ORDINANCE: AHE-03

Bachelor, Master and Ph.D. In Medical Radiology and Imaging Technology (MRIT)

[w.e.f. Academic Session 2026-27]

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PREFACE

All the norms prescribed by the National Commission for Allied and Healthcare Professions (NCAHP) vide their publication No. F.No. Z/58/2024-AHS-DOHFW Department, dated 24 April 2025 **"Competency Based Curriculum for Medical Radiology and Imaging Technology (CBMRIT) Guidelines- National Commission for Allied Health Profession"**, are adhered to by the university and incorporated into the Ordinance.

The regulations so framed are subject to changes depending on modifications of the guidelines issued by NCAHP from time to time. To ensure seamless education and to achieve academic excellence, the University lays down further regulations, as deemed necessary. These regulations will be in addition to the norms prescribed by the regulatory body (NCAHS).

National Commission for Allied and Healthcare Professions

COMPETENCY BASED CURRICULUM

for

"MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY"

As per NCAHP Act-2021

APPROVED SYLLABUS
2025

Ministry of Health & Family Welfare

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List of Abbreviations

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
BSc. MRIT	Bachelor of Science in Medical Radiology and Imaging Technology
BMW	Bio Medical Waste
BVM	Bag-Valve-Masks
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	Computerized Tomography
DC	Direct Current
DMRIT	Diploma in Medical radiology and Imaging Technology
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	Gastro Intestinal
HRCT	High-resolution computed tomography
HSSC	Healthcare Sector Skill Council
HU	Heat 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
RIAHS	Regional Institute of Allied Health Sciences
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
sWBC	White Blood Cells
WHO	World Health Organization
WWW	World Wide Web

Chapter 1
Introduction to the Handbook

Chapter 1: Introduction to the Handbook

The report 'From Paramedics to Allied Health Professionals: Landscaping the Journey and Way Forward' that was published in 2012, marked the variance in education and training practices for the allied and healthcare courses offered by institutions across the country. This prompted the Ministry of Health and Family Welfare to envisage the creation of national guidelines for education and career pathways of allied and healthcare professionals, with a structured curriculum based on skills and competencies. Thus, this handbook has been designed to familiarize universities, colleges, healthcare providers as well as educators offering allied and healthcare courses with these national standards.

Individually, created for different professional groups of allied and healthcare, this hand book aims to reduce the variation in education by comprising of a standardized curriculum, career pathways, nomenclature and other details for each profession. The change from a purely didactic approach will create better skilled professionals and improve the quality of overall patient care. In the absence of a national standard-setting authority, this handbook can also guide the thousands of young adults who choose healthcare as a profession – not as doctors or nurses but to play several other critical roles – on the appropriate course of action to enable them to be skilled allied and healthcare professionals of the future.

Who is an Allied and Healthcare Professional?

The Ministry of Health and Family Welfare, accepted in its entirety the definition of an allied and healthcare professional based on the afore-mentioned report, though the same has evolved after multiple consultations and the recommended definition is now as follows-

'Allied and healthcare professionals (AHPs) includes individuals involved with the delivery of health or healthcare related services, with qualification and competence in therapeutic, diagnostic, curative, preventive and/or rehabilitative interventions. They work in multidisciplinary health teams in varied healthcare settings including doctors (physicians and specialist), nurses and public health officials to promote, protect, treat and/or manage a person('s) physical, mental, social, emotional, environmental health and holistic well-being.'[i]

Since the past few years, many professional groups have been interacting and seeking guidance on all those who would qualify under the purview of "allied and healthcare professionals". In the healthcare system, statutory bodies exist for clinicians, nurses, pharmacists and dental practitioners; but a regulatory structure for around 50 professions is absent in India. Currently, the Government is considering these professions under the ambit of the allied and healthcare system. However, this number is subject to changes and modifications over time, particularly considering how quickly new technologies and new clinical avenues are expanding globally, creating newer cadres of such professionals.

Scope and need for allied and healthcare professionals in the Indian healthcare system

The quality of medical care has improved tremendously in the last few decades due to the advances in technology, thus creating fresh challenges in the field of healthcare. It is now widely recognized that health service delivery is a team effort involving both clinicians and non-clinicians, and is not the sole duty of physicians and nurses.[i] Professionals that can competently handle sophisticated machinery and advanced protocols are now in high demand. In fact, diagnosis is now so dependent on technology, that allied and healthcare professionals (AHPs) are vital to successful treatment delivery.

Effective delivery of healthcare services depends largely on the nature of education, training and appropriate orientation towards community health of all categories of health personnel, and their capacity to function as an integrated team. For instance in the UK, more than 84,000 AHPs, with a range of skills and expertise, play key roles within the National Health Service, working autonomously, in multi-professional teams in various settings. All of them are first-contact practitioners and work across a wide range of locations and sectors within acute, primary and community care. Australia's health system is managed not just by their doctors and nurses, but also by the 90,000 university-trained, autonomous AHPs vital to the system.[ii,iii]

As the Indian government aims for Universal Health Coverage, the lack of skilled human resource may prove to be the biggest impediment in its path to achieve targeted goals. The benefits of having AHPs in the healthcare system are still unexplored in India. Although an enormous amount of evidence suggests that the benefits of AHPs range from improving access to healthcare services to significant reduction in the cost of care, though the Indian healthcare system still revolves around the doctor-centric approach. The privatization of healthcare has also led to an ever-increasing out-of-pocket expenditure by the population. However, many examples assert the need of skilled allied and healthcare professionals in the system, such as in the case of stroke survivors, it is the support of AHPs that significantly enhance their rehabilitation and long term treatment ensures return to normal life. AHPs also play a significant role to care for patients who struggle mentally and emotionally in the current challenging environment and require mental health support; and help them return to well-being.ii Children with communication difficulties, the elderly, cancer patients, patients with long term conditions such as diabetes people with vision problems and amputees; the list of people and potential patients who benefit from AHPs is indefinite.

Thus, the breadth and scope of the allied and healthcare practice varies from one end to another, including areas of work listed below:

- Across the age span of human development from neonate to old age;
- With patients having complex and challenging problems resulting from systemic illnesses such as in the case of diabetes, cardiac abnormalities/conditions and elderly care to name a few;
- Towards health promotion and disease prevention, as well as assessment, management and evaluation of interventions and protocols for treatment;
- In a broad range of settings from a patient's home to community, primary care centers, to tertiary care settings; and
- With an understanding of the healthcare issues associated with diverse socio-economies and cultural norms within the society.

Learning goals and objectives for allied and healthcare professionals

The handbook has been designed with a focus on performance-based outcomes pertaining to different levels. The learning goals and objectives of the undergraduate and graduate education program will be based on the performance expectations. They will be articulated as learning goals (why we teach this) and learning objectives (what the students will learn). Using the framework, students will learn to integrate their knowledge, skills and abilities in a hands-on manner in a professional healthcare setting. These learning goals are divided into nine key areas, though the degree of required involvement may differ across various levels of qualification and professional cadres:

1. Clinical care
2. Communication
3. Membership of a multidisciplinary health team
4. Ethics and accountability at all levels (clinical, professional, personal and social)
5. Commitment to professional excellence

6. Leadership and mentorship
7. Social accountability and responsibility
8. Scientific attitude and scholarship (only at higher level- PhD)
9. Lifelong learning

1. Clinical Care[iv]

Using a patient/family-centered approach and best evidence, each student will organize and implement the prescribed preventive, investigative and management plans; and will offer appropriate follow-up services. Program objectives should enable the students to:

- Apply the principles of basic science and evidence-based practice
- Use relevant investigations as needed
- Identify the indications for basic procedures and perform them in an appropriate manner
- Provide care to patients – efficiently and in a cost-effective way – in a range of settings, and maintain foremost the interests of individual patients
- Identify the influence of biological, psychosocial, economic, and spiritual factors on patients' well-being and act in an appropriate manner
- Incorporate strategies for health promotion and disease prevention with their patients

2. Communication iv[v]

The student will learn how to communicate with patients/clients, care-givers, other health professionals and other members of the community effectively and appropriately. Communication is a fundamental requirement in the provision of health care services. Program objectives should enable the students to:

- Provide sufficient information to ensure that the patient/client can participate as actively as possible and respond appropriately to the information
- Clearly discuss the diagnosis and options with the patient, and negotiate appropriate treatment plans in a sensitive manner that is in the patient's and society's best interests
- Explain the proposed healthcare service – its nature, purpose, possible positive and adverse consequences, its limitations, and reasonable alternatives wherever they exist
- Use effective communication skills to gather data and share information including attentive listening, open-ended inquiry, empathy and clarification to ensure understanding
- Appropriately communicate with, and provide relevant information to, other stakeholders including members of the healthcare team
- Use communication effectively and flexibly in a manner that is appropriate for the reader or listener
- Explore and consider the influence that the patient's ideas, beliefs and expectations have during interactions with them, along with varying factors such as age, ethnicity, culture and socioeconomic background
- Develop efficient techniques for all forms of written and verbal communication including accurate and timely record keeping
- Assess their own communication skills, develop self-awareness and be able to improve their relationships with others
- Possess skills to counsel for lifestyle changes and advocate health promotion

3. **Membership of a multidisciplinary health team**[vi]

The student will put a high value on effective communication within the team, including transparency about aims, decisions, uncertainty and mistakes. Team-based health care is the provision of health services to individuals, families, and/or their communities by at least two health providers who work collaboratively to accomplish shared goals within and across settings to achieve coordinated, high quality care. Program objectives will aim at making the students being able to:

- Recognize, clearly articulate, understand and support shared goals in the team that reflect patient and family priorities
- Possess distinct roles within the team; to have clear expectations for each member's functions, responsibilities, and accountabilities, which in turn optimizes the team's efficiency and makes it possible for them to use division of labor advantageously, and accomplish more than the sum of its parts
- Develop mutual trust within the team to create strong norms of reciprocity and greater opportunities for shared achievement
- Communicate effectively so that the team prioritizes and continuously refines its communication channels creating an environment of general and specific understanding
- Recognize measurable processes and outcomes, so that the individual and team can agree on and implement reliable and timely feedback on successes and failures in both the team's functioning and the achievement of their goals. These can then be used to track and improve performance immediately and over time.

4. **Ethics and accountability**

Students will understand core concepts of clinical ethics and law so that they may apply these to their practice as healthcare service providers. Program objectives should enable the students to:

- Describe and apply the basic concepts of clinical ethics to actual cases and situations
- Recognize the need to make health care resources available to patients fairly, equitably and without bias, discrimination or undue influence
- Demonstrate an understanding and application of basic legal concepts to the practice
- Employ professional accountability for the initiation, maintenance and termination of patient-provider relationships
- Demonstrate respect for each patient's individual rights of autonomy, privacy, and confidentiality

5. **Commitment to professional excellence**[vii]

The student will execute professionalism to reflect in his/her thought and action a range of attributes and characteristics that include technical competence, appearance, image, confidence level, empathy, compassion, understanding, patience, manners, verbal and non-verbal communication, an anti-discriminatory and non-judgmental attitude, and appropriate physical contact to ensure safe, effective and expected delivery of healthcare. Program objectives will aim at making the students being able to:

- Demonstrate distinctive, meritorious and high quality practice that leads to excellence and that depicts commitment to competence, standards, ethical principles and values, within the legal boundaries of practice

- Demonstrate the quality of being answerable for all actions and omissions to all, including service users, peers, employers, standard-setting/regulatory bodies or oneself
- Demonstrate humanity in the course of everyday practice by virtue of having respect (and dignity), compassion, empathy, honour and integrity
- Ensure that self-interest does not influence actions or omissions, and demonstrate regards for service-users and colleagues

6. Leadership and mentorship[viii]

The student must take on a leadership role where needed in order to ensure clinical productivity and patient satisfaction. They must be able to respond in an autonomous and confident manner to planned and uncertain situations, and should be able to manage themselves and others effectively. They must create and maximize opportunities for the improvement of the health seeking experience and delivery of healthcare services. Program objectives should enable the students to:

- Act as agents of change and be leaders in quality improvement and service development, so that they contribute and enhance people's wellbeing and their healthcare experience
- Systematically evaluate care; ensure the use of these findings to help improve people's experience and care outcomes, and to shape clinical treatment protocols and services
- Identify priorities and effectively manage time and resources to ensure the maintenance or enhancement of the quality of care
- Recognize and be self-aware of the effect their own values, principles and assumptions may have on their practice. They must take charge of their own personal and professional development and should learn from experience (through supervision, feedback, reflection and evaluation)
- Facilitate themselves and others in the development of their competence, by using a range of professional and personal development skills
- Work independently and in teams. They must be able to take a leadership role to coordinate, delegate and supervise care safely, manage risk and remain accountable for the care given; actively involve and respect others' contributions to integrated person-centered care; yet work in an effective manner across professional and agency boundaries. They must know when and how to communicate with patients and refer them to other professionals and agencies, to respect the choices of service users and others, to promote shared decision-making, to deliver positive outcomes, and to coordinate smooth and effective transition within and between services and agencies.

7. Social Accountability and Responsibility[ix]

The students will recognize that allied and healthcare professionals need to be advocates within the health care system, to judiciously manage resources and to acknowledge their social accountability.[x]They have a mandate to serve the community, region and the nation and will hence direct all research and service activities towards addressing their priority health concerns. Program objectives should enable the students to:

- Demonstrate knowledge of the determinants of health at local, regional and national levels and respond to the population needs

- Establish and promote innovative practice patterns by providing evidence-based care and testing new models of practice that will translate the results of research into practice, and thus meet individual and community needs in a more effective manner
- Develop a shared vision of an evolving and sustainable health care system for the future by working in collaboration with and reinforcing partnerships with other stakeholders, including academic health centres, governments, communities and other relevant professional and non-professional organizations
- Advocate for the services and resources needed for optimal patient care

8. Scientific attitude and Scholarship[x]

The student will utilize sound scientific and/or scholarly principles during interactions with patients and peers, educational endeavors, research activities and in all other aspects of their professional lives. Program objectives should enable the students to:

- Engage in ongoing self-assessment and structure their continuing professional education to address the specific needs of the population
- Practice evidence-based by applying principles of scientific methods
- Take responsibility for their educational experiences
- Acquire basic skills such as presentation skills, giving feedback, patient education and the design and dissemination of research knowledge; for their application to teaching encounters

9. Lifelong learning[xi]

The student should be committed to continuous improvement in skills and knowledge while harnessing modern tools and technology. Program objectives will aim at making the students being able to:

- Perform objective self-assessments of their knowledge and skills; learn and refine existing skills; and acquire new skills
- Apply newly gained knowledge or skills to patient care
- Enhance their personal and professional growth and learning by constant introspection and utilizing experiences
- Search (including through electronic means), and critically evaluate medical literature to enable its application to patient care
- Develop a research question and be familiar with basic, clinical and translational research in its application to patient care
- Identify and select an appropriate, professionally rewarding and personally fulfilling career pathway

Introduction of new elements in allied and healthcare education

Competency-based curriculum

A significant skill gap has been observed in the professionals offering healthcare services irrespective of the hierarchy and level of responsibility in the healthcare settings. The large variation in the quality of services is due to the diverse methodologies opted for healthcare education and the difference in expectations from a graduate after completion of a course and at work. What one is expected 'to perform' at work is assumed to be learned during the course, however, the course design focuses on what one is expected 'to know'. The competency-based curriculum thus connects the dots between the 'know what' and 'do how'.

The efficiency and effectiveness of any educational programme largely depends on the curriculum design that is being followed. With emerging medical and scientific knowledge, educators have realized that learning is no more limited to memorizing specific lists of facts and data; in fact, by the time the professional aims to practice in the healthcare setting, the acquired knowledge may stand outdated. Thus, competency-based education is the answer; a curricular concept designed to provide the skills that professionals need. A competency-based program is a mix of skills and competencies based on individual or population needs (such as clinical knowledge, patient care, or communications approaches), which is then developed to teach relevant content across a range of courses and settings. While the traditional system of education focuses on objectives, content, teacher-centric approach and summative evaluation; competency-based education has a focus on competencies, outcomes, performance and accomplishments. In such a case, teaching activities are learner-centered, and evaluation is continuous and formative in structure. The competency-based credentials depend on the demonstration of a defined set of competencies which enables a professional to achieve targeted goals. Competency frameworks comprise of a clearly articulated statement of a person's abilities on the completion of the credential, which allows students, employers, and other stakeholders to set their expectations appropriately.[xii,xiii]

Considering the need of the present and future healthcare delivery system, the curriculum design depicted in this handbook thus will be based on skills and competencies.

Promoting self-directed learning of the professionals

The shift in the focus from traditional to competency-based education has made it pertinent that the learning processes may also be revisited for suitable changes. It is a known fact that learning is no more restricted to the boundaries of a classroom or the lessons taught by a teacher. The new tools and technologies have widened the platform and introduced innovative modes of how students can learn and gain skills and knowledge. One of the innovative approaches is learner-centric and follows the concept of **self-directed learning.**

Self-directed learning, in its broadest meaning, describes a process in which individuals take the initiative with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying resources for learning, choosing and implementing learning strategies and evaluating learning outcomes (Knowles, 1975).[xiv]

In self-directed learning, learners themselves take the initiative to use resources rather than simply reacting to transmissions from resources, which helps them learn more in a better way.[xv] Lifelong, self-directed learning (SDL) has been identified as an important ability for medical graduates (Harvey, 2003)[xvi] and so is applicable to other health professionals including AHPs. It has been proven through many studies worldwide that the self-directed method is better than the teacher-centric method of learning. Teacher-directed learning makes learners more dependent and the orientation to learning becomes subject-centred. If a teacher provides the learning material, the student is usually satisfied with the available material, whereas if a student is asked to work on the same assignment, he or she invariably has to explore extensive resources on the subject.[xv]

Credit hours vs traditional system

Recently the National Assessment and Accreditation Council (NAAC) and the University Grants Commission (UGC) have highlighted the need for the development of a Choice-Based Credit System (CBCS), at par with global standards and the adoption of an effective grading system to measure a learner's performance.[xvii] All the major higher education providers across the globe are operating a system of credits. The European Credit Transfer System (ECTS), the 'National Qualifications Framework' in Australia, the

Pan-Canadian Protocol on the Transferability of University Credits, the Credit Accumulation and Transfer System (CATS) in the UK as well as the systems operating in the US, Japan, etc. are examples of these. Globally, a need now exists for the use of a fully convertible credit-based system that can be accepted at other universities. It has now become imperative to offer flexible curricular choices and provide learners mobility due to the popularity of initiatives such as 'twinning programmes', 'joint degrees' and 'study abroad' programmes.[xviii]

In order to ensure global acceptability of the graduates, the current curriculum structure is divided into smaller sections with focus on hours of studying which can be converted into credit hours as per the international norms followed by various other countries.

Integrated structure of the curriculum

Vertical integration, in its truest sense, is the interweaving of teaching clinical skills and knowledge into the basic science years and, reinforcing and continuing to teach the applications of basic science concepts during the clinical years. (Many efforts called 'vertical integration' include only the first half of the process).

Horizontal integration is the identification of concepts or skills, especially those that are clinically relevant, that cut across (for example, the basic sciences), and then putting these to use as an integrated focus for presentations, clinical examples, and course materials. e.g. Integration of some of the basic science courses around organ systems, e.g., human anatomy, physiology, pathology; or incorporating ethics, legal issues, finance, political issues, humanities, culture and computer skills into different aspects of a course like the Clinical Continuum.

The aim of an integrated curriculum is to lead students to a level of scientific fluency that is beyond mere fact and concept acquisition, by the use of a common language of medical science, with which they can begin to think creatively about medical problems.[xix]

This innovative new curriculum has been structured in a way such that it facilitates horizontal and vertical integration between disciplines; and bridges the gaps between both theory & practice, and between hospital-based practice and community practice. The amount of time devoted to basic and laboratory sciences (integrated with their clinical relevance) would be the maximum in the first year, progressively decreasing in the second and third year of the training, making clinical exposure and learning more dominant.[xi] However it may differ from course to course depending on the professional group.

Introduction of foundation course in the curriculum

The foundation course for allied and healthcare professions is an immersive programme designed to impart the required knowledge, skills and confidence for seamless transition to the second semester of a professional allied and healthcare course. Post admission, the foundation course is designed for a period of 6 months to prepare a student to study the respective allied and healthcare course effectively and to understand the basics of healthcare system. This aims to orient the student to national health systems and the basics of public health, medical ethics, medical terminologies, communication skills, basic life support, computer learning, infection prevention and control, environmental issues and disaster management, as well as orientation to the community with focus on issues such as gender sensitivity, disability, human rights, civil rights etc. Though the flexibility to the course designers have been provided in terms of – modifying the required numbers of hours for each foundation subject and appropriate placement of the subject across various semesters.

Learning methodologies

With a focus on self-directed learning, the curriculum will include a foundation course that focuses on communication, basic clinical skills and professionalism; and will incorporate clinical training from the first year itself. It is recommended that the primary care level should have sufficient clinical exposure integrated with the learning of basic and laboratory sciences. There should also be an emphasis on the introduction of case scenarios for classroom discussion/case-based learning.

Healthcare education and training is the backbone of an efficient healthcare system and India's education infrastructure is yet to gain from the ongoing international technological revolution. The report '*From Paramedics to Allied Health: Landscaping the Journey and way ahead*', indicates that teaching and learning of clinical skills occur at the patient's bedside or other clinical areas such as laboratories, augmented by didactic teaching in classrooms and lecture theatres. In addition to keeping up with the pace of technological advancement, there has been a paradigm shift to outcome-based education with the adoption of effective assessment patterns. However, the demand for demonstration of competence in institutions where it is currently limited needs to be promoted. The report also mentions some of the allied and healthcare schools in India that have instituted clinical skill centres, laboratories and high-fidelity simulation laboratories to enhance the practice and training for allied and healthcare students and professionals. The report reiterates the fact that simulation is the replication of part or all of a clinical encounter through the use of mannequins, computer-assisted resources and simulated patients. The use of simulators addresses many issues such as suboptimal use of resources and equipment, by adequately training the manpower on newer technologies, limitations for imparting practical training in real-life scenarios, and ineffective skills assessment methods among others.[i] The table mentioned below lists various modes of teaching and learning opportunities that harness advanced tools and technologies.

Table 1 Clinical learning opportunities imparted through the use of advanced techniques[i,xx]

Teaching modality	Learning opportunity examples
Patients	Teach and assess in selected clinical scenarios
	Practice soft skills
	Practice physical examination
	Receive feedback on performance
Mannequins	Perform acquired techniques
	Practice basic procedural skills
	Apply basic science understanding to clinical problem solving
Simulators	Practice teamwork and leadership
	Perform cardiac and pulmonary care skills
	Apply basic science understanding to clinical problem solving
Task under trainers	Practice phlebotomy, lumbar puncture, etc.

Assessment methods

Traditional assessment of students consists of the yearly system of assessments. In most institutions, assessments consist of internal and external assessments, and a theory examination at the end of the year or semester. This basically assesses knowledge instead of assessing skills or competencies. In competency-based training, the evaluation of the students is based on the performance of the skills as per their competencies. Hence, all the three attributes – knowledge, skills, and attitudes – are assessed as required for the particular competency.

Several new methods and tools are now readily accessible, the use of which requires special training. Some of these are given below:

- Objective Structured Clinical Examination(OSCE), Objective Structured Practical Examination (OSPE), Objective Structured Long Examination Record(OSLER)
- Mini Case Evaluation Exercise(CEX)
- Case-based discussion(CBD)
- Direct observation of procedures(DOPs)
- Portfolio
- Multi-source feedback
- Patient satisfaction questionnaire

An objective structured clinical examination (OSCE) is used these days in a number of allied and healthcare courses, e.g. Optometry, Physiotherapy, and Radiography. It tests the performance and competence in communication, clinical examination, and medical procedures/prescriptions. In physiotherapy, orthotics, and occupational therapy, it tests exercise prescription, joint mobilization/manipulation techniques; and in radiography it tests radiographic positioning, radiographic image evaluation, and interpretation of results. The basic essential elements consist of functional analysis of the occupational roles, translation of these roles ("competencies") into outcomes, and assessment of trainees' progress in these outcomes on the basis of demonstrated performance. Progress is defined solely by the competencies achieved and not the underlying processes or time served in formal educational settings. Most methods use predetermined, agreed assessment criteria (such as observation check-lists or rating scales for scoring) to emphasize on frequent assessment of learning outcomes. Hence, it is imperative for teachers to be aware of these developments and they should suitably adopt them in the allied and healthcare education system.[xxi]

Chapter 2
Background of the profession

Chapter 2: Background of the profession

Statement of Philosophy– Why this profession holds so much importance

Medical Radiology and Imaging Technology is the health profession concerned with the direct administration of radiation, primarily x-rays, in disease diagnosis and injury assessment and treatment. From the humble beginnings of plain film techniques, we are now with a wide array of imaging methods using Conventional and Digital X-rays, ultrasound, magnetic resonance and Radionuclide. Modern diagnostic radiography and Medical Imaging forms an integral part of medical practice, both in making diagnosis and also in treatment. The term "diagnostic radiography" is used to describe a variety of radiographic or x-ray examinations. These simple procedures as well as those which require the use of contrast agents, make it possible to study organs that otherwise cannot be seen. These professionals are at the heart of modern medicine.

Diagnostic radiographers employ a range of different imaging techniques and sophisticated equipment to produce high quality images of an injury or disease. They take the images using range of techniques including: X-rays, Mammography, Fluoroscopy, CT (computed tomography), MRI (magnetic resonance imaging), Nuclear medicine, Angiography etc. Medical imaging studies have been a cornerstone in medical diagnosis for decades; however, technological advances and the addition of new imaging modalities now place medical imaging among the most dynamic, expanding and high demand fields in clinical medicine.

About Medical Radiology and Imaging Technology

Radiology is a branch of medicine that uses radiation and imaging technology to diagnose and treat disease. It allows the radiologic technologist to produce images of various internal parts of the body, to aid in the detection of injury or disease by using radiations. Radiology is central to the clinical practice of medicine across a wide range of disciplines. It is the best practical way to diagnose, monitor treatment and detect progression or relapse of many important and common diseases in a minimally invasive and anatomically precise manner. As a consequence of the increasing sophistication and accuracy of clinical imaging, the utilization and importance of radiology has increased dramatically and consistently over the last 20 years. In recent years, the increasing complexity of radiologic procedures has made Medical Radiology and Imaging technology a highly specialized and sophisticated science requiring competently trained personnel to maintain a high degree of accuracy in radiographic positioning and exposure technique. A qualified Medical Imaging Technologist is skilled in both interventional and Diagnostic Radiology.

Scope of practice

Diagnostic Radiographers/technologists possess, utilize and maintain knowledge of radiation protection and safety. Radiographers have an extremely thorough understanding of the structure of the body, how the body can be affected by injury, and causes and effects of disease when taking X-ray images. Their work does include a wide range of different imaging modalities radiographers are the primary liaison between patients, radiologist and other members of the support team. They remain sensitive to needs of the patient through good communication, patient assessment, patient monitoring and patient care skills. As members of the health care team, diagnostic radiographer /technologist participate in quality improvement processes and continually assess their professional performance. They engage in continuing education to include their area of practice to enhance patient care, public education, knowledge and technical competence. Diagnostic radiographers use a range of imaging technology:

- X-ray - Penetrate through the body to examine and view internal structures
- Fluoroscopy uses X-rays to obtain real-time moving images of the internal parts of the body.
- CT (Computed Tomography) provides cross-sectional views / images of the body using computer with the help of X-Rays.
- MRI (Magnetic Resonance Imaging) - images of the different tissue types within the body using strong magnet and RF waves
- Ultrasound –uses high frequency sound waves to produce images of the structure within the body. It is well known for its use in obstetrics and gynecology. Also used to check circulation and examine the heart
- Angiography –radiological study which is used to investigate blood vessels.
- Mammography-Imaging of the soft tissue breast
- DEXA—Bone Densitometry.

Recognition of Title and qualification

The practice of medical radiography is performed by health care professionals responsible for the administration of ionizing radiation for diagnostic purposes. In addition to medical radiology and imaging technologists, they are also known as *Diagnostic Radiographers/ Imaging Technologist/ Radio-Diagnosis Technologist.*

The recommended title thus stands as the Medical Radiology and Imaging Technologists for this group of professionals.

A medical radiology and imaging technologist performs radiographic procedures at the request of practitioner. They form an indispensable part of the medical team.

Definition of Medical Radiology and Imaging Technology professionals

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.[xxii]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.

Education of these professionals

When developing any education program it is necessary that program planning should be outcome-based, meeting local and national manpower requirements, personal satisfaction and career potential for the professionals with supporting pathway in the development of the profession. One of the major changes is the shift from a focus based on traditional theoretical knowledge and skills to competency based education and training. Optimal education/training requires that the student is able to integrate knowledge, skills and attitude in order to be able to perform a professional act adequately in a given situation.

Thus the following curriculum aims to focus on skills and competencies based approach for learning and is designed accordingly. The curriculum is prescriptive and is designed with an aim to standardize the content across the nation.

Course duration

It is recommended that any programme developed from this curriculum should have a minimum of the following duration to qualify as an entry level professional in Medical Radiology and Imaging Technology.

- **4 year programme (including 1 year of clinical training /internship)- Bachelor's degree level**
- **2 year programme – Master's level**

The emphasis during the initial year should be on the academic content establishing a strong scientific basis and engagement with the course principles. During the second and third years of training, emphasis should be laid on process to refine the acquired theoretical knowledge and its application to clinical/reflective practice. In Bachelor degree programme minimum one year should be devoted to clinical practice and this should be on a continuum of rotation from theory to practice over the programme. The aim of the 4 year degree programme is to enable the development of the medical radiology and imaging technologist as a key member of the multidisciplinary team and to enable him/her to execute advanced preparation/ planning/delivery as well as quality assurance.

With the change in the disease dynamics and multifold increase in the cases needing diagnostic medical imaging and evaluation, it is imperative that a well-structured programme of postgraduate education is also encouraged so as to enhance research capacity within the country to widen the scope of clinical practice for the profession. **Thus, a master's degree programme is recommended with minimum of two years of education in specialized field of Medical Radiology and Imaging Technology.** The post graduate students can contribute significantly in research and academics.

PhD also play a significant role in the academic system, research and innovation.
However as per ICAHP Committee - 3 (Minimum Standards and Procedures for Award of Ph.D. Degree in MRIT in the related special fields) to be followed as per UGC Guidelines has also been incorporated in this curriculum

Teaching faculty and infrastructure (minimum standard to start the programmes)

One of the important recommendation of the task force members should be associated with the state medical colleges whereby they can make use of the available patient load and medical infrastructure as a part of their training curriculum (May be through MOU).

- Standalone institutions must have an MoU with either a medical college or hospital or healthcare facility as per the guidelines (desired number of Radiology equipment/beds/OPD etc.) defined in the curriculum to
- ensure practical exposure to the students.
- The MOU must be done with either a medical college or hospital or healthcare facility having minimum of 100 investigation per day includes of x-rays, Radiological imaging procedures, CT and MRI includes advance imaging techniques.
- MoU to also define the radiology clinical supervision of the students –institutional staff or clinical preceptors can be considered.

For the institutes to be capable of providing high quality training to the student and exposure to all the related modalities, it should have the following:[xxiii]

- Conventional X-ray Unit for routine X-ray and IVU
- Mobile X-ray unit
- Fluoroscopic unit
- Ultrasonography, Color Doppler Equipment
- Multi-slice C.T. Scan,
- Mammography
- MRI
- DSA(preferably)

The teaching faculty for the department should have a minimum of (for the 20 intake)

- 1 Professor
- 1 Assoc. Professor
- 3 Asst. Professor
- 2 demonstrators

Method of teaching and learning-

- Lecture
- Tutorial
- Problem based learning
- Small group teaching and learning
- Continuous interactive learning
- Case-based
- Project based
- Research project- Research was considered by the group to be very important in order to keep pace with other professions and to generate a research background for our own profession.
- Seminars
- Clinical conferences
- E-learning
- Skills laboratory

Job availability-

Diagnostic radiography is a fast-moving and continually changing profession, and long-term career prospects include: management, research, clinical work, teaching etc.

Employment opportunities available in a variety of settings in both rural and urban areas include:

- More generalized practice in medium to small hospitals;
- Specialized clinical practice in large academic medical hospitals and trauma centers,
- Clinics and free-standing imaging centers which may offer both special and general practice opportunities; or
- Clinical practice coupled with expanded responsibilities in quality control, education, data management and supervision, particularly in large hospitals.
- Research Scholar/ Research Assistant

- Medical imaging professionals are usually employed in the medical imaging/radiology departments of large teaching hospitals, private and country hospitals, and private radiological clinics. Graduates may work in the field of teaching, Research , Application Specialist , Radiology Technologist , Clinical Supervisor and even as a clinical research consultant. Professionals may eventually specialise in particular areas of practice, or in specific techniques such as computed tomography, ultrasound, magnetic resonance imaging or picture archiving and communication systems (PACS). Graduates may also pursue more technical careers in medical physics or biophysics, quality control, radiation health, or with equipment manufacturers. Managerial careers within medical imaging service departments are also possible, as is pursuing further education or research. The medical imaging graduates are highly regarded and employment opportunities are readily available, in both metropolitan and rural and regional areas. There is high industry demand, and you will be qualified to work anywhere in India and in many locations internationally.

The demand for qualified radio-imaging technologist is on the rise and such jobs come with well-paid salary packages. The job profile may vary according to the modality and scope of practice.

The program aims to train human resources with requisite skills in the area of medical radiology & imaging technology who can be hired in all kinds of healthcare settings including:

- Hospitals
- Diagnostic centers
- Medical Records and Transcription organizations
- Clinical and Medical Research organisations
- Pharma and Bio-Tech companies
- Medical equipment and device companies

Diagnostic radiographers provide a service for most departments within the hospital including, accident and emergency, outpatients, operating theatres and wards. Close liaison and collaboration with a wide range of other health care professionals is therefore vital. After completion of this curriculum, a Medical Radiology &Imaging Technologist gets opportunities to work at various health care institutes under designations as:

- Radiographer
- Radiological Technologist
- X-ray Technologist
- CT scan Technologist
- MRI Technologist

- Mammography Technologist
- Cathlab Technologist
- Applications Specialist
- Radiological Safety Officer
- Interventional Technologist
- Quality control Technologist
- PACS manager
- Sales and marketing of radiology industry
- Diagnostic Manager, etc.
- Other Administrative posts in Medical Imaging department & hospital.
- Teaching & research faculty in Medical colleges
- Research Scientists in Medical imaging industry

Chapter 3

Model Curriculum of Medical Radiology and Imaging Technology Courses

Chapter 3: Model Curriculum

Background

This curriculum document outlines the structure of the Medical Radiology and Imaging Technology training program, the knowledge and skills expected from the graduates at various levels. It also enumerates the nature of the various examinations and assessments that planned throughout the training program.

The aims of the recommended curriculum are to produce MRIT'S who are
- Technically and clinically competent;
- Aware of radiation safety issues and the importance of quality assurance;
- Understand the theoretical basis for evidence based practice;
- Effective members of the multidisciplinary team;
- Prepared to participate in or initiate research into practice;
- Can work according to registration requirements on the respective continents.

All aspects of medical radiological and imaging technology have been considered in the development of this curriculum together with the identification of the roles expected for different levels of MRIT'S based on their qualification and experience. The need for connecting the dots between the education and employment practices has been the road map for devising this curriculum.

Foundation course has also been designed to bring all the students at the same level of understanding with respect to basic healthcare related norms before the start of a career in a healthcare professional course. The foundation course is mandatory for all the allied and healthcare professional courses and for both entry level courses – diploma as well as degree. If a diploma holder has completed the foundation course and is willing to pursue the degree course, the candidate will directly get entry for next semester, however a pre- qualifier skill test will have to be satisfactorily completed, if not, then the candidate will have to undergo the first semester of foundation course again.

3.1 Bachelor in Medical Radiology and Imaging Technology (BMRIT)

Introduction:

Learning Objectives:

Bachelor in Medical Radiology and Imaging Technology (BMRIT) 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 BMRIT 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.

Expectation from the future graduate in the providing patient care.

- 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.

Teaching faculty and infrastructure (minimum standard to start the programmes):

Institute should mandatorily be associated with the state medical colleges whereby they can make use of the available patient load and medical infrastructure as a part of their training curriculum (May be through MOU).

- Standalone institutions must have an MoU with either a medical college or hospital or healthcare facility as per the guidelines (desired number of Radiology equipment/beds/OPD etc.) defined in the curriculum to ensure practical exposure to the students.

- MoU to also define the radiology clinical supervision of the students –institutional staff or clinical preceptors can be considered.

For the institutes to be capable of providing high quality training to the student and exposure to all the related modalities, it should have the following:

- X-ray Unit (CR, DR)
- Mobile X-ray unit
- Fluoroscopic unit
- Ultrasonography, Color Doppler Equipment
- Multi-slice C.T. Scan,
- Mammography
- DEXA
- MRI
- DSA

The teaching faculty (with annual intake of up to 20 students or students staffs ratios must be 5:1 to be maintained) for the MRITs should have a minimum of Master in the MRIT or MRIT with PhD in relevant subject.

- 1 Professor
- 1 Assoc. Professor
- 3 Asst. Professor
- 2 demonstrators

Method of teaching and learning-

- Lecture
- Tutorial
- Problem based learning
- Small group teaching and learning
- Continuous interactive learning
- Case-based
- Project based
- Research project- Research was considered by the group to be very important in order to keep pace with other professions and to generate a research background for our own profession.
- Seminars
- Clinical conferences
- E-learning
- Skills laboratory
- Industrial visit

Infrastructure requirements (with annual intake of up to 20 students)**:**

- Minimum 4 classrooms with minimum seating capacity of 30 students
- Faculty rooms, Common rooms for students
- Auditorium/Conference room with minimum seating capacity of 150 students.
- A minimum 2000 sqft library area

- Student canteen/cafeteria
- Office rooms for staff

Eligibility for admission

Selection procedure:

He/she has passed the Higher Secondary (10+2) or equivalent examination recognized by any Indian University or a duly constituted Board with Physics, Chemistry, Biology

OR

Candidates who have studied abroad and have passed the equivalent qualification as determined by the University will form the guideline to determine the eligibility and must have passed in the subjects: Physics, Chemistry, Biology and English up to 12th Standard level.

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

- He/she has attained the age of 17 years as on or before the 31st December of the year of admission) & maximum age limit is 30 years.
- He/she must furnish at the time of submission of application form, a certificate of Physical fitness from a registered medical practitioner and two references from persons other than relatives testifying to satisfactory general character.

Admission to Bachelor Medical Radiology and Imaging Technology course shall be made based on eligibility and an entrance test to be conducted for the purpose.

Selection of eligible candidates:

Selection to the BMRIT course shall be based on merit obtained in the National Entrance and Eligibility Test (NEET) conducted by the central government or its authorized agency.

In accordance with NCAHP regulations Institution/university having hospital setup shall be permitted an annual intake capacity of 20 admissions annually apart from inservice /Govt.Sponsored Candidates as per NCIAHP Act. Thereafter these can be increased to 40/60 BMRIT admissions annually. The phase-wise requirements to be fulfilled by the applicant colleges after obtaining letter of intent and Letter of Permission for establishment of new college or increase in annual intake for 40/60 BMRIT admissions annually as per ICAHP regulations.

Admission of Lateral Entry candidates:

Number of intake: lateral entry admission must not be more than 10% of the annual intake.

Lateral entry to second year for allied and healthcare science courses for candidates who have passed diploma program from the Government Boards and recognized by State/Central University, fulfilling the conditions specified and these students are eligible to take admission on lateral entry system only if the same subject have been studied at diploma level.

There may be need of deliberation on the inclusion of a few bridging courses are advisable for those having less qualified subjects.

A candidate with a minimum 2 years full-time diploma in Medical Imaging Technology/Radiography recognized by a Government Body is eligible for lateral entry to the 3rd semester.

Note: Candidates with minimum 2 years full-time diploma in Medical Imaging Technology/Radiography from a recognized Government Body shall have passed 'plus-two' [10+2] with Physics, Chemistry and Biology as subjects with minimum 1 years of radiology working experience in hospital/academic institution or

Candidates with minimum 3 years full-time diploma in Medical Imaging Technology/Radiography from a recognized Government Body shall have passed 'plus-two' [10+2] with Arts/Commerce as subjects, should have studied Physics, Chemistry and Biology as principal subjects during the tenure of the Medical Imaging Technology course with minimum 1 years of radiology working experience in hospital/academic institution. Eligibility of the lateral candidates based on examination conducted by NCAHP.

Foreign nationals and candidates who have qualified from a foreign University/Board should obtain permission from the NCAHP commission prior to the admission for equivalence of the qualification.

Note: Curriculum task force members decided not to submit the Diploma of MRIT curriculum and requested NCAHP to phase out the course within five years. (As it was decided during the previous meeting).

Duration of the course

Duration of the course: 3 years (6 semesters) + 1 year (7th and 8th semester) internship. Total 4 years or 8 semesters programme. (per semester 640 hours of Theory & Practical hours) and 2400 hours of internship.

Total hours of the course: 6240 hours.

Medium of instruction:

English shall be the medium of instruction for all the subjects of study and for examination of the course.

Maximum period for completion of the course:

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

Attendance and Monitoring progress of studies:

- 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.

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 for 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
    - 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.

Criteria for pass:

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.

Attendance and appearance for Exam:

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.

Stipend: All students shall be paid a minimum amount of Rupees 7000/- per month as stipend during internship or at par with other streams as per Consumer Price Index as per NCIAHP Act.

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 Courses (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	

Distribution of Credits:

L – Lectures- 1 hour: 1 credit

T – Tutorial- 1 hour: 1 credit

P – Practical- 2 hours: 1 credit

Clinical (Studentship)- 3 hours: 1 credit

Curriculum Outline

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	BMRIT-001	3	--	--	3	2.5	30	70	100	50	--	--	--	--	**100**
2.	Physiology	BMRIT-002	3	--	--	3	2.5	30	70	100	50	--	--	--	--	**100**
3.	Basics of Radiation Physics	BMRIT-003	2	-	6	5	2.5	30	70	100	50	30	70#	100	50	**200**
4.	Introduction to Healthcare	BMRIT-004	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
5.	Medical Terminology and Record keeping	BMRIT-005	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
6.	Basic Computers and Information science	BMRIT-006	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
7.	Medical Law and Ethics	BMRIT-007	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
8.	Professionalism and Values	BMRIT-008	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
9.	Principals of Management	BMRIT-009	1	--	--	1	--	30	70*	100	50	--	--	--	--	--
10.	English & Communication skills	BMRIT-010	1	--	--	1	--	30	70*	100	50	--	--	--	--	--

S.N.	Course Title	Course Code	L (hrs/ week)	T	C/ P (hrs/week)	Credits (L+T+P)	Exam Duration in Hrs.	Theory CIE Max Marks	Theory ESE Max Marks	Theory Total Max Marks	Theory Total Min Marks	Practical CIE Max Marks	Practical ESE Max Marks	Practical Total Max Marks	Practical Total Min Marks	Grand Total
11.	BMRIT 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.

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: L (hrs/ week)	T	C/ P (hrs/week)	Credits (L+T+P)	Examination Scheme: Exam Duration in Hrs.	Theory CIE Max Marks	Theory ESE Max Marks	Theory Total Max Marks	Theory Total Min Marks	Practical CIE Max Marks	Practical ESE Max Marks	Practical Total Max Marks	Practical Total Min Marks	Grand Total
1.	Basics of Microbiology	BMRIT -011	2	--	--	2	2.5	30	70	100	50	--	--	--	--	100
2.	Basics of Biochemistry	BMRIT -012	2	--	--	2	2.5	30	70	100	50	--	--	--	--	100
3.	Conventional Radiography and Equipment	BMRIT -013	4	--	2	5	2.5	30	70	100	50	--	--	--	--	100
4.	Clinical Radiography Positioning (Part I)	BMRIT -014	4	1	6	8	--	30	70	100	50	30	70#	100	50	200
5.	BMRIT 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.

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: L (hrs/week)	T	C/ (hrs/week)	Credits (L+T+P)	Examination Scheme: Theory: Exam Duration in Hrs.	Theory: CIE Max Marks	Theory: ESE Max Marks	Theory: Total Max Marks	Theory: Total Min Marks	Practical: CIE Max Marks	Practical: ESE Max Marks	Practical: Total Max Marks	Practical: Total Min Marks	Grand Total
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.	BMRIT 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.

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				Grand Total
			L (hrs/week)	T	C/P (hrs/week)	L (hrs/week)	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.	Cross sectional anatomy	BMRIT-019	2	--	6	5	--	--	--	--	--	70#	30	100	50	**100**
2.	Modern Radiological Imaging Equipment and Physics	BMRIT-020	2	1	2	3	2.5	70	30	100	50	--	--	--	--	**100**
3.	Interventional Radiology Techniques	BMRIT-021	2	1	4	4	2.5	70	30	100	50	70#	30	100	50	**200**
4.	Patient Care in Radiology	BMRIT-022	1	1	4	4	2.5	70	30	100	50	70#	30	100	50	**200**
5.	BMRIT 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.

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									Grand Total
			Theory (hrs/week)	Tutorial	Clinical / Practicals (hrs/week)	Credits (L+T+P)	Theory					Practical				
							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.	Basics Techniques in CT Technology	BMRIT-023	4	1	8	9	2.5	30	70	100	50	30	70#	100	50	**200**
2.	Radiation Safety in Diagnostic Radiology	BMRIT-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	BMRIT-025	1	1	2	3	--	--	--	--	--	30	70#	100	50	**100**
4.	BMRIT 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.

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	BMRIT-026	3	1	8	8	2.5	30	70	100	50	30	70#	100	50	**200**
2.	Introduction to Nuclear Medicine Techniques	BMRIT-027	1	1	2	3	2.5	30	70	100	50	--	--	--	--	**100**
3.	Ultrasound Techniques	BMRIT-028	2	1	--	3	2.5	30	70	100	50	--	--	--	--	**100**
4.	Biostatistics And Research Methodology	BMRIT-029	1	1	--	2	--	30	70*	100	50	--	--	--	--	--
5.	BMRIT 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.

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.

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 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.

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

	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 BMRIT 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	Examination Scheme												
					Theory						Practical					
					CIE		ESE		Total		CIE		ESE*		Total	
L	T	P	(L+T+P)	Paper Hrs.	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
--	--	--	20	--	--	--	--	--	--	--	100	50	100	50	**200**	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 type of Radiography/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	
6 months	Max. marks	Min. marks	Max. marks	Min. marks	Max. marks	Min. marks
	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 marls
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.

Logo Book Template:

Cover Page

Institute/University Logo

Bachelor in Medical Radiology and Imaging Technology

(BMRIT)

Log Book

Name of the Student:

Name of the Under Graduate degree:

USN:

Batch:

PARTICULARS OF STUDENT

PHOTOGRAPH

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 (BMRIT) from (name of the Institute/University & address). She/He has completed all the clinical responsibilities during her/his Under-graduation training from……………………………….to……................................

Signature	**Signature**
Head/Programme Co-ordinator	**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							

Scoring:
1 Poor
2 Below Average
3 Average
4 Good
5 Excellent

IMMUNIZATION FORM

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

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, butremained 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:

∑ [(course credit) X (Grade point)] for all courses with Letter grades, including F

SGPA = --

∑ [(course credits)] for all courses with Letter grades, including F

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

∑ [(course credit) X (Grade point)] for all courses for all semesters with, Letter grades excluding F

CGPA = --

∑ [(course credits)] 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.

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.

Re-totaling:

Re-totaling 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 of marks for the course/s applied. The marks obtained after re-totaling shall be the final marks awarded. There is no facility provided for repeat paper valuation of any subjects.

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.

Conduct and discipline:

Candidates shall conduct themselves within and outside the premises of the Institute in a manner befitting the student of an educational institution.

As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

The following act of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures:

Ragging as defined and described by the Supreme court/Government Lack of courtesy and decorum; indecent behaviour anywhere within or outside the campus. Willful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow candidates/citizens. Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs. Mutilation or unauthorized possession of library books. Noisy or unseemly behavior, disturbing studies of fellow candidates. Hacking in computer systems (such as entering into other person's domain without prior permission, manipulation and/or damage to the computer hardware and software or any other cyber-crimes.) Plagiarism of any nature. Any other act of gross indiscipline as decided by the Board of Management from time to time.

Commensurate with the gravity of offense, the punishment may be: reprimand, fine, expulsion from the hostel, debarment from an examination, disallowing the use of certain facilities of the Institution, rustication for a specific period or even outright expulsion from the Institution, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

For any offence committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department and the Head of the Institution, respectively, shall have the authority to reprimand or impose fine.

All cases involving punishment other than reprimand shall be reported to the Vice-Chancellor.

Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Controller of Examinations for taking appropriate action.

Graduation requirements:

Candidate shall be declared eligible for the award of the degree if he or she has:

- Fulfilled all degree requirements.
- No dues to the University, Institution, departments, hostels, library etc.
- No disciplinary action pending against him.

The award of degree must be recommended by the Board of Management.

Convocation:

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

Board of examiners for each semester (except 7th & 8th semesters):

The Examination Committee shall recommend in such manner as may be determined by the State Board, names of suitable experts as the chairman of panels of Board of examiner for setting and moderating the question papers and arrange the panels of moderators, senior examiners and examiners prepared in such manner as per the guidelines of the NCAHP.

HOD of Radiology: Chairperson

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

Subject Experts:

External examiner (two):

- The examiner must be subject expert.

Internal examiner (two):

- The examiner must be subject expert.

First Semester

Subject: Human Anatomy

Subject Code: BMRIT - 001

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

At the end of the course students will be able to...

CO1: Describe the general anatomy of human body

CO2: Explain normal disposition of various structures and organs in the body and its clinical correlation

CO3: Describe the microscopic structure of various tissues

CO4: Determine the topography of various structures on the surface of the body

CO5: Identify and locate structures of the body

CO6: Identify organs and tissues under microscope

CO7: Point out various features of appearance of normal body in skiagrams

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**	**08**	20

	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.		
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

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

Sr. No		Hours
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)			150

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

Subject: PHYSIOLOGY

Subject Code: BMRIT - 002

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

At the end of the course students will be able to...

CO1: Explain the normal functioning of organs and systems.

CO2: Understand the interrelationships and interactions among various organs and systems for maintaining homeostasis.

CO3: Assess the relative contribution of each organ systems toward the maintenance of constant internal environment

CO4: Differentiate between normal and abnormal functioning of organs and systems,

CO5: Understand physiological basis of pathogenesis and treatment of diseases and disorders.

CO6: Apply the physiological basis in the field of allied health care

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

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

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	8	10

	tract. 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,	**8**	**15**

	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.		
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	**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	8

	SUGGESTED PRACTICALS/DEMONSTRATION	Hours
	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	
	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;

Subject: Basics of Radiation Physics

Subject Code: BMRIT - 003

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

At the end of the course students will be able to...

CO1: Describe general physics related to imaging

CO2: Differentiate between within general radiation

CO3: Identify construction of radiology equipment's

CO4: Interpret quality of control of radiology equipment's

CO5: Differentiate between x-ray equipment's and other radiology related equipment's

CO6: Describe production of x-rays

CO7: Describe circuit system of radiology equipment's

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

Sr. No		**Hours**
1.	Basic concepts	**108**
2.	Electricity and magnetism, Electromagnetic waves	
3.	Electronics	
4.	Discovery of x-rays-X-ray production and properties	
5.	Heat	
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 Brothers Medical 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

Subject: Introduction to Healthcare

Subject Code: BMRIT - 004

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.

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
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	**18**

Monitoring and recording of vitals Simple aseptic techniques, sterilization and disinfection Observation of surgical dressings Concepts of First Aid	

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

Subject: Medical Terminologies and Record Keeping

Subject Code: BMRIT - 005

RATIONALE

This course introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes, and suffixes.

<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>
</table>

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

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

<table>
<tr><th>Topic and contents</th><th>Hours</th></tr>
<tr><td>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.</td><td>18</td></tr>
</table>

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

Subject: Basic Computers and Information Science

Subject Code: BMRIT - 006

RATIONALE

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.

<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>
</table>

L, lecture; T, Tutorial; P, Practical

THEORY COMPONENTS

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

<table>
<tr><th>Topic and contents</th><th>Hours</th></tr>
<tr><td>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.</td><td>18</td></tr>
</table>

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

Subject: Medical law and ethics

Subject Code: BMRIT – 007

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
				Institute level exam only:
L	**T**	**P**	**C**	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

Subject: Professionalism and Values

Subject Code: BMRIT – 008

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.

<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>
</table>

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

S.No.	Title of Book	Author	Publication
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

Subject: Principals of Management

Subject Code: BMRIT – 009

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

Subject: English and Communication skills

Subject Code: BMRIT - 010

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 LEARNING RESOURCES

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

BMRIT 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 semesters.
- 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

Subject: Basics of Microbiology

Subject Code: BMRIT - 011

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

At the end of the course students will be able to...

CO001: Describe the structure, classification, morphology and growth of bacteria

CO002: Describe the methods sterilization and disinfection and its applications

CO003: Explain the concepts of immunity, hypersensitivity and immunization

CO004: Describe Nosocomial infections and methods for prevention of Hospital acquired infections

CO005: Describe the management of biomedical waste

CO006: List the common fungi and viruses and explain their importance

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**	**70**	**30**	**--**	**--**	**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	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	**9**

	Culture Methods Antimicrobial sensitivity tests Sterilization and Disinfections: Definition, Dry heat Sterilization, Moist heat Sterilization, Chemical disinfectants, Gaseous disinfection, Test for disinfection / Sterilization control	
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 (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%)
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

Subject: Basics of Biochemistry

Subject Code: BMRIT - 012

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

At the end of the course students will be able to...

CO1: Understand the responsibility of health care personals and hazards faced in the clinical laboratory

CO2: Explain the different types, use, care and maintenance of laboratory apparatus and instruments.

CO3: Understand the fundamental chemistry and knowledge of different solutions

CO4: Understand what acids, bases, salts and indicators are and also know about acid base balance

CO5: Describe the sample collection procedure to analyse various biochemical parameters

CO6: Describe assimilation of nutrients and consequences of malnutrition

CO7: Understand the different functional tests like LFT (Liver function test), RFT (Renal function test)

CO8: Understand the overview of tumor markers, cardiac markers, blood sugar and GTT, lipid profile and diagnostic enzymology

CO9: Describe the applications of radioisotopes

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)			150

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

Subject: Conventional Radiography and Equipment

Subject Code: BMRIT -013

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

At the end of the course students will be able to...

CO001: Describe the structure and working of x-ray tube, production of x-rays

CO002: Describe the types of x-ray tube and heat dissipation methods

CO003: Explain the x-ray generator circuits

CO004: Describe the different circuit types

CO005: Describe the meters and exposure timers

CO006: List the control of scattered radiation

CO007: Describes about the fluoroscopy

CO008: Explains about the care and maintenance of x-ray equipment's

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

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

Subject: Clinical Radiography Positioning (Part I)

Subject Code: BMRIT - 014

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

At the end of the course students will be able to...

CO1: Understand the basic patient positioning during radiographic investigation.

CO2: Apply special positioning skills for different pathological and physical conditions.

CO3: Application of equipments while working in radiology departments.

CO4: Choose proper position during radiography.

CO5: Explain relative positions of x-ray tube and patient relevant exposure factors during radiography.

CO6: Explain the use of accessories.

CO7: Explain the anatomic and physiological basis of the procedure to be undertaken.

CO8: Explain the radiographic appearances of both normal and common abnormal conditions.

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	8

	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.	
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.	**10**

	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.	
Total		**72**

SUGGESTED PRACTICALS/DEMONSTRATION

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)			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	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

BMRIT 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

Subject: Pathology

Subject Code: BMRIT -015

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

At the end of the course students will be able to...

CO1: Define the term "Disease" or concepts of Diseases.

CO2: Define, classify diseases and the medical terms used.

CO3: Describe the cause and mechanism of a few common diseases they come across during their routine work.

CO4: Common changes seen in these diseased persons in different organs/tissues/bodyfluids.

CO5: Names of the common laboratory tests done to diagnose the diseases like examination of urine, blood, other body fluids and tissues.

CO6: Enumerate the proper methods of collection, preservation and delivery of the samples to the respective laboratories.

CO7: Describe the procedures of procuring the whole blood or blood components from blood bank and the complications of blood transfusion.

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 airway diseases – causes, pathology and complications of	**7**	**15**

	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**

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

Sr.No		Hours
	• 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)			150

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 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

Subject: Clinical Radiography Positioning (Part- II)

Subject Code: BMRIT - 016

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

At the end of the course students will be able to...

CO1: Prepare management and positioning of patients

CO2: Correlate of indications, contraindications of the patient

CO3: Understand the patient preparations needed before any radiological examination.

CO4: Generalize knowledge of post procedural care.

CO5: Students will be able position the patients for radiological procedures.

CO6: Knowledge of image quality in radiological images.

CO7: Management of patients in radiology department for various procedures.

CO8: Ability to handle emergency situations in radiology department.

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

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

Sr. No		Hours
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
Long Essay	3 (to answer 2)	10	20
Short Essay	8 (to answer 6)	5	30
Short Answer	12 (to answer 10)	3	30
			80
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.	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
	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

S.No.	Title of Book	Author	Publication
5	A Concise Guide on Basic Radiographic Physics Darkroom Procedures, Radiographic Positioning & Techniques	Lalit Agarwal	JBD Publications

Subject: Radiography and Image Processing Techniques

Subject Code: BMRIT -017

RATIONALE

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

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Know basic physics of radiography processing system

CO2: Describe construction and working of film, intensifying screen, cassette, dark room and automatic processor

CO3: Explain radiographic film Processing chemistry

CO4: Discuss the factors affecting image quality in radiographic image and their application

CO5: Operate the workflow in x-ray imaging

CO6: Apply knowledge for the use of radiation factors

CO7: Demonstrate process the radiographic film in different systems

CO8: Prepare care and maintenance of radiographic films, cassettes, intensifying screens, darkroom accessories and X-ray equipment

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

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**
Long Essay	3 (to answer 2)	10	20
Short Essay	8 (to answer 6)	5	30
Short Answer	12 (to answer 10)	3	30
			80
Duration (minutes)			150

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

Subject: Contrast and Special Radiological Procedures

Subject Code: BMRIT - 018

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

At the end of the course students will be able to...

CO1: Prepare management and positioning of patients while performing radiological procedures.

CO2: Correlate of indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for different radiological procedures.

CO3: Understand the patient preparations needed before any radiological examination.

CO4: Generalize knowledge of post procedural care.

CO5: Students will be able position the patients for radiological procedures.

CO6: Knowledge of image quality in radiological images.

CO7: Management of patients in radiology department for various procedures.

CO8: Ability to handle emergency situations in radiology department.

CO9: Precautions and care required in interventional suits.

<table>
<tr><td colspan="3" rowspan="2">Teaching Scheme
(In Hours)</td><td rowspan="2">Total Credits
(L+T+P)</td><td colspan="5">Examination Scheme</td></tr>
<tr><td colspan="2">Theory Marks</td><td colspan="2">Practical Marks</td><td>Total Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CIE</td><td>ESE</td><td>CIE</td><td>ESE</td><td rowspan="2">200</td></tr>
<tr><td>2</td><td>1</td><td>6</td><td>6</td><td>30</td><td>70</td><td>30</td><td>70</td></tr>
</table>

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

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
Long Essay	3 (to answer 2)	10	20
Short Essay	8 (to answer 6)	5	30
Short Answer	12 (to answer 10)	3	30
			80
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.	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

BMRIT 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

Subject: Cross Sectional Anatomy

Subject Code: BMRIT - 019

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

At the end of the course students will be able to...

CO1: Identify cross-sectional anatomy in the sagittal, coronal and axial planes on CT and MR images.

CO2: Describe anatomical structural relationships.

CO3: Recognize normal anatomy and build a personal resource system for future study.

CO4: Locate and identify pertinent cerebral, upper thorax, mid-thorax, and abdominal anatomy.

CO5: On CT and MR images, identify anatomical structures of the body and of the head.

CO6: Distinguish between arterial and venous anatomy of the entire body's vascular system.

CO7: Classify the various sections of anatomical regions and their associated parts.

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.	**12**	**--**

	Divisions of the mid-thorax, heart and great vessels-Lungs, heart and great vessels, Esophagus		
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

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 –**	36

	Normal and pathologic anatomy of the Pelvis- Bony structures and associated muscles, Digestive and urinary systems **Reproductive Organs -** Normal and abnormal imaging	
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 practical 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)

No theory paper 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	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

Subject: Modern Radiological Imaging Equipment and Physics

Subject Code: BMRIT - 020

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

At the end of the course students will be able to...

CO001: Describe the special radiological equipments

CO002: Describe the digital and computed radiography

CO003: Describe PACS, RIS and HIS

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

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

Subject: Interventional Radiology Techniques

Subject Code: BMRIT -021

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

At the end of the course students will be able to...

CO1: Know the basic principle and physics of interventional equipment.
CO2: Know the management and positioning of patients while performing interventional radiological procedure.
CO3: Have knowledge about the indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for the different interventional radiological procedure.
CO4: Understand the patient preparation needed before any interventional radiological procedures.
CO5: Have knowledge about the post procedural care and safety.

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, CO_2 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

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)			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.	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
5	A Guide on Special Radiographic Investigations & Techniques	Lalit Agarwal	JBD Publications

Subject: Patient Care in radiology

Subject Code: BMRIT - 022

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

At the end of the course, students will be able to…

CO1: Understand the responsibility of the imaging technologist and other health care facility.

CO2: Understand the management and care of patient during different procedures and emergency situations.

CO3:Know about different patient transfer techniques and to restrain the uncooperative patients during radiological examination

CO4: Differentiate the types of consent forms

CO5: Know about infection control, infection source and isolation techniques

CO6: Describe sterilization techniques

CO7: Understand the radiation safety and protection

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 Radiolog**y**:** 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

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)			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.	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

BMRIT 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

Subject: Basics Techniques in CT Technology

Subject Code: BMRIT - 023

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

At the end of the course students will be able to...

CO1: Define basic principle and physics of Computed Tomography scan

CO2: Recognize protocols needed for Computed Tomography examination

CO3: Prepare and positioning for Computed Tomography examination

CO4: Interpret post processing of raw Computed Tomography images

CO5: Prepare and position the patients for Computed Tomography examination

CO6: Categorize knowledge of improving image quality in Computed Tomography images

CO7: Plan of scanning with various Computed Tomography protocols for better representation of images

CO8: Systematize post processing for Computed Tomography scan

CO9: Management of patient for any post contrast reactions

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

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

Sr. No		Hours
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**
Long Essay	3 (to answer 2)	10	20
Short Essay	8 (to answer 6)	5	30
Short Answer	12 (to answer 10)	3	30
			80
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.	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

Subject: Radiation Safety in Diagnostic Radiology

Subject Code: BMRIT - 024

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

At the end of the course, students will be able to learn:
CO1: Aim and need of radiation protection
CO2: Introduction to Radiation units and quantities
CO3: Understanding of various Radiation protection regulations and the dose limits
CO4: Radiation protection to patients, occupational workers and general public in Diagnostic Radiology
CO5: Layout of Radiology department
CO6: Use of protective devices and awareness of radiation with radiation signages
CO7: Dose reduction measures with technical protective considerations during radiology
CO8: Different radiation measuring devices
CO9: Effects of radiation on biological tissue

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

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 and personal dosimeter	20
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

Subject: Quality Assurance in Diagnostic Radiology and Regulatory Requirements

Subject Code: BMRIT -025

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

At the end of the course students will be able to...

CO1: Aim and need of radiation protection

CO2: Introduction to quality assurance

CO3: Understanding of regulatory requirements

CO4: Follow radiation protection regulations and apply practically

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	**3**	

	maintenance of equipments; Record keeping and log book maintenance; Reject analysis and objectives of reject analysis programme.		
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

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

Sr. No		Hours
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

BMRIT 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

Subject: Basics Techniques in MRI Technology

Subject Code: BMRIT - 026

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

At the end of the course students will be able to...

CO1: Define basic principle and physics of Magnetic Resonance Imaging.

CO2: Recognize protocols needed for Magnetic Resonance Imaging examination.

CO3: Prepare and positioning for Magnetic Resonance Imaging examination.

CO4: Interpret post processing of Magnetic Resonance Imaging images.

CO5: Prepare and position the patients for Magnetic Resonance Imaging examination.

CO6: Categorize knowledge of improving image quality in Magnetic Resonance Imaging .

CO7: Scanning of patient with various Magnetic Resonance Imaging protocols for better representation of images.

CO8: Plan of post processing for Magnetic Resonance Imaging data.

CO9: Management of patient for any post contrast reactions.

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

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)			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.	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

Subject: Introduction to Nuclear Medicine Techniques

Subject Code: BMRIT -027

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.

At the end of the course students will be able to...

CO1: Define basic principle and physics of nuclear medicine.

CO2: Apply precautions while handling radiopharmaceuticals.

CO3: Recognizing the artefacts associated with nuclear medicine.

CO4: Assess the knowledge of improving image quality in nuclear medicine.

CO5: Management of patient for any late reactions associated with radiotracers in nuclear medicine.

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

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

Subject: Ultrasound Techniques

Subject Code: BMRIT -028

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 ultrasound and patient care during ultrasound procedures

COURSE OUTCOMES

At the end of the course students will be able to...

CO001: Describethe Ultrasound properties, interaction of ultrasound with matter

CO002: Describe the transducer and types

CO003: Explain the concepts of image display

CO004: Describe Doppler imaging and ultrasound contrast agents

CO005: Describe the image characteristics and artefacts

CO006: explain the safety considerations in ultrasound and protocols

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

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

Sr. No		Hours
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)			150

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)	World Health 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

Subject: Biostatistics and Research Methodology

Subject Code: BMRIT -029

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

At the end of the course students will be able to...
CO1: Understand the Importance of statistics course in the curriculum

CO2: Understands Statistical Terms

CO3: Possess Knowledge and Skill in the use of Basic Statistics in the analysis and interpretation of data

<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>1</td><td>--</td><td>2</td></tr>
</table>

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	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	

BMRIT 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 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.

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	100

S. no.	Learning outcomes	Knowledge/comprehension	Applications / synthesis /evaluation	Hours
	Be able to prepare the diagnostic machinery		individual patient within the context of the protocol	
		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	

S. no.	Learning outcomes	Knowledge/comprehension	Applications / synthesis /evaluation	Hours
		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

S. no.	Learning outcomes	Knowledge/comprehension	Applications / synthesis /evaluation	Hours
		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, apply and 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 legislation regulations 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	

S. no.	Learning outcomes	Knowledge/comprehension	Applications / synthesis /evaluation	Hours
		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

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.

3.2 Master in Medical Radiology and Imaging Technology (MMRIT)

Master in Medical Radiology and Imaging Technology

Introduction:

Learning Objectives:

Master in Medical Radiology & Imaging Technology is specifically aimed at those candidates pursuing a professional/academic career in Radiology &Imaging Technology. It is designed to provide specialized training in the scientific principles of modern imaging sciences and in the application of these principles in the field of Radiology & Imaging Technology. It is designed as a higher degree course suitable for graduates having experience in the technology of Radiology & Imaging Technology. The objective of the programme is to train students to be qualified, patient focused, compassionate, critical thinkers for the community who are engaged in lifelong learning.

Upon successful completion of the Master course, students will have developed a broad knowledge of the principles, technology, instrumentation, recent developments and proper handling of the modern radiological and imaging equipment's and proper execution of the various radiological procedures and be able to embark upon a successful career in their chosen direction of Imaging Science research.

Expectation from the future post graduate in providing research/academics/patient care

Perform a range of radiographic/radiological examinations on patients to produce high quality images.

1. Verifying informed consent, assuming responsibility for patient needs during procedures.
2. Applying principles of ALARA to minimize exposure to patient, self and others. Starting and maintaining intravenous access as prescribed, Identifying, preparing and/or administering medications as prescribed
3. Evaluating images for technical quality, ensuring proper identification is recorded.
4. Performing diagnostic radiographic/radiological and non-interpretive fluoroscopic procedures
5. Assist radiologists and senior staff in complex radiological examinations.
6. Record imaging identification and patient documentation quickly and accurately and observes protocols.
7. Research and development of new techniques and procedures as assigned.
8. Promotes effective working relationships and works effectively as part of a department / unit / team inter and intra departmentally to facilitate the department/unit's ability to meet its goals and objectives.
9. Follows established safety practices including biohazards, exposure control plan
10. Demonstrates respect and regard for the dignity of all patients, families, visitors and fellow employees to ensure a professional, responsible and courteous environment.
11. Identifying and managing emergency situations.
12. Performing ongoing quality assurance activities.
13. Ensure safe custody of all the accessories of the X-ray/radiological unit of which he/she is in charge. Keeps the X-ray room locked when not in use.
14. Understands and observes health and safety regulations/precautions and instruction for self and others protection. He/she should wear a dosimeter during duty hours.
15. Attends all in service education program required as per hospital policy.
16. Providing education and monitoring students and other health care providers.
17. Orientation and teaching students and new employees.
18. Learns new technologies and technologies as required by the professional bodies.
19. Impart appropriate training to the students and other staff.

20. Should have management and research skills.
21. To exhibit keen interest, initiative & drive in the overall development of the Department and 'Leadership Qualities' for others to follow.
22. He / She is expected to be confident and to perform all the duties diligently with utmost sincerity and honesty.
23. Any other duty/task/work assigned by any higher authority like Director, Dean, Medical Superintendent, Head of the Department from time to time; either in "Public Interest" or in the interest of upkeep / development of the Department / Institutions.

Minimum standard to start the MMRIT programmes:

Accordance with NCAHP regulations Institution/university with having medical college with hospital setup shall be permitted an annual intake capacity of 10 admissions (maximum) annually. No shall paramedical institutes/colleges having no own medical college shall permitted to start the Master degree programme. The phase-wise requirements to be fulfilled by the applicant colleges for obtaining letter of intent and Letter of Permission for establishment of new college or increase in annual intake MMRIT admissions annually from 10 to 15 intake. Maximum of intake in the Master degree programe is 15 candidates. No shall permission of the intake to be permitted more then 15 to any institute or college.

For the institutes to be capable of providing high quality training to the student and exposure to all the related modalities, it should have the following:

- X-ray Unit (CR, DR)
- Mobile X-ray unit
- Fluoroscopic unit
- Ultrasonography, Color Doppler Equipment
- Multi-slice CT Scan
- Mammography
- DEXA
- MRI
- DSA

Note: Starting MMRIT program in CT, MRI and Breast Imaging apart from the above equipment's the institute must have state of art high end equipment in these specializations.

The teaching faculty (with annual intake of up to 10 students) for the MMRITs should have a minimum of Master in the MRIT or MRIT with PhD in relevant subject.

- 1 Professor
- 2 Assoc. Professor
- 4 Asst. Professor
- 8 demonstrators

Method of teaching and learning-

- Lecture
- Tutorial
- Problem based learning
- Small group teaching and learning
- Continuous interactive learning
- Case-based
- Project based

- Research project- Research was considered by the group to be very important in order to keep pace with other professions and to generate a research background for our own profession.
- Seminars
- Clinical conferences
- E-learning
- Skills laboratory
- Industrial visit

Infrastructure requirements:

- Minimum 4 classrooms with minimum seating capacity of 10 students
- Faculty rooms, Common rooms for students
- Auditorium/Conference room with minimum seating capacity of 150 students.
- Minimum 2000 sqft Library
- Student canteen/cafeteria

Eligibility for admission:

Selection procedure:

Bachelor in Medical Radiology & Imaging Technology (3+1)/B.Sc. Medical Technology Radio diagnosis and Imaging/ B.Sc. Radiological Technology/B.Sc. in Radiography/B.Sc. Medical Technology (X-ray) or equivalent to BMRIT with a minimum 60% marks in Bachelor. Bachelor course must be three years course and one year of internship/one year of working experience must be considered for the Master degree admission.

The selection of the candidates for admission to the course is made on merit on the basis of combined entrance examination conducted by NCAHP/NEET. The admission notice is released in all leading English Newspaper. Only those candidates will be eligible who score minimum 60% marks in the entrance test for General Category candidates and 55% of for those belonging to SC/ST category.
Selection of the candidate on the basis of Entrance examination conducted by the national commission (NCAHP) norms.

Elective specializations:

MMRIT course offers three elective broad specializations during the admissions. First and Second semesters will be having common core subjects to all the students. During the study of Third and Fourth semesters there will be a three elective broad specializations. Three elective broad specializations are as follows:

- **CT Imaging Technology**
- **MR Imaging Technology**
- **Breast Imaging Technology**

Selecting of elective broad specializations must be done during the admission itself as per ranking. There will be no option to change the elective broad specializations after the start of the academic year.

Selection of eligible candidates:

Every student, selected for admission to a MMRIT in any of the para medical institutions/university on acquiring BMRIT or an equivalent qualification thereto shall have obtained permanent registration with the NCAHP, or any of the State Medical Council(s) or shall obtain the same within a period of three months from the date of his/her admission, failing which his/her admission shall stand cancelled.

Selection to the MMRIT course shall be based on merit obtained in the National Entrance and Eligibility Test (NEET) conducted by the central government or its authorized agency.

Accordance with NCAHP regulations Institution/university with having medical college with hospital setup shall be permitted an annual intake capacity of 10 admissions (maximum) annually. No shall paramedical institutes/colleges having no own medical college shall permitted to start the Master degree programme. The phase-wise requirements to be fulfilled by the applicant colleges for obtaining letter of intent and Letter of Permission for establishment of new college or increase in annual intake MMRIT admissions annually from 10 to 15 intake. Maximum of intake in the Master degree programe is 15 candidates. No shall permission of the intake to be permitted more then 15 to any institute or college.

Number of approved admission/seats will be distributed on elective subjects as follows:

Intake: 10 seats
MMRIT – Elective of CT Imaging Technology: 4 seats
MMRIT – Elective of MR Imaging Technology: 4 seats
MMRIT – Elective of Breast Imaging Technology: 2 seats

Duration of the course

Duration of the course: 4 semesters or 2 Years (640 hours of Theory & Practical Classes).
Total - 2560 hours

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

Maximum period for completion of the course:

The maximum period for completion of MMRIT is 4 years.

If a candidate does not complete within the 4 years, he/she should re-register.

Attendance and Monitoring progress of studies:

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

No candidate is permitted to work in any other laboratory/college/ hospital/pharmacy etc. while studying.

A candidate who has a minimum of 80% attendance in theory and practical separately and who has fulfilled other requirements of the course shall be permitted to appear for the examination.

A candidate having a shortage of attendance shall repeat the exam when it is offered next.

Stipend: All students shall be paid minimum sum of Rupees 15000/- per month as stipend in all the four semesters or at par with other similar streams as per consumer price index as per NCIAHP Act.

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. 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 of 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 course in order to be eligible to appear for the End Semester Examination for that course.

- **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 fulfil all the following conditions
- Undergone satisfactorily the approved program of study in the course/courses for the prescribed duration
- 80% 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 40% of total marks fixed for CIE in a particular course; and
- Fulfil 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.

Criteria for pass:

A Candidate has to score 50% each in theory and practical wherever applicable to be declared as pass. In case of fail, subsequently candidate has to appear for both theory and practical examination of the university in that particular course.

Attendance and appearance for Exam:

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 university conducts exam for the particular course very next time.

Overview

Core courses **(credits)**	1. Radiological and Medical Physics 2. Clinical Special Radiography Positioning 3. Modern Radiological Imaging - Equipment and Physics 4. Contrast Media and Interventional Radiology 5. Modern Imaging and Special Radiological Procedures 6. Biostatistics and Research Methodology
Broad specific core courses (CT Technology)	1. Principles of CT Imaging Technology 2. CT Imaging Procedures and Scanning Protocols 3. Basic and Cross Sectional Anatomy in CT Imaging 4. Advancements in CT Technology 5. Quality Assurance, Radiation Protection and Patient care in CT Imaging 6. Basic Pathology and Image Interpretation in CT Imaging
Broad specific core courses (MRI Technology)	1. Principles of MR Imaging Technology 2. MR Imaging Procedures and Scanning Protocols 3. Basic and Cross Sectional Anatomy in MR Imaging 4. Advancements in MRI Technology 5. Planning, Safety and Patient care in MR Imaging 6. Basics Pathology and Image Interpretation in MR Imaging
Broad specific core courses (Breast Imaging Technology)	1. Principles of Breast Imaging Technology 2. Breast Imaging Procedures and Scanning Protocols 3. Basics and Cross sectional anatomy of Breast 4. Advancements in Breast Imaging Technology 5. Quality Assurance, Radiation Protection and Patient care in Breast Imaging 6. Basics Pathology and Image Interpretation in Breast Imaging

Distribution of Credits:

L – Lectures- 1 hour: 1 credit

T – Tutorial- 1 hour: 1 credit

P – Practical- 2 hours: 1 credit

Clinical (Studentship)- 3 hours: 1 credit

Curriculum Outline

Teaching and Examination Scheme															
Course Name: Master in Medical Radiology and Imaging Technology															
Duration of Program: Two Years (Four Semesters) Pattern : Full Time Duration : 18 Weeks Semester : **First**															
S.N.	**Course Code**	**Course Title**	**Teaching Scheme**				**Examination Scheme**								
							Theory				**Practical**				**Grand Total**
								CIE	**ESE**	**Total**	**CIE**	**ESE**	**Total**		
			L (hrs/week)	**Tutorial**	**C/P (hrs/week)**	**Credits (L+T+P)**	**Exam Duration in Hrs.**	**Max Marks**	**Max Marks**	**Max Marks**	**Max Marks**	**Max Marks**	**Max Marks**	**Min Marks**	
1.	MMRIT01	Radiological and Medical Physics	2	1	6	6	2.5	30	70	100	--	--	--	--	**100**
2.	MMRIT02	Clinical Special Radiography Positioning	2	1	6	6	2.5	30	70	100	30	70#	100	50	**200**
3.	MMRIT03	Biostatistics and Research Methodology	3	--	--	3	2.5	30	70	100	--	--	--	--	**100**
4.		MMRIT Radiology Clinical Education – part I (studentship) *	--	--	15	5	--	--	--	--	30	70	100	50	**100**
	Total		**7**	**2**	**27**	**20**	**--**	**--**	**--**	**300**	**--**	**--**	**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.
*Internal Assessment (Institutional Level examination) marks are not to be counted for the grade at the end of the semester.

Teaching and Examination Scheme

Course Name: Master in Medical Radiology and Imaging Technology

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

Semester : Second

S.N.	Course Code	Course Title	Teaching Scheme				Examination Scheme									Grand Total
							Theory					Practical				
								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	
5.	MMRIT04	Modern Radiological Imaging - Equipment and Physics	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
6.	MMRIT05	Modern Imaging and Special Radiological Procedures	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
7.	MMRIT0 6	Contrast Media and Interventional Radiology	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
8.		MMRIT Radiology Clinical Education - part II (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**7**	**2**	**27**	**20**	**--**	**--**	**--**	**300**	**--**	**--**	**--**	**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.

Teaching and Examination Scheme

Course Name: Master in Medical Radiology and Imaging Technology

Duration of Program: Two Years (Four Semesters) Pattern : Full Time **Duration : 18 Weeks**
Semester : Third (**electives of CT Technology)**

S.N.	Course Code	Course Title	Teaching Scheme				Examination Scheme									Grand Total
							Theory					Practical				
			Theory (hrs/week)	Tutorial	C/P (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.	MMRIT07	Principles of CT Imaging Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT08	CT Imaging Procedures and Scanning Protocols	3	1	4	6	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT09	Basic and Cross-Sectional Anatomy in CT Imaging	--	2	4	4	--	--	--	--	--	30	70#	100	50	**100**
4.		MMRIT Radiology Clinical Education - part III (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**5**	**4**	**27**	**20**	**--**	**--**	**--**	**200**	**--**	**--**	**--**	**200**	**--**	**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.

Teaching and Examination Scheme

Course Name: Master in Medical Radiology and Imaging Technology

Duration of Program: Two Years (Four Semesters) Pattern : Full Time Duration : 18 Weeks
Semester : Fourth (**electives of CT Technology)**

S.N.	Course Code	Course Title	Teaching Scheme				Examination Scheme									Grand Total
							Theory					Practical				
			L (hrs/week)	T	C/P (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.	MMRIT10	Advancements in CT Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT11	Quality Assurance, Radiation Protection and Patient care in CT Imaging	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT12	Basic Pathology and Image Interpretation in CT Imaging	--	--	6	3	--	--	--	--	--	30	70#	100	50	**100**
4.	MMRI	Dissertation	--	--	--	2	--	--	--	--	--	30	70#	100	50	**100**
5.		MRMMRIT Radiology Clinical Education - part IV (studentship)*	--	--	15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**4**	**2**	**29**	**20**	**--**	**--**	**--**	**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.

Teaching and Examination Scheme																
Course Name: Master in Medical Radiology and Imaging Technology																
Duration of Program: Two Years (Four Semesters) Pattern : Full Time Duration : 18 Weeks Semester : Third (**electives of MRI Technology)**																
S.N.	**Course Code**	**Course Title**	**Teaching Scheme**				**Examination Scheme**									**Grand Total**
								Theory				**Practical**				
								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.	MMRIT14	Principles of MR Imaging Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT15	MR Imaging Procedures and Scanning Protocols	3	1	4	6	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT16	Basic and Cross Sectional Anatomy in MR Imaging	--	2	4	4	--	--	--	--	--	30	70#	100	50	**100**
4.		MMRIT Radiology Clinical Education - part III (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**5**	**4**	**27**	**20**	**--**	**--**	**--**	**200**	**--**	**--**	**--**	**200**	**--**	**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.

Teaching and Examination Scheme																
Course Name: Master in Medical Radiology and Imaging Technology																
Duration of Program: Two Years (Four Semesters) Pattern : Full Time Duration : 18 Weeks Semester : Fourth (**electives of MRI Technology)**																
S.N.	**Course Code**	**Course Title**	**Teaching Scheme**				**Examination Scheme**									**Grand Total**
								Theory				**Practical**				
								CIE	**ESE**	**Total**		**CIE**	**ESE**	**Total**		
			L (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.	MMRIT17	Advancements in MR Imaging Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT18	Planning, Safety and Patient care in MR Imaging	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT19	Basics Pathology and Image Interpretation in MR Imaging	--	--	6	3	--	--	--	--	--	30	70#	100	50	**100**
4.	MMRIT20	Dissertation	--	--	--	2	--	--	--	--	--	30	70#	100	50	**100**
5.		MRMMRIT Radiology Clinical Education - part IV (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**4**	**2**	**29**	**20**	**--**	**--**	**--**	**200**	**--**	**--**	**--**	**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.																

Teaching and Examination Scheme																
Course Name: Master in Medical Radiology and Imaging Technology																
Duration of Program: Two Years (Four Semesters) Pattern : Full Time Duration : 18 Weeks Semester : Fourth (**electives of Breast Imaging Technology)**																
S.N.	**Course Code**	**Course Title**	**Teaching Scheme**				**Examination Scheme**									**Grand Total**
							Theory					**Practical**				
								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.	MMRIT24	Advancements in Breast Imaging Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT25	Quality Assurance, Radiation Protection and Patient care in Breast Imaging	2	1	4	5	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT26	Basics Pathology and Image Interpretation in Breast Imaging	--	--	6	3	--	--	--	--	--	30	70#	100	50	**100**
4.	MMRIT27	Dissertation	--	--	--	2	--	--	--	--	--	30	70#	100	50	**100**
5.		MMRIT Radiology Clinical Education - part IV (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**4**	**2**	**29**	**20**	**--**	**--**	**--**	**200**	**--**	**--**	**--**	**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.

Teaching and Examination Scheme

Course Name: Master in Medical Radiology and Imaging Technology

Duration of Program: Two Years (Four Semesters) Pattern : Full Time **Duration : 18 Weeks**
Semester : Third (**electives of Breast Imaging Technology)**

S.N.	Course Code	Course Title	Teaching Scheme				Examination Scheme									Grand total
								Theory				Practical				
			Theory (hrs/week)	Tutorial	C/P (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.	MMRIT21	Principles of Breast Imaging Technology	2	1	4	5	2.5	30	70	100	50	--	--	--	--	**100**
2.	MMRIT22	Breast Imaging Procedures and Scanning Protocols	3	1	4	6	2.5	30	70	100	50	30	70#	100	50	**200**
3.	MMRIT23	Basics and Cross sectional anatomy of Breast	--	2	4	4	--	--	--	--	--	30	70#	100	50	**100**
4.		MMRIT Radiology Clinical Education - part III (studentship)*	--		15	5	--	--	--	--	--	30	70	100	50	**100**
	Total		**5**	**4**	**27**	**20**	**--**	**--**	**--**	**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.

Studentship or observership must include:

- A minimum of 14 hours per week is considered as studentship in very semesters.
- Provide simulation and skill labs for practising skills specific to the program in the initial years of observership/studentship.
- Every semester must have journal club/UG teaching/Mentoring/seminars/workshops on new developments/ technologies. Check annexure for marking criteria.

- All practical skills must be supervised and recorded in a digital Logbook and skills to be evaluated after the completion of the studentship.

Dissertation:

A candidate is required to carry out a research study in select area of his/her subject, under the supervision of a faculty guide. The results of such a study shall be submitted to the University in the form a dissertation as per the prescribed format and within the date stipulated by the University.

The dissertation work is aimed at training a postgraduate candidate in research methodology and techniques. It includes identification of the problem, formulation of a hypothesis, review of literature, getting acquainted with recent advances, designing of a research study, collection of data, critical analysis, and comparison of results and drawing conclusions.

Guide:

A Guide shall be a Post MD/PhD or MMRIT with atleast 2 years of teaching experience. Each guide can take up to a maximum of three students per academic year. However a co-guide can be opted wherever required with prior permission of the Institute and University. The co-guide shall also be a postgraduate teacher recognized by the University as a guide.

Candidate shall submit synopsis to the University through the Guide and Head of the Institute on or before end of first semester or within date notified by the University, whichever earlier.

Once the synopsis is approved and registered by the University no change in the topic or Guide shall be made without the prior approval of the University.

In the event of registered Guide leaving the Institute or in the event of the death of the Guide, a change of Guide shall be permitted by the University, on the specific recommendation of the Institute.

Schedule

The following procedure and schedule shall be strictly followed:

Ethical clearance

Ethical Clearance should be obtained for a study involving any procedure on human subject. The candidate should apply for the certificate to the Ethics Committee of the Institute/University, through the Guide and present the study before the Committee for clearance. A copy of the certificate should be attached along with the synopsis forwarded at the time of submission of synopsis. All such clearance should be sought within three months of the commencement of the I semester.

Submission of synopsis

Synopsis should be vetted by guide, HOD and departmental curriculum development cell and approved by the institutional ethics committee before submission to the university. The synopsis should be submitted as per the format on or before the end of first semester, or within the date notified by the University, whichever is earlier. Once the synopsis is approved and registered by the university no change in the topic or Guide shall be made without the prior approval of the University.

Final submission of the dissertation

The dissertation complete in all respects and duly certified by the Guide/Co-guide, Course Co-ordinator/ HoD/ Director should be submitted it to the Controller of Examinations as per the date specified by the University, generally three month before commencement of University examinations.

Preparation of dissertation

The written text of dissertation shall be as per the format, shall not exceed 100 pages (cover to cover). It should be neatly typed with 1.5 line spacing on one side of the paper (A4 size: 8.27" x 11.69") and properly bound. Spiral binding should be avoided. E-submission of the dissertation is mandatory.

Scheme of evaluation

The dissertation will be evaluated at the time of university examination of IV semester by a panel of examiner (Internal and External) appointed as per guidelines of NCAHP.

Evaluation format for dissertation

Sl. No	**University Evaluation**	**Marks**
		Max Marks
1.	Objectives, Research Question, Literature Review	25
2.	Results and Discussion	25
3.	Viva voce	50
	Total	**100**

Criteria for pass:

A candidate is declared to have passed the examination in a subject if he secures minimum 40% of marks separately and overall 50% marks separately in theory and practical including internal assessment.

A candidate who fails in any subject shall have to appear only in that subject in subsequent examination.

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.
- Results of candidates will be declared at the end of IV 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 any subjects within three attempts will be considered as withdrawal of the course. Grading and Classification

Re-totalling:

Re-totalling of marks is permitted only for theory papers. The University, on application within the stipulated time and remittance of a prescribed fee, shall permit a re-totalling of marks for the course/s applied. The marks obtained after re-totalling shall be the final marks awarded. There is no re-evaluation offered for any of the subjects in MMRIT.

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.

Conduct and discipline:

Candidates shall conduct themselves within and outside the premises of the Institute in a manner befitting the student of an educational institution.
As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

The following act of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures:
Ragging as defined and described by the Supreme court/Government Lack of courtesy and decorum; indecent behaviour anywhere within or outside the campus. Willful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow candidates/citizens. Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs. Mutilation or unauthorized possession of library books. Noisy or unseemly behaviour, disturbing studies of fellow candidates. Hacking in computer systems (such as entering into other person's domain without prior permission, manipulation and/or damage to the computer hardware and software or any other cyber crime etc.) Plagiarism of any nature. Any other act of gross indiscipline as decided by the Board of Management from time to time.
Commensurate with the gravity of offense, the punishment may be: reprimand, fine, expulsion from the hostel, debarment from an examination, disallowing the use of certain facilities of the Institution, rustication for a specific period or even outright expulsion from the Institution, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
For any offence committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department and the Head of the Institution, respectively, shall have the authority to reprimand or impose fine.
All cases involving punishment other than reprimand shall be reported to the Vice-Chancellor.
Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Controller of Examinations for taking appropriate action.

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	7.50 and above
80-89	9	S	Excellent		
75-79	8	A+	Very Good		
65-74	7	A	Good	First Class	6.50 -7.49
60-64	6	B	Average	Second Class	6.00 - 6.49
50-59	5	C	Pass		5.00 - 5.99
Below 50	0	F	Fail	Fail	Less than 5.00
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
ESE 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:

∑ [(course credit) X (Grade point)] for all courses with

Letter grades, including F

SGPA = --

∑ [(course credits)] for all courses with Letter grades, including F

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

∑ [(course credit) X (Grade point)] for all courses for all semesters

with, Letter grades excluding F

CGPA = ---

∑ [(course credits)] 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.

Graduation requirements:
Candidate shall be declared eligible for the award of the degree if he or she has:

- Fulfilled all degree requirements.
- No dues to the University, Institution, departments, hostels, library etc.
- No disciplinary action pending against him.

The award of degree must be recommended by the Board of Management.

Convocation:

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

Board of examiners for each semester:

The Examination Committee shall recommend in such manner as may be determined by the State Board, names of suitable experts as the chairman of panels of Board of examiner for setting and moderating the question papers and arrange the panels of moderatorsand examiners prepared in such manner as per the guidelines of the NCAHP.

HOD of Radiology: Chairperson

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

Subject Experts:

External examiner (one person):

- The examiner must be subject expert.

Internal examiner (one person):

- The examiner must be subject expert.

First Semester

Subject: Radiological and Medical Physics

Subject Code: MMRIT01

RATIONALE

Radiological and Imaging Technology instrumentation and its physics are the primary pillars underlying the practice of radiological and Imaging technology and understanding the principles of radiation physics helps MMRIT to become a qualified MMRIT technologist.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Describe general physics related to imaging

CO2: Differentiate between within general radiation

CO3: Identify construction of radiology equipment's

CO4: Interpret quality of control of radiology equipment's

CO5: Differentiate between x-ray equipment's and other radiology related equipment's

CO6: Describe production of x-rays

CO7: Describe circuit system of radiology equipment's

CO8: Describe the structure and working of x-ray tube, production of x-rays

CO9: Describe the types of x-ray tube and heat dissipation methods

CO10: Explain the x-ray generator circuits

CO11: Describe the different circuit types

CO12: Describe the meters and exposure timers

CO13: List the control of scattered radiation

CO14: Describes about the fluoroscopy

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 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
1.	**Basic concepts**: Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table-Isotopes-Ionization-excitation-Binding energy-electron volt-Electromagnetic radiation-Quantum nature of radiation-mass energy equivalence-Fluorescence-electromagnetic spectrum.	4	5
2.	**Electricity and magnetism**: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and Capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law. Varying currents-Growth and decay of current in LR circuit time constant, charge and discharge of a Capacitor through a resistance and inductance. Oscillations in an LC circuit. Alternating currents: Peak and RMS values and current and voltage, circuit containing LR, CR and LCR-Power factor, series and parallel LCR circuits, DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current. **Electromagnetic waves**: Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere.	4	5
3.	**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.	4	5
4.	**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.	4	5
5.	**Heat** Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transfer-conduction, convection, radiation, thermal conductivity, equation for thermal conductivity (k), the value of k of various material of interest in radiology, thermal expansion, Newton's law of cooling,	4	5

	Heat radiation, perfect black body, Stefan law, application in Diagnostic Radiology (Heat dissipation in both stationary and rotating X-ray tubes).		
6.	**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.	**4**	**5**
7.	**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.	**3**	**5**
8.	**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;	**4**	**5**
9.	**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.	**4**	**5**

	Heat dissipation methods, tube rating, heat units, operating conditions and maintenance and QA procedures.		
10.	**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.	**4**	**5**
11.	**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; 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.	**2**	**2**
12.	**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.	**3**	**5**
13.	**Control of scattered radiation and 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.	**2**	**5**
14.	**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	**4**	**5**

	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.		
15.	**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.	**2**	**3**
	Total	**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No	Radiological physics	Hours
1.	Discovery of X-ray production and properties	10
2.	Interaction of ionizing radiation with matters	10
3.	Exponential attenuation, Physical quantity, its unit and measurement	10
	Medical Physics	
4.	X-ray tube; Production of x-rays	18
5.	Rotating anode x - ray tube; Grid controlled and high speed tubes; Heat dissipation methods	10
6.	Filament current and voltage; X-ray generator circuits	10
7.	High tension circuits; Interlocking circuits; Relays	10
8.	Meters and exposure timers	10
9.	Fluoroscopy	10
10.	Care and Maintenance of X-ray equipment	10
	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination practical exams:

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

SUGGESTED LEARNING RESOURCES

SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Basic radiologicalphysics	K. Thayalan	Jaypee Brothers Medical Publishers (P) Limited, 2003
2.	Christinsens physics of diagnosticradiology	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 Publcation
5.	Radiographic Imaging (Cbs)I.C.R.P.	D.N. Chesney & M.O Chesney	CBS Publishers & Distributors
6.	An Introduction Of Physics to Diagnostic Radiography	Christensen, Curry &Dowdey	Lea&Febiger
7.	Radiological Science for technologists	Stewart C Bushong	Mosby
8.	Equipment for Diagnostic Radiography	E. Forster	Springer Dordrecht

Subject: Clinical Special Radiography Positioning

Subject Code: MMRIT02

RATIONALE

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

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic patient positioning during radiographic investigation.

CO2: Apply special positioning skills for different pathological and physical conditions.

CO3: Application of equipments while working in radiology departments.

CO4: Choose proper position during radiography.

CO5: Explain relative positions of x-ray tube and patient relevant exposure factors during radiography.

CO6: Explain the use of accessories.

CO7: Explain the anatomic and physiological basis of the procedure to be undertaken.

CO8: Explain the radiographic appearances of both normal and common abnormal conditions.

CO9: Prepare management and positioning of patients

CO10: Correlate of indications, contraindications of the patient

CO11: Understand the patient preparations needed before any radiological examination.

CO12: Generalize knowledge of post procedural care.

CO13: Students will be able position the patients for radiological procedures.

CO14: Knowledge of image quality in radiological images.

CO15: Management of patients in radiology department for various procedures.

CO16: Ability to handle emergency situations in radiology department.

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**	**6**	**7**	**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	Marks
1.	**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.	6	5
2.	**Upper limb:** Special 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	6	9
3.	**Lower limb:** Special 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.	6	9
4.	**Shoulder Girdle and Thorax:** Special 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.	6	6

5.	**Vertebral Column:** Special 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.	**6**	**6**
6.	**Skull:** Special 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.	**6**	**6**
7.	**Pelvic girdle and hip region:** Special 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.	**6**	**6**
8.	**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 manoeuvre. - Phonation.	**6**	**6**
9.	**Lungs 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**	**6**

10.	**Mammography:** Basic views, special views, wire localization.	**6**	**3**
11.	**Trauma radiography/Emergency radiography**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.	**6**	**3**
12.	**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. **Neonatal and Paediatric Radiography** **Forensic Radiography** **Scatter elimination; beam collimation; grid ratio.** **Speed and type of grid movement**	**6**	**5**
Total		**72**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Principles of Radiography	5
2.	Upper limb	10
3.	Lower limb	10
4.	Shoulder Girdle and Thorax	10
5.	Vertebral Column	10
6.	Skull	10
7.	Pelvic girdle and hip region, Skeletal survey	5
8.	Dental Radiography; Upper respiratory system	5
9.	Lungs and Mediastinum; Abdominal viscera	10
10.	Radiography in the ward; Mammography	13
11.	Operation theatre techniques; C-arm	5
12.	Soft Tissue Radiography	10

Sr. No		Hours
	Multiple radiography High kV Radiography Scatter elimination; beam collimation; grid ratio Speed and type of grid movement Radiographic factor; application and uses	
13.	Neonatal and Paediatric Radiography; Forensic Radiography Macroradiography Localization of foreign bodies	5
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	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	GarkalGs	Jaypee Brothers Medical Publishers

Subject: Biostatistics and Research Methodology

Subject Code: MMRIT03

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

At the end of the course students will be able to...
CO1: Understand the Importance of statistics course in the curriculum

CO2: Understands Statistical Terms

CO3: Possess Knowledge and Skill in the use of Basic Statistics in the analysis and interpretation of data

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 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
1.	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.	6	**10**
2.	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.	6	**10**
3.	Measure of Central Tendency: Need For Measures of Central Tendency; Definition and Calculation of Mean; Ungrouped and Grouped Meaning, Interpretation and Calculation of Median	6	**15**

	Ungrouped and Grouped; Meaning and Calculation of Mode; Comparison of the Mean, and Mode; Guidelines for the Use of Various Measures of Central Tendency.		
4.	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.	**6**	**15**
5.	Probability and Standard Distributions: Meaning of Probability of Standard Distribution, The Binominal Distribution. The Normal Distribution; Divergence from Normality - Skewness,Kurtosis	**6**	**10**
6.	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.	**6**	**10**
Total		**54**	**70**

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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

SUGGESTED LEARNING RESOURCES

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

MMRIT Radiological Clinical Education- part I (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Second Semester

Subject: Modern Radiological Imaging - Equipment and Physics

Subject Code: MMRIT04

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

At the end of the course students will be able to...

CO001: Describe the special radiological equipments

CO002: Describe the digital and computed radiography

CO003: Describe PACS, RIS and HIS

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**	**4**	**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 assignmentsminimum 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
1.	Modern x-ray tube: its principle, physics & equipment	5	5
2.	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	5	**5**

3.	Dual energy x-ray absorptionometry (DEXA) scan: its principle, physics & equipment	5	5
4.	Computed radiography: its principle, physics & equipment.	5	5
5.	Mammography and Tomosynthesis: its principle, physics & equipment	5	5
6.	Modern dental equipments. Cone beam dental CT	5	5
7.	Bone mineral density test: its principle, physics & equipment	5	5
8.	Picture archiving and communication system (PACS), RIS, HIS and Teleradiology	5	5
9.	Computed Tomography	7	5
10.	Magnetic Resonance Imaging	5	5
11.	Ultrasound Imaging	5	5
12.	Hybrid Imaging	5	5
13.	Smart Simulator/virtual imaging	5	5
14.	Artificial Intelligence in Modern Radiological Imaging	**5**	**5**
Total		**72**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Modern x-ray tube: its principle, physics & equipment	5
2.	Digital Radiography	5
3.	Dual energy x-ray absorptionometry (DEXA) scan: its principle, physics & equipment	2
4.	Computed radiography	3
5.	Mammography and Tomosynthesis: its principle, physics & equipment	5
6.	Modern dental equipments. Cone beam dental CT	3
7.	Bone mineral density test: its principle, physics & equipment	2

Sr. No		Hours
8.	Picture archiving and communication system (PACS), RIS, HIS and Teleradiology	5
9.	Computed Tomography	5
10.	Magnetic Resonance Imaging	5
11.	Ultrasound Imaging	5
12.	Hybrid Imaging	5
13.	Smart Simulator/virtual imaging AI Imaging	4
Total		**54**

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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.
Distribution of marks for university examination 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	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 (Author), James E. Dowdey (Author), Robert E. Murry (Author)	Lea &Febiger,U.S
4	Textbook Of Radiology For Residents And Technicians	BHARGAVA S. K	CBS; publishers
5	Ultrasound physics and technology	Vivien gibbs, davidcole, Antonio sassano	Churchill Livingstone;
6	Manual of Diagnostic Ultrasound	Philip E. S. Palmer (Author)	World Health Organization
7	Physics and Technical Aspects Diagnostic Ultrasound	DINESH K BAGHEL (Author	AITBS PUBLISHERS

Subject: Contrast Media and Interventional Radiology

Subject Code: MMRIT05

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

At the end of the course students will be able to...

CO1: Know the basic principle and physics of interventional equipment.
CO2: Know the management and positioning of patients while performing interventional radiological procedure.
CO3: Have knowledge about the indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for the different interventional radiological procedure.
CO4: Understand the patient preparation needed before any interventional radiological procedures.
CO5: Have knowledge about the post procedural care and safety.

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
1.	**Contrast Media**: Positive and Negative, Ionic &Non Ionic, Adverse Reactions to contrast media and patient management.	8	10
2.	Introduction to interventional procedures **DSA:** principles and types **Equipment:** Basics of angiographic equipments, single and biplane angiographic equipments, angiographic table, image intensifier, flat panel detectors, recording systems, pulseoximetry, cardiac resuscitation measure-ECG, pressure injector, catheters, needle and other tools, 3D rotational angiography, image processing, patient monitor, CO2 angiography	8	10
3.	**Interventional procedures:** Catheter- classification, types and applications, Guide wire- classification, types andapplications, Pressure Injector and Accessories,Percutaneous catheterization, Digital Subtraction Angiography, Catheterization Sites, Asepsis	8	10
4.	**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	20	20
5.	**Safety considerations in angiography room**; room design, protective devices, radiation monitoring	5	10
6.	**Care and maintenance tests:** General care, functional test **Quality assurance program:** Acceptable limits of variation, corrective action	5	10
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
5.	Contrast Media	10
6.	Basics of angiographic equipments	10
7.	Catheter and guide wires	10
8.	Arteriography and venography procedures	20
9.	Safety considerations in angiography room	12
10.	Care and maintenance tests Quality assurance program:	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	The practice of interventional radiology	Karim valji	
2	Interventional radiology: a survival guide	EBIR Kessel, David, MB, BS, MA, MRCP, FRCR (Author), FRCR Robertson, Iain, MB, ChB, MRCP	Elsevier Health Sciences
3	Handbook of Interventional Radiologic Procedures	Krishna kandarpa (author), lindsay machan (author), janettedurham (author)	Lippincott Williams and Wilkins
4	Interventional Radiology: A Survival Guide	David Kessel MB BS MA MRCP FRCR EBIR, Iain Robertson MB chb MRCP FRCR	sevier Health Sciences

Subject: Modern Imaging and Special Radiological Procedures

Subject Code: MMRIT06

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

At the end of the course students will be able to...

CO1: Prepare management and positioning of patients while performing radiological procedures.

CO2: Correlate of indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for different radiological procedures.

CO3: Understand the patient preparations needed before any radiological examination.

CO4: Generalize knowledge of post procedural care.

CO5: Students will be able position the patients for radiological procedures.

CO6: Knowledge of image quality in radiological images.

CO7: Management of patients in radiology department for various procedures.

CO8: Ability to handle emergency situations in radiology department.

CO9: Precautions and care required in interventional suits.

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
1.	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.	**6**	**5**
2.	Basics and modern Emergency Equipment's in the Radiology Department	**4**	**5**
3.	Gastrointestinal Tract: Barium Swallow; Barium Meal - Single and Double Contrast; Barium Meal Follow Through; Small Bowel Enema (Enteroclysis); Barium Enema - Gastrograffin Enema; Loopogram Advanced procedures of Gastrointestinal Tract	**10**	**15**
4.	Biliary Tract: Oral & Intravenous Cholecystography; Percutaneous Transhepatic Cholengiography; Percutaneous Transhepatic Biliary Drainage; Endoscopic Retrograde Cholengiopancreatography Advanced procedures ofBiliary Tract	**10**	**15**
5.	Urinary System: IVU (Intravenous Urography), Retrograde Pyeloureterography (RGU), Micturating Cysto Urethrography, Ascending Urethrography. Advanced procedures of Urinary System	**10**	**15**
6.	Reproductive System: HysteroSalpingogram, FTR (Fallopian Tube Recanalization) Advanced procedures of Reproductive System	**5**	**5**
7.	Respiratory System: Bronchography, Percutaneous Lung Biopsy Advanced procedures of Respiratory System	**5**	**5**
8.	Other procedures in radiology: Arthrography, Sialography, Lymphography, Sinography & Fistulography, Dacryocystography, Embolization & embolic agents Related Advanced procedures.	**4**	**5**
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
5.	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	10
6.	Procedures for gastrointestinal tract including barium studies Procedures for biliary tract	15
7.	Procedures for urinary system and reproductive system	15
8.	Procedures for central nervous system and respiratory system	15
9.	Other procedures in radiology: Arthrography, Sialography, Lymphography, Sinography & Fistulography, Dacryocystography, Embolization & embolic agents Related Advanced procedures.	17
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	Radiographic Imaging (Cbs)I.C.R.P.	Bhushan and Lakkhar	Arya Publications
2	A guide to radiological procedures	Chapman	Elsevier

MMRIT Radiological Clinical Education- part II (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Elective – Specialization of CT Imaging Technology

Third Semester

Subject: Principles of CT Imaging Technology

Subject code: MMRIT07

Rationale: It aims to provide knowledge related to the basic working principle and construction of CT scanners and the various hardware and software mechanisms required for obtaining the cross-sectional imaging. It also gives a brief review of the history and evolution of the CT scanners.

Course Outcome

At the end of the semester student must be able to:

CO1: Should gain a comprehensive understanding of the principles behind CT imaging, including the physics and technology involved in generating cross-sectional images.

CO2: Will learn the practical aspects of CT scanning such as patient positioning, selection of appropriate protocols and the use of contrast agents.

CO3: Students should be able to explain the process of image reconstruction in CT and understand how raw data is transformed into meaningful images.

CO4: Will learn to assess CT image quality and identify common imaging artefacts, as well as strategies to minimize or correct these artefacts.

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 content	Hours	Marks
1	**Introduction to CT:** Basic principle of tomography,definition of terms, Image reconstruction from projections. AI in CT	7	10
2	Evolution of terms	3	3
3	**Process**: data acquisition and image reconstruction Image display, Processing, storage, Recording and communications	6	10
4	**Working of CT** Basic principle of CT Instrumentation Reconstruction algorithms AI in CT	10	15
5	**History of CT:** Early experiments by Godfrey Newbold Hounsfield, Allan Macleod Cormack	3	2
6	**Generations of CT** Generation of CT /Geometry	7	10
7	**Fast scanner** Helical/ Spiral scanner Applications of volume scanning AI in CT	7	7
8	**Image formation in CT** Hounsfield unit, CT windowing, CT image quality CT artifacts. Quality assurance and control in CT AI in CT	9	10
9	Merits and demerits of Computed tomography	2	3
	Total	54	70

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Introduction and History CT and Evolution of terms	6
2.	Process and Working in CT	19
3.	Generations and Image formation in CT	25
4.	Fast scanner Merits and demerits of Computed tomography	20
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	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

Subject: CT Imaging Procedures and Scanning Protocols

Subject code: MMRIT08

Rationale

CT Procedures and Scanning Protocol course is to provide participants with a comprehensive understanding of the various procedures involved in computed tomography (CT) imaging and the principles of selecting appropriate scanning protocols for different clinical scenarios.

Outcome

At the end of the semester student must be able to:

CO1:CT procedures and scanning protocols result in high-quality images that allow radiologists and healthcare professionals to make accurate and precise diagnoses. Clear and detailed CT images aid in identifying and characterizing various medical conditions, such as tumors, fractures, infections, and other abnormalities.

CO2: Will be able to acquire Accurate CT imaging helps healthcare providers create effective treatment plans for patients. The information obtained from CT scans can guide surgical procedures, radiation therapy, and other interventions, leading to improved patient outcomes.

CO3: Must follow appropriate scanning protocols and employ dose reduction techniques to minimize the amount of radiation the patient receives during the scan. This ensures that the benefits of the CT scan outweigh any potential risks associated with radiation exposure.

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.

S. No	Topic	Hours	Marks
1	**CT Head and Neck:** CT Brain, Cerebral Angiography, CT orbit, CT face with 3D post-processing, CT temporal bone, CT PNS, CT neck, neck angiography, Head and neck venography, CT cisternography	**10**	**10**
2	**CT Thorax:** CT thorax (Supine, prone, Expiratory), HRCT thorax, CT pulmonary angiography, CT aortography.	**8**	**8**
3	**CT Abdomen and Pelvis:** CT KUB, CT abdomen (Dual and triple phase), Liver, pancreas and renal protocol, CT enterography, CT pelvis, CT abdominal angiography, CT renal angiography, CT urography, CT cystogram	**12**	**15**
4	**CT Musculoskeletal System:** CT shoulder, elbow, wrist, hand, hip, femur, knee, tibia & fibula, ankle, foot. CT peripheral angiography/Venography.	**8**	**10**
5	**CT Spine:** CT whole spine, CT cervical, thoracic, lumbar and LS spine, CT sacrum & coccyx, CT Myelography. Lumbar Puncture, CSF Aspiration.	**9**	**15**
6	**Miscallaneous:** Paediatric CT, Adult Whole-body CT, CT fluoroscopy, Breast CT Imaging	**7**	**12**
	Total	**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	CT Head and Neck	10
2.	CT Thorax	10
3.	CT Abdomen and Pelvis	10
4.	CT Musculoskeletal System	10
5.	CT Musculoskeletal System	10
6.	CT Spine	10

Sr. No		Hours
7.	Miscallaneous	12
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	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

Subject: Basic and Cross Sectional Anatomy in CT Imaging

Subject code: MMRIT09

Rationale

CT Cross Sectional Anatomy course typically aims to provide participants with a comprehensive understanding of the anatomical structures as visualized in computed tomography (CT) images. The course focuses on developing the necessary knowledge and skills to accurately interpret CT cross-sectional images of the human body.

At the end of semester student must be able to:

CO1: Participants should be able to identify and label major anatomical structures in CT cross-sectional images, including organs, bones, blood vessels, nerves, and other relevant tissues.

CO2: Will learn to interpret CT images in different planes (transverse, sagittal, and coronal) to gain a complete understanding of the spatial relationships and dimensions of anatomical structures.

CO3: Will become proficient in recognizing normal anatomy across various body regions, enabling them to distinguish variations from pathology.

CO4: Will develop the ability to identify and describe common pathological conditions and abnormalities seen in CT cross-sectional images, such as tumors, inflammation, fractures, and vascular anomalies.

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**	
--	**--**	**6**	**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.

PRACTICAL COMPONENTS

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

Unit	Topic and content	Hours	Marks
1	Cross Sectional Anatomy of: Head Vascular supply of brain Venous supply of brain Cranial nerves	20	**14**
2	Neck cross sectional anatomy Vascular supply of neck Venous supply of neck	**14**	**8**
3	Thorax cross sectional anatomy Vascular supply of thorax Venous supply of thorax	**18**	**12**
4	Abdomen cross sectional anatomy Vascular supply of adomen Venous supply of abdomen	**20**	**12**
5	Pelvis cross sectional anatomy (male and female) Vascular supply of pelvis Venous supply of pelvis	**16**	**6**
6	Vertebral body and extremities	**8**	**5**
7	Muscles, ligaments and tendons	**6**	**5**
8	Upper and lower limb blood supply	**6**	**8**
	Total	**108**	**70**

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical 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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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 and MRI	Govind Chavhan, Bhavin Jankharia	Jaypee Brothers Medical Pub.
2	Cross-Sectional Anatomy for Computed Tomography	Michael L. Farkas	Springer New York
3.	Sectional Anatomy by MRI and CT	Mark W. Anderson, Michael G Fox	Elsevier Health Sciences
4.	Atlas of Human Cross-Sectional Anatomy With CT and MR Images	Donald R. Cahill, Matthew J. Orland, Gary M. Miller	Wiley

MMRIT Radiological Clinical Education- part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Fourth Semester

Subject: Advancements in CT Technology

Subject code: MMRIT10

Rationale

Advances Techniques in Computed Tomography Technology aims to provide participants with specialized knowledge and skills related to the latest advancements and cutting-edge techniques in the field of Computed Tomography (CT) imaging.

Outcome

At the end of the semester student must be able to:

CO1: Will gain a comprehensive understanding of the latest advancements and cutting-edge techniques in CT imaging. This knowledge may include advanced imaging protocols, reconstruction methods and clinical applications.

CO2: Will give a deeper understanding of advanced CT techniques, participants can potentially improve diagnostic accuracy, leading to better patient outcomes and more effective treatment planning.

CO3: Involved in research and development, the course may inspire new ideas and insights that contribute to the ongoing advancement of CT technology and medical imaging.

CO4: Completion of this advanced course may provide continuing education credits or professional development recognition for individuals in the medical field.

CO5: Acquiring knowledge and skills in advanced CT techniques could lead to expanded career opportunities or increased responsibilities within their respective workplaces.

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 content	Hours	Marks
1	**Advanced CT Imaging Techniques:** Dual-Energy CT Dynamic CT, and iterative reconstruction algorithms. Role of these techniques enhance image quality and improve diagnostic accuracy	4	3
2	**CT Angiography (CTA**): principles and applications of CT angiography, including vascular imaging, cardiac CTA, CTPA and peripheral CTA. Role of CTA in diagnosing vascular diseases and assessing blood flow.	8	10
3	**CT Perfusion Imaging:** CT perfusion imaging and its use in assessing tissue perfusion, blood flow, and detecting cerebral or abdominal ischemia.	4	5
4	**Dual-Source CT and Multidetector CT (MDCT):** benefits of dual-source and MDCT scanners, such as reduced scan times, improved spatial resolution, and decreased radiation dose	4	5
5	**Cardiac CT Imaging**: cardiac CT imaging, including coronary artery assessment, cardiac function evaluation, and the role of CT in cardiac disease diagnosis, Calcium Scoring.	4	10
6	**Radiation Dose Optimization**: advanced techniques for optimizing CT scanning protocols to reduce radiation dose while maintaining image quality	2	3
7	**Advanced Post-processing Techniques**: advanced image post-processing techniques, such as 3D volume rendering, maximum intensity projection (MIP), and multiplanar reconstruction (MPR)	3	5
8	**CT-guided Interventions**: CT-guided procedures and interventions, including biopsy, drainage and ablation techniques	4	5
9	**Virtual CT**: Colonoscopy: the techniques used in virtual CT colonoscopy, a non-invasive method for imaging the colon and detecting polyps and other abnormalities Bronchoscopy: technique, post processing and applications.	4	5
10	**Advanced Image Reconstruction**: advanced image reconstruction techniques such as iterative reconstruction algorithms which improve image quality while reducing radiation dose.	3	5
11	**Artifact Reduction Strategies**: techniques to minimize and correct artifacts that can arise in advanced CT imaging, ensuring accurate diagnosis and interpretation	4	5
12	**Radiation Dose Management**: strategies for optimizing CT protocols to reduce radiation dose while maintaining diagnostic image quality.	2	2
13	**Contrast Media Innovations**: new contrast media agents and protocols used in CT imaging to enhance image contrast and visualization of specific tissues or pathologies, automatic contrast tracking techniques.	2	2
14	**Quality Assurance and Image Quality Assessment**: quality assurance protocols specific to advanced CT technology and the assessment of image quality.	4	3

15	**Emerging Trends in CT**: latest developments and emerging trends in CT technology, including artificial intelligence applications and new imaging advancements.	**2**	**2**
	Total	**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Dual-Source CT and Multidetector CT (MDCT Advanced CT Imaging Techniques	8
2.	Radiation Dose Management Radiation Dose Optimization	6
3.	Contrast Media Innovations	4
4.	Advanced Post-processing Techniques Advanced Image Reconstruction	8
5.	Quality Assurance and Image Quality Assessment	4
6.	Emerging Trends in CT	4
7.	Artifact Reduction Strategies	8
8.	Virtual CT CT-guided Interventions	10
9.	CT Angiography (CTA) Cardiac CT Imaging	14
10.	CT Perfusion Imaging	6
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	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

Subject: Quality Assurance, Radiation Protection and Patient care in CT Imaging

Subject code: MMRIT11

Rationale

Radiation Protection and Patient Care in CT course aims to provide participants with essential knowledge and skills related to ensuring patient safety and implementing radiation protection measures during computed tomography (CT) examinations.

Course Outcome

At the end of semester student must be able to:

CO1: Should gain a comprehensive understanding of the principles of ionizing radiation, its interaction with human tissues, and the potential risks associated with radiation exposure.

CO2: Will be familiarized with the ALARA (As Low As Reasonably Achievable) principle and learn techniques to minimize radiation dose to patients while maintaining image quality.

CO3: Should learn strategies for optimizing CT scanning protocols and adjusting parameters to achieve appropriate image quality with the lowest possible radiation dose.

CO4: Radiation Protection Guidelines: Participants will be introduced to national and international radiation protection guidelines specific to CT imaging.

CO5: Will learn proper patient positioning and centering techniques to ensure accurate imaging and reduce the need for repeat scans.

CO6: Should be aware of the unique considerations and radiation protection protocols when imaging paediatric and pregnant patients.

CO7: Will understand the use of contrast agents in CT imaging, their potential risks, and the importance of proper patient screening for allergies and contraindications.

CO8: Should understand the importance of infection control practices in the CT environment, including equipment cleaning and proper hygiene measures.

CO9: Will become aware of ethical and legal responsibilities in providing radiation protection and patient care in CT imaging.

CO10: Will be educated on safety measures and protocols to protect healthcare professionals and staff working in the CT department.

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 content	Hours	Marks
1	**Introduction of Radiation Protection**: Principles of radiation protection, ALARA/ALARP, MPD, The Role of the CT Technologist, Radiation in Pregnancy and children.	10	15
2	**Radiation quantities and units:** Factors Affecting Dose in CT, CT Dosimetry – MSAD, Bed Index, CTDIw, CTDIvol, DLP.	6	10
3	**Biological units of radiation**: Radiation detection and measurements, LET, OER, survey meters, Geiger muller counter, ionisation chambers.	6	10
4	**Radiation Hazard evaluation and control**: Scatter and Leakage radiation, ICRP guidelines for CT room design, Radiation Signage, Protective devices.	10	10
5	**AERB and ICRP guidelines:** Limits for radiation exposure	4	5
6	**Contrast media in CT**: ionic and non-ionic agents, lethal dose, contrast administration techniques, contrast tracking techniques.	4	5
7	**Radiation protection**: Radiation protection for patient and staff, personnel protective apparel. AI in radiation safety.	6	5
8	**Pre and post-procedural care in CT**: Patient transfer and Restraining techniques, Infection control and sterilization, Medical ethics and records, Patient care in special cases: Spinal injuries, Trauma, Stroke, Burns, Cardiac emergency.	8	10
	Total	**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Introduction of Radiation Protection AERB and ICRP guidelines	20
2.	Radiation quantities and units Biological units of radiation	20
3.	Pre and post-procedural care in CT	5
4.	Radiation protection	10
5.	Radiation Hazard evaluation and control	12
6.	Contrast media in CT	5
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	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

Subject: Basic Pathology and Image Interpretation in CT Imaging

Subject code: MMRIT13

Rationale

Imaging pathology and image interpretation in computed tomography (CT) is to facilitate accurate and early detection, characterization, and evaluation of various medical conditions and abnormalities within the body. CT imaging is a non-invasive, widely available, and valuable medical imaging modality that provides detailed cross-sectional images of the internal structures of the body.

Outcome

At the end of the semester the student must be:

CO1: To Identify diseases and abnormalities at an early stage often leads to better patient outcomes.

CO2: Learn the extent and location of pathologies, aiding in precise diagnosis and treatment planning.

CO3: Will learn CT guide certain medical procedures such as biopsies, drainages, and needle aspirations.

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**	
--	**--**	**6**	**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.

PRACTICAL COMPONENTS

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

Unit	Topic and content	Hours	Marks
1.	Basic pathologies and general interpretations of Head, Face&Neck	15	10
2.	Basic pathologies and general interpretations of Vascular imaging	5	5
3.	Basic pathologies and general interpretations of Spine	15	10
4.	Basic pathologies and general interpretations of Brachial plexus,Chest, Heart and great vessels	10	5
5.	Basic pathologies and general interpretations of Breast	5	5
6.	Basic pathologies and general interpretations of Kidney, Pancreas, Liver and biliary system	13	5

7.	Basic pathologies and general interpretations of Abdomen and Pelvis	10	5
8.	Basic pathologies and general interpretations of Upper limb	10	5
9.	Basic pathologies and general interpretations of Lower Limb	10	5
10.	Basic pathologies and general interpretations of Peripheral vascular system	5	5
11.	Basic pathologies and general interpretations of Pediatric imaging	10	10
	Total	**108**	**70**

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical 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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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	CT & MRI Pathology: A Pocket Atlas, Third Edition	Michael L. Grey, Jagan Mohan Ailinani	Snippet view
2	Normal Findings in CT and MRI	Torsten Bert Moeller, Emil Reif	
3.	Neurological Practice: An Indian Perspective	Wadia	

MMRIT Radiological Clinical Education- part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Elective – Specialization of MR Imaging Technology Third Semester

Subject: Principles of MR Imaging Technology

Subject Code: MMRIT14

RATIONALE

The basic working principles of Magnetic resonance imaging along with the construction and equipments necessary for the image formation, processing, encoding, storage and display. To comprehend the image quality parameters, identify artifacts and assure image quality with the aid of quality assurance tests and tolerance limits.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the basic physical concepts involved in MRI

CO2: Understand the various imaging parameters that determine image contrast.

CO3: Describe the various image weighting techniques and its application

CO4: To comprehend principles of gradients and spatial encoding.

CO5: Concept of K- space and its traversal involved in MR image formation.

CO6: Knowledge of image quality in MRI images.

CO7: Apply MR imaging parameters in the clinical setting and its trade-off to optimize image quality.

CO8: Ability to minimize image artifacts and understand various Quality assurance tests.

CO9: Precautions and care required during MR Imaging

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 assignmentsminimum 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
1.	**Introduction and Basic principles**: Atomic structure and motion, MR active nuclei, Hydrogen MRI, spin precession, Larmor equation, Resonance, Relaxation, T1 and T2 Times.	**8**	**10**
2.	**Image contrast and weighting**: Intrinsic and extrinsic parameters of MR Image contrast, T1, T2 and PD weighting and its applications, T2* decay, FID.	**6**	**8**
3.	**Spatial Encoding and K-Space**: Gradients, Slice selection, frequency and phase encoding, K space basic concept, its filling and traversal, Fast Fourier transform.	**4**	**6**
4.	**MRI Pulse sequences:** Spin echo sequences, Inversions recovery sequences, Gradient eco sequences, echo planar imaging, Parallel imaging.	**10**	**10**
5.	**MR Instrumentation and Safety**: Magnets- types and application, Radio waves, Coils- types and functions, Shielding, Shimming, MR scanner Construction and components, MRI safety considerations, Signage, MR Compatible/conditional/non-compatible devices. AI in MRI.	**10**	**10**
6.	**Image Parameters and quality**: SNR, CNR, Scan time, Spatial Resolution. Trade-offs between parameters.	**4**	**8**
7.	**MRI Contrast Agents**: Mechanism of action, T1 and T2 Agents, classification and applications of contrast agents, doses in adults and pediatrics, Safety considerations in pregnancy and lactation.	**6**	**8**
8.	**MRI artifacts**: Causes, appearance, remedy. Quality assurance tests and tolerance limits.	**6**	**10**
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Image contrast and distinction between differently weighted images.	10
2.	Manipulating TR and TE for T1, T2 and PD weighted images.	10
3.	Identifying and manipulating various image parameters to maintain image quality	10
4.	Identifying the various types of coils and their uses. Distinction between SE and GRE sequences.	12
5.	Understanding MRI safety principles and patient screening.	10
6.	Contrast agents and its uses, dosage and administration process, time-intensity curves.	10
7.	MRI artifacts	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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	Fundamentals of MRI	Stark &Bradely	
2	MRI in practice, 4th edition	Catherine Westbrook, Carolyn Kaut Roth, and John Talbot	Wiley-Blackwell
3.	Magnetic Resonance Imaging, Physical and Biological Principles 4th edition.	Stewart Bushong and Geoffrey Clarke	

Subject: MR Imaging Procedures and Scanning Protocols

Subject Code: MMRIT15

RATIONALE

To comprehend the indications, contraindications, patient preparation, positioning, coils used and other specific considerations while performing the different MRI scan Protocols. Basic understanding of Parameter manipulation and post procedural care.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the indications and contraindications for various protocols

CO2: Understand the various patient preparation aspects, including history taking and screening.

CO3: Describe the parameters and sequences used to acquire necessary images.

CO4: To comprehend principles of image quality for each type of protocol and the trade-off.

CO5: Types of coils used, positioning and landmark for each anatomical examination.

CO6: Knowledge of Post procedural care.

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 assignmentsminimum 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
1.	**MRI Brain:** Routine, stroke, epilepsy, MS, tumour protocols, MR Angiography (COW), MR Venography, CSF Flow analysis.	**10**	**14**

2.	**MRI Face:** Orbit, Cochlea, OSA, Pituitary, Neck, Brachial Plexus, Sialography, Dacrocystography	**7**	**10**
3.	**MRI Upper limb protocols:** Shoulder, elbow, wrist, hand. MR Upper limb angiography/venography. Shoulder Arthrography.	**9**	**10**
4.	**MRI Lower limb Protocols:** Pelvis- bony, male and female, hip joint, knee, ankle, foot. MR Cartigram. Lower Limb Angiography/Venography.	**9**	**10**
5.	**MRI Spine:** Cervical, Thoracic, Lumbo-sacral, Flexion-Extension, Whole spine screening.Composing. MR Cisternography, Myelography.	**9**	**12**
6.	**MRI Thorax-Abdomen:** Cardiac MR, routine Abdomen, MRCP, Fetal MRI, Fistulography, MR Prostate, MR Placenta, MR Urography, Enteroclysis. Respiratory and ECG Gating techniques	**5**	**7**
7.	**All special MRI procedures** including MRCP, perfusion scan, ASL, FMRI, Cardiac MRI etc. Pediatric scan: Kitten MRI	**5**	**7**
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	MRI Brain and special sequences acquired in different pathologic conditions.	10
2.	MRI Face and neck region, angiographies and various post-processing techniques involved.	10
3.	Upper and Lower limb MRI protocols for various anatomical structures.	10
4.	Fistulography, Sialography, Dacrocyctography, MRCP and the various contrasts, techniques and parameters of acquisition.	12
5.	Understanding MRI safety principles and patient screening prior to patient position in the clinical setting.	10
6.	Contrast agents and its uses, dosage and administration process, time-intensity curves.	10
7.	MR in Pregnancy	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	Musculoskeletal MRI E-Book	Major, Nancy M., Anderson, Mark W	
2.	MRI in practice, 4th edition	Catherine Westbrook, Carolyn Kaut Roth, and John Talbot	Wiley-Blackwell
3.	Magnetic Resonance Imaging, Physical and Biological Principles 4th edition.	Stewart Bushong and Geoffrey Clarke	

Subject: Basic and Cross-Sectional Anatomy in MR Imaging

Subject Code: MMRIT16

RATIONALE

To identify and understand the various anatomical structures, so that positioning and planning of protocols is performed proficiently. To also comprehend various pathological conditions and interpret images efficiently.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the cross –sectional anatomical structures with ease

CO2: Understand the various post processing techniques to optimize anatomical visualization. .

CO3: Identify the various blood vessels or nerves and its anatomical correlation.

CO4: To comprehend principles of image quality for each type of protocol based on anatomical structure

CO5: Types of coils used, positioning and landmark for each anatomical examination.

CO6: Knowledge of various pathological conditions and the special sequences used to optimize its visualization.

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**	
--	**-**	**6**	**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 assignmentsminimum one per unit based on the curriculum.

PRACTICAL COMPONENTS

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

Unit	Topic and contents	Hours	Marks
1.	**Basic Anatomy:** Anatomical Terminologies, Sectional planes, movements, Joints, surface anatomy.	12	6
2.	**Brain**: Cross-sectional Anatomy, lobes, ventricles, Brainstem, blood supply, venous sinuses, cranial nerves. Paranasal sinuses, orbits, pituitary gland.	16	10
3.	**Neck:** Major vessels – carotids, aorta, pulmonary vessels, Brachial plexus, Thyroid, cartilages, salivary glands and duct system, muscles of the back.	14	8
4.	**Upper limb:** Shoulder- rotator cuff, elbow, wrist, hand, metacarpals, carpals,phalangs, related muscles and tendons. Arterial supply and venous drainage.	14	8
5.	**Lower limb:** Pelvis- bony, male and female, hip joint, knee, ankle, foot, metatarsals, tarsals, ligaments, tendons, muscles,popliteal fossa, arterial supply and venous drainage.	14	10
6.	**Spine:** Cervical, Thoracic, Lumbar, sacrum, coccyx, ribcage, muscles attached. Spinal cord, meninges, nerve roots, vertebral disc.	12	10
7.	**Thorax:** Lungs, Heart, Mediastinum, Respiratory volumes, Esophagus, Trachea, Bronchial tree, Bronchopulmonary segments, Diaphragm.	12	8
8.	**Abdomen:** Stomach, Small and Large Intestines, Liver, pancreas, Biliary tree, Spleen, Kidneys and renal vasculature, excretory system, reproductive system (male and female), Aorta and its branches.	14	10
Total		108	70

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical tests Same pattern as Summative test	50		
	Average of two to be considered Absence without prior permission to be marked as 0			
	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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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 and MRI	Govind Chavhan, Bhavin Jankharia	Jaypee Brothers Medical Pub.
2	Cross-Sectional Anatomy for Computed Tomography	Michael L. Farkas	Springer New York
3.	Sectional Anatomy by MRI and CT	Mark W. Anderson, Michael G Fox	Elsevier Health Sciences
4.	Atlas of Human Cross-Sectional AnatomyWith CT and MR Images	Donald R. Cahill, Matthew J. Orland, Gary M. Miller	Wiley

MMRIT Radiological Clinical Education- part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Fourth Semester

Subject: Advancements in MR Imaging Technology

Subject Code: MMRIT17

RATIONALE

To Stay abreast of the advancements and special procedures performed Using MRI in various conditions. The innovation in Hardware, software and post-processing techniques available for advanced image acquisition and diagnosis.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic principles of advanced techniques of MRI

CO2: To constantly stay abreast of the latest advancements and innovations in the field of MRI

CO3: Identify the various Diffusion related processes and its applications.

CO4: To comprehend principles of magnetic susceptibility and its uses.

CO5: Advancement in the hardware, software and post-processing techniques.

CO6: Knowledge of various pathological conditions and the special sequences or protocols/procedures performed to optimize its visualization.

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 assignmentsminimum 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
1.	**Flow Phenomenon:** Types of flow, mechanisms, Compensation, CSF Flow Analysis.	10	10
2.	**MRA:** Conventional Vascular imaging techniques, DSA, TOF-MRA, Phase Contrast MRA, Velocity encoding MRA	10	10
3.	**Diffusion and its advancements:** DWI, Diffusion Tensor Imaging, White matter Tractography. Physics, protocol and its applications.	4	10
4.	**MR Spectroscopy:** Metabolites, hunters angle, CHESS, STEAM, PRESS, MRS in Breast and Prostrate. Related pathologies and protocol.	10	10
5.	**fMRI:** Paradigms, Hemodynamic response function,Perfusion Imaging - DSC, DCE, ASL and its types. Protocols, Principles and applications.	6	10
6.	**Iron and Fat quantification:** Fat suppression techniques, Elastography, Quantification techniques, parameters and applications.	6	10
7.	**Miscallaneous advancements**: Sodium MRI, Portable MRI Systems, Ultra-high Magnetic field systems, MR Mammography, Synthetic MRI, Interventional MRI techniques.	6	10
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Flow Phenomenon and MRA	20
2.	Diffusion and its advancements	12
3.	MR Spectroscopy and fMRI	20
4.	Iron and Fat quantification	10
5.	Miscallaneous advancements	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	Tomography and Magnetic Resonance Imaging of the Whole Body (Vol.1&II) (Saunders)	John R. Haaga (Author), Daniel Boll (Author)	Elsevier
2.	MRI inPractice	Catherine Westbrook &CaralynKaut	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

Subject: Planning, Safety and Patient care in MR Imaging

Subject Code: MMRIT18

RATIONALE

Students comprehend the effects of MRI on the human body, learn the safety aspects to prevent accidents and maintain high image quality while ensuring patient compliance and pleasant patient experience

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic safety measures to be taken while performing MRI

CO2: To Ensure optimum patient care

CO3: Identify the various MRI compatible/conditional and non compatible devices and warn patients accordingly.

CO4: To comprehend the various hazards involved in MRI and to know how to prevent Accidents.

CO5: To learn the various MRI facility zones and other MRI Safety considerations.

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 assignmentsminimum 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
1.	**Bioeffects of MRI:** Bio-effects of static and gradient magnetic fields, Acoustic noise, Bio-effects of radiofrequency power deposition and induced heating during MRI, SAR, Claustrophobia, anxiety and emotional distress in the MR	14	16

2.	**MRI facility design:** Site selection, MRI safety zones, Scanner room layout. Shielding techniques, Faraday Cage.	10	14
3.	**Implants:** Materials used as implants and prosthesis,cardiac devices, Patient monitoring in the MRI environment, Managing Acute situations, Screening, History, Metal Detection.	10	14
4.	**MRI Contrast Safety:** Identification and management of acute reactions related to gadolinium based contrast agents, Contrast safety in pregnancy and lactation, nephrogenic systemic fibrosis, Extravasation.	10	16
5.	**Miscallaneous Safety aspects:** Quenching, Ambient temperature, cryogen levels,Safety issues for interventional MR Systems, MRI safety guidelines, policies and procedures.	10	10
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Bioeffects of MRI	14
2.	MRI facility design	12
3.	MRI Contrast Safety	12
4.	Miscallaneous Safety aspects	16
5.	Implants	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	Tomography and Magnetic Resonance Imaging of the Whole Body (Vol.1&II) (Saunders)	John R. Haaga (Author), Daniel Boll (Author)	Elsevier
2.	MRI inPractice	Catherine Westbrook &CaralynKaut	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

Subject: Basics Pathology and Image Interpretation in MR Imaging

Subject Code: MMRIT19

RATIONALE

Students comprehend the effects of MRI on the human body, learn the safety aspects to prevent accidents and maintain high image quality while ensuring patient compliance and pleasant patient experience

COURSE OUTCOMES

At the end of the course students will be able to...

- To Identify diseases and abnormalities at an early stage often leads to better patient outcomes.
- Learn the extent and location of pathologies, aiding in precise diagnosis and treatment planning.
- Will learn MR guide certain medical procedures such as biopsies, drainages, and needle aspirations.

Image-guided procedures improve accuracy, minimize risks, and reduce the need for exploratory surgeries.

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**	
--	--	6	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 assignmentsminimum one per unit based on the curriculum.

PRACTICAL COMPONENTS

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

Unit	Topic and content	Hours	Marks
1.	Basic pathologies and general interpretations of Head, Face&Neck	15	10
2.	Basic pathologies and general interpretations of Vascular imaging	5	5
3.	Basic pathologies and general interpretations of Spine	15	10
4.	Basic pathologies and general interpretations of Brachial plexus, Chest, Heart and great vessels	10	5
5.	Basic pathologies and general interpretations of Breast	5	5
6.	Basic pathologies and general interpretations of Kidney, Pancreas, Liver and biliary system	13	5
7.	Basic pathologies and general interpretations of Abdomen and Pelvis	10	5
8.	Basic pathologies and general interpretations of Upper limb	10	5
9.	Basic pathologies and general interpretations of Lower Limb	10	5

10.	Basic pathologies and general interpretations of Peripheral vascular system	5	5
11.	Basic pathologies and general interpretations of Pediatric imaging	10	10
	Total	**108**	**70**

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical 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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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	CT & MRI Pathology: A Pocket Atlas, Third Edition	Michael L. Grey, Jagan Mohan Ailinani	Snippet view
2	Normal Findings in CT and MRI	Torsten Bert Moeller, Emil Reif	
3.	Neurological Practice: An Indian Perspective	Wadia	

MMRIT Radiological Clinical Education- part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Elective-specialization of Breast Imaging Technology

Third Semester

Subject: Principle of Breast Imaging Technology

Subject Code: MMRIT21

RATIONALE

Mammography is a specialized imaging technique that uses low-dose X-rays to visualize and assess breast tissue.The role of imaging technologist specializing in mammography is crucial in the early detection and diagnosis of breast abnormalities, including breast cancer.

COURSE OUTCOMES

At the end of the course students will be able to...

C01: Understand the various components of the mammographic equipment, properly operate it and demonstrate thecorrect use of compression devices, filtration devices, the magnification setup, exposure controls etc.

C02: State the specifications and parameters of physical principles related to mammography (eg. half-valuelayer, focal spot size, heel effect, source-to-image distance and the minimum requirements).

C03: Explain the significance of target/filtercombinations.

C04: Differentiate between the various types of x-ray generators used inmammography.

C05: Discuss and define digitalmammography.

C06: Define compression, its usefulness and minimum and maximum requirements.

C07: State the purpose ofmagnification.

C08: Process digital images if available.

C09: Describe a picture archiving and communications system (PACS) and itsfunction.

C010: Define digital imaging and communications in medicine(DICOM).

C011: Discuss the image storage and viewing capabilities related to digitalmammography.

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 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
1.	**Basic Principles:** History, Xero-mammography, Screen film mammography**,** Physics of image formation, Mammography Instrumentation, Mammographic cassettes, X-ray tube, Filters, AEC & Console	6	10
2.	**Conventional Mammography Equipment:** C-arm x-ray tube stand**,** Mammography tube: Rotating vs. stationary anodes**,** Tube design, Anode design and configuration, Biangular targets, Focal spot: Standard sizes, Magnification size, Effective target angle, Filtration, Beam geometry, Heel effect.	8	10
3.	**Beam limiting devices:** Collimation, SID, OID, Generators: Three-phase, High-frequency and Constant potential, Homogenous x-ray beam**,** Ripple factor**,** Tube capacity (Ma output)**,** Automatic exposure control(AEC), Grids, Compression devices, Magnification.	8	10
4.	**Digital mammography:** Detectors, Types of digital mammography systems, Image processing, CAD for mammography**,** technical considerations: Charged coupled device (CCD), Matrix/pixels, FOV, Resolution, SNR, CNR, AEC, Single-and Multiple exposure approach, Tele mammography.	8	10
5.	**Other aspects of digital technology:** Expense**,** Additional equipment**,** Review workstation**,** PACS**,** Laser printer**,** Computer-aided detection (CAD)**,** Connectivity, Compatibility & Computer literacy of technologist**,** Digital imaging and communications in medicine (DICOM), HIS, RIS, EMR andHL7	10	10
6.	**Sonomammography:** Physics of USG, Instrumentation & equipment, Image quality, Breast density and influencing factors	7	10
7.	**Mammographic compression:** Rationale for breast compression, Clinical image assessment for proper breast positioning, exposure, contrast, sharpness, and noise	7	10
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Basic Principles	
2.	Conventional Mammography Equipment	10
3.	Beam limiting devices	10
4.	Digital mammography	10

Sr. No		Hours
5.	Other aspects of digital technology	10
6.	Sonomammography	12
7.	Mammographic compression	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	Basic radiological physics	K. Thayalan	Jaypee Brothers Medical Publishers (P) Limited, 2003
2.	Christinsens physics of diagnosticradiology	Curry and Dowdey	Wolters Kluwer
3.	X-Ray Equipment for Student	D.N. And M.O. Chesney	Blackwell Science Ltd
4.	Digital Mammography	Ulrich Bick, Felix Diekmann	

Subject: Breast Imaging Procedures and Scanning Protocols

Subject Code: MMRIT22

RATIONALE

Breast Imaging Procedures and Scanning Protocols provide the knowledge base in the type and application of interventional procedures involving breast imaging modalities.

COURSE OUTCOMES

At the end of the course students will be able to...

C01 Illustrate the sterile technique.
C02 Describe localization techniques.
C03 Describe biopsy techniques.
C04 Delineate galactography.
C05 Describe specimen imaging guidelines.
C06 Describe specimen handling and record keeping for pathologic analysis.
C07 Describe continuous patient care from pre-biopsy topostbiopsy.
C08 Define patient transport requirements pre and post biopsy.

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	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 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
1.	**Sterile Techniques:** Spread of infection: Exogenous, Endogenous, Iatrogenic and Nosocomial**,** Preparation of local anesthetics, contrast media, Patient allergies and alternative options. Proper glove use, hand washing technique, Skin preparation Sterile tray preparation, Disposal of items.	8	10

2.	**Localization Modalities** Mammography localization: Stereotactic biopsy : Definition, Application & Technique Wire localization: Definition, Application &Technique Ultrasound Guidance: Definition, Application &Technique MR localization: Definition, Application, Technique.	**8**	**10**
3.	**Interventional Procedures:** Cyst aspirations, Fine-needle aspiration or biopsies, Core biopsy,Vacuum-assisted breast biopsy, Galactography, Specimen Imaging: Imaging Guidelines- Core Specimen and Surgical specimens.	**6**	**10**
4.	**Patient Positioning:** Foot Placement, Arm placement, Degree of obliquity- Size of breast, Lesion location, Patient comfort	**10**	**10**
5.	**Evaluation of Images** :Positioning , Compression, Exposure, Contrast, Sharpness, Noise, Artifacts, Motion, Labeling, Collimation	**6**	**10**
6.	**Patients requiring modification of positioning techniques :**Males, Transgender patients, Kyphotic patients, Large breasts, Small breasts, Encapsulated implants, Pectus excavatum, Pectus carinatum, Protruding abdomens, Pacemaker, Wheelchair, Infuse-port (Port-A-Cath), Physically disabled, Mentally disabled, Frozen shoulder, Barrel chest, Thick axilla, Irradiated breast, Reduction mammoplasty, Postsurgical breast, Loop recorder	**10**	**10**
7.	**Image Quality Problems and remedy**: Nipple not in profile, Skin folds or wrinkling, Difficulty compressing due to patient body habitus, Incorrect or uneven compression, Superimposition of extra anatomy, Drooping of breast, Motion, Artifact.	**6**	**10**
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		**Hours**
1.	Sterile Techniques	10
2.	Localization Modalities	12
3.	Interventional Procedures	14
4.	Patient Positioning and Evaluation of Images	12
5.	Patients requiring modification of positioning techniques	14
6.	Image Quality Problems and remedy	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

SUGGESTED LEARNING RESOURCES

S. No.	**Title of Book**	**Author**	**Publication**
1.	Clarks Positioning In Radiography	Ra Swallow, E Naylor	Lippincott William and Wilkins
2.	Merrill's Atlas of Radiographic Positioning and Procedures	Bruce W. Long & Jeannean Hall Rollins & Barbara J. Smith	Mosby

Subject: Basics and Cross Sectional anatomy of Breast

Subject Code: MMRIT23

RATIONALE

The knowledge of breast anatomy is of paramount importance for Imaging technology students, especially those specializing in mammography or breast imaging. Understanding breast anatomy is crucial for several reasons like proper positioning, differentiating normal and abnormal structure and image interpretation.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Describe breast structure, developmental stages, and the differences between the male and female breast.
CO2: Identify and label external and internal anatomy of the breast.
CO3: Identify and label the breakdown of the single lobe.
CO4: Identify the three arterial branches supplying the breast and the three venous drainage channels.
CO5: Describe the lymphatic system and lymphatic drainage.
CO6: Correlate breast anatomical structures to mammographic anatomical structures.

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**	
-	-	6	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.

PRACTICAL COMPONENTS

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

Unit	Topic and contents	Hours	Marks
1.	**Definition of the Breast:** Male vs female**,** breast developmental stages: Fetal, Puberty, Menstruation, Pregnancy, Lactation, Menopause, Post menopause**,** Breast landmarks: Quadrants, Clock face references.	**20**	**14**

2.	Gross Anatomy of the Normal Breast, Nipple, Areola, Montgomery's glands, Morgagni's tubercles, Skin: Sebaceous glands, Sweat glands, Hair follicles, Axillary tail, Breast margins, Inframammary fold, Axilla, Internal Anatomy: Fascia, Layers, Retromammary(fat)space. Breast parenchymal components, Lobes and ducts, Cooper's ligaments, stroma, Lymphatic drainage, Breast Vasculature, Pectoral muscle.	**40**	**25**
3.	**Histology of the breast:** Terminal ductal lobular unit**,** Extra lobular terminal duct, Intra-lobular terminal duct, Ductal sinus(acinus)**,** Cellular components: Epithelial cells, Myoepithelial cells, Basement membrane	**20**	**16**
4.	**Mammographic Appearance of Breast:** Density variations, BIRADS, Variances, Life cycle changes, lesions and characteristic features, lesion measurement.	**28**	**15**
Total		**108**	**70**

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical 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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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 and MRI	Govind Chavhan, Bhavin Jankharia	Jaypee Brothers Medical Pub.
2.	Cross-Sectional Anatomy for Computed Tomography	Michael L. Farkas	Springer New York
3.	Sectional Anatomy by MRI and CT	Mark W. Anderson, Michael G Fox	Elsevier Health Sciences
4.	Atlas of Human Cross-Sectional Anatomy With CT and MR Images	Donald R. Cahill, Matthew J. Orland, Gary M. Miller	Wiley

MMRIT Radiological Clinical Education- part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Fourth Semester

Subject: Advancements in Breast Imaging Technology

Subject Code: MMRIT24

RATIONALE

Advances in breast imaging techniques have been instrumental in improving the early detection, diagnosis, and management of breast conditions, especially breast cancer. These advanced techniques offer several key benefits and rationale for their adoption

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Describe the uses of computer-aided detection for mammography images.
CO2: Describe the basic theory of digital breast tomosynthesis including appropriate use.
CO3: Identify the value of biomarkers and those specific to breast imaging modalities.
CO4: Discuss dual energy contrast digital mammography and its appropriate use.
CO5: Describe the potential benefits and use of breast elastography.
CO6: Discuss the potential benefits and use of nuclear medicine studies.
CO7: Describe the use of 3-Dsonography.
CO8: Discuss the potential benefits and use of abbreviated breast MRI.
CO9: Discuss the use of computed tomography laser mammography (CTLM) and thermography

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 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
1.	**Computer-Aided Detection** Define, Proper protocol for use, Tool for mammography interpretation	**4**	**6**
2.	**Digital Breast Tomosynthesis (DBT):** Define, physical principle and components of DBT, Personnel training requirements (MQSA), Potential benefits, Types of images: Projection images &Reconstruction images.	**8**	**10**

3.	**Breast Imaging Biomarkers:** Breast Density assessment: Breast arterial calcification scoring, Cancer markers, MRM.	4	6
4.	**Dual Energy Contrast-enhanced Mammography** Define, Theory, Potential benefits	4	8
5.	**Breast Elastography:** Ultrasound Imaging, Basic principle, types, advantages, image interpretation.	4	6
6.	**Nuclear Medicine Studies**: Define, basic principle, Potential benefits, Types: Scintimammography, Lympho-scintigraphy, Positron emission tomography.	10	8
7.	**3-D Ultrasound Imaging**: Concept, mechanism of action, advantages, indications.	8	8
8.	**Abbreviated Breast MRI:** Define, Theory, Potential benefits	6	6
9.	**Non-ionizing techniques:** CTML, Thermal Imaging, Breast Imaging with EIS**,** Breast Photo Imaging	4	6
10.	**Dedicated Breast CT:** Fundamental principle, dose estimation, indications, pros and cons, protective apparel.	2	6
Total		**54**	**70**

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	Computer-Aided Detection	8
2.	Digital Breast Tomosynthesis (DBT)	6
3.	Breast Imaging Biomarkers	8
4.	Non-ionizing techniques	8
5.	Dedicated Breast CT	8
6.	3-D Ultrasound Imaging	8
7.	Dual Energy Contrast-enhanced Mammography Breast Elastography	10
8.	Abbreviated Breast MRI	6
9.	Nuclear Medicine Studies	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**
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

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

Distribution of marks for university examination 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.	Basic radiological physics	K. Thayalan	Jaypee Brothers Medical Publishers (P) Limited, 2003
2.	Christinsens physics of diagnostic radiology	Curry and Dowdey	Wolters Kluwer
3.	X-Ray Equipment for Student	D.N. And M.O. Chesney	Blackwell Science Ltd
	Digital Mammography	Ulrich Bick, Felix Diekmann	

Subject: Quality Assurance, Radiation Protection and Patient care in Breast Imaging
Subject Code: MMRIT25

RATIONALE

Radiation Protection and Patient care provides an overview of the principles of radiation protection, including the responsibilities of the radiographer for patients, personnel and the public. This content provides the concepts of optimal patient care, including consideration for the physical and psychological needs of the patient and family. Routine and emergency patient care procedures are described, as well as infection control procedures using standard precautions. The role of the Imaging Technologist in patient education is identified.

COURSE OUTCOMES

At the end of the course students will be able to...

C01:	Identify and justify the need to minimize unnecessary radiation exposure of humans.
C02:	Explain the objectives of a radiation protection program.
C03:	Define radiation and radioactivity units of measurement.
C04:	Identify effective dose limits (EDL) for occupational and non-occupational radiation exposure.
C05:	Describe the ALARA concept.
C06:	Identify ionizing radiation sources from natural and man-made sources.
C07:	Comply with legal and ethical radiation protection responsibilities of radiation workers.
C08:	Identify appropriate applications and limitations for each radiation detection device.
C09:	Describe how iso-exposure curves are used for radiation protection.
C010:	Identify performance standards for beam-limiting devices.
C011:	Distinguish between controlled and non-controlled areas and list acceptable exposure levels.
C012:	Describe the function of federal, state and local regulations governing radiation protection practices.
C013:	Role of Radiation safety officer
C014:	Describe personnel monitoring devices, including applications, advantages and limitations for each device.
C015:	Compare values for individual effective dose limits for occupational radiation exposures (annual and lifetime).
C016:	Identify effective dose limits for the embryo and fetus in occupationally exposed women.
C017:	Distinguish between primary and secondary radiation barriers.
C018:	Demonstrate how the operation of various x-ray and ancillary equipment influences radiation safety and describe the potential consequences of equipment failure.

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 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
1.	**ALARA Principle:** Optimizing imaging techniques and using the lowest possible radiation dose are essential components of ALARA.	10	12
2.	**Appropriate Indications and contraindications.** **Technique Optimization:** Patient education, consent and preparation, history taking, exposure factors and compression settings based on the patient's breast size and density.	10	14
3.	**Mammographic Procedure:** Collimation and Field Size**,** Compression**,** Receptor Sensitivity (reduction of patient dose), Use of AEC, Patient Comfort.	8	14
4.	**Staff Education and Training:** Radiation safety protocols, Regular continuing education and training about latest techniques and guidelines. **Quality Assurance and Audits:** Implement quality assurance programs to monitor and assess radiation dose levels, image quality, and compliance with radiation safety protocols.	8	16
5.	**Patient Care in Interventional Mammographic procedures:** **Pre-procedural care:** Knowledge of informed consent, Use of 2 patient identifiers, Hard stop process, Vital signs, Explanation of procedure, Proper documentation **During procedure:** Patient awareness**,** Signs of vasovagal reaction and syncope**,** Signs of allergic reactions to anesthesia**,** Anxiety, patient compliance. **Post-procedural care:** Post-procedure imaging for clip placement**,** compression and wound dressing**,** instructions and medications prescribed, Follow-up.	18	14
	Total	54	70

SUGGESTED PRACTICALS/DEMONSTRATION

Sr. No		Hours
1.	ALARA Principle	15
2.	Appropriate Indications and contraindications. Technique Optimization	10
3.	Mammographic Procedure	6
4.	Staff Education and Training Quality Assurance and Audits	20
5.	Patient Care in Interventional Mammographic procedures: Pre-procedural care During procedure Post-procedural care	21
	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
Long Essay	2	15	30
Short Essay	8	5	40
			70
Duration (minutes)			150

End Semester Evaluation (ESE)

There shall be practical examination for 70 marks in the subject.
Distribution of marks for university examination 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.	Ultrasound physics and technology	Vivien gibbs, davidcole, Antonio sassano	Churchill Livingstone;
2.	Manual of Diagnostic Ultrasound	Philip E. S. Palmer (Author)	World Health 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.	Concise Textbook on Hospital Managment& Patient Care In Diagnostic Radiology	N.K.Kardam,, Lalit Agarwal	JBD Publications
6.	Patient care in radiography : with an introduction to medical imaging	Ehrlich, Ruth Ann and joanA.daly	St. Louis, Mo. : Mosby Elsevier

Subject: Basics Pathology and Image Interpretation in Breast Imaging

Subject Code: MMRIT26

RATIONALE

ImagingPathology and image Interpretationprovides the knowledge about the concepts of breast pathology detection and diagnosis. This section presents characteristics of benign and cancerous pathologies and their mammographic appearance.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Discuss the factors and physiologic changes that will affect breast tissue composition.
CO2: Identify physical changes of the breast.
CO4: Correlate clinical breast changes with imaging findings, and comparison with previous mammograms.
CO5: Identify the mammographic appearance of pathologies.
CO6: Describe assessment categories and the recommended clinical follow up.
CO7: Identify the high risk and low risk factors limited to breast cancer.
CO8: Describe the etiology, mammographic appearance, diagnosis and treatment of benign breast pathologies.
CO9: Describe the etiology, mammographic appearance, diagnosis and treatment of malignant breast pathology.
CO10: Identify the procedures used to diagnosis breast cancer.
CO11: Describe treatment options for breast cancer.
CO12: Explain breast cancer stages 0 to IV and stage characteristics.
CO13: Explain tumor node metastasis (TNM) classifications of breast cancer.
CO14: Identify the significance of breast cancer detection through patient screening and diagnostic mammograms.
CO15: Discuss the practice of clinical breast examinations and breast self-examinations, and current evidence-based data about them.
CO16: Identify the risk factors associated with breast cancer.

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**	
--	--	6	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.

PRACTICAL COMPONENTS

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

Unit	Topic and contents	Hours	Marks
1.	**Breast Anomalies** Asymmetry Inverted nipples Accessory nipples Accessory breast tissue Other (e.g. congenital)	8	5
2.	**Clinical Breast Changes** Lumps: Location, Size, Pain, Mobility, Duration and Other associated indications (e.g. trauma, fever, antibiotics) Thickening: Location, Size and Duration Swelling: Location, Size and Duration Dimpling: Location, Size and Duration Skin irritation and lesions (e.g. moles, keratosis, cysts, ulcers, blisters, scaling): Location, Size and Duration Pain: Location, Duration and New Onset Discharge: Duration, New onset, Color of discharge, Ipsilateral or bilateral, Single duct or multiple ducts and Spontaneous vs. Expressed Nipple retraction, inversion, and areolar changes: Location, Duration and New Onset Edema Erythema Mammoplasty Breast Augmentation: Types: Silicone, Saline Location: Sub-glandular & Subpectoral Breast lift, Breast reduction & Other Reconstructive surgery: Autologous (e.g. TRAM flap, DIEP flap, latissimus dorsi flap), Tissue expander, Implant & Other Post surgical excision Radiation changes	20	10
3.	**Mammographic Appearance of Pathology** Masses: Definition, Location & Margins Circumscribed Ill-defined(indistinct) Lobulated Spiculated Asymmetric density: Definition & Location Focal asymmetry: Definition & Location Calcifications: Location- Dermal and Internal Causes:	20	15

	Cystic changes, Sutural, Vascular, Malignancy, Characteristics, Number(quantity), Size & Shape **Distribution:** Clustered or grouped, Segmental, Regional, Diffuse(scattered), Multiplegroups Margins Benign characteristics(typical) Coarse Rim or eggshell Milk of calcium(teacup-like) Dystrophic Vascular Skin(superficial) Secretory Fat necrosis Punctate Suspicious morphology (nondeterminate characteristics) Indistinct(amorphous) Pleomorphic, granular (clustered) Irregular Linear Casting		
4.	Reporting Terminology (e.g.BI-RADS) Assessment categories Recommendations Interpretation of imaging Density Score, BIRADS, Comparison of mammographic images with other modalities.	**10**	**5**
5.	Benign Breast Pathology Cyst, Galactocele, Fibroadenoma, Lipoma, Hamartoma(fibroadenolipoma), Papilloma, Ductal ectasia, Breast infection/abscess, Hematoma, Fat Necrosis, Radial Scar, Lymph node & Gynecomastia Etiology, Mammographic appearance, Diagnosis and Treatment	**10**	**5**
6.	Breast Cancer Classification Stage Characteristics Description Size Invasive vs. Noninvasive Lymph node involvement Spread beyond the breast Stages Stage 0	**15**	**10**

	Stage I Stage II Stage III Stage IV TNM classification characteristics TNM description Size Lymph node involvement Metastasis T –size TX T0 Tis T1, T2, T3,T4 N – lymph node involvement NX N0 N1, N2,N3 M –metastasis MX, M0, M1 Cell grade Definition Grade1 Grade2 Grade3 Multifocal Multicentric Hormone receptors andHER2 Importance oftests Estrogen Progesterone HER2		
7.	**Risk Factors Associated with Breast Cancer** Gender Age Breast density and breast composition Personal history of breast cancer Family history of breast cancer Personal history of female cancer Genetic predisposition Menses: Early age at menarche Late age at menopause Parity: Nulliparity, Primiparity Hormone replacement therapy Obesity Ethnicity Risk assessment models (e.g. Gail, Tyrer Cuzick)	**15**	**10**

8.	**Breast Cancer Detection Methods** Screening mammograms ACS and ACR guidelines Diagnostic mammograms: Clinical findings & Recall from screening Clinical examinations Women aged 20 to 40 years, every 3years Women older than 40 years, every year Breast self-examinations	**10**	**10**
Total		**108**	**70**

Evaluation System

There will be no Theory examination at university level for this subject.

Continuous Internal Evaluation (CIE)

Sl. No.	Component	Marks	Weightage	IA marks
1.	Sessional test(s)			
	Two Practical 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 shall be practical examination for 70 marks in the subject.

Distribution of marks for university examination 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.	Clinical Breast Imaging: A Patient Focused Teaching File	Gilda Cardenosa	
2.	Interventional Breast Procedures: A Practical Approach	Cherie M. Kuzmiak	
3.	Diagnostic Ultrasound	Carol M. Rumack (Author), Deborah Levine (Author)	Elsevier;

MMRIT Radiological Clinical Education- part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

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:

e. 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.

f. Journal Review Meeting (Journal Club): the ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting using a checklist ***(see Model ChecklistI)***.

g. 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 Checklist II).***

h. Teaching skills: candidates should be encouraged to teach undergraduate students. This performance should be based on assessment by the faculty members of the department and from feedback from the undergraduate students ***(see Model Checklist III).***

i. Work diary/ Log Book- every candidate shall maintain a work diary and record his participation in the training programs 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.

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

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.

Format of Model Checklists

Checklist- I: MODEL CHECKLIST FOR EVALUATION OF JOURNAL REVIEW PRESENTATIONS

Name of the student: Date:

Name of the faculty/ observer:

Title of the paper:

Journal detail:

Sl. No.	Items of observation during presentation	Poor 0	Below average 1	Average 2	Good 3	Very good 4
1	Article 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 paper					
8	Clarity of presentation					
9	Any other observation					
	Total score					
Remarks						

Name and Signature of the Faculty ……………………………………………………………………..

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

Name ofthe 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 ……………………………………………………………

Checklist – III: MODEL CHECKLIST FOR EVALUATION OF TEACHING SKILL

Name ofthe student: Date:

Name of the faculty/ observer:

Topic:

Under Graduate batch:

Sl no.	Items to be observed during teaching	Strong Point	Weak Point
1	Communication of the purpose of the talk		
2	Evokes audience interest in the subject		
3	The introduction		
4	The sequence of ideas		
5	The use of practical examples and/or illustrations		
6	Speaking style (enjoyable, monotonous, etc., specify)		
7	Summary of the main points at the end		
8	Ask questions		
9	Answer questions asked by the audience		
10	Rapport of speaker with the audience		
11	Effectiveness of the talk		
12	Uses of AV aids appropriately		
Remarks			

Name and Signature of the Faculty……………………………………………………………

Checklist- IV: CONTINOUS EVALUATION OF DISSERTATION WORK BY GUIDE/ CO- GUIDE

Name ofthe student: Date:

Name of the faculty/ observer: Topic:

Sl. No	Points of observation during presentation	Poor 0	Below average 1	Average 2	Good 3	Very good 4
1	Periodic consultation with guide/ co-guide					
2	Depth of Analysis/ Discussion					
3	Department presentation of findings					
4	Quality of Final Output					
5	Others					
	Total score					
Remarks						

Name and Signature of the Faculty

……………………………………

…………………………………...

Cover Page

Institute/University Logo

Master in Medical Radiology and Imaging Technology

(MMRIT)

Log Book

Name of the Student:

Name of the Post Graduate degree:

USN:

Batch:

PARTICULARS OF STUDENT

PHOTOGRAPH

Name of the student:

Reg no:

Year of admission:

Year of completion:

Address :

Contact details:

Email id :

Signature of the student:

DISSERTATION DETAILS

Title of Dissertation :

Name of the Guide :

Designation of the Guide :

Name of the Co-guide :

Designation of the Co-guide :

Synopsis Presentation date :

IEC Approval :

Completion and Submission date :

CERTIFICATE

This is to certify that Mr/Ms……………………………………………………………………………………….. has completed the training requirements for the programme Master in Medical Radiology and Imaging Technology (MMRIT) of (name of the Institute/University & address). She/He has completed all the clinical responsibilities during her/his Post-graduation training from………………………………to……................................

Signature **Signature**

Head/Programme Co-ordinator **Principal/Dean**

Index

Sl.No.	Content	Page No.

SECTION I: CLINICAL/AREA/FIELD POSTINGS

Date	Clinical/Dept /Area/Field	Particulars	Name & Signature of the staff/mentor /supervisor

SECTION II. SEMINARS PRESENTED/ATTENDED

Sl.No	Date	Topic	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*

SECTION III. JOURNAL PRESENTED/ATTENDED

Sl.No	Date	Title	Signature Of The Faculty

JOURNAL CLUB EVALUATION

Sl. No	Criteria	5 Excellent	4 Good	3 Average	2 Below Average	1 Poor
1	Paper Selection (importance, interest, general appeal):					
2	Background Knowledge & Introduction of Topic, Questions, and Experimental System.					
3	Critical Analysis of Results, Concise and Accurate Conclusions, and Future Experiments or Implications:					
4	Slides / Visual aids: (organization, number, clarity) , Oral Presentation & Delivery: (Confidence, eye contact, rate of speech, enunciation, appropriate use of pauses)					
5	Ability to Answer Questions from the Audience. Overall Performance and Contribution toOthers Journal					
Total Marks: **25**						

JOURNAL CLUB SCORE SHEET

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

SECTION IV: Seminar taken for UG students

Sl.No	Date	Topic Taught	UG Batch	Signature of the Moderator

Review of Dissertation

Sl. No.	Date	ACTIVITY	Remarks	Signature of the Co-Guide	Signature of the Guide

SECTION V. Extension/Extra Curricular activities
(CONFERENCES/CME/WORKSHOP/TRAININGS)

SL.NO	DATE	Event	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 semester	II semester	III semester	IV semester
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/Seminareffectively				
7	Work Relationship & Frequency of consulting faculty				
8	Overall quality of department work				
	Total Score				
	Signature of the Co-ordinator				

Scoring:
1 Poor
2 Below Average
3 Average
4 Good
5 Excellent

IMMUNIZATION FORM

SL.NO.	Vaccination	Date of vaccination	Dose

ICAHP Committee - 3 (Minimum Standards and Procedures for Award of Ph.D. Degree in MRIT in the related special fields) to be followed as per UGC Guidelines.

The ICAHP Committee – 3 hereby makes the following Regulations:

1. Short title, Application, and Commencement. –

(1) These Regulations may be called ICAHP Committee - 3 (Minimum Standards and Procedure for Award of Ph.D. Degree) Regulations, 2024.

2. Definitions.- (1) In these Regulations, unless the context otherwise requires,-

a) "Adjunct Faculty" means a part-time or contingent instructor, but not full-time faculty member hired to teach by a Higher Educational Institution

b) "Cumulative Grade Point Average (CGPA)" means a measure of the overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all semesters. It is expressed up to two decimal places;

c) "Credit" means the number of hours of instruction required per week over the duration of a semester. A three-credit course in a semester means three one-hour lectures per week, with each one-hour lecture counted as one credit;

d) "College" means an institution engaged in higher education and/or research, either established by a University as its constituent unit or is affiliated with it;

e) "Course" means one of the specified units which go to comprise a programme of study;

f) "Course Work" means courses of study prescribed by the School/Department/ Centre to be undertaken by a student registered for the Ph.D. Degree;

g) "Degree" means a degree awarded by a Higher Educational Institution in accordance with NCAHP act;

h) "External examiner" means an academician/researcher with published research work who is not part of the Higher Educational Institution where the Ph.D. scholar has registered for the Ph.D. programme;

i) "Foreign Educational Institution" means–(i) an institution duly established or incorporated in its home country and offering educational programmes at the undergraduate, postgraduate and higher levels in its home country and (ii) which offers programme(s) of study leading to the award of a degree through conventional face-to-face mode, but excluding distance, online, ODL mode;

j) "Grade Point" means a numerical weight allotted to each letter grade on a 10-point scale;

k) "Guide/Research Supervisor" means an academician/researcher recognized by Higher Educational Institution to supervise the Ph.D. scholar for his/her research;

l) "Higher Educational Institution" means a university or institution;

m) "Interdisciplinary Research" means research conducted by a Ph.D. scholar in two or more academic disciplines;

n) "Plagiarism" means the practice of taking someone else's work or idea and passing them as one's own;

o) “Programme” means a higher education programme pursued for a degree specified by the NCAHP;

p) “Research Proposal” means a brief write-up giving an outline of the proposed research work which the Ph.D. scholar shall submit along with the application for registration for Ph.D. programme;

q) Stipend/Remuneration to be paid to the candidate as per UGC Guidelines.

3. Eligibility criteria for admission to the Ph.D. Programme.-The following are eligible to seek admission to the Ph.D. programme:

Candidates who have completed:

A 2-year/4-semester MMRIT degree programme after BMRIT or Equivalent Degree or a 1-year/2-semester master's degree programme after a 4-year/8-semester honors degree programme or a 2-year/4-semester master’s degree programme after a 3-year bachelor’s degree programme or qualifications declared equivalent to the master’s degree by the corresponding statutory regulatory body of NCAHP, with at least 55% marks in aggregate or its equivalent grade in a point scale wherever grading system is followed or equivalent qualification from a foreign educational institution accredited by an assessment and accreditation agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country to assess, accredit or assure quality and standards of the educational institution.

A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time.

4. Duration of the Programme.-

(1) Ph.D. Programme shall be for a minimum duration of three years, including course work, and a maximum duration of six (6) years from the date of enrolment to the Ph.D. programme.

(2) A maximum of an additional two (2) years can be given through a process of re-registration as per the Statute/Ordinance of the Higher Educational Institution concerned; provided, however, that the total period for completion of a Ph.D. programme should not exceed eight (8) years from the date of admission in the Ph.D. programme.

Provided further that, female Ph.D. scholars and Persons with Disabilities (having more than 40% disability) may be allowed an additional relaxation of two (2) years; however, the total period for completion of a Ph.D. programme in such cases should not exceed ten (10) yearsfrom the date of admission in the Ph.D. programme.

(3) Female Ph.D. Scholars may be provided Maternity Leave/Child Care Leave for up to 240 days in the entire duration of the Ph.D. programme.

5. Procedure for admission. -

(1) The admission shall be based on the criteria notified by the institution, keeping in view the guidelines/norms in this regard issued by the NCAHP and other statutory/regulatory bodies concerned, and taking into account the reservation policy of the Central/State Government from time to time.

(2) Admission to the Ph.D. programme shall be made using the following methods:

i. HEIs may admit students who qualify for fellowship/scholarship in UGC-NET/UGC-CSIR NET/GATE/CEED and similar National level tests based on an interview.

And/or

ii. HEIs may admit students through an Entrance Test conducted at the level of the individual HEI. The Entrance Test syllabus shall consist of 50% of research methodology, and 50% shall be subject- specific.

iii. Students who have secured 50 % marks in the entrance test are eligible to be called for the interview.

iv. A relaxation of 5 % marks will be allowed in the entrance examination for the candidates belonging to SC/ST/OBC/differently-abled category, Economically Weaker Section (EWS), and other categories of candidates as per the decision of the Commission from time to time.

v. HEIs may decide the number of eligible students to be called for an interview based on the number of Ph.D. seats available.

vi. Provided that for the selection of candidates based on the entrance test conducted by the HEI, a weightage of 70 % for the entrance test and 30 % for the performance in the interview/viva- voce shall be given.

(3) Universities and Colleges which are eligible to conduct Ph.D. programmes, shall:

i. Notify a prospectus well in advance on the institution's website specifying the number of seats for admission, subject/discipline-wise distribution of available seats, criteria for admission, the procedure for admission, and all other relevant information for the candidates;

ii. Adhere to the National/State-level reservation policy, as applicable.

(4) The Higher Educational Institution shall maintain a list of Ph.D. supervisors (specifying the name of the supervisor, his or her designation, and the department/school/centre), along with the details of Ph.D. scholars (specifying the name of the registered Ph.D. scholar, the topic of his/her research and the date of admission) admitted under them on the website of the institution and update this list every academic year.

6. Allocation of Research Supervisor.- Eligibility criteria to be a Research Supervisor, Co-Supervisor, Number of Ph.D. scholars permissible per supervisor, etc.

(1) Permanent faculty members working as Professor/Associate Professor of the Higher Educational Institution with a Ph.D., and at least five research publications in peer-reviewed or refereed journals and permanent faculty members working as Assistant Professors in Higher Educational Institutions with a Ph.D., and at least three research publications in peer-reviewed or refereed journals may be recognized as a Research Supervisor in the university where the faculty member is employed or in its affiliated Post-graduate Colleges/institutes.

Such recognized research supervisors cannot supervise research scholars in other institutions, where they can only act as co-supervisors. Ph.D. awarded by a university under the supervision of a faculty member who is not an employee of the university or its affiliated Post- graduate Colleges/institutes would be in violation of these Regulations.

For Ph.D. scholars working in Central government/ State government research institutions whose degrees are given by Higher Educational Institutions, the scientists in such research institutions who are equivalent to Professor/Associate Professor/Assistant Professor can be recognized as supervisors if they fulfill the above requirements.

Provided that in areas/disciplines where there is no, or only a limited number of peer-reviewed or refereed journals, the Higher Educational Institution may relax the above condition for recognition of a person as Research Supervisor with reasons recorded in writing.

Co-Supervisors from within the same department or other departments of the same institution or other institutions may be permitted with the approval of the competent authority.

Adjunct Faculty members shall not act as Research Supervisors and can only act as co-supervisors.

(2) In case of interdisciplinary/multidisciplinary research work, if required, a Co-Supervisor from outside the Department/School/Centre/College/University may be appointed.

(3) An eligible Professor/Associate Professor/Assistant Professor can guide up to eight (8) / six (6) / four (4) Ph.D. scholars, respectively, at any given time.

(4) In case of relocation of a female Ph.D. scholar due to marriage or otherwise, the research data shall be allowed to be transferred to the Higher Educational Institution to which the scholar intends to relocate, provided all the other conditions in these Regulations are followed, and the research work does not pertain to a project sanctioned to the parent Institution/Supervisor by any funding agency. Such scholar shall, however, give due credit to the parent institution and the supervisor for the part of research already undertaken.

(5) Faculty members with less than three years of service before superannuation shall not be allowed to take new research scholars under their supervision. However, such faculty members can continue to supervise Ph.D. scholars who are already registered until superannuation and as a co-supervisor after superannuation, but not after attaining the age of 70 years.

7. Admission of International students in Ph.D. programme.-

(1) Each supervisor can guide up to two international research scholars on a supernumerary basis over and above the permitted number of Ph.D. scholars as specified in clause 6.3 above.

(2) The HEIs may decide their own selection procedure for Ph.D. admission of international students keeping in view the guidelines/norms in this regard issued by statutory/regulatory bodies concerned from time to time.

8. At any point, the total number of Ph.D. scholars under a faculty member, either as a supervisor or a co-supervisor, shall not exceed the number prescribed in clause 6.3 and clause 7.1.

9. Course Work.- Credit requirements, number, duration, syllabus, minimum standards for completion, etc.

(1) The Credit requirement for the Ph.D. coursework is a minimum of 12 credits, including a "Research and Publication Ethics" course as notified by UGC vide D.O. No. F.1-1/2018(Journal/CARE) in 2019 and a research methodology course. The Research Advisory Committee can also recommend UGC recognized online courses as part of the credit requirements for the Ph.D. programme.

(2) All Ph.D. scholars, irrespective of discipline, shall be required to train in teaching /education /pedagogy/writing related to their chosen Ph.D. subject during their doctoral period. Ph.D. scholars may also be assigned 4-6 hours per week of teaching/research assistantship for conducting tutorial or laboratory work and evaluations.

(3) A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the programme and submit his or her thesis.

10. Research Advisory Committee and its Functions.-

(1) There shall be a Research Advisory Committee or an equivalent body as defined in the Statutes/Ordinances of the Higher Educational Institution concerned for each Ph.D. scholar. The Research Supervisor of the Ph.D. scholar concerned shall be the Convener of this committee, and this committee shall have the following responsibilities:

i. To review the research proposal and finalize the topic of research.

ii. To guide the Ph.D. scholar in developing the study design and methodology of research and identify the course(s) that he/she may have to do.

iii. To periodically review and assist in the progress of the research work of the Ph.D.scholar.

(2) Each semester, a Ph.D. scholar shall appear before the Research Advisory Committee to make a presentation and submit a brief report on the progress of his/her work for evaluationand further guidance. The Research Advisory Committee shall submit its recommendations along with a copy of Ph.D. scholar's progress report to the Higher Educational Institution concerned. A copy of such recommendations shall also be provided to the Ph.D. scholar.

(3) In case the progress of the Ph.D. scholar is unsatisfactory, the Research Advisory Committee shall record the reasons for the same and suggest corrective measures. If the Ph.D. scholar fails to implement these corrective measures, the Research Advisory Committee may recommend, with specific reasons, the cancellation of the registration of the Ph.D. scholar from the Ph.D. programme.

11. Evaluation and Assessment Methods, minimum standards/credits for award of the degree,etc.-

(1) Upon satisfactory completion of course work and obtaining the marks/grade prescribed inclause (3) of Regulation 9 above, the Ph.D. scholar shall be required to undertake research work and produce a draft dissertation/thesis.

(2) Before submitting the dissertation/thesis, the Ph.D. scholar shall make a presentation before the Research Advisory Committee of the Higher Educational Institution concerned, which shall also be open to all faculty members and other research scholars/students.

(3) The Higher Educational Institution concerned shall have a mechanism using well-developed software applications to detect Plagiarism in research work and the research integrity shall be an integral part of all the research activities leading to the award of a Ph.D. degree.

(4) A Ph.D. scholar shall submit the thesis for evaluation, along with (a) an undertaking from the Ph.D. scholar that there is no plagiarism and (b) a certificate from the Research Supervisor attesting to the originality of the thesis and that the thesis has not been submitted for the award of any other degree/diploma to any other Higher Educational Institution.

(5) The Ph.D. thesis submitted by a Ph.D. scholar shall be evaluated by his/her Research Supervisor and at least two external examiners who are experts in the field and not in employment of the Higher Educational Institution concerned. Such examiner(s) should be academics with a good record of scholarly publications in the field. Wherever possible, one of the external examiners should be chosen from outside India. The viva-voce board shall consist of the Research Supervisor and at least one of the two external examiners and may be conducted online. The viva-voce shall be open to the members of the Research Advisory Committee/faculty members/research scholars, and students. Higher Educational Institutions may formulate appropriate rules/ordinances to effect the provisions of this Regulations.

(6) The viva-voce of the Ph.D. scholar to defend the thesis shall be conducted if both the external examiners recommend acceptance of the thesis after incorporating any corrections suggested by them. If one of the external examiners recommends rejection, the Higher Educational Institution concerned shall send the thesis to an alternate external examiner from the approved panel of examiners, and the viva-voce examination shall be held only if the alternate examiner recommends acceptance of the thesis. If the alternate examiner does not recommend acceptance of the thesis, the thesis shall be rejected, and the Ph.D. scholar shall be declared ineligible for the award of a Ph.D.

(7) The Higher Educational Institution concerned shall complete the entire process of evaluating a Ph. D. thesis, including the declaration of the viva-voce result, within a period of six (6) months from the date of submission of the thesis.

12. Academic, research, administrative, and infrastructure requirements to be fulfilled by Colleges for getting recognition for offering Ph.D. programmes.-

(1) Post-graduate Colleges offering 4-year Undergraduate Programmes and/or Post-graduate Programmes, may offer Ph.D. programmes, provided they satisfy the availability of eligible Research Supervisors, required infrastructure, and supporting administrative and research facilities as per these Regulations.

(2) Colleges and research institutions established by the central government or a State government whose degrees are awarded by Higher Educational Institutions shall offer Ph.D. programmes provided they have:

i. At least two faculty members in a college or two Ph.D.-qualified scientists in the research institution.

ii. Adequate infrastructure, administrative support, research facilities and library resources as specified by the HEI.

13. Ph.D. through Part-time Mode-

(1) Ph.D. programmes through part-time mode will be permitted, provided all the conditions stipulated in these Regulations are fulfilled.

(2) The Higher Educational Institution concerned shall obtain a "No Objection Certificate" through the candidate for a part-time Ph.D. programme from the appropriate authority in the organization where the candidate is employed, clearly stating that:

i. The candidate is permitted to pursue studies on a part-time basis.

ii. His/her official duties permit him/her to devote sufficient time for research.

iii. If required, he/she will be relieved from the duty to complete the course work.

(3) Not with standing anything contained in these Regulations or any other law, for the time being in force, no Higher Educational Institution or research institution of the Central government or a State Government shall conduct Ph.D. programmes through distance and/online mode.

14. Issuing a Provisional certificate.-

Prior to the actual award of the Ph.D. degree, the degree- awarding Higher Educational Institution shall issue a provisional certificate to the effect that the Ph.D. is being awarded in accordance with the provisions of these Regulations.

15. Depository with INFLIBNET.-

Following the successful completion of the evaluation process and before the announcement of the award of the Ph.D. degree(s), the Higher Educational Institution concerned shall submit an electronic copy of the Ph.D. thesis to INFLIBNET, for hosting the same so as to make it accessible to all the Higher Educational Institutions and research institutions.

NOTE: Above contents are prepared as per UGC Guidelines.

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