Apply knowledge of radiographic imaging to the production of radiographs and the assessment of image quality	Perform X-ray film / image processing techniques (including dark room techniques)	100

		Control and manipulate parameters associated with exposure and processing to produce a required image of desirable quality	Acquire an appropriate image as per instructions	
13	Recognize contrast induced adverse reactions	Promptly recognize and assess the reactions	Know the correct medications and other treatment options	100
		Taking precautionary measures to avoid the reactions	Recognise the contraindications of allergic reactions	
14	Be able to carry out corrective actions as per instructions	Recognize the critical structures on the verification images	Make corrections in accordance with the protocol	100
		Identify the correct imaging protocol	Record any corrections	
15	Be able to Implement health and safety procedures	Explain the health and safety issues for patients and staff	Assess the safety features to ensure they are in place and adhered to	100
16	Be able to interpret, applyand disseminate information as a member of the medical imaging team	Define and explain the data that must be disseminated	Identify the appropriate personnel to whom specific information should be disseminated	100
			Communicate the correct, relevant and appropriate information	
17	Be able to demonstrate professional behaviour	Explain the legal and ethical guidelines related to the profession	Practice in accordance with legislationregulations and ethical guidelines	100
		Be aware of your own competency levels	Promote collaborative practice	
		Identify the elements that reflect professional appearance and manner		
18	Be able to demonstrate a sensitive and caring attitude to patients	Explain the components of good communication	Self-awareness of their own personality traits	100
		Describe the main personality types	Analyze how the differences in personality influence approach	
		Be aware of the patient ‘gender, age, cultural background, educational level and social situation		

19	Be able to ensure radiation protection legislation is adhered to	Describe the radiation hazards and how they are managed	Routinely inspect the area to ensure that radiation protection measures are in place and functional	100
		Explain the legislation Relating to radiation protection		
20	Be able to carry out the daily/weekly Quality Control (QC) checks	Explain Quality Management System (QMS), Quality Assurance (QA) and Quality Control (QC	Perform the daily/weekly/monthly QC procedures	100
21	Be able to review the literature	Define search terms for specific treatment sites	Identify the appropriate literature in the area of interest	100
22	Be able to suggest implementation of research findings	Identify relevant sources of Research	Evaluate research with respect to current departmental practice	50
23	Be able to suggest/ initiate topics for medical imaging research	Identify literature to support research proposal	Review the literature in the area	50
		Define the necessary steps in preparing and carrying out research	Formulate a research question	

Total Hours- 2400

7th and 8th Semester

Bachelor of Medical Radiology and Imaging Technology

(B.MRIT)

Dissertation/ Internship/ Project/ Clinical Postings:

7th and 8th Semester: Internship (Lab posting/ Research dissertation):

Teaching and Examination Scheme

Course Name	**Bachelor in Medical Radiology and Imaging Technology**
Duration of Program	Four Years (8 Semesters)
Pattern	Full Time Rotatory Internship
Semester	Seventh & Eighth (4th year)
Internship	Minimum 2400 hours (calculated based on 8 hours per day for one year of internship)

Every candidate after passing all semesters examination is required to undergo compulsory internship to the

satisfaction of the college authorities and University for a period of 1 year as to be eligible for the award of the degree. The internship is partial fulfilment of the requirements for the graduation and no candidate shall be declared to have completed the program otherwise. The internship shall be completed within 18 months of the date of passing final examination.

Students must undertake rotational postings during which students have to work under supervision of an experienced staff in the following areas:

S.No	**Postings**	**Duration**
1	Conventional Radiography, Mammography, CR, DR and PACS	4 months
2	Radiological Imaging & Special Procedures and Advanced Equipments	2 months
3	Ultrasonography & Doppler Imaging	1 month
4	Interventional Radiology	1 month
5	Computed Tomography	2 months
6	Magnetic Resonance Imaging	2 months

Assessment of Internship

The intern shall maintain a record of work which is to be verified and certified by the faculty under whom he/she works. Apart from scrutiny of the record of work, assessment and evaluation of training shall be undertaken by an objective approach using situation tests in knowledge, skills and attitude during and at the end of the training. Based on the record of work and date of evaluation, the Head of the Institution/hospital will issue a certificate of satisfactory completion of training, following which the University will award the B.MRIT degree or declare him eligible for it.

Guideline for Internship

1. **RATIONALE**

The Clinical Education is designed for the students to familiarize them with the applications of radiography, mammography, radiological special procedures, CT, MRI and advanced imaging techniques etc. Student should be able

to reliably perform all non-contrast plain radiography as well as contrast radiological and imaging procedures along with Radiologist.

2. COMPETENCY

Identify the Anatomy to be imaged, properly position the patient for Imaging, Correctly select appropriate projection/projections to demonstrate the area of interest Use appropriate radiographic/radiological and imaging parameters.

3. COURSE OUTCOMES

On completion of this subject, the student should be able to:

• Correctly Identify the Anatomy to be imaged

• To properly position the patient for radiography/Radiological and Imaging procedures

• Correctly select appropriate projection/projections to demonstrate the area of interest

• Use appropriate radiographic parameters to produce a radiographic image with satisfactory results

• Should be able to differentiate a properly positioned and exposed radiographic image from a wrongly positioned and over or underexposed radiographic image

• Should be able to correctly identify anatomical features displayed in radiographic image obtained.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme	**Credit**	**Theory**			**Practical**			**Grand Total**
L	T	P	(L+T+P)	Paper Hrs.	CIE	ESE	Total	
--	--	--	20	--	--	--	--	
					Max 100	Min 50	Max 100	Min 50
					Max 100	Min 50	Max 200	Min 100

Note: ESE* will be conducted immediate after end of the 7th & 8th semester at the institutional level.

Legends:
L–Lecture, T–Tutorial/Teacher Guided Theory Practice, P–Practical, ESE–End Semester Examination, CIE–Continuous Internal Evaluation.

LIST OF PRACTICALS/ EXERCISES/ASSIGNMENTS/CASE STUDIES

Students have to do hands on practice on following Techniques:

Exp. No.	**Name of Practical/ Exercise/ Assignment/ Case Study**

	Seventh Semester
1	Radiation Physics
2	Radiographic Positioning
3	Conventional Radiography and Equipment
4	Contrast Media & Special Radiological/ imaging procedures
5	Interventional Radiology/ imaging techniques
6	Patient Care in Radiology
	Eighth Semester
7	Basics Techniques in CT Imaging Technology
8	Radiation Safety in Diagnostic Radiology
9	Quality Assurance in Diagnostic Radiology and Regulatory Requirements
10	Basics Techniques in MRI Imaging Technology
11	Introduction to Nuclear Medicine Techniques* (if facility available)
12	Ultrasound Techniques

5. GENERAL GUIDELINES FOR CLINICAL EDUCATION (INTERNSHIP)

The Institutes/Hospitals/Diagnostic Centers can be Government, Public limited, private enterprises or ownership.

• **Training Area:** Students should be trained in Large and Medium scale Hospitals/Diagnostic Centers. However, despite the best efforts by the Institute, if large and medium scale Hospitals/Diagnostic Centers are not available to all students then, students can also be placed in Small scale Institutes/Hospitals/Diagnostic Centers approved by the NCAHP competent body.

• **Skill Knowledge Partner (SKP):** To be identified by the Institute as per their programme areas like:

1. Government Hospitals
2. Corporate Hospitals
3. Private Hospitals
4. Diagnostic Centers
5. Any other relevant industry

Note: All these needs to be approved by the NCAHP competent body.

6. EXPECTATIONS FROM Skill Knowledge Partner (SKP)

Helping institute in developing the following competencies among students.

• Soft Skills i.e. Communication, Presentation and others.

• Life Skills i.e. Time management, Safety, Innovation, Entrepreneurship, Team building and others

• Hands-on Practices i.e. Patient Safety, Radiography/Radiological and Imaging and Quality Assurance aspects.

7. ROLE OF PARENT DEPARTMENT OF THE INSTITUTE

1. Identify Hospitals/Diagnostic Centers available for training along with capacity.
2. Institutions have to enter in to MOU with number of SKPs (Institutes/Hospitals/Diagnostic Centers) for accommodating all the enrolled students for the mandatory internship.
3. Student and mentor allocation as per the slots available for Hands on training (Desirable mentor-student ratio is 1:10).
4. Communication with Institutes/Hospitals/Diagnostic Centers available for training along with capacity and its confirmation.
5. Student enrollment for training.
6. Issuing letter to the Institutes/Hospitals/Diagnostic Centers for the training along with details of students and mentors.
7. Principal/HOD/ Faculty should address students about safety norms, rules and discipline to be maintained in the Institutes/Hospitals/Diagnostic Centers during the training before relieving students for training.
8. The designated faculty member would visit the Institutes/Hospitals/Diagnostic Centers periodically to check the progress of the student in the training, his/ her attendance, discipline, log book preparation & project report preparation.
9. Mentors to carry out progressive assessment of the students during the training through Continuous Internal Evaluation (CIE), End Semester Examination (ESE) assessment by mentor along with Institutes/ Hospitals/Diagnostic Centers expert as external examiner.

8. ROLES AND RESPONSIBILITIES OF THE STUDENTS

Following should be informed to students in the letter deputing them for the training; an undertaking for this should also be taken from them

• Students would interact with the mentor to suggest choices for suitable Institutes/Hospitals/Diagnostic Centers. If students have any contact in Institutes/Hospitals/Diagnostic Centers (through their parents, relatives or friends) then same may be utilized for securing placement for themselves and their peers.

• Students have to fill the forms duly signed by authorities along with training letter and submit it to training officer

in the Institutes/Hospitals/Diagnostic Centers on the first day of training. Student should also carry with him/her the Identity card issued by institute during training period.

• He/she will have to get all the necessary information from the training officer regarding schedule of the training, rules and regulations of the Institutes/Hospitals/Diagnostic Centers and safety procedures to be followed. Student is expected to observe these rules, regulations, procedures.

• Students should know that if they break any rule of Institutes/Hospitals/Diagnostic Centers or do not follow the discipline then Institutes/Hospitals/Diagnostic Centers can terminate the training and send back the student.

• It is the responsibility of the student to collect information from Institutes/Hospitals/Diagnostic Centers about Radiography/Radiological & Imaging procedures/ Patient Safety /work ethics/professional practices/organizational structure etc.

• During the training period students have to keep daily record of all the useful information in Log book along with the time and date and details of Radiological & Imaging procedures, how it was performed with patient's history any difficulty encountered.

• Maintain the Diary/Logbook and get it signed from mentor as well as Institutes/Hospitals/Diagnostic Centers Training in-charge.

• In case they face any major problem in industry such as an accident or any disciplinary issue then they should immediately report the same to the institute.

• Prepare final report about the training for submitting to the department at the time of presentation and viva-voce and get it signed from mentor as well as Institutes/Hospitals/Diagnostic Centers training in-charge.

9. FORMAT FOR TRAINING REPORT

Following is the suggestive format for the training report; actual format may differ slightly depending upon the nature of Institutes/Hospitals/Diagnostic Centers. The training report may contain the following

• Title page

• Certificate

• Abstract

• Acknowledgement

• Content Page with date and time start and end

Chapter 1.

Organizational structure of Institutes/Hospitals/Diagnostic Centers and General Lay Out

Chapter 2.

Introduction of Institutes/Hospitals/Diagnostic Centers (History, Facilities available, Specialization and number of employees etc.)

Chapter 3.

Types of major equipment/instruments/machines used in Radiology with their specification, approximate cost and specific use and their routine maintenance.

Chapter 4.

Standard Operating procedures.

Chapter 5.

Quality assurance and radiation safety procedures.

Chapter 6.

Equipment handling and procedures.

Chapter 7.

Safety procedures followed

Chapter 8.

Particulars of Practical Experiences in Radiology and Imaging

Chapter 9.

Short report/description of the project (if any done during the training)

Chapter 10.

Special/challenging experiences encountered during training if any (may include students liking & disliking of work places)

References /Bibliography

10. SUGGESTED LEARNING STRATEGIES

Students should visit the website of the Institutes/Hospitals/Diagnostic Centers where they are undergoing training to collect information about Facilities, Specialization, capacity, number of employees, etc. They should also refer the operating manuals of the major machines and operation, testing, quality control and standard operating procedures and practices used in the Radiology. Students may also visit websites related to other similar industries as their learning resource. The training activity may vary according to nature and size of Institutes/Hospitals/Diagnostic Centers. The details of activities to be completed during 6 months should be planned appropriately. The evaluation of Clinical Education (Internship) will be done on the basis of skills acquired by the student during this 6 months period.

ASSESSMENT SCHEME FOR CLINICAL EDUCATION (INTERNSHIP)

Training duration	**CONTINUOUS INTERNAL EVALUATION (Weekly report of all 6 months and attendance)**		**END SEMESTER ASSESSMENT (Practical and Oral)**		**Total marks**	

	Max. marks	Min. marks	Max. marks	Min. marks	Max. marks	Min. marks
6 months	100	50	100	50	200	100

EVALUATION SHEET FOR CONTINUOUS INTERNAL EVALUATION

Sr. No.	Enrollment Number	Name of Student	Seminar/presentation in workshop or conference	Marks by Supervisor	Marks by Mentor Faculty	Total Marks
			Out of 40 (A)	Out of 30 (B)	Out of 30 (C)	Out of 100 (A+B+C)

Marking criteria for seminar/presentation at workshop/conference and marking criteria for supervisor/mentor faculty mentioned in the log book template.

DISTRIBUTION OF END-SEMESTER-EXAMINATION (ESE*) MARKS

Marks for Training Report	Marks for Practical's	Marks for Oral/Viva-voce	Total ESE marks
25	25	50	100

Practical (25 marks) must include minimum two practical related demonstration infront of the internal examiners.

Board of examiners for 7th & 8th semester:

• HOD of Radiology: Chairperson

• Programme Co-ordinator/Course Co-ordinator/Chief of MRIT/Incharge of MRIT: Co-chairperson

• Subject Experts: Internal examiners (two) members.

Log Book Template:

Cover Page

Institute/University Logo

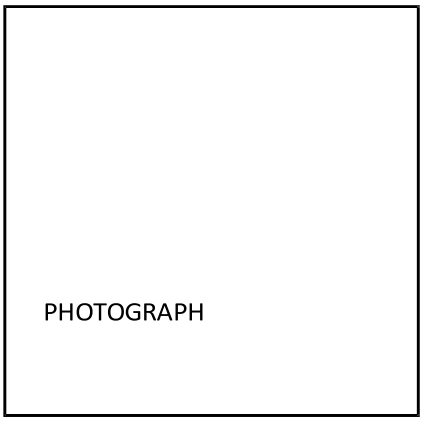
Bachelor in Medical Radiology and Imaging Technology

(B.MRIT)

Log Book

Name of the Student: _____
Name of the Under Graduate degree: _____
USN: _____
Batch: _____

PARTICULARS OF STUDENT



Name of the student:

Reg no:

Sessions:

Year of admission:

Year of completion:

Address:

Contact details:

Email id:

Signature of the student:

CERTIFICATE

This is to certify that

Mr./Ms. _____ has satisfactorily completed the training requirements for the programme of Bachelor in Medical Radiology and Imaging Technology (B.MRIT) from (name of the Institute/University & address). She/He has completed all the clinical responsibilities during her/his Under-graduation training from _____ to _____ .

Signature

Head/Programme Co-ordinator

Signature

Principal/Dean

Index		
Sl.No.	Content	Page No.

SECTION I: CLINICAL POSTINGS

Date	Department/ Modalities	Posting brief descriptions	Name & Signature of the staff/mentor /supervisor

SECTION II. SEMINARS PRESENTED/ATTENDED

Sl. No.	Date	Topic of the Seminar	Signature of the Moderator

SEMINAR EVALUATION FORM

Evaluation of Seminar

Sl. No	Criteria	5 Excellent	4 Good	3 Average	2 Below Average	1 Poor
1.	Content of the Presentation					
2.	Aesthetic of slides preparation					
3.	Oratory & Presentation Skills					
4.	Audio- visual aids used					
5.	Clarity of presentation					
6.	Critical Analysis					
7.	Ability to respond to questions on the subject					
8.	Ability to defend the topic					
9.	Referencing					
10.	Implementation recent advancement on the topic					
Total Marks**: 50**						

SEMINAR SCORE SHEET

Sl. No.	Date	Topic	Total Marks (Max.50)	Evaluations Signature	Co-ordinator Signature

Supervisor/mentor shall be determined the marks basis of the following:

S.No.	Parameter	Score
1.	Proficiency of knowledge required for each radiological imaging procedures	0-5
2.	The competency in skills expected to manage each radiological imaging procedures	0-5
3.	Responsibility, punctuality, work up of case, involvement in follow-up reports	0-5
4.	Capacity to work in a team (Behaviour with colleagues, technologist and relationship with other healthcare workers)	0-5
5.	Initiative, participation in discussions, research aptitude	0-5

SCORING SCALE:
1 Poor
2 Below Average
3 Average
4 Good
5 Excellent

Note: A score of less than 2 in any of above items will represent unsatisfactory completion of internship.

SECTION III. EXTENSION/EXTRA CURRICULAR ACTIVITIES
(CONFERENCES/CME/WORKSHOP/TRAININGS)

Sl. No.	Date	Event (Institution/Place)	Achievements	Signature of the Faculty

DETAILS OF ABSENCE

Sl.No.	Date of Absence		Reason	Signature of the faculty
	From	To		

EVALUATION OF THE LOGBOOK

Sl. No.	Items of observation during presentation	I	II	III	IV	V	VI	Internship
1	Organization of the log book							
2	Adequacy of Content/ Information in the log book							
3	Punctuality							
4	Relevance of Content/ Information in the log book							
5	Shows professional conduct during the Teaching Learning session							
6	Timely submissions of Projects/Synopsis/Seminar effectively							
7	Work Relationship & Frequency of consulting faculty							
8	Overall quality of department work							
	Total Score							
	Signature of the Co-ordinator							

IMMUNIZATION FORM

SL.NO.	Vaccination	Date of vaccination	Dose (Attach Bar code Slip)

Annexures

MONITORING LEARNING PROGRESS

It is essential to monitor the learning progress of each candidate through continuous appraisal and regular assessment. It not only helps teachers to evaluate students, but also students to evaluate themselves. The monitoring be done by staff of the department based on participation of students in various teaching/ learning activities. It may be structured and assessment shall be done using checklists that assess various aspects. Model checklists are given which may be copied and used.
The learning out comes to be assessed should include:

a. Acquisition of knowledge: the methods used comprise of 'Log Book' which records participation in various teaching/ learning activities and mentoring of students. The number of activities attended and the number in which presentations are made are to be recorded. The log bookshouldperiodicallybe validated by the supervisors. Some of the activities are listed.

b. Seminars/ symposia: the topics should be assigned to the student well in advance to facilitate in depth study. The ability to do literature search, in depth study, presentation skills and use of audio- visual aids are to be assessed using a checklist (see Model ChecklistI).

c. Work diary/ Log Book- every candidate shall maintain a work diary and record his 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 experiments or procedures, if any conducted by the candidate.

d. Records: records, log books and marks obtained in tests will be maintained by the Head of the Department and will be made available to theUniversity.

Log Book

The log book is a record of important activities of the candidates during his training, Internal assessment should be based on the evaluation of log book. Collectively, log books are a tool for the evaluation of training programme of the institution by external agencies. The record includes academic activities as well as the presentations and procedures carried out by the candidate.

Procedure for defaulters: every department should have a committee to review such situations. The defaulting candidate is counseled by the guide and head of the department. In extreme cases of default the departmental committee may recommend that defaulting candidate be withheld from appearing the examination, if he fails to fulfill the requirements inspite of being given adequate chances to set himself right.

Checklist- I: MODEL CHECKLIST FOR THE EVALUATION OF THE SEMINAR PRESENTATIONS

Name of the student: Date:

Name of the faculty/ observer:

Title of the seminar:

Sl. No.	**Items of observation during presentation**	**Poor0**	**Below average 1**	**Average 2**	**Good 3**	**Very good 4**
1	Topic chosen was					
2	Extent of understanding of scope & objectives of the paper by the candidate					
3	Whether cross- references have been consulted					
4	Whether other relevant references have been consulted					
5	Ability to respond to questions on the paper/ subject					
6	Audio- visual aids used					
7	Ability to defend the topic					
8	Clarity of presentation					
9	Any other observation					
	Total score					
Remarks						

Name and Signature of the Faculty ……

Model marking criteria for Supervisor/mentor faculty

S.No.	Parameter	Score
1.	Proficiency of knowledge required for each radiological imaging procedures	0-5
2.	The competency in skills expected to manage each radiological imaging procedures	0-5
3.	Responsibility, punctuality, work up of case, involvement in follow-up reports	0-5
4.	Capacity to work in a team (Behaviour with colleagues, technologist and relationship with other healthcare workers)	0-5
5.	Initiative, participation in discussions, research aptitude	0-5

SCORING SCALE:
0 Dissatisfied
1 Poor
2 Below Average
3 Average
4 Good
5 Excellent

Note: A score of less than 3 in any of above items will represent unsatisfactory completion of internship.

BACHELOR OF MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY (B.MRIT)
MODEL QUESTION PAPER (WITH CO–PO-BT(L) MAPPING)

Bloom's Taxonomy — Cognitive Domain Reference

Bloom's Level	Order	Action Verbs (for question framing)
L1 – Remember	1	Define, Recall, List, Name, Identify, State
L2 – Understand	2	Explain, Describe, Classify, Summarize, Interpret
L3 – Apply	3	Apply, Demonstrate, Solve, Use, Illustrate
L4 – Analyse	4	Analyse, Compare, Differentiate, Examine, Categorize
L5 – Evaluate	5	Evaluate, Critique, Judge, Justify, Assess
L6 – Create	6	Design, Construct, Propose, Develop, Formulate

MODEL PAPER

B.MRIT Semester-I
Paper Code: BMRIT-001

Bachelor of Medical Radiology & Imaging Technology
Semester-I
HUMAN ANATOMY
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any Two) (2 × 10 = 20 Marks)

A. Explain the gross anatomy of the heart including chambers. (CO2, L2)

B. Explain the structure of the kidney and describe the histology of the nephron. (CO2, CO6, L2)

C. Describe the cerebrum, cerebellum and brain stem. (CO2, L2)

Q.2. Short Essay Questions (Attempt Any Seven) (7 × 5 = 35 Marks)

A. Define anatomy and explain its subdivisions. (CO1, L1)

B. Classify epithelial tissue with suitable examples. (CO3, L1)

C. Explain the classification of bones with examples. (CO2, L2)

D. Explain the classification of joints with examples. Describe a typical synovial joint. (CO2, L2)

E. Describe the bronchopulmonary segments of the lungs. (CO2, L2)

F. Explain the gross anatomy of the stomach. (CO2, L2)

G. Explain the structure of the thyroid gland. (CO2, L2)

H. Explain the structure of the eyeball. (CO2, L2)

I. Determine the surface landmarks used to locate the heart on the anterior chest wall. (CO4, L3)

Q.3. Short Answer Questions (Attempt Any Five) (5 × 3 = 15 Marks)

A. Define anatomical position and mention its importance. (CO1, L1)

B. Name the types of cartilage with one example each. (CO3, L1)

C. Identify any three major arteries of the upper limb. (CO5, L1)

D. Define peripheral pulse. (CO4, L2)

E. What is peritoneum? (CO2, L2)

F. Name the endocrine glands of the human body. (CO1, L1)

G. Identify the parts of the cerebrum. (CO5, L1)

H. Differentiate between testis and ovary on the basis of their functions. (CO6, L2)

MODEL PAPER

B.MRIT Semester-I
Paper Code: BMRIT-002

Bachelor of Medical Radiology & Imaging Technology
Semester-I
Physiology
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Explain erythropoiesis in detail and discuss the structure, functions, life span. (CO1, L2)
B. Describe the cardiac cycle with suitable diagrams and explain the significance of heart sounds. (CO1, CO6, L2)
C. Describe how endocrine glands help maintain homeostasis in the body. (CO3, L3)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Explain the concept of homeostasis. (CO2, L2)
B. Mechanism of neuromuscular transmission. (CO1, L2)
C. Intrinsic and extrinsic pathways of blood coagulation. (CO4, L2)
D. Factors regulating arterial blood pressure. (CO2, L2)
E. Discuss oxygen and carbon dioxide transport in blood. (CO2, L2)
F. Process of urine formation. (CO1, CO2, L2)
G. Describe the composition and functions of gastric juice, pancreatic juice. (CO1, L2)
H. Differentiate between normal and abnormal thyroid gland function. (CO4, L4)
I. Explain the organization of the autonomic nervous system and discuss its functions. (CO1, L2)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Enumerate the functions of plasma proteins. (CO1, L1)
B. Define cardiac output and mention factors affecting it. (CO1, L1)
C. Define hypoxia. (CO4, L1)
D. Define GFR and state its normal value. (CO1, L1)
E. List the functions of the liver. (CO1, L1)
F. Differentiate between diabetes mellitus and diabetes insipidus. (CO4, L2)
G. Mention the functions of cerebrospinal fluid. (CO1, L1)
H. Explain the physiological basis of family planning methods. (CO5, L2)

MODEL PAPER

B.MRIT Semester-I
Paper Code: BMRIT-003

Bachelor of Medical Radiology & Imaging Technology
Semester-I
Basics of Radiation Physics
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Describe the atomic structure, electronic configuration, isotopes, ionization, and excitation. (CO1, L1)

B. Explain the production of X-rays and discuss Bremsstrahlung and characteristic X-rays along with factors affecting X-ray quality and quantity. (CO6, L1)

C. Interpret the interaction of X-rays and gamma rays with matter, emphasizing photoelectric effect, Compton scattering, and pair production. (CO4, L4)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Describe electromagnetic radiation, electromagnetic spectrum, and quantum nature of radiation. (CO1, L1)

B. Explain Coulomb's law, electric potential, capacitance, and capacitors connected in series and parallel. (CO7, L2)

C. Discuss alternating current and explain peak value, RMS value, and power factor. (CO7, L2)

D. Identify the construction and working of a p-n junction diode and explain forward and reverse bias. (CO3, L3)

E. Describe the construction and working of a transistor as an amplifier. (CO3, L3)

F. Differentiate between soft X-rays and hard X-rays. Discuss the role of filtration and heel effect in X-ray imaging. (CO2, L4)

G. Explain the transfer of heat by conduction, convection, and radiation. Discuss its application in X-ray tube cooling. (CO1, L1)

H. Interpret the significance of half-value layer (HVL) in determining X-ray beam quality. (CO4, L4)

I. Differentiate between X-ray equipment and semiconductor electronic devices used in radiology systems. (CO5, L4)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Define electron volt (eV) and binding energy. (CO1, L1)

B. State Ohm’s law and Joule’s law. (CO1, L1)

C. List the properties of X-rays. (CO6, L1)

D. Define Bremsstrahlung radiation. (CO6, L1)

E. Define thermal conductivity and mention its importance in radiology. (CO1, L1)

F. Differentiate between photoelectric effect and Compton scattering. (CO2, L4)

G. Define HVT and TVT. (CO1, L1)

H. List any three radiation-related physical quantities and their SI units used in diagnostic radiology. (CO1, L1)

MODEL PAPER

B.MRIT Semester-II
Paper Code: BMRIT-011

Bachelor of Medical Radiology & Imaging Technology
Semester-II
Basics of Microbiology
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Describe the morphology of bacteria, including structure, size, shape, arrangement, cell wall, capsule, flagella, and spores. (CO1, L1)

B. Explain the various methods of sterilization and disinfection and discuss their applications in healthcare settings. (CO2, L2)

C. Describe the general properties, classification, morphology, and reproduction of fungi. (CO1, L1)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Explain the bacterial growth curve and discuss factors affecting bacterial growth. (CO1, L1)

B. Describe culture media and various culture methods used in microbiology. (CO1, L1)

C. Discuss antimicrobial sensitivity testing and its significance in patient management. (CO2, L2)

D. Explain the classification, sources, and modes of transmission of infection. (CO2, L2)

E. Describe nosocomial infections and discuss measures for prevention and control of hospital-acquired infections. (CO4, L2)

F. Explain immunity, antigen, and antibody with suitable examples. (CO3, L2)

G. Discuss hypersensitivity reactions and their clinical significance. (CO3, L2)

H. Explain biomedical waste management and describe the methods of segregation and disposal of biomedical waste (CO5, L3)

I. Describe the general properties, classification, and replication of viruses. (CO6, L1)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Define capsule and mention its functions. (CO1, L1)

B. List the characteristics of an ideal disinfectant. (CO2, L2)

C. Define nosocomial infection. (CO4, L2)

D. Define antigen and antibody. (CO3, L2)

E. Enumerate the categories of biomedical waste. (CO5, L1)

F. List any three common fungal infections. (CO6, L1)

G. Mention the causative organism of pulmonary tuberculosis and HIV/AIDS. (CO6, L1)

H. Define food poisoning and mention two common causes. (CO6, L1)

MODEL PAPER

B.MRIT Semester-II
Paper Code: BMRIT-012

Bachelor of Medical Radiology & Imaging Technology
Semester-II
Basics of Biochemistry
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Explain the nutritional importance of carbohydrates, lipids, proteins. (CO6, L2)
B. Explain acid-base balance in the human body. (CO4, L2)
C. Explain liver function tests (LFT) and renal function tests (RFT) with their clinical significance and interpretation. (CO7, L2)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Describe the responsibilities of healthcare personnel in a clinical biochemistry laboratory. (CO1, L2)
B. Explain the types, uses, care, and maintenance of common laboratory apparatus and instruments. (CO2, L2)
C. Discuss the preparation of different solutions and their importance in clinical biochemistry. (CO3, L2)
D. Explain water and electrolyte balance and discuss the clinical significance of electrolyte estimation. (CO4, L2)
E. Describe the procedure for specimen collection, handling, and transportation for biochemical investigations. (CO5, L3)
F. Explain blood sugar estimation and glucose tolerance test (GTT) with their diagnostic importance. (CO8, L2)
G. Discuss lipid profile and its significance in cardiovascular diseases. (CO8, L2)
H. Describe tumor markers and cardiac markers with their clinical applications. (CO8, L2)
I. Explain the applications and hazards of radioisotopes in healthcare. (CO9, L1)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Define calorific value. (CO6, L2)
B. List any three laboratory safety precautions. (CO1, L2)
C. Define acids, bases, and salts with examples. (CO4, L2)
D. Define anion gap. (CO4, L2)
E. List the normal fasting blood glucose values. (CO8, L2)
F. Enumerate any three liver function tests. (CO7, L2)
G. Define radioisotopes and mention two applications. (CO9, L1)
H. List any three biochemical parameters used in renal function tests. (CO7, L2)

MODEL PAPER

B. MRIT Semester-II
Paper Code: BMRIT-013

Bachelor of Medical Radiology & Imaging Technology
Semester-II
Conventional Radiography and Equipment
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Describe the construction and working of a modern X-ray tube. (CO1, L2)
B. Explain the X-ray generator circuits with suitable block diagrams. (CO3, L2)
C. Describe fluoroscopy and explain the construction and working of an image intensifier. (CO7, L2)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Describe the production of X-rays. (CO1, L2)
B. Describe line focus principle and space charge effect. (CO2, L1)
C. List and explain the methods of heat dissipation in X-ray tubes. (CO2, L1)
D. Explain automatic exposure control (AEC) and its practical applications. (CO3, L2)
E. Describe high-tension circuits. (CO4, L1)
F. Describe ammeter and voltmeter. (CO5, L1)
G. List the methods used for control of scattered radiation and discuss the advantages of grids. (CO6, L1)
H. Explain the construction and working of a light beam collimator. (CO6, L1)
I. Apply the principles of quality assurance in the care and maintenance of X-ray equipment. (CO8, L3)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Define heel effect. (CO1, L2)
B. List the Properties of X-Ray. (CO2, L1)
C. Define rectification and mention its purpose in X-ray circuits. (CO3, L2)
D. Enumerate the functions of Anode in diagnostic X-ray machines. (CO4, L1)
E. List the commonly used exposure timers in diagnostic radiology. (CO5, L1)
F. Define grid ratio and grid cut-off. (CO6, L1)
G. State any three advantages of image intensifiers. (CO7, L2)
H. List any three routine maintenance checks performed on X-ray equipment. (CO8, L1)

MODEL PAPER

B. MRIT Semester-II
Paper Code: BMRIT-014

Bachelor of Medical Radiology & Imaging Technology
Semester-II
Clinical Radiography Positioning (Part I)
Time: 3 Hours | Maximum Marks: 70

Q.1. Essay Questions (Attempt Any 2) (2 × 10 = 20 Marks)

A. Explain the different views of chest radiography. (CO1, CO6, L2)
B. Apply radiographic positioning techniques for routine projections of the vertebral column with suitable diagrams. (CO2, CO4, L3)
C. Analyze the radiographic appearances of normal skull and paranasal sinuses. (CO8, L4)

Q.2. Short Essay Questions (Attempt Any 7) (7 × 5 = 35 Marks)

A. Describe the routine projections of the wrist joint and scaphoid. (CO1, L2)
B. Apply appropriate positioning techniques for imaging the elbow joint. (CO2, L3)
C. Explain the radiographic positioning and exposure factors for the knee joint and patella. (CO5, L2)
D. Describe routine radiographic projections of the shoulder joint and clavicle. (CO1, L2)
E. Apply radiographic positioning for the sacroiliac joints and lumbar spine. (CO4, L3)
F. Explain the radiographic techniques used for imaging the mandible and temporomandibular joints. (CO7, L2)
G. Describe the routine projections of the pelvis and hip joint. (CO1, L2)
H. Explain ALARA. (CO7, L2)
I. Apply suitable modifications in radiographic techniques for patients with physical disabilities. (CO2, L3)

Q.3. Short Answer Questions (Attempt Any 5) (5 × 3 = 15 Marks)

A. Define decubitus position. (CO1, L1)
B. List any three positioning aids used in radiography. (CO6, L1)
C. State the purpose of a gonad shield. (CO6, L2)
D. Mention the routine projections for the ankle joint. (CO4, L1)
E. List the projections used for cervical spine examination. (CO4, L1)
F. Mention any three radiographic signs of a fracture. (CO8, L1)
G. State the indication of Frog-leg projection. (CO2, L1)
H. List any three methods to reduce radiation dose to the patient. (CO5, L2)

MODEL PAPER

B. MRIT Semester-III
Paper Code: BMRIT-015

Bachelor of Medical Radiology & Imaging Technology
Semester-III
Pathology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions (Attempt Any Two) (2 × 10 = 20 Marks)

A. Describe acute inflammation. (CO3, L2)
B. Discuss neoplasia with reference to definition & nomenclature. (CO4, L2)
C. Explain ischemic heart disease (IHD). (CO4, L2)

Q.2 Short Essay Questions (Attempt Any Seven) (7 × 5 = 35 Marks)

A. Explain reversible and irreversible cell injury with suitable examples. (CO3, L2)
B. Classify edema and discuss the pathogenesis of pulmonary edema. (CO3, L2)
C. Describe thrombosis. (CO3, L2)
D. Explain fracture healing and factors influencing wound healing. (CO4, L2)
E. Discuss iron deficiency anemia. (CO4, L2)
F. Describe blood grouping and cross-matching procedures carried out before blood transfusion. (CO7, L2)
G. Explain atherosclerosis with its risk factors. (CO4, L2)
H. Describe pulmonary tuberculosis with classification and complications. (CO4, L2)
I. Explain acute and chronic renal failure. (CO4, L2)

Q.3 Short Answer Questions (Attempt Any Five) (5 × 3 = 15 Marks)

A. Define apoptosis and mention its significance. (CO1, L1)
B. Enumerate the types of necrosis with one example each. (CO2, L1)
C. List the common laboratory tests included in liver function tests (LFTs). (CO5, L1)
D. Enumerate the steps involved in blood sample collection and transportation. (CO6, L2)
E. Define leukemia and classify acute and chronic leukemias. (CO2, L1)
F. List the mandatory screening tests performed in a blood bank. (CO5, L1)
G. Differentiate between osteoarthritis and rheumatoid arthritis. (CO4, L1)
H. Define pleural effusion and mention its causes. (CO1, L1)

MODEL PAPER

B. MRIT Semester-III
Paper Code: BMRIT-0016

Bachelor of Medical Radiology & Imaging Technology
Semester-III
Clinical Radiography Positioning (Part-II)
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions (Attempt Any Two) (2 × 10 = 20 Marks)

A. Describe the radiographic techniques used for examination of the lungs. (CO5, L3)

B. Explain ward/mobile radiography. (CO7, L3)

C. Discuss soft tissue radiography and high kV radiography, including principles, techniques, applications. (CO6, L2)

Q.2 Short Essay Questions (Attempt Any Seven) (7 × 5 = 35 Marks)

A. Describe intraoral full-mouth radiography and occlusal projections used in dental radiography. (CO5, L3)

B. Explain the radiographic techniques for postnasal airways, larynx, trachea, and thoracic inlet examination. (CO3, L2)

C. Discuss the radiographic projections used in acute abdomen and localization of abdominal foreign bodies. (CO5, L3)

D. Explain radiography in specialized units such as ICU, CCU, and neonatal units. (CO7, L3)

E. Describe mammography basic views, special views, and wire localization techniques. (CO5, L3)

F. Discuss operation theatre radiography, including aseptic precautions, exposure factor selection, and radiation protection measures. (CO8, L3)

G. Explain neonatal and pediatric radiography with special reference to patient handling and radiation protection. (CO1, L3)

H. Describe the principles, equipment, and applications of forensic radiography. (CO3, L2)

I. Explain the techniques used for localization of foreign bodies in soft tissues. (CO2, L4)

Q.3 Short Answer Questions (Attempt Any Five) (5 × 3 = 15 Marks)

A. List the indications of orthopantomography (OPG). (CO2, L1)

B. Enumerate the projections used to demonstrate pleural fluid levels. (CO5, L1)

C. Mention the precautions to be followed during mobile radiography. (CO7, L2)

D. Define wire localization in mammography. (CO3, L2)

E. List the radiation protection measures adopted in operation theatre radiography. (CO8, L1)

F. Define microradiography and mention its uses. (CO6, L1)

G. Enumerate the advantages of high kV radiography. (CO6, L1)

H. List the methods used to locate non-opaque foreign bodies. (CO2, L1)

MODEL PAPER

B. MRIT Semester-III
Paper Code: BMRIT-017

Bachelor of Medical Radiology & Imaging Technology
Semester-III
Radiography and Image Processing Techniques
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions (Attempt Any Two) (2 × 10 = 20 Marks)

A. Describe the construction, types of intensifying screens. (CO2, L2)
B. Explain radiographic image quality with reference to density, contrast, sharpness. (CO4, L4)
C. Discuss film processing. (CO3, L2)

Q.2 Short Essay Questions (Attempt Any Seven) (7 × 5 = 35 Marks)

A. Explain latent image formation. (CO1, L1)
B. Describe the construction, types, and maintenance of X-ray cassettes. (CO2, L2)
C. Explain the planning and construction requirements of a dark room in a radiology department. (CO2, L2)
D. Discuss dark room accessories and their functions. (CO8, L3)
E. Explain the working principle, advantages, and limitations of an automatic processor. (CO7, L3)
F. Describe xeroradiography. (CO5, L3)
G. Analyze the factors affecting image resolution and methods used to improve image quality. (CO4, L4)
H. Explain PACS and DICOM. (CO5, L3)
I. Describe screen-film contact tests and their significance in radiographic imaging. (CO8, L3)

Q.3 Short Answer Questions (Attempt Any Five) (5 × 3 = 15 Marks)

A. Define fluorescence and phosphorescence. (CO1, L1)
B. List any six radiographic film artifacts. (CO1, L1)
C. Enumerate the types of safe lights used in dark rooms. (CO2, L2)
D. Mention the functions of developer solution. (CO3, L2)
E. Define rapid processing and state its advantages. (CO7, L1)
F. List factors affecting radiographic contrast. (CO4, L1)
G. Enumerate the applications of high-quality radiographic reproduction. (CO6, L1)
H. State the advantages of PACS over conventional film storage. (CO5, L1)

MODEL PAPER

B. MRIT Semester-III
Paper Code: BMRIT-018

Bachelor of Medical Radiology & Imaging Technology
Semester-III
Contrast Media & Special Radiological Procedures
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions (Attempt Any Two) (2 × 10 = 20 Marks)

A. Discuss contrast media used in radiology. (CO2, L4)

B. Describe the procedure of Intravenous Urography (IVU. (CO1, CO3, L3)

C. Explain myelography with special reference to lumbar and cervical myelography. (CO2, CO9, L4)

Q.2 Short Essay Questions (Attempt Any Seven) (7 × 5 = 35 Marks)

A. Explain the responsibilities of a radiology technologist during special radiographic procedures. (CO7, L3)

B. Describe the layout and essential facilities of an interventional radiology and fluoroscopy room. (CO9, L2)

C. Discuss the procedure and positioning for Barium Swallow examination. (CO5, L3)

D. Explain Double Contrast Barium Meal and its clinical applications. (CO2, L4)

E. Describe Endoscopic Retrograde Cholangiopancreatograph with indications and patient preparation. (CO3, L2)

F. Discuss Micturating Cystourethrography with indications, technique, and precautions. (CO5, L3)

G. Explain Hysterosalpingography with patient preparation, procedure, and complications. (CO1, L3)

H. Describe bronchography and its radiographic technique. (CO5, L3)

I. Explain embolization procedures and the commonly used embolic agents. (CO9, L2)

Q.3 Short Answer Questions (Attempt Any Five) (5 × 3 = 15 Marks)

A. Enumerate the indications of Gastrograffin enema. (CO2, L4)

B. List the emergency equipment required in a radiology department. (CO8, L3)

C. Define Enteroclysis and mention its advantages. (CO6, L2)

D. List the contraindications of Intravenous Urography. (CO2, L4)

E. Enumerate the steps in patient preparation for HSG. (CO3, L2)

F. Define Percutaneous Lung Biopsy and mention its indications. (CO6, L2)

G. List the indications of arthrography. (CO2, L4)

H. Mention four radiation safety precautions followed during special radiological procedures. (CO2, L4)

MODEL PAPER

B. MRIT Semester-IV
Paper Code: BMRIT-019

Bachelor of Medical Radiology & Imaging Technology
Semester-IV
Cross Sectional Anatomy
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain sectional anatomy and discuss sagittal, coronal and axial planes with suitable CT/MRI illustrations. (CO1, CO2, L3)

B. Describe the cross-sectional anatomy of the heart and great vessels as visualized on CT and MRI images. (CO4, CO5, L3)

C. Explain the cerebral hemispheres, ventricles and brainstem anatomy with reference to CT/MRI sectional imaging. (CO4, CO5, L3)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Describe the anatomical relationships and terminology used in sectional anatomy. (CO2, L2)

B. Explain the cross-sectional anatomy of the lungs and mediastinum. (CO4, L3)

C. Describe the major abdominal organs and their appearance on CT/MRI images. (CO5, L3)

D. Discuss the anatomy of abdominal blood vessels and their clinical significance in imaging. (CO6, L4)

E. Explain the cross-sectional anatomy of the male pelvis. (CO5, L3)

F. Describe the reproductive organs of the female pelvis as seen on CT/MRI. (CO5, L3)

G. Explain the anatomy of the spinal cord and meninges with suitable diagrams. (CO5, L3)

H. Discuss the arterial and venous systems of the neck. (CO6, L4)

I. Classify the cranial nerves and mention their anatomical course. (CO7, L2)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define sectional anatomy and mention its importance in diagnostic imaging. (CO2, L1)

B. List the bony structures forming the upper thorax. (CO7, L1)

C. Identify any three structures visualized in an axial CT section of the abdomen. (CO1, L1)

D. Differentiate between arterial and venous anatomy of the abdomen. (CO6, L1)

E. Name the components of the ventricular system of the brain. (CO3, L2)

F. Mention the parts of a vertebra seen in sectional imaging. (CO5, L1)

G. List the major salivary glands of the neck region. (CO7, L1)

H. State the anatomical contents of the mediastinum. (CO3, L1)

MODEL PAPER

B. MRIT Semester-IV
Paper Code: BMRIT-020

Bachelor of Medical Radiology & Imaging Technology
Semester-IV
Modern Radiological Imaging Equipment and Physics
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the construction, working and advantages of a modern X-ray tube. (CO1, L2)

B. Describe the principle used in Digital Radiography. Compare it with Computed Radiography. (CO2, L2)

C. Explain the architecture, components and workflow of PACS and discuss its role in modern radiology departments. (CO3, L2)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Discuss the principle and applications of Digital Mammography. (CO1, L2)

B. Explain Tomosynthesis. (CO1, L2)

C. Describe the working principle of DEXA Scan. (CO1, L2)

D. Explain the working principle and components of Computed Radiography. (CO2, L2)

E. Differentiate between Direct and Indirect Digital Radiography systems. (CO2, L3)

F. Discuss the advantages, disadvantages and applications of Digital Radiography. (CO2, L2)

G. Describe Cone Beam Dental CT and its clinical applications. (CO1, L2)

H. Explain modern dental radiographic equipment used in dentistry. (CO1, L2)

I. Discuss the functions and advantages of RIS and HIS in-hospital management. (CO3, L2)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define Stitch Radiography and mention its applications. (CO1, L1)

B. List the advantages of Digital Mammography. (CO1, L1)

C. State any three differences between CR and DR systems. (CO2, L1)

D. Name the components of a flat panel detector. (CO2, L1)

E. Mention the advantages of portable digital X-ray units. (CO2, L1)

F. Define Cone Beam CT. (CO1, L1)

G. Expand PACS, RIS and HIS. (CO3, L1)

H. List any three functions of PACS. (CO3, L1)

MODEL PAPER

B. MRIT Semester-IV
Paper Code: BMRIT-021

Bachelor of Medical Radiology & Imaging Technology
Semester-IV
Interventional Radiology Techniques
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the basic principles of Digital Subtraction Angiography. (CO1, L2)
B. Discuss the classification, types and clinical applications of catheters and guide wires used in interventional radiology. (CO2, L3)
C. Analyze radiation safety measures, room design requirements and radiation monitoring practices in an angiography suite. (CO3, L4)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Describe single-plane and biplane angiographic equipment. (CO1, L2)
B. Explain the functions of image intensifiers and flat panel detectors in angiography. (CO1, L2)
C. Discuss percutaneous catheterization and various catheterization sites. (CO2, L3)
D. Explain the role of pressure injectors and their accessories during angiographic procedures. (CO2, L3)
E. Analyze the indications, contraindications and contrast media used in coronary arteriography. (CO3, L4)
F. Describe peripheral venography and central venography procedures. (CO2, L3)
G. Explain patient preparation required before interventional radiological procedures. (CO4, L2)
H. Discuss post-procedural care and monitoring following angiographic examinations. (CO5, L2)
I. Explain the quality assurance program in angiography equipment and mention corrective actions for deviations. (CO5, L2)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define Digital Subtraction Angiography. (CO1, L1)
B. List any three types of angiographic catheters. (CO2, L1)
C. Mention three applications of guide wires in interventional radiology. (CO2, L1)
D. State the purpose of CO_2 angiography. (CO1, L1)
E. List any three radiation protective devices used in an angiography room. (CO3, L1)
F. Enumerate the steps of patient preparation before angiography. (CO4, L1)
G. Mention any three post-procedural care measures after catheterization. (CO5, L1)
H. Define quality assurance in angiographic equipment. (CO5, L1)

MODEL PAPER

B. MRIT Semester-IV
Paper Code: BMRIT-022

Bachelor of Medical Radiology & Imaging Technology
Semester-IV
Patient Care in Radiology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the responsibilities of a Medical Imaging Technologist and discuss the importance of effective communication with patients in the radiology department. (CO1, L2)

B. Discuss infection control practices in radiology departments. (CO5, L2)

C. Explain patient care and preparation required for radiological investigations of the gastrointestinal systems. (CO2, CO7, L2)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Explain the importance of obtaining patient history and informed consent before radiological examinations. (CO4, L4)

B. Discuss patient transfer techniques and methods used to restrain uncooperative patients. (CO3, L3)

C. Describe hospital staffing, organization and maintenance of departmental records. (CO1, L2)

D. Explain the management of unconscious patients in the radiology department. (CO2, L2)

E. Discuss first aid management of shock, burns and fractures. (CO2, L2)

F. Explain sterilization methods and the role of the Central Sterile Supply Department (CSSD). (CO6, L1)

G. Discuss about hospital-acquired infections with special reference to HIV. (CO5, L2)

H. Explain the importance of medical ethics, consent and medico-legal aspects in radiology practice. (CO4, L4)

I. Describe the storage, labeling and handling of drugs in the radiology department, including crash cart management. (CO1, L2)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. List the responsibilities of a Medical Imaging Technologist. (CO1, L1)

B. Mention four vital signs routinely recorded before procedures. (CO2, L1)

C. State any three methods of patient transfer. (CO3, L1)

D. Differentiate between implied consent and informed consent. (CO4, L1)

E. Define asepsis and antisepsis. (CO5, L1)

F. Enumerate any three methods of sterilization. (CO6, L1)

G. List any three radiation protection measures for patients and staff. (CO7, L1)

H. Mention the contents of a crash cart. (CO1, L1)

MODEL PAPER

B. MRIT Semester-V
Paper Code: BMRIT-023

Bachelor of Medical Radiology & Imaging Technology
Semester-V
Basics Techniques in CT Technology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the principle of Computed Tomography and discuss the evolution of CT generations. (CO1, L1)
B. Analyze image reconstruction techniques and discuss the importance of post-processing in CT imaging. (CO4, CO8, L4)
C. Evaluate the role of multidetector CT, dual-energy CT and dual-source CT in modern diagnostic imaging. (CO7, L5)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Describe the components and instrumentation of a CT scanner. (CO1, L2)
B. Explain slip-ring technology and its significance in helical CT scanning. (CO1, L2)
C. Discuss CT image reconstruction algorithms and their applications. (CO4, L4)
D. Explain CT artifacts and methods to reduce them. (CO4, L4)
E. Describe CT protocols used for angiography and perfusion studies. (CO2, CO7, L5)
F. Explain CT contrast media, routes of administration and patient preparation before contrast studies. (CO3, CO5, L3)
G. Discuss CT-guided interventional procedures and their clinical applications. (CO3, L3)
H. Explain isotropic imaging and its advantages in multidetector CT. (CO7, L5)
I. Discuss quality assurance procedures and the role of Medical Imaging Technologists in CT departments. (CO2, CO9, L2)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define Computed Tomography. (CO1, L1)
B. List the generations of CT scanners. (CO1, L1)
C. Mention any three CT image reconstruction techniques. (CO4, L1)
D. State three common CT artifacts. (CO4, L1)
E. Enumerate the precautions before administering CT contrast media. (CO3, L1)
F. Define Multidetector CT (MDCT). (CO1, L1)
G. List any three responsibilities of a CT technologist. (CO2, L1)
H. Mention the management steps for post-contrast reactions. (CO6, CO9, L2)

MODEL PAPER

B. MRIT Semester-V
Paper Code: BMRIT-024

Bachelor of Medical Radiology & Imaging Technology
Semester-V
Radiation Safety in Diagnostic Radiology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain various radiation quantities and units used in diagnostic radiology. (CO2, CO3, L2)

B. Discuss the biological effects of ionizing radiation on human tissues and explain stochastic and deterministic effects with suitable examples. (CO9, L2)

C. Explain the principles of radiation protection and discuss the ALARA concept in diagnostic radiology. (CO1, CO4)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Describe natural and man-made sources of radiation. (CO2, L1)

B. Explain occupational exposure limits and dose limits for the general public. (CO3, L2)

C. Discuss chromosomal aberrations and their role in biological dosimetry. (CO9, L2)

D. Explain the principles, functions and applications of Geiger-Müller counters and scintillation detectors. (CO8, L1)

E. Discuss Thermoluminescent Dosimeters used in personnel monitoring. (CO4, L2)

F. Explain CT Dose Index, Dose Length Product and their significance in dose optimization. (CO7, L3)

G. Describe the importance of time, distance and shielding in radiation protection. (CO4, CO6, L3)

H. Discuss workload, use factor and occupancy factor in radiology department planning. (CO5, CO7, L3)

I. Explain the role of Artificial Intelligence in radiation safety and dose optimization. (CO7, L3)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define Kerma and Exposure. (CO2, L1)

B. List any three weighting factors used in radiation dosimetry. (CO2, L1)

C. Differentiate between stochastic and deterministic effects. (CO9, L2)

D. Mention any three radiation measuring devices. (CO8, L1)

E. State the functions of a radiation survey meter. (CO8, L1)

F. List any three personal protective devices used in diagnostic radiology. (CO6, L1)

G. Define ALARA. (CO1, L1)

H. Mention any three good work practices in diagnostic radiology. (CO7, L1)

MODEL PAPER

B. MRIT Semester-V
Paper Code: BMRIT-025

Bachelor of Medical Radiology & Imaging Technology
Semester-V
Quality Assurance in Diagnostic Radiology and Regulatory Requirements
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the objectives of Quality Control in Diagnostic Radiology. (CO2, L2)

B. Discuss quality assurance tests performed in diagnostic radiology with special reference to beam alignment & focal spot size. (CO2, L2)

C. Explain the responsibilities of licensees, registrants and employers in maintaining radiation safety and regulatory compliance in diagnostic radiology departments. (CO3, CO4, L3)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Explain the need and importance of quality assurance in diagnostic radiology. (CO2, L2)

B. Discuss acceptance testing and preventive maintenance of radiological equipment. (CO2, L2)

C. Explain quality assurance procedures for Computed Tomography. (CO2, L2)

D. Describe quality assurance tests performed in Digital Radiography systems. (CO2, L2)

E. Discuss the role and organization of the National Regulatory Body in diagnostic radiology. (CO3, L2)

F. Explain safety standards, codes and regulatory guides used in diagnostic radiology practice. (CO3, L2)

G. Describe routine maintenance procedures and record keeping in radiology departments. (CO4, L3)

H. Explain reject analysis and its importance in quality assurance programmes. (CO2, CO4, L3)

I. Discuss the care and maintenance requirements of mobile radiographic equipment. (CO4, L3)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define Quality Assurance and Quality Control. (CO2, L1)

B. List four objectives of Quality Control in radiology. (CO2, L1)

C. Mention any three tests used for quality assurance of X-ray equipment. (CO2, L1)

D. State the purpose of laser printer calibration. (CO2, L1)

E. Define Half Value Layer (HVL). (CO1, L1)

F. List any three responsibilities of a radiology technologist in quality assurance. (CO4, L3)

G. What is a reject analysis programme? (CO2, L1)

H. Mention any three records maintained in a radiology department. (CO3, L1)

MODEL PAPER

B. MRIT Semester-VI
Paper Code: BMRIT-026

Bachelor of Medical Radiology & Imaging Technology
Semester-VI
Basics Techniques in MRI Technology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the instrumentation of MRI. (CO1, CO2, L2)

B. Explain Spin Echo and Gradient Echo pulse sequences. Compare their applications. (CO2, CO6, L4)

C. Analyze MRI safety considerations with respect to implants, pacemakers, metallic hazards, bio-effects and quality assurance practices in MRI departments. (CO6, CO9, L4)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Describe image weighting and contrast mechanisms in MRI. (CO1, L2)

B. Explain K-space and its role in MRI image formation. (CO3, L4)

C. Discuss parameters and trade-offs affecting MRI image quality. (CO6, L4)

D. Explain fast imaging sequences used in MRI. (CO2, L2)

E. Describe Time-of-Flight MRA and Phase Contrast MRA techniques. (CO2, CO7, L3)

F. Explain flow phenomena and flow compensation techniques in MRI. (CO6, L4)

G. Discuss MRI artifacts and methods used for their compensation. (CO6, L4)

H. Describe MRI contrast agents and differentiate between T1 and T2 contrast agents. (CO2, L2)

I. Explain the role of quality assurance in MRI and its importance in maintaining image quality. (CO6, L4)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define MRI and state its basic principle. (CO1, L1)

B. List any three advantages of superconducting magnets. (CO1, L1)

C. Define RF shielding and mention its purpose. (CO1, L1)

D. What is velocity encoding in MR angiography? (CO2, L2)

E. Enumerate any three MRI safety precautions. (CO5, L3)

F. List any three causes of MRI artifacts. (CO6, L1)

G. State the purpose of MRI documentation. (CO5, L2)

H. Mention any three steps in patient preparation before MRI examination. (CO5, CO9, L3)

MODEL PAPER

B. MRIT Semester-VI
Paper Code: BMRIT-027

Bachelor of Medical Radiology & Imaging Technology
Semester-VI
Introduction to Nuclear Medicine Techniques
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any TWO (2 × 10 = 20 Marks)

A. Explain the production of radionuclides. (CO1, L1)
B. Describe the construction and working principle of a Gamma Camera with a neat labeled diagram. (CO1, CO3, L2)
C. Assess the role of hybrid imaging modalities in improving image quality and diagnostic accuracy. (CO4, L5)

Q.2 Short Essay Questions Attempt Any SEVEN (7 × 5 = 35 Marks)

A. Discuss the history and development of Nuclear Medicine. (CO1, L1)
B. Explain specific activity and its significance in Nuclear Medicine. (CO1, L2)
C. Describe the preparation of radiopharmaceuticals and precautions required during handling. (CO2, L3)
D. Classify collimators and explain the applications of any two types. (CO1, L2)
E. Explain the principle and clinical applications of SPECT. (CO3, L2)
F. Explain the principle and clinical applications of PET. (CO3, L2)
G. Assess various methods used to improve image quality in Nuclear Medicine imaging. (CO4, L5)
H. Discuss radiation safety considerations for Nuclear Medicine personnel and patients. (CO5, L3)
I. Explain the room layout requirements of a Nuclear Medicine department. (CO5, L3)

Q.3 Short Answer Questions Attempt Any FIVE (5 × 3 = 15 Marks)

A. Define radionuclide and isotope. (CO1, L1)
B. List any three methods of radionuclide production. (CO1, L1)
C. Mention any three precautions while handling radiopharmaceuticals. (CO2, L2)
D. Define collimator and state its function. (CO1, L1)
E. Differentiate between PET and SPECT. (CO3, L2)
F. List any three Nuclear Medicine image artefacts. (CO3, L2)
G. State the ALARA principle in Nuclear Medicine. (CO5, L1)
H. Mention any three causes of patient reactions associated with radiotracers. (CO5, L1)

MODEL PAPER

B. MRIT Semester-VI
Paper Code: BMRIT-028

Bachelor of Medical Radiology & Imaging Technology
Semester-VI
Ultrasound Techniques
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any TWO (2 × 10 = 20 Marks)

A. Explain the properties of ultrasound and discuss the interaction of ultrasound waves with biological tissues. (CO1, L2)

B. Describe various types of ultrasound. (CO2, L1)

C. Explain Doppler principles and compare continuous wave Doppler and pulsed wave Doppler with suitable diagrams. (CO4, L2)

Q.2 Short Essay Questions Attempt Any SEVEN (7 × 5 = 35 Marks)

A. Discuss reflection, refraction and attenuation of ultrasound waves. (CO1, L2)

B. Classify ultrasound transducers and describe the applications of any two types. (CO2, L1)

C. Explain display modes used in ultrasound imaging. (CO3, L2)

D. Describe scan converter memory and image storage methods used in ultrasound systems. (CO3, L2)

E. Explain colour flow imaging and power Doppler. (CO4, L2)

F. Describe ultrasound contrast agents and their clinical applications. (CO4, L2)

G. Discuss common ultrasound image artefacts and their causes. (CO5, L2)

H. Explain the principles and applications of 3D and 4D ultrasound imaging. (CO5, L2)

I. Discuss bio-effects and safety considerations in diagnostic ultrasound. (CO6, L2)

Q.3 Short Answer Questions Attempt Any FIVE (5 × 3 = 15 Marks)

A. Define attenuation in ultrasound. (CO1, L2)

B. List any three types of ultrasound transducers. (CO2, L1)

C. State any three functions of scan converter memory. (CO3, L2)

D. Define duplex scanning. (CO4, L1)

E. List any three applications of Doppler ultrasound. (CO4, L2)

F. Mention any three ultrasound artefacts. (CO5, L1)

G. Define Artificial Intelligence in ultrasound imaging. (CO5, L2)

H. List any three quality assurance tests performed on ultrasound equipment. (CO6, L1)

MODEL PAPER

B. MRIT Semester-VI
Paper Code: BMRIT-029

Bachelor of Medical Radiology & Imaging Technology
Semester-VI
Biostatistics and Research Methodology
Time: 3 Hours | Maximum Marks: 70

Q.1 Essay Questions Attempt Any Two (2 × 10 = 20 Marks)

A. Explain the meaning, characteristics and importance of statistics in health sciences. Discuss the branches of statistics. (CO1, L2)
B. Describe the measures of central tendency and compare mean, median and mode with suitable examples. (CO3, L3)
C. Explain probability and normal distribution. Discuss skewness and kurtosis as measures of divergence from normality. (CO3, L3)

Q.2 Short Essay Questions Attempt Any Seven (7 × 5 = 35 Marks)

A. Differentiate between descriptive and inferential statistics. (CO1, L2)
B. Explain variables and measurement scales used in statistics. (CO2, L1)
C. Describe frequency distribution and its importance in data presentation. (CO2, L1)
D. Explain histogram and frequency polygon with suitable illustrations. (CO1, L2)
E. Calculate and interpret median for grouped and ungrouped data. (CO3, L3)
F. Explain variance and standard deviation and their significance in data analysis. (CO3, L3)
G. Discuss the characteristics and applications of the normal distribution. (CO3, L3)
H. Explain the criteria of a good sample and discuss common sampling techniques. (CO3, L3)
I. Describe sampling errors and tests of significance. (CO3, L3)

Q.3 Short Answer Questions Attempt Any Five (5 × 3 = 15 Marks)

A. Define statistics and mention any two characteristics of statistics. (CO2, L1)
B. Define nominal and ordinal scales of measurement. (CO2, L1)
C. What is an Ogive curve? State its use. (CO2, L1)
D. Define mean and write its formula. (CO2, L1)
E. Define standard deviation. (CO2, L1)
F. What is binomial distribution? (CO2, L1)
G. Define sampling variation. (CO2, L1)
H. State any three advantages of sampling. (CO3, L1)

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