MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Manipal College of Health Professions

Manipal Academy of Higher Education, Manipal

Outcome-Based Education (OBE) Framework

Four years Full time
Undergraduate Program

Bachelor of Science in
Medical Imaging Technology
(B.Sc. MIT)

With effect from July 2020

T A B L E O F C O N T E N T S

Head of the Department **Dean**

Deputy Registrar - Academics **Registrar**

1. NATURE AND EXTENT OF THE PROGRAM

Background and need for the program

Technology in healthcare is rapidly increasing, bringing with it many opportunities for careers in the field of Medical Imaging. Medical imaging has advanced in remarkable ways since the discovery of x-rays 120 years ago. It involves in-depth knowledge of human anatomy, physiology and pathology, positioning and imaging techniques, radiation physics, and an understanding of various imaging techniques as well as the radiation safety measures. Medical Imaging is a patient-centred discipline, using a range of technologies to provide diagnostic images and imaging guidance in interventional procedures. It deals with various imaging modalities like computed radiography (CR), digital radiography (DR), computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, fluoroscopy, and mammography.

Need for the program

The role of Medical Imaging Technologist involves acting as a patient advocate, displaying a high level of professionalism, and functioning as part of the multidisciplinary team. This program provides highly skilled imaging professionals in the field of radiology and imaging sciences to perform high quality diagnostic imaging procedures and to ensure holistic patient care.

Program duration

B.Sc. MIT is a 4-year full time program with 1 year of clinical training/internship, affiliated to Manipal Academy of Higher Education (MAHE), University at Manipal, Karnataka, India.

Aim of the Program

- To educate and train the students to become a reflective medical imaging practitioner with the ability to engage effectively in a multidisciplinary healthcare environment and enable them to independently manage various imaging equipments in Radio-diagnosis and imaging with minimum radiation hazards and quality patient care.
- To promote continual learning and professional development for the benefit of students and the profession increasing the effectiveness of health care delivery.

Qualifications:

- Candidate must have passed 10+2/ A level/ IB/ American 12th grade or equivalent with Science (Physics, Chemistry, Biology) .
- Candidate must have obtained an minimum aggregate of 50% and 55% in Physics, Chemistry & Biology.

- Candidate should be of age 17 years or above or as per rules of universities with regard to the entry age

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Eligibility Criteria for lateral Entry:

- Candidates with 10+2 and 2 years of diploma in Medical Imaging/Radiography are eligible for the admission to Undergraduate Program.
- Candidate must have obtained minimum of 50% marks in aggregate or equivalent grade points in respective qualifying exams.
- Candidates must have adequate English Proficiency. A score of 6 or above in IELTS or equivalent exam is mandatory for the International admission.

Professional scope:

Medical Imaging is Ever-evolving, and with that comes widely varied opportunities, career paths and future study. Medical Imaging Technology is a unique professional degree combining various aspects of Radio Diagnosis and Imaging. Graduates will be able to effectively manage Radio-diagnostic service facilities and assist in radiological procedures involving Conventional Radiography, Computed Radiography, Digital Radiography, Interventional Radiography, Ultrasonography, Mammography, Computed Tomography and Magnetic Resonance Imaging. The role of the Medical Imaging Technologist under various imaging modalities is Ever-changing with the rapid advancement of technology.

Graduates have excellent prospects to work in a variety of roles either in public hospitals or private radiology practices such as: -

- Imaging Technologists
- An academic career engaging in teaching and research
- Clinical application specialists or sales managers with Medical Imaging equipment vendors.
- Management positions in Medical Imaging departments.

Clinical Work:

Students will be receiving extensive hands-on clinical experience throughout the program, supported by experienced Medical Imaging technologists in radiology departments for the following:

- Performing all types of routine radiographs including portable, handling different trauma and forensic cases
- Performing conventional radiography, mammography, advanced Computed Radiography, Digital Radiography and PACS

- Assisting in Ultrasonography and Ultrasound guided procedures.
- Performing and assisting all the routine, emergency and special cases in CT scan.
- Performing and assisting all routine, emergency and special cases of MRI scans.
- Assisting in Image guided procedures.

2. PROGRAM EDUCATION OBJECTIVES (PEOs)

The overall objective of the learning outcome-based curriculum framework (LOCF) for Bachelor of Science in Medical Imaging Technology (BSc. MIT) Program are as follows:

PEO No.	Education Objective
PEO 1	Students will be able to use their fundamental knowledge and technical competence in Radiology and Imaging field as and when required to achieve professional excellence.
PEO 2	Students will demonstrate strong and well defined practical skills in equipment's available in the field of radio-diagnosis and imaging
PEO 3	Students will be able to practice the profession with a highly professional and ethical attitude, strong communication skills, and effective professional skills to work in a inter-disciplinary team.
PEO 4	Students will be able to use interpersonal and collaborative skills in providing imaging services to the patient
PEO 5	Students will be able to imbibe the culture of research, innovation, entrepreneurship and incubation.
PEO 6	Students will be able to participate in lifelong learning process for a highly productive career and will be able to relate the concepts of radiation physics and Imaging science towards serving the cause of the society.

3. GRADUATE ATTRIBUTES

S No.	Attribute	Description
1	**Professional Knowledge**	Demonstrate scientific knowledge and understanding to work as a health care professional
2	**Clinical / technical /skills**	Demonstrate Clinical / technical skills in order to implement the preventive, assessment and management plans for quality health care services
3.	**Communication**	Ability to communicate effectively and appropriately in writing and orally to patients/clients, care-givers, other health professionals and other members of the community
4.	**Cooperation/Team work**	Ability to work effectively and respectfully with interdisciplinary team members to achieve coordinated, high quality health care
5.	**Professional ethics**	Ability to identify ethical issues and apply the ethical values in the professional life
6.	**Research / Innovation-related Skills**	A sense of inquiry and investigation for raising relevant and contemporary questions, synthesizing and articulating.
7.	**Critical thinking and problem solving**	Ability to think critically and apply once learning to real-life situations
8.	**Reflective thinking**	Ability to employ reflective thinking along with the ability to create the a sense of awareness of one self and society
9.	**Information/digital literacy**	Ability to use ICT in a variety of learning situations
10.	**Multi-cultural competence**	Ability to effectively engage in a multicultural society and interact respectfully
11.	**Leadership readiness/qualities**	Ability to respond in an autonomous and confident manner to planned and uncertain situations, and should be able to manage themselves and others effectively
12.	**Lifelong Learning**	Every graduate to be converted into lifelong learner and consistently update himself or herself with current knowledge, skills and technologies. Acquiring Knowledge and creating an understanding in learners that learning will continue throughout life.

4. QUALIFICATION DESCRIPTORS:

a) Demonstrate (i) a fundamental and systematic knowledge and understanding of an academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established theories, principles and concepts, and several advanced and emerging issues in the field of Radiology and Imaging sciences (ii) Procedural knowledge that creates different types of professionals related to the Radiology, including research and development, teaching and in government and public service; (iii) Professional and communication skills in the domain of Radiology and Imaging sciences, including a critical understanding of the latest developments, and an ability to use established techniques in the field of Radiology and Imaging sciences.

b) Demonstrate comprehensive knowledge about Radiology and Imaging sciences, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the Radiology and Imaging sciences field of study, and techniques and skills required for identifying problems and issues.

c) Demonstrate skills in i) identifying the issues in health care needs; ii) collection of quantitative and/or qualitative data relevant to client's needs and professional practice; iii) analysis and interpretation of data using methodologies as appropriate for formulating evidence-based hypotheses and solutions

d) Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues related to the Medical imaging program

e) Communicate appropriately with all stakeholders, and provide relevant information to the members of the healthcare team

f) Address one's own learning needs relating to current and emerging areas of study, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge

g) Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts and to identify and analyse problems and issues and seek solutions to real-life problem

5. PROGRAM OUTCOMES (POs)

After successful completion of Bachelor / BSc Medical Imaging Technology program, students will be able to:

PO No.	Attribute	Competency
PO 1	**Professional knowledge**	Possess and acquire **scientific knowledge** to work as a health care professional
PO 2	**Clinical/ Technical skills**	Demonstrate and possess **clinical skills** to provide quality health care services
PO 3	**Team work**	Demonstrate **team work skills** to support shared goals with the interdisciplinary health care team to improve societal health
PO 4	**Ethical value & professionalism**	Possess and demonstrate **ethical values and professionalism** within the legal framework of the society
PO 5	**Communication**	**Communicate effectively** and appropriately with the interdisciplinary health care team and the society
PO 6	**Evidence based practice/learning**	Demonstrate high quality **evidence based practice/learning** that leads to excellence in professional practice
PO 7	**Life-long learning**	Enhance knowledge and skills with the use of advancing technology for the **continual improvement** of professional practice
PO 8	**Entrepreneurship, leadership and mentorship**	Display **entrepreneurship, leadership and mentorship** skills to practice independently as well as in collaboration with the interdisciplinary health care team

6. COURSE STRUCTURE, COURSE WISE LEARNING OBJECTIVE, COURSE OUTCOMES (COs)

SEMESTER - I

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
ANA1101	Anatomy - I	3	-	-	-	3	30	70	100
PHY1101	Physiology - I	2	-	-	-	2	30	70	100
EIC1001	Environmental Science and Indian Constitution	2	-	-	-	2	100	-	100
CSK1001	Communication Skills	2	-	-	-	2	100	-	100
MIT1101	Radiation Physics	2	1	-	-	3	50	50	100
MIT1102	Radiographic Positioning and Techniques - I	2	1	-	-	3	50	50	100
MIT1103	Image evaluation and interpretation of Radiographs- I	2	-	-	-	2	100	-	100
MIT1131	Clinical aspect of Radiographic Positioning and Techniques - I	-	-	-	9	3	50	50	100
	TOTAL	**15**	**2**	**-**	**9**	**20**	**510**	**290**	**800**

Note:
- ESE for ANA1101, PHY1101 will be conducted for 50 marks and normalized to 70 marks
- ESE for MIT1101, MIT1102 will be conducted for 100 marks and normalized to 50 marks

SEMESTER- II

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
ANA1201	Anatomy - II	2	-	-	-	2	30	70	100
PHY1201	Physiology - II	2	-	-	-	2	30	70	100
BIC1201	Biochemistry	3	-	-	-	3	30	70	100
MIT1201	Radiographic Positioning and Techniques - II	2	1	-	-	3	50	50	100
MIT1202	Digital Imaging & Image processing methods in Radiography	2	1	-	-	3	50	50	100
MIT1203	Image evaluation and Interpretation of Radiographs - II	2	-	-	-	2	100	-	100
MIT1231	Clinical aspect of Radiographic Positioning and Techniques - II	-	-	-	15	5	50	50	100
	TOTAL	**13**	**2**	**-**	**15**	**20**	**340**	**360**	**700**

Note:
- ESE for ANA1201, PHY1201 and BIC1201 will be conducted for 50 marks and normalized to 70 marks.
- ESE for MIT1201, MIT1202, MIT1231 will be conducted for 100 marks and normalized to 50 marks.

SEMESTER- III

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
PAT2103	Pathology	3	-	-	-	3	30	70	100
MCB2101	Microbiology	2	-	-	-	2	30	70	100
SUR4101	General Surgery	3	-	-	-	3	30	70	100
MIT2101	Orthopaedics in Radiology	2	-	-	-	2	100	-	100
MIT2102	Radiographic Special Procedures	3	1	-	-	4	50	50	100
MIT2131	Clinical aspect of Radiographic special procedures	-	-	-	9	3	50	50	100
*** ****	Open Elective - I	3	-	-	-	3	S/NS		
	TOTAL	**16**	**1**	**-**	**9**	**20**	**290**	**310**	**600**

Note:
- ESE for PAT2103, MCB2101 and SUR4101 will be conducted for 50 marks and normalized to 70 marks
- ESE for MIT2102 and MIT2131 will be conducted for 100 marks and normalized to 50 marks

SEMESTER- IV

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
PHC2203	Pharmacology	3	-	-		3	30	70	100
GPY2201	General Psychology	2	-	-		2	30	70	100
MED3201	General Medicine	3	-	-	-	3	30	70	100
MIT2201	Radiation Safety in Radio diagnosis	3	1	-	-	4	50	50	100
MIT2231	Clinical aspect of Radiography and Fluoroscopy	-	-	-	15	5	50	50	100
MIT****	Program Elective - I	3	-	-	-	3	50	50	100
TOTAL		**14**	**1**	**-**	**15**	**20**	**240**	**360**	**600**

Note:
- ESE for PHC2203, GPY2201, MED3201 will be conducted for 50 marks and normalized to 70
- ESE for MIT2201, MIT2231 will be conducted for 100 marks and normalized to 50 marks

SEMESTER - V

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
MIT3101	Physics of Ultrasound	2	1	-	-	3	50	50	100
MIT3102	Computed Tomography - I	2	-	-	-	2	50	50	100
MIT3103	Magnetic Resonance Imaging - I	1	1	-	-	2	50	50	100
MIT3104	Specialized Imaging Modalities	2	1	-	-	3	50	50	100
MIT3105	Patient care and Ethics in Radio-diagnosis	2	-	-	-	2	100	-	100
MIT3131	Clinical aspect of Specialized Imaging Modalities	-	-	-	15	5	50	50	100
*** ****	Open Elective - II	3	-	-	-	3	S/NS		
TOTAL		**12**	**3**	**-**	**15**	**20**	**350**	**250**	**600**

Note:
ESE for MIT3101, MIT3103, MIT3131 will be conducted for 100 marks and normalized to 50 marks
ESE FOR MIT3102, MIT3103 will be conducted out of 50 marks only

SEMESTER - VI

Course code	Course title	Credit distribution (L,T,P are hours/week)					Marks Distribution		
		L	T	P	CL	CR	IAC	ESE	TOTAL
BST3201	Biostatistics and Research Methodology	3	-	-	-	3	30	70	100
MIT3201	Computed Tomography II	2	1	-	-	3	50	50	100
MIT3202	Magnetic Resonance Imaging II	2	1	-	-	3	50	50	100
MIT3203	Cross sectional anatomy in CT and MRI	2	-	-	-	2	100	-	100
MIT3231	Clinical aspect of CT & MRI	-	-	-	18	6	50	50	100
MIT****	Program Elective -II	2	1	-	-	3	50	50	100
TOTAL		**11**	**3**	**-**	**18**	**20**	**330**	**270**	**600**

Note:
- ESE for MIT3201, MIT3202 and MIT3231 will be conducted for 100 marks and normalized to 50.
- ESE for BST3201 will be conducted for 100 marks and normalized to 70 marks

Open Electives

Open elective is credited, choice-based and is graded as satisfactory / not satisfactory (S/NS). Students make a choice from pool of electives offered by MAHE institution / Online courses as approved by the department

Program Electives

Program elective is credited and choice-based. The students make a choice from pool of electives offered by the department. The ESE is conducted for 50 marks.

Semester	Course Code	Course Title	Credit (s) Distribution (L,T,P,CL are hours/ week)				
			L	T	P	CL	CR
IV Semester	MIT2241	Advanced Image guided procedures	3	-	-	-	3
	MIT2242	Imaging Informatics	2	1	-	-	3
VI Semester	MIT3241	Quality Assurances in Diagnostic Equipment's	2	1	-	-	3
	MIT3242	Basic in Nuclear medicine Technology	2	1	-	-	3

SEMESTER - VII and VIII

Internship

Semester VII	**Internship -** I	Duration 6 months 48 hours in a week / 8 hours in a day
Semester VIII	**Internship -** II	Duration 6 months 48 hours in a week / 8 hours in a day

OVERALL CREDIT DISTRIBUTION

Semester	Hours per week				Total Credits	Marks		
	L	T	P	CL		IAC	ESE	Total
Semester - I	15	2	-	9	20	510	290	800
Semester - II	13	2	-	15	20	340	360	700
Semester - III	16	1	-	9	20	290	310	600
Semester - IV	14	1	-	15	20	240	360	600
Semester - V	12	3	-	15	20	350	250	600
Semester - VI	11	3	-	18	20	330	270	600
Semester - VII	-	-	-	48	Na	-	-	-
Semester - VIII	-	-	-	48	Na	-	-	-
				Total	**120**	**2060**	**1840**	**3900**

SEMESTER - I

COURSE CODE	:	COURSE TITLE
ANA1101	:	Anatomy - I
PHY1101	:	Physiology - I
MIT1101	:	Radiation Physics
MIT1102	:	Radiographic Positioning And Techniques - I
MIT1103	:	Image evaluation and interpretation of Radiographs - I
EIC1001	:	Environmental science and Indian constitution
CSK1001	:	Communication skills
MIT1131	:	Clinical aspect of Radiographic Positioning and Techniques - I

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Anatomy - I**
Course Code	**ANA1101**
Academic Year	First
Semester	I
Number of Credits	3
Course Prerequisite	Student should have basic knowledge of Biology
Course Synopsis	Human anatomy is the study of gross features and relations of various structures of the human body by dissection.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Explain the General Anatomy in the human body (C2)
CO2	Explain the Systemic Anatomy of the human body (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**x**							
CO2	**x**							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours (Theory)**
Unit 1:		
General Anatomy	• Define the Anatomical position and Anatomical terms (C1) • Explain the epithelium – types and functions (C2) • Explain the connective tissue – fibers and cells (C2) • Explain the cartilage – types, structure and function (C2) • Explain the bone – types, structure and blood supply (C2) • Explain the muscle – classification, structure and function (C2) • Explain the neurons- types and structure, typical spinal nerve (C2) • Explain the blood vessels – arteries, veins, lymph vessels, lymph nodes, structure of lymph node (C2) • Explain the joints: Classification, examples , structure of a typical synovial joint (C2) • Explain the classification of synovial joints (C2)	**7**
Unit 2:		
Respiratory system	• List the parts of respiratory tract (C1) • Explain the boundaries of the Nasal cavity (C2)	**5**

Content	Competencies	Number of Hours (Theory)
	• Explain the Lateral wall of nasal cavity - features, blood supply, nerve supply and lymphatic drainage (C2) • Explain the nasal septum: Formation, blood supply, nerve supply, lymphatic drainage and applied anatomy (C1, C2) • List and Explain the paranasal air sinuses and their function (C1, C2) • Explain the pharynx - extent, parts- nasopharynx , oropharynx and laryngopharynx - internal features (C2) • Explain the cavity of larynx, blood supply, nerve supply (C1, C2) • Explain the vocal cords and their movements, and Rima glottidis (C2) • List the intrinsic muscles of the larynx, their nerve supply and actions (C1) • List the Cartilaginous framework and ligaments (C1) • Explain the trachea: Extent, Structure and nerve supply (C2) • Explain the diaphragm - attachments, nerve supply and actions (C2) • Explain the thoracic cage: thoracic wall, intercostal spaces and their contents (C1, C2) • Explain the Lungs- gross anatomy, roots of the lungs, surface marking of pleura and lungs (C1, C2) • Explain the pleura- parts, pleural cavity, pleural recesses, pulmonary ligament (C2)	
Unit 3:		
Cardiovascular system	• Explain the heart - position, external features, right atrium internal features (C1, C2) • Explain the right ventricle internal features, Blood supply to the heart (C1, C2) • Explain the left atrium and left ventricle, nerve supply of heart (C2) • Explain the pericardium - Parts, blood supply, nerve supply and function (C2) • Explain the mediastinum - boundaries and contents (C2) • List and explain the arteries - Arch of aorta and descending thoracic aorta (extent course and branches) (C1, C2) • Explain the veins -Azygos system of vein (formation, course and termination) (C1, C2) • Define the thoracic duct: formation, course and termination (C2) • Explain the arteries - pulmonary trunk, ascending aorta (extent course and branches) (C2)	**4**

Content	Competencies	Number of Hours (Theory)
	• Explain the veins - branchiocephalic veins, superior vena cava (formation, course and termination) (C2) • Explain the major arteries and veins of head and neck (name and positions) (C2) • Explain the major arteries and veins of abdomen and pelvis (name and positions) (C2) • Explain the abdominal aorta, inferior vena cava, portal vein (C1, C2)	
Unit 4:		
Digestive system	• List the parts of digestive system (C1) • Explain the tongue – gross anatomy, blood supply and nerve supply (C2) • Explain the salivary glands- Names and location (C2) • Explain the oesophagus- extent, parts, constrictions, blood supply, nerve supply and lymphatic drainage (C2) • Explain the stomach- position, relations, blood supply, nerve supply and lymphatic drainage (C1, C2) • Explain the duodenum- parts, important relations, blood supply and nerve supply (C2) • Explain the pancreas - position, parts, important relations, blood supply and nerve supply (C2) • Explain the small intestine - parts- duodenum, jejunum and ileum- blood supply and nerve supply (C1, C2) • Explain the large intestine - parts, position of each of the parts, extent, blood supply and nerve supply (C2) • List the differences between jejunum and ileum (C1) • List the differences between small intestine and large intestine (C1) • Explain the rectum and anal canal-position, blood supply, nerve supply and lymphatic drainage (C2) • Explain the liver- position, anatomical and physiological lobes, surfaces, relations, porta hepatis, blood supply and nerve supply (C1, C2) • Explain the extrahepatic biliary apparatus – gall bladder and bile duct (C2)	**6**
Unit 5:		
Urinary system	• List the parts of urinary system (C1) • Explain the kidneys: position, external features, capsules, relations, macroscopic structure, blood supply and nerve supply (C1, C2) • Explain the ureter- length, constrictions and blood supply (C2) • Explain the urinary bladder- position, external features, blood supply and nerve supply (C2) • Explain the urethra- female urethra, male urethra- parts (C2)	**2**
Unit 6:		

Content	Competencies	Number of Hours (Theory)
Male reproductive system	• List the parts of male reproductive system (C1) • List the spermatic cord- constituents and coverings (C1) • Explain the testes- position, coverings, gross structure, blood supply, nerve supply and lymphatic drainage (C2) • Explain the vas deferens- commencement, course and termination (C2) • Explain the prostate – position, external features, lobes and structure (C2) • Explain the seminal vesicles and ejaculatory ducts (C2)	**2**
Unit 7:		
Female reproductive system	• Name the parts of female reproductive system (C1) • Explain the uterus-position, parts, external features, relations, blood supply and lymphatic drainage (C2) • Explain the uterine tube- parts, blood supply and nerve supply (C2) • Explain the ovary – position and structure (C2)	**2**
Unit 8:		
Endocrine glands	• Name the endocrine glands (C1) • Explain the pituitary gland (Hypophysis cerebri)- position, parts, blood supply (C2) • Explain the suprarenal glands- position, relations, parts, blood supply and lymphatic drainage (C2) • Explain the thyroid gland- position, parts, blood supply and lymphatic drainage (C2) • Name the parathyroid glands-their position and blood supply (C1)	**2**
Unit 9:		
Central Nervous system	• Name the parts of the CNS (C1) • List the features and explain the spinal cord- position, external features, internal structure, brief note on important ascending and descending tracts (C1, C2) • Explain the major motor and sensory pathways (C2) • Explain the pyramidal tract in detail (C2) • Name the parts of brain (C2) • List the external and internal features of medulla oblongata (C1) • List the cranial nerves attached to medulla oblongata (C1) • List the external and internal features pons (C1) • Explain the cranial nerves attached to pons and ponto-medullary junction (C2) • Explain the cerebellum- functional lobes of the cerebellum and its functions (C2) • Explain the midbrain- external features and internal	**12**

Content	Competencies	Number of Hours (Theory)
	structure – in brief (C1) • Explain the cranial nerves attached to midbrain (C2) • Explain the cerebral hemispheres – lobes, important sulci and functional areas (C2) • List the fiber system of the brain and explain the corpus callosum and internal capsule (C1, C2) • Explain the diencephalon- Thalamus and hypothalamus-position and functions (C2) • Explain the basal nuclei: Corpus striatum – parts and functions (C2) • Explain the blood supply to the central nervous system (C2) • Explain the ventricles: 4th and 3rd ventricles (features, position and communications) (C2) • Explain the lateral ventricles- parts, features, position and communications (C2) • Define the CSF production and circulation (C1)	
Unit 10:		
Special senses	• Recall the gross anatomy of the eye (C1) • Recall the gross anatomy of external, middle and internal ear (C1) • Recall the skin and its features (C1)	**3**

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	45	135
Seminar		
Small group discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment		
Total	**45**	**135**

Assessment Methods:	
Formative:	**Summative:**
nil	Sessional Exam I / Sessional Exam II (Theory)
	End Semester Exam (Theory)
Mapping of Assessment with COs:	

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Sessional Examination 1	x	x				
Sessional Examination 2	x	x				
End Semester Exam	x	x				

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Manipal Manual of Anatomy by Dr. Sampath Madhyastha
Additional References	1. Human Anatomy by Dr. B. D. Chaurasia (Vol 1,2,3,4) 2. Chaurasia's handbook of human anatomy 3. Netter's Atlas

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Physiology - I**
Course Code	**PHY1101**
Academic Year	First
Semester	I
Number of Credits	2
Course Prerequisite	Student should have basic knowledge in Biology
Course Synopsis	This module provides a comprehensive knowledge about normal functions of the organ systems of the body to understand the physiological basis of health and disease required for health professional (paramedical) courses.

Course Outcomes (COs): At the end of the course student shall be able to:	
CO1	Know the basic facts and concepts of Physiology (C1)
CO2	Explain the normal functions of various systems of the body.(C2)
CO3	Describe the relative contribution of various systems in maintaining the homeostasis.(C2)
CO4	Explain the physiological basis of disease processes.(C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1. BASIC CONCEPTS AND NERVE PHYSIOLOGY		
Transport across cell membrane	• Name the various transport mechanisms across cell membrane(C1) • Describe passive transport mechanisms such as simple diffusion, facilitated diffusion and osmosis (C2) • Describe primary and secondary active transport mechanisms(C2)	4
Body fluid compartments	• Mention the total body water as percentage of body weight and its distribution. (C1) • Give the ionic composition of body fluids(C1)	
Physiology of neuron	• Describe the morphology of a neuron (C2) • Mention the structure and functions of myelinated and unmyelinated nerve fibers (C2)	

Content	Competencies	Number of Hours
Membrane potential	• Describe resting membrane potential(C2) • Draw and label the action potential (C2) • Describe the ionic basis of the action potential (C2)	
Unit 2: MUSCLE PHYSIOLOGY		
Skeletal muscle	• Describe the characteristic features of skeletal, cardiac and smooth muscles(C2) • Describe the structure of skeletal muscles(C2) • Mention the types of skeletal muscles(C1) • Explain neuromuscular transmission in skeletal muscle(C2) • Explain excitation contraction coupling in skeletal muscle(C2) • Describe rigor mortis (C2)	4
Smooth muscle	• Mention the types of smooth muscle(C1)	
Unit 3: BLOOD		
Composition and functions of blood	• Describe the composition of blood(C2) • List the functions of blood(C1)	6
Plasma proteins	• Name the different types of plasma proteins (C1) • List the functions of plasma proteins(C1)	
Red blood cells	• Mention the morphology and functions of red blood cells (C1) • Mention the normal count of RBC and its variations (C1) • Describe the stages and factors influencing erythropoiesis(C2) • Mention the normal value of hemoglobin concentration and its variations(C1) • Mention the functions of hemoglobin (C1) • Define anemia(C1)	
White blood cells	• Classify White Blood Cells (WBC) (C2) • List the functions of WBCs(C1) • Mention the normal count of various types of WBCs (C1)	

Content	Competencies	Number of Hours
Hemostasis	• Mention the normal range of platelets and its variations(C1) • List the functions of platelets(C1) • Define hemostasis(C1) • Describe the various stages involved in haemostasis (C2) • List the clotting factors(C1) • Describe the intrinsic and extrinsic pathways of coagulation (C2) • Describe hemophilia(C2) • Classify anticoagulants and give examples for each(C2)	
Blood types/groups	• Describe the ABO and Rh systems of blood grouping(C2) • Explain the importance of blood grouping(C2) • Mention the hazards of blood transfusion(C1) • Explain the cause and clinical features of hemolytic disease of the newborn (erythroblastosis fetalis) (C2)	
Lymph	• List the functions of lymph(C1)	
Unit 4: CARDIOVASCULAR SYSTEM		
Organization of cardiovascular system	• Describe the structure of heart (C2) • Describe the innervation of heart and blood vessels(C2) • Describe the properties of cardiac muscle(C2)	9
Cardiac cycle	• Define cardiac cycle (C1) • State the normal duration of cardiac cycle (C1) • Explain the various events occurring during a cardiac cycle with the help of graphs(C2)	
Heart sounds	• Enumerate the differences between first and second heart sounds(C2)	
Electrocardiogram (ECG)	• Define electrocardiogram (ECG) (C1) • Draw a labeled diagram of a normal ECG recorded from limb lead II (C1) • Describe the waves and intervals of ECG (C2) • Mention the uses of ECG(C1)	
Heart rate	• Mention the normal value and variations of heart rate(C1) • Describe the regulation of heart rate(C2)	
Cardiac output	• Define cardiac output (C1) • State the normal value of cardiac output (C1) • Mention the variations of cardiac output(C1) • Describe the regulation of cardiac output(C2) • Mention the effect of muscular exercise on cardiac output (C1)	
Blood pressure	• Define blood pressure (BP) (C1)	

Content	Competencies	Number of Hours
(BP)	• Mention the normal value of BP (C1) • Mention the factors influencing BP(C1) • Mention the variations of blood pressure(C1) • Describe the short term regulation of arterial blood pressure(C2)	
Unit 5: RESPIRATORY SYSTEM		
Introduction to respiration	• Describe the functional anatomy of the respiratory system (C2)	6
Mechanics of respiration	• Mention the muscles of respiration(C1) • Describe the mechanism of inspiration and expiration(C2) • Describe the intra-pulmonary and intra-pleural pressure changes during the various phases of respiration(C2)	
Lung volumes and capacities	• Draw a labelled spirogram(C2) • Define various lung volumes and capacities (C1) • Mention the normal values of lung volumes and capacities (C1)	
Ventilation	• Define pulmonary ventilation (C1) • Mention the normal value of pulmonary ventilation (C1) • Define alveolar ventilation(C1) • Mention the normal value of alveolar ventilation(C1) • Define anatomical dead space (C1) • Mention the normal value of anatomical dead space (C1)	
Gas exchange	• Describe the structure of respiratory membrane (C2) • Mention the factors affecting diffusion of gases across it (C1)	
Transport of gases	• Mention the forms in which oxygen is transported in the blood(C1) • Describe the oxygen-hemoglobin dissociation curve(C2) • Mention the factors shifting the oxygen-hemoglobin dissociation curve to the right and to the left(C1) • Mention the forms in which carbon dioxide is transported in the blood(C1) • Describe the mechanism of carbon dioxide transport(C2)	
Regulation of respiration	• Explain the neural regulation of respiration(C2) • Explain the chemical regulation of respiration(C2)	
Applied aspects	• Define hypoxia(C1) • Mention the types of hypoxia with example (C1) • Define cyanosis(C1) • Mention the cause of cyanosis (C1)	

Content	Competencies	Number of Hours
	• Mention the types of hypoxia in which cyanosis occurs (C2) • Define apnea, dyspnea and asphyxia(C1)	
Unit 6: SPECIAL SENSES		
Vision	• Describe the structure of human eye with the help of a diagram (C2) • Mention the functions of aqueous humor (C1) • Name the photoreceptors (C1) • Mention the differences between the rods and cones (C1) • Draw the visual pathway (C2) • Explain the defects in field of vision due to lesions of visual pathway at different locations (C2) • Describe the mechanism of accommodation(C2) • Describe light reflex with the help of a diagram (C2) • Define visual acuity and mention the tests (C2) • Describe the cause and correction for refractory errors of the eye(C2)	4
Hearing and vestibular apparatus	• Describe the structure and functions of external, middle and inner ear (C2) • Describe the mechanism of hearing (C2) • Mention the parts and functions of vestibular apparatus (C1)	
Taste and smell	• Name the receptors for taste and smell (C1) • Mention the disorders of taste and smell (C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	33	99
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**33**	**99**

Assessment Methods:	
Formative:	**Summative:**
Nil	Mid Semester/Sessional Exam (Theory)
	End Semester Exam (Theory)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination I	x	x	x	x		
Sessional Examination II	x	x	x	x		
End Semester Exam	x	x	x	x		
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	1. Basics of Medical Physiology,4th edition, D.Venkatesh, H.H.Sudhakar 2. Manipal Manual of Medical Physiology,1st edition, C. N. ChandraShekar					
Additional References						

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Environmental Science**
Course Code	**EIC1001**
Academic Year	First
Semester	I
Number of Credits	1
Course Prerequisite	Nil
Course Synopsis	1. Aim to give students a general understanding of environmental science and introduce them to some of the main principles 2. It covers the study of subjects for example understanding of earth procedures, evaluating alternative energy frameworks, mitigation and pollution control, natural resource management, effects of global climate change and so on

Course Outcomes (COs): At the end of the course student shall be able to:	
CO1	Explain the role of Environmental Science, its multidisciplinary nature in conservation of global environment (C2)
CO2	Describe the natural resources, utility and the role of ecosystems in maintaining planetary cycles (C2)
CO3	Outline the types, sources, prevention and control measures of pollution (C2)
CO4	List the laws, acts and policies related to environmental protection in India (C1)
CO5	Explain the types, mitigation and management techniques of disaster (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x					x		
CO2	x			x				
CO3	x					x		
CO4			x				x	
CO5			x			x		

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Environmental Studies and multi-disciplinary nature	1. Explain the meaning, objectives and major environmental issues (C2) 2. What is sustainable development? (C1) 3. Explain the global environmental concerns (C2)	**2**
Unit 2:		
Biodiversity,	1. Classify the natural resources (C2)	**4**

Content	Competencies	Number of Hours
Ecosystem, Energy and natural resources	2. List the renewable and non- renewable resources (C1) 3. Outline the consumption of renewable and non-renewable resources 4. Explain the conservation methods of renewable and non-renewable resources 5. Outline the availability of water resources, forest, land and mineral resources. 6. Summarize the different types of energy (C2) (Conventional sources & Non-Conventional sources of energy, solar energy, Hydro electric energy, Wind Energy, Nuclear energy, Biomass & Biogas, Fossil Fuels, Hydrogen as an alternative energy) 7. Define Ecosystem (C1) 8. Explain the meaning, structure and functions of ecosystem (C2) 9. Explain the biotic and abiotic components of ecosystem (C2) 10. Describe the trophic levels in ecosystem (C2) 11. What is an energy flow in an ecosystem (C1) 12. Explain Biodiversity and its conservation (C2) (in situ & ex situ, IUCN red list)	
Unit 3:		
Environmental Pollution	1. Explain the various types of Environmental Pollution (C2) (water, air, land, noise, solid waste, Biomedical waste, nuclear pollution, marine pollution)	**2**
Unit 4:		
Environmental laws and legislations	1. Outline the environmental laws and legislations (C2) (Related to general, air, water, biodiversity and forests) 2. Explain the roles and responsibilities of state and central Pollution control Boards (C2) 3. What is Environmental impact assessment (EIA) (C1)	**2**
Unit 5:		
Disaster management	1. Define disaster (C1) 2. What is disaster management? (C1) 3. Classify the types of disaster (C2) 4. What is disaster risk formula (C1) 5. Explain the phases in Disaster management phases (C2) (Disaster management cycle, Emergency response and recovery, Hazardous waste spills and dangers posed)	**3**

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	13	39
Seminar	-	
Small group discussion (SGD)	-	
Self-directed learning (SDL)	-	
Problem Based Learning (PBL)	-	
Case Based Learning (CBL)	-	
Clinic	-	
Practical	-	
Revision	-	
Assessment	-	
Total	**13**	**39**

Assessment Methods:	
Formative:	**Summative:**
Assignments	Mid Semester/Sessional Exam (Theory)

Mapping of Assessment with COs:					
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Assignments			x	x	x
Mid Semester / Sessional Examination	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Benny Joseph, Environmental Studies, Tata McGraw-Hill Publishing Company Ltd., New Delhi (2008). 2. Aloka Debi, “Environmental Science and Engineering”, Universities Press (India) Pvt. Ltd. (2012).
Additional References	1. Mohan kanda, Disaster Management in India evolution of institutional arrangements & operational strategies. (2017) 2. Student guide: Environment Reader for Universities, based on UGC syllabus published by Centre for Science and Environment, (2017). 3. G.Swarajya Lakshmi, Environmental science: A Practical Manual, (2010).

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Indian Constitution**
Course Code	**EIC1001**
Academic Year	First
Semester	I
Number of Credits	1
Course Prerequisite	Nil
Name of the Department	Medical Imaging Technology
Course Synopsis	1. To provide understanding of knowledge of the Indian constitution. 2. To familiarize students with the fundamental rights and duties. 3. To understand the importance of constitutional laws. 4. To understand the correlation between Indian constitution, democracy and society.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the salient features, importance and need of the Constitution (C2)
CO2	Infer the need of fundamental rights in a democratic system for a holistic development of a society (C2)
CO3	Outline the directions given to the state by the constitution and fundamental duties of a citizen towards the state (C2)
CO4	Explain the working nature of State and Centre, roles and responsibilities of President and Governors, amendments emergency powers enjoyed by the government (C2)
CO5	Explain various laws listed under IPC and CrPC and understand importance of voting in a democracy and RTI (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x						x	
CO2				x	x			
CO3			x				x	
CO4						x		x
CO5				x			x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction to Indian Constitution	1. Outline the evolution of the Legal System (C1) (pre-colonial and colonial times, Common Law, Civil Law and Socialist Legal System) 2. Explain the constitutional history and constitutional	3

Content	Competencies	Number of Hours
	assembly (C2) 3. Explain the various organs of the Government (C2) (Executive, Legislature and Judiciary, and Panchayat institutions) 4. Summarise the functions of high court and supreme court of India (C2)	
Unit 2:		
Fundamental Rights	1. Explain the individual rights and fundamental rights (C2) 2. Outline the history of the demand for fundamental rights (C2) 3. Classify the fundamental rights (C2) 4. Explain how fundamental rights are a guarantee against state action (C2) 5. Summarise Article 14 to Article 30 (C2) 6. Explain supreme court as the guardian of Fundamental Rights (C2)	4
Unit 3:		
Fundamental Duties and Directive Principles of State Policy	1. Explain fundamental duties and its enforcement (C2) 2. Summarise the utility and the scope of DPSP(C2) 3. Outline the socialistic pattern of society (C2) 4. Explain the conflict between fundamental rights and DPSP (C2)	3
Unit 4:		
Role of President and Governors/ Cabinet	1. What is the procedure followed while electing a President (C1) 2. Explain the power and duties of the President (C2) 3. Outline the power and duties of the Governors (C2) 4. Explain the role and functions of the council of Ministers (C2)	2
Unit 5:		
Role of citizens, Constitutional laws(IPC and CrPC), RTI	1. Explain the role of citizens in a democracy (C2) 2. Explain constitutional laws (C2) 3. Explain the Indian Penal Code and Code of Criminal Procedure (C2) 4. Summarise right to Information (C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):

Learning Strategies	Contact Hours	Student Learning Time (SLT)
Lecture	15	45
Seminar	-	
Small group discussion (SGD)	-	
Self-directed learning (SDL)	-	
Problem Based Learning (PBL)	-	
Case Based Learning (CBL)	-	
Clinic	-	

Practical		-				
Revision		-				
Assessment		-				
Total		**15**			**45**	
Assessment Methods:						
Formative:		**Summative:**				
Assignments		Mid Semester/Sessional Exam (Theory)				
Mapping of Assessment with COs:						
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Assignments			x		x	x
Mid Semester / Sessional Examination		x	x	x		
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	1. **Subhash C**. **Kashyap, Our Constitution,** National Book Trust. (2011) 2. P. M. Bhakshi. The Constitutution of India. Universal Law Publishing.(2017)					
Additional References	1. Dr. B. R. Ambedkar. The Constitution of India. Educreation Publishing. (2020) 2. Bipan Chandra.History of Modern India. Orient BlackSwan. (2009) 3. Dr. Durga Das Basu. Introduction to the Constitution of India. Lexis Nexis.(2013)					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Communication Skills**
Course Code	**CSK1001**
Academic Year	First
Semester	I
Number of Credits	2
Course Prerequisite	Nil
Course Synopsis	1. Equips the students with primary oral and written communication skills in English. 2. Orients students to focus on diverse interactive situations and enhances the interpersonal skills required in a professional environment.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify the components of communication skills and apply them in a professional setting (C3)
CO2	Outline effective oral communication skills in diverse context (C2)
CO3	Summarize different ways to write creatively, coherently and effectively on a given topic (C2)
CO4	Develop active listening skills involving feedback in diverse interactive situation. (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1					x		x	
CO2					x		x	
CO3		x					x	
CO4			x				x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Communication Skills	1. Define Communication (C1) 2. Outline the process and barriers in Communication (C2) 3. Explain the types of communication (C2) (Oral, Verbal, non-verbal, dyadic) 4. How to improve spoken skills (C1)(Telephone, face – to- face) 5. How to improve communication (C1) 6. Apply the concepts of communication skills in a professional setting (C3) 7. Identify the difference between formal and informal communication (C3)	6

Content	Competencies	Number of Hours
Unit 2:		
Reading Skills	1. Explain the types of reading (C2) (Oral, Silent, Extensive, Scanning, Skimming) 2. Outline the reading techniques (C2) (3Q3R) 3. What is the difference between scanning and skimming(C1) 4. Define source of information (C1) 5. Explain feedback on LSWR in individual presentation (C2) 6. Summarise the role played by prepositions in understanding what to read (C2)	4
Unit 3:		
Listening Skills	1. Explain the types of listening (C2) 2. Summarize the context and purpose of listening (C2) 3. Explain various types of listening obstacles (C2) 4. How to improve hearing and focused listening (C1) 5. What is facilitating understanding, static & process description-gambits (C1)	8
Unit 4:		
Writing skills	1. What is the difference between spoken and written form (C1) 2. How words are formed into phrases & clauses (C1) 3. Outline writing paragraphs, cohesion, coherence (C2) 4. Explain summary, precise and essay writing (C2) 5. How to write a formal and informal letters (C1) 6. How to write a resume /CV(C1) 7. Explain the role of visual aids and meetings in writing (C2) 8. Explain the importance of abbreviations and punctuations in writing(C2)	8

Learning Strategies, Contact Hours and Student Learning Time (SLT):

Learning Strategies	Contact Hours	Student Learning Time (SLT)
Lecture	26	78
Seminar	-	
Small group discussion (SGD)	-	
Self-directed learning (SDL)	-	
Problem Based Learning (PBL)	-	
Case Based Learning (CBL)	-	
Clinic	-	
Practical	-	
Revision	-	
Assessment	-	
Total	**26**	**78**

Assessment Methods:					
Formative:	**Summative:**				
Assignments	Mid Semester/Sessional Exam (Theory)				
Mapping of Assessment with COs:					
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**
Assignments		x	x	x	
Mid Semester / Sessional Examination		x	x	x	x
Feedback Process:	Mid-Semester Feedback				
	End-Semester Feedback				
Main Reference:	1. Jain, A K & et al., (2008-5th Edition). *Professional Communication Skills*, 2008, New Delhi, S Chand and Company 2. Raman, M., & Singh, P. (2012). *Business communication*. New Delhi: Oxford University Press				
Additional References	3. Raman, M & Sharma, S (2014). *Technical communication: Principles and Practice.* New Delhi: Oxford University				

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Radiation Physics**
Course Code	**MIT1101**
Academic Year	First
Semester	I
Number of Credits	3
Course Prerequisite	Student should have basic knowledge of Physics
Course Synopsis	• This module helps to understand the basic physics underpinning diagnostic radiography and imaging science • To understand the mechanisms describing production and interactions of ionizing radiation • To discuss the component and working principle of imaging and treatment equipment used for the clinical care of patients. • To apply radiation physics knowledge to optimize the protocols, using minimal exposure to reach the image quality level needed for the task

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the atomic physics and Nuclear physics (C1,C2)
CO2	Discuss the equipment and the components used for the production of X-ray and optimization of radiographic quality. Explain the photographic principle in radiographic image formation (C2)
CO3	Demonstrate the ability to optimize the radiographic protocols, using minimal exposure to reach the image quality level needed for the task (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x					x		
CO2	x	x						
CO3		x					x	

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Atomic And Nuclear Physics	1. Define atomic structure. (C1) 2. List the atomic Theory. (C1) 3. Define the principles of radioactivity and types of radioactive decay. (C1) 4. Define electromagnetic radiation. (C1) 5. Illustrate the energy characteristics in respect of the electromagnetic spectrum. (C2) 6. Explain Wave and Particle Concept of Electromagnetic Radiation(C2)	4

Content	Competencies	Number of Hours
Unit 2:		
Production of X Rays	1. Explain the production of X-Rays(C2) 2. Illustrate the Continuous and characteristic X-Ray spectrum. (C2) 3. Identify the factor affecting the Quality and quantity of X-Rays(C3) 4. Illustrate the effect of changes in radiographic exposure factors and X-ray tube settings on spectral output of X-rays. (C2) 5. Explain the Thermionic emission (C1) 6. Illustrate the Hard and soft X-Rays(C2) 7. Outline the parts and working principle of Stationary anode X ray tube and Rotating anode X-ray tube(C2) 8. Explain the Heel effect and Line focus principle (C2) 9. Explain the modern x-ray tube(C2) 10. Explain how a significant amount of heat is dissipated following X-ray production. (C2)	6
Unit 3:		
X-Ray Generators	1. Explain Basic principle of Transformer (C2) 2. List the Laws of Transformers(C1) 3. Classify the types of Transformers (C2) 4. Explain transformer power loss(C2) 5. Define the Autotransformer **6.** Explain the filament circuit and high voltage circuit(C2) 7. Recall Alternating Current and Direct Current (C1) 8. Define rectification and its role in X-ray generation (C1) **9.** List out the types of Rectification (C1) 10. Recall Energy Band in solids(C1) 11. Define semiconductors and its types (C1) 12. What are rectifiers?(C1) 13. Explain the vacuum tube rectifiers in X- ray circuit (C2) 14. Explain the semiconductor rectifiers used in the X-ray Circuit (C2) 15. Recall the principle of Generator(C1) 16. Classify the types of generators (Six pulses, six-rectifier six pulses, twelve-rectifier Twelve-pulse, Capacitor discharge generators). (C2) **17.** Classify the types of generators (Battery-powered generators, Medium-Frequency Generators and Falling load Generators). (C2) 18. Explain the Transformer rating. (C2) 19. Explain the Exposure Switch(Primary and Secondary Switching)(C2) 20. Explain the four basic types of exposure timers. (1. Mechanical 2. Electronic timers 3. Automatic exposure control (photo timers) 4. Pulse-counting timers). (C2)	11

Content	Competencies	Number of Hours
	21. Make use of the Automatic Exposure control in controlling the production of X- ray (C3) 22. Explain the different component in x-ray circuit (C2)	
Unit 4:		
Basic Interactions between X Rays and Matter	1. Explain the Interactions between X Rays and Matter(C2) 2. Classify the Interactions between X Rays and Matter(C2) 3. Explain Coherent scattering, Photoelectric effect, Compton scattering, Pair production and Photodisintegration(C2) 4. Identify the effect of Interactions Between X Rays and Matter in Diagnostic Radiology(C3)	3
Unit 5:		
Attenuation of radiation	1. Explain the Attenuation of radiation (C2) 2. Explain the attenuation of monochromatic radiation. (C2) 3. Explain the linear attenuation coefficients, the mass attenuation coefficients, the electronic attenuation coefficients, and the atomic attenuation coefficients. (C2) 4. Relate the Density, Atomic Number, and Electrons per Gram with Attenuation of radiation. (C2) 5. Explain the attenuation of Polychromatic Radiation. (C2) 6. Make use of Attenuation of radiation in diagnostic radiology (C3) 7. Explain the Scatter Radiation(C2) **8.** Illustrate the factors Affecting Scatter Radiation(C2)	3
Unit 6:		
Filters	1. Explain the Filtration and Filters(C2) 2. Classify the different level the x-ray is filtered after the production in x-ray tube (inherent filtration, added filter, and patient). (C2) 3. Explain Wedge Filters and K-Edge Filters. (C2) 4. Explain the effect on exposure factors and Filters effect the Patient exposure (C2) 5. Make use of Filters in patient care (C2)	3
Unit 7:		
X-Ray Beam Restrictors	1. Define X-Ray Beam Restrictors(C1) 2. Classify the different type of X-Ray Beam Restrictors(aperture diaphragms, cones, and cylinders, collimators)(C2) 3. Interpret the testing of X-Ray Beam and Light Beam Alignment. (C2) 4. Make use of restrictors in patient care (Patient Protection and Decreased Scatter Radiation with Collimators). (C3)	3
Unit 8:		
Grids	1. Explain Grids and Grid ratio(C2) 2. List the Grid pattern(linear grid, crossed grid, focused grid, parallel grid)(C1) 3. Explain the Lines per inch in the grid (C2) 4. Explain the evaluation of grid performance (primary transmission, Bucky factor, and contrast improvement	6

Content	Competencies	Number of Hours
	factor) (C2) 5. Explain the Grid Cut-off(C2) 6. List the situations that produce grid cut-off (focused grids used upside down, lateral decentring, focus-grid distance decentring and combined lateral and focus-grid distance decentring)(C1) 7. Explain the Moving Grids(C2) 8. Choose the Grid for proper image quality in radiography(C3) 9. Define the air gap techniques(C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):			
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**	
Lecture	26	52	
Seminar			
Small group discussion (SGD)	5	10	
Self-directed learning (SDL)	-	-	
Problem Based Learning (PBL)	-	-	
Case Based Learning (CBL)	-	-	
Clinic	-	-	
Practical	-	-	
Revision	-	-	
Assessment	8	16	
Total	**39**	**78**	
Assessment Methods:			
Formative:	**Summative:**		
Unit Test	Mid Semester Exam (Theory)		
Assignments/Presentations	End Semester Exam (Theory)		
Mapping of Assessment with COs:			
Nature of Assessment	**CO1**	**CO2**	**CO3**
Mid Semester Examination	x	x	
Assignments/Presentations	x	x	x
End Semester Exam	x	x	x
Feedback Process:	Mid-Semester Feedback		
	End-Semester Feedback		

Main Reference:	• Christensen, E. E., Curry, T. S., Dowdey, J. E., & Murry, R. C. (1984). Christensen's Introduction to the physics of diagnostic radiology. Philadelphia: Lea & Febiger. • Selman, J. (1961). The fundamentals of X-ray and radium physics. Springfield, Ill.
Additional References	• Bushberg, J. T. (2002). The essential physics of medical imaging. Philadelphia: Lippincott Williams & Wilkins. • Allisy-Roberts, P. J., Williams, J. R., & Farr, R. F. (2008). Farr's physics for medical imaging. Edinburgh: Saunders Elsevier. • Holmes, K., Clark, K. C., Elkington, M., & Harris, P. (2014). Clark's essential physics in imaging for radiographers. Boca Raton, FL: CRC Press, Taylor & Francis Group.

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science inMedical Imaging Technology
Course Title	**Radiographic Positioning and Techniques - I**
Course Code	**MIT1102**
Academic Year	First
Semester	I
Number of Credits	3
Course Prerequisite	Student should have basic knowledge of Physics and Biology
Course Synopsis	• This module provides the basis for students to undertake radiographic practice within the clinical environment. • To provide fundamental knowledge of the skeletal system and the different part of the bones. • To provide fundamental knowledge of the various radiographic x-ray views (both standard and special views) for the thorax, upper limb and lower limb. • To identify the factors and characteristics of the radiographic image quality that affect the clinical application • To provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Explain about the related radiological anatomy. (C2)
CO2	Explain the clinical indications and preparation of the patient for the various radiological projections. (C2)
CO3	Explain the basic and special projections related to appendicular and axial skeleton. (C2)
CO4	Select the appropriate radiographic factors to generate good radiographic quality image. (C3)
CO5	Identify and interpret the structures seen on the radiograph. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2		x		x				
CO3	x	x						
CO4		x				x		
CO5	x							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1: Introduction to Radiographic Terminologies		
• Anatomical	1. Explain the various anatomical terminology.(C2)	2

Content	Competencies	Number of Hours
Terminology • Positioning Terminology • Projection Terminology	2. Explain the various radiographic positions and Terminology. (C2) 3. Explain the various radiographic projections and terminology. (C2)	
Unit 2: Radiographic Image Quality		
• Density • Noise • Contrast • Sharpness • Resolution • Magnification • Distortion Exposure Factors • Milliampere seconds • Kilovoltage • Focus to film distance • Secondary radiation • Grids	1. Define the various characteristics of a radiographic image quality.(C2) 2. Outline the factors affecting the radiographic image quality(C2) 3. Define the various exposure factors.(C2) 4. Explain the significances and effect of the exposure factors for obtaining a radiographic image(C2)	2
Unit 3: Chest		
• Related radiological anatomy and Pathology	1. Explain the related radiological anatomy of chest (C2). 2. Classify the indications for chest radiography (C2).	1
Basic Projection • Posterior Anterior (PA) • Lateral	1. Explain the patient preparation required for basic chest radiographic projection (C2). 2. Explain the step wise process of positioning for basic chest projection (C2). 3. Identify appropriate centring for basic chest radiography (C2). 4. Select the appropriate radiographic exposure factors for basic chest radiography (C3). 5. Identify the structure seen on basic projection chest radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
Special Projections • Anterior Posterior (AP) supine • Semi-erect • Lateral decubitus • Anterior Posterior lordotic • Anterior oblique • Posterior oblique • Upper airway: Anterior	1. Explain the patient preparation required for Special chest radiographic projection (C2). 2. Explain the step wise process of positioning for special chest projection (C2). 3. Identify appropriate centring for special chest radiography (C2). 4. Select the appropriate radiographic exposure factors for special chest radiography (C3). 5. Identify the structure seen on special projection chest radiographic image (C2). 6. Explain the image evaluation criteria (C2).	2

Content	Competencies	Number of Hours
Posterior, Lateral	7. Outline the radiation protection method used (C2) 8. Explain the differences between AP and PA chest radiography (C2).	
UNIT 4: Shoulder girdle		
• Related radiological anatomy and Pathology	1. Explain the related radiological anatomy of Shoulder joint, sterno-clavicular joint, clavicle, and Scapula (C2). 2. Classify the indications for shoulder joint, sterno-clavicular joint, clavicle, and scapula Radiography (C2).	1
Basic Projection Shoulder (non trauma) • Anterior • Posterior (external rotation) • Anterior Posterior (internal rotation) • Superior-inferior (axial view) • Inferiosuperior axial (Lawrence method) Shoulder (trauma routine) • Anterior Posterior neutral rotation • Transthoracic lateral (Lawrence method) Clavicle: • Anterior Posterior • Anterior Posterior axial Acromioclavicular joints: • Anterior Posterior bilateral with and without weight Sternoclavicular joints • Posterior Anterior • Right Anterior Oblique • Left Anterior Oblique Scapula • Anterior Posterior • Scapula Y view • Lateral recumbent	1. Explain the patient preparation required for basic shoulder joint, sterno-clavicular joint, clavicle, and scapula radiographic projection (C2). 2. Explain the step wise process of positioning for basic shoulder joint, sterno-clavicular joint, clavicle, and scapula projection (C2). 3. Identify appropriate centring for basic shoulder joint, sterno-clavicular joint, clavicle, and scapula radiography (C2). 4. Select the appropriate radiographic exposure factors for basic shoulder joint, sterno-clavicular joint, clavicle, and scapula radiography (C3). 5. Identify the structure seen on basic projection shoulder joint, sterno- clavicular joint, clavicle, and scapula radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method (C2)	3
Special Projection Shoulder (non trauma) • Inferiosuperior shoulder projection(west point method)	1. Explain the patient preparation required for Special shoulder joint radiographic projection (C2). 2. Explain the step wise process of positioning for special shoulder joint projection (C2). 3. Identify appropriate centring for special	2

Content	Competencies	Number of Hours
• Posterior oblique – glenoid cavity(Grashey method) • Intertubercular groove (Fisk method) Shoulder (trauma routine) • Tangential projection-supraspinatus outlet (Neer method) • Apical oblique projections (garth method)	shoulder joint radiography (C2). 4. Select the appropriate radiographic exposure factors for special shoulder joint radiography (C3). 5. Identify the structure seen on special projection shoulder joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2)	
UNIT 5: Humerus		
• Related radiological anatomy	1. Explain the related radiological anatomy of Humerus (C2). 2. Classify the indications for Humerus radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic projection of Humerus (C2). 2. Explain the step wise process of positioning for basic projection of Humerus (C2). 3. Identify appropriate centring for basic projection of Humerus (C2). 4. Select the appropriate radiographic exposure factors for basic projection of Humerus (C3). 5. Identify the structure seen on basic projection of Humerus (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
Special Projection • Horizontal beam • Proximal humerus views	1. Explain the patient preparation required for Special projection of Humerus (C2). 2. Explain the step wise process of positioning for Special projection of Humerus (C2). 3. Identify appropriate centring for Special projection of Humerus (C2). 4. Select the appropriate radiographic exposure factors for Special projection of Humerus (C3). 5. Identify the structure seen on Special projection of Humerus (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 6: Elbow Joint		
• Related radiological anatomy	1. Explain the related radiological anatomy of Elbow Joint (C2). 2. Classify the indications for Elbow Joint	1

Content	Competencies	Number of Hours
	radiography (C2).	
Basic Projection • Anterior Posterior – fully extended, partially flexed • Anterior Posterior oblique- external and internal rotation • Lateral	1. Explain the patient preparation required for basic elbow joint projection (C2). 2. Explain the step wise process of positioning for basic elbow joint projection (C2). 3. Identify appropriate centring for basic elbow joint radiography (C2). 4. Select the appropriate radiographic exposure factors for basic elbow joint radiography (C3). 5. Identify the structure seen on basic elbow joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
Special Projection • Acute flexion (jones method) • Trauma axial lateral (coyle method) • Radial head lateral	1. Explain the patient preparation required for Special elbow joint radiographic projection (C2). 2. Explain the step wise process of positioning for Special elbow joint projection (C2). 3. Identify appropriate centring for Special elbow joint radiography (C2). 4. Select the appropriate radiographic exposure factors for Special elbow joint radiography (C3). 5. Identify the structure seen on Special elbow joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 7: Forearm		
• Related radiographic anatomy	1. Explain the related radiological anatomy of forearm (C2). 2. Classify the indications for forearm radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic forearm radiographic projection (C2). 2. Explain the step wise process of positioning for basic forearm projection (C2). 3. Identify appropriate centring for basic forearm radiography (C2). 4. Select the appropriate radiographic exposure factors for basic forearm radiography (C3). 5. Identify the structure seen on basic forearm radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
UNIT 8: Wrist Joint		

Content	Competencies	Number of Hours
• Related radiographic anatomy	1. Explain the related radiological anatomy of wrist joint (C2). 2. Classify the indications for wrist joint radiography (C2).	1
Basic Projection • Posterior Anterior • Anterior Posterior • Posterior Anterior oblique • Lateral	1. Explain the patient preparation required for basic wrist joint radiographic projection (C2). 2. Explain the step wise process of positioning for basic wrist joint projection (C2). 3. Identify appropriate centring for basic wrist joint radiography (C2). 4. Select the appropriate radiographic exposure factors for basic wrist joint radiography (C3). 5. Identify the structure seen on basic wrist joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
Special Projection • Posterior Anterior scapula views • Radial deviation, ulnar deviation • Carpal canal-inferiosuperior (gaynor-hart method) • Carpel bridge	1. Explain the patient preparation required for special wrist joint radiographic projection (C2). 2. Explain the step wise process of positioning for special wrist joint projection (C2). 3. Identify appropriate centring for special wrist joint radiography (C2). 4. Select the appropriate radiographic exposure factors for special wrist joint radiography (C3). 5. Identify the structure seen on special projection wrist joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 9: Hand		
Related radiographic anatomy	1. Explain the related radiological anatomy of hand (C2). 2. Classify the indications for hand radiography (C2).	1
Basic Projection • Posterior Anterior • Posterior Anterior oblique • Lateral • Lateral- flexion and extension	1. Explain the patient preparation required for basic hand radiographic projection (C2). 2. Explain the step wise process of positioning for basic hand projection (C2). 3. Identify appropriate centring for basic hand radiography (C2). 4. Select the appropriate radiographic exposure factors for basic hand radiography (C3). 5. Identify the structure seen on basic hand radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	

Content	Competencies	Number of Hours
Special Projection • Anterior Posterior bilateral oblique (norgaard method)	1. Explain the patient preparation required for special hand radiographic projection (C2). 2. Explain the step wise process of positioning for special hand projection (C2). 3. Identify appropriate centring for special hand radiography (C2). 4. Select the appropriate radiographic exposure factors for special hand radiography (C3). 5. Identify the structure seen on special projection hand radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 10: Fingers		
• Related radiological anatomy	1. Explain the related radiological anatomy of fingers (C2). 2. Classify the indications for finger radiography (C2).	1
Basic Projection • Posterior Anterior • Oblique • Lateral	1. Explain the patient preparation required for basic finger projection (C2). 2. Explain the step wise process of positioning for basic finger projection (C2). 3. Identify appropriate centring for basic finger radiography (C2). 4. Select the appropriate radiographic exposure factors for basic finger radiography (C3). 5. Identify the structure seen on basic finger radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
UNIT 11: Thumb		
• Related radiographic anatomy	1. Explain the related radiological anatomy of thumb (C2). 2. Classify the indications for thumb radiography (C2).	1
Basic Projection • Anterior Posterior • Posterior Anterior oblique • Lateral	1. Explain the patient preparation required for basic thumb radiographic projection (C2). 2. Explain the step wise process of positioning for basic thumb projection (C2). 3. Identify appropriate centring for basic thumb radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic thumb radiography (C3). 5. Identify the structure seen on basic thumb radiographic image (C2). 6. Explain the image evaluation criteria (C2).	

Content	Competencies	Number of Hours
	7. Outline the radiation protection method used (C2).	
Special Projection • Anterior Posterior (Roberts method) • Skiers thumb (folio method)	1. Explain the patient preparation required for special thumb radiographic projection (C2). 2. Explain the step wise process of positioning for special thumb projection (C2). 3. Identify appropriate centring for special thumb radiography (C2). 4. Select the appropriate the radiographic exposure factors for special thumb radiography (C3). 5. Identify the structure seen on special projection thumb radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 12: Femur		
• Related radiographic anatomy	1. Explain the related radiological anatomy of femur (C2). 2. Classify the indications for femur radiography (C2).	1
Basic Projection Mid and distal femur • Anterior Posterior • Lateral Mid and proximal femur • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic femur radiographic projection (C2). 2. Explain the step wise process of positioning for basic femur projection (C2). 3. Identify appropriate centring for basic femur radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic femur radiography (C3). 5. Identify the structure seen on basic femur radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 13: Knee Joint		
• Related radiographic anatomy	1. Explain the related radiological anatomy of knee joint (C2). 2. Classify the indications for knee joint radiography (C2).	1
Basic Projection • Anterior Posterior • Oblique- medial and lateral rotations • Lateral	1. Explain the patient preparation required for basic knee joint radiographic projection (C2). 2. Explain the step wise process of positioning for basic knee joint projection (C2). 3. Identify appropriate centring for basic knee joint radiography (C2). 4. Select the appropriate the radiographic	1

Content	Competencies	Number of Hours
	exposure factors for basic knee joint radiography (C3). 5. Identify the structure seen on basic knee joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
Special Projection • Skyline view • Anterior Posterior (weight bearing) • Knee- intercondylar fossa • Posterior Anterior axial(camp coventry and holmblad method) • Anterior Posterior axial	1. Explain the patient preparation required for special knee joint radiographic projection (C2). 2. Explain the step wise process of positioning for special knee joint projection (C2). 3. Identify appropriate centring for special knee joint radiography (C2). 4. Select the appropriate the radiographic exposure factors for special knee joint radiography (C3). 5. Identify the structure seen on special projection knee joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 14: Leg		
• Related radiographic anatomy	1. Explain the related radiological anatomy of leg (C2). 2. Classify the indications for leg radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic leg radiographic projection (C2). 2. Explain the step wise process of positioning for basic leg projection (C2). 3. Identify appropriate centring for basic leg radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic leg radiography(C3) 5. Identify the structure seen on basic leg radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
UNIT 15: Ankle joint		
• Related radiographic anatomy	1. Explain the related radiological anatomy of ankle joint (C2). 2. Classify the indications for ankle joint radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic ankle joint radiographic projection (C2). 2. Explain the step wise process of positioning	1

Content	Competencies	Number of Hours
	for basic ankle joint projection (C2). 3. Identify appropriate centring for basic ankle joint radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic ankle joint radiography (C3). 5. Identify the structure seen on basic ankle joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	
Special Projection • Anterior Posterior mortise (15° oblique) • Anterior Posterior stress	1. Explain the patient preparation required for special ankle joint radiographic projection (C2). 2. Explain the step wise process of positioning for special ankle joint projection (C2). 3. Identify appropriate centring for special ankle joint radiography (C2). 4. Select the appropriate the radiographic exposure factors for special ankle joint radiography (C3). 5. Identify the structure seen on special projection ankle joint radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 16: Foot		
• Related radiographic anatomy	1. Explain the related radiological anatomy of foot (C2). 2. Classify the indications for foot radiography (C2).	1
Basic Projection • Anterior Posterior • Oblique • Lateral • Anterior Posterior and lateral weight bearing	1. Explain the patient preparation required for basic foot radiographic projection (C2). 2. Explain the step wise process of positioning for basic foot projection (C2). 3. Identify appropriate centring for basic foot radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic foot radiography(C3). 5. Identify the structure seen on basic foot radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
UNIT 17: Calcaneus		
• Related radiographic anatomy	1. Explain the related radiological anatomy of calcaneus (C2). 2. Classify the indications for calcaneus radiography (C2).	1

Content	Competencies	Number of Hours
Basic Projection • Planto-dorsal(axial) • Lateral	1. Explain the patient preparation required for basic calcaneus radiographic projection (C2). 2. Explain the step wise process of positioning for basic calcaneus projection (C2). 3. Identify appropriate centring for basic calcaneus radiography (C2). 4. Select the appropriate the radiographic exposure factors for basic calcaneus radiography (C3). 5. Identify the structure seen on basic calcaneus radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	3	6
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	5	10
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory and/or Practical)
Quiz	End Semester Exam (Theory and/or Practical)
Viva	Viva
Assignments/Presentations	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	-	x	-	-	x
Quiz / Viva	x	-	-	-	x	-
Assignments/Presentations	x		x	-	-	-
Clinical/Practical Log Book/ Record Book	-	x	-	x	-	-
End Semester Exam	x	x	x	x	x	-

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback

Main Reference:	Clarks Positioning in Radiography, R.A. Swallow, E. Naylor Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D.
Additional References	Skeletal Anatomy, Bryan Glenda J Text Book of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Image evaluation and Interpretation of Radiograph - I**
Course Code	**MIT1103**
Academic Year	First
Semester	I
Number of Credits	2
Course Prerequisite	Students should have basic knowledge of Physics and Biology
Course Synopsis	• This module provides fundamental knowledge to interpret the radiological anatomy and structures seen on the radiographic image of Chest, Upper limb and lower limb. • To provide fundamental knowledge of evaluation of radiographic image quality of Chest, Upper limb and lower limb by using definable standard (evaluation criteria). • To provide fundamental knowledge of exposure factors and techniques in order to obtain radiographic image with optimum radiation and diagnostic image quality. • To provide fundamental knowledge to determine the radiograph required for chest, upper limb and lower limb based on indication • To provide fundamental knowledge of common faults in the radiographs and remedy

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	List the radiological anatomy and structures seen on the radiographic image. (C1)
CO2	Relate the radiological anatomy with radiographic image (C2)
CO3	Identify the radiographic view required for the patient based on the indication. (C3)
CO4	Make use of evaluation criteria format to identify the radiographic image quality by a using definable standard. (C3)
CO5	Choose the appropriate remedy measure for faults in the radiographs. (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x	x						
CO3	x	x						
CO4	x	x						
CO5	x	x						

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Image evaluation and Interpretation of Chest for basic and special views: • PA • Lateral • AP • Lateral decubitus • AP lordotic • Anterior oblique • Posterior oblique Upper Airway • Lateral • AP	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	3
Unit 2:		
Image evaluation and Interpretation of shoulder girdle for basic and special view: Shoulder girdle-non-trauma • AP-external rotation • AP-internal rotation • Inferosuperior axial-Lawrence method • PA transaxillary-Hobbs modification • Inferosuperior axial-Clements method • Posterior oblique-Grashey method • Intertubercular (bicipital) groove-Fisk modification Shoulder girdle-trauma • AP-neutral rotation • Transthoracic lateral-Lawrence method • Scapular “Y” • Tangential-supraspinatus outlet-Neer method • AP apical oblique axial-Garth method Clavicle • AP • AP axial Acromio clavicular joint	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) **6.** Identify and Summarize the basic and special projections with indication (C2, C3)	3

Content	Competencies	Number of Hours
•AP with and without weight Sternoclavicular joint •AP •RAO •LAO Scapula • AP • Lateral-erect • Lateral-recumbent		
Unit 3:		
Image evaluation and Interpretation of Humerus for basic and special views: • AP • Rotational lateral-lateromedial and mediolateral • Trauma-horizontal beam lateral • Transthoracic lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	2
Unit 4:		
Image evaluation and Interpretation of Elbow basic and special views: • AP • AP oblique lateral(external) rotation • AP oblique medial (internal) rotation • Lateromedial • AP-acute flexion • Trauma axial laterals-Coyle method • Radial head laterals	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	2
Unit 5:		
Image evaluation and Interpretation of Forearm basic and special views: • AP • Lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2)	1

Content	Competencies	Number of Hours
	3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	
Unit 6:		
Image Evaluation and Interpretation of Wrist basic and special views: • PA, AP • PA oblique • Lateral • PA scapula views • Radial deviation, ulnar deviation • Carpal canal- inferiosuperior (gaynor-hart method) • Carpel bridge	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	2
Unit 7:		
Image Evaluation and Interpretation of Hand basic and special views: • PA • PA Oblique • “Fan” lateral-lateromedial or mediolateral • Lateral in extension and flexion • Bilateral AP oblique-Norgaard method	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	2
Unit 8:		
Image Evaluation and Interpretation of finger basic and special views: • PA • PA Oblique • Lateral-lateromedial or	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in	1

Content	Competencies	Number of Hours
mediolateral	relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	
Unit 9:		
Image Evaluation and Interpretation of thumb basic and special views: • AP • PA Oblique • Lateral • AP Axial-modified Robert's method • PA Stress-folio method	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	1
Unit 10:		
Image Evaluation and Interpretation of femur basic and special views: Mid and distal femur • AP • Lateral Mid and proximal femur • AP • Lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	1
Unit 11:		
Image Evaluation and Interpretation of knee basic and special views: • AP • Oblique-medial rotation • Oblique-lateral rotation • Lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2)	3

Content	Competencies	Number of Hours
• AP weight bearing bilateral • PA axial weight-bearing (Rosenberg method) Knee-intercondylar fossa • PA axial (Camp Coventry and Holmblad methods) • AP axial Patella and femoropatellar joint • PA • Lateral • Tangential-axial or sunrise/skyline (Merchant method) • Tangential- inferosuperior, Superoinferior	4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	
Unit 12:		
Image Evaluation and Interpretation of leg basic and special views: • AP • Lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	1
Unit 13:		
Image Evaluation and Interpretation of ankle basic and special views: • AP • AP mortise (15° to 20°oblique) • AP oblique (45°) • Lateral • AP Stress	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication.(C2, C3)	1

Content	Competencies	Number of Hours
Unit 14:		
Image Evaluation and Interpretation of calcaneus basic and special views: • Plantodorsal (axial) • Lateral	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	1
Unit 15:		
Image Evaluation and Interpretation of foot basic and special views: • AP • Oblique • Lateral • AP weight bearing • Lateral weight bearing	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication. (C2, C3)	1
Unit 16:		
Image Evaluation and Interpretation of toes basic and special views: • AP • Oblique-medial or lateral rotation • Lateral-mediolateral or lateromedial • Tangential-Sesamoids	1. What anatomical parts and structures that should be clearly visualized on that radiographic image? (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication. (C2, C3)	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)

Mapping of Assessment with COs:					
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester / Sessional Examination 1	x	x	x	x	x
Sessional Examination 2	-	-	-	-	-
Quiz / Viva	-	x	-	-	-
Assignments/Presentations	x	-	-	-	-
Clinical/Practical Log Book/ Record Book	-	-	-	-	-
Any others: WPBA	-	-	-	-	-
End Semester Exam	-	-	-	-	-

Feedback Process:	Mid-Semester Feedback
Main Reference:	• Text Book of Radiographic Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P. • Merrill's Atlas of Radiographic Positions and Radiologic Procedures Vol 1,2,3, Ballinger Philip W; Frank Eugene D
Additional References	Clarks Positioning In Radiography, R. A. Swallow, E Naylor

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical Aspect of Radiographic Positioning and Techniques - I**
Course Code	**MIT1131**
Academic Year	First
Semester	I
Number of Credits	3
Course Prerequisite	Basic knowledge of general anatomy
Course Synopsis	• This module provides the basis for students to undertake radiographic practice within the clinical environment. • To provide fundamental knowledge of the skeletal system and the different part of the bones. • To provide fundamental knowledge of the various radiographic x-ray views (both standard and special views) for the thorax, upper limb and lower limb. • To identify the factors and characteristics of the radiographic image quality that affect the clinical application • To provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Make use of learned instructions to prepare the patient for the various radiological projections. (C3, P4, A3)
CO2	Explain the positioning technique for various radiographic projections. (C3, P5, A2)
CO3	Select the appropriate radiographic factors to generate good radiographic quality image. (C3, P6)
CO4	Identify and interpret the structures seen on the radiograph. (C3)
CO5	Use appropriate radiographic accessories .(C3)
CO6	Operate the radiographic equipment. (C3, P5)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x			x				
CO2		x		x				
CO3		x				x		
CO4	x							
CO5		x				x		
CO6		x	x					

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1: Chest		
Basic Projection • Posterior Anterior (PA) • Lateral **Special Projections** • Anterior Posterior (AP) supine • Semierect • Lateral decubitus • Anterior Posterior lordotic • Anterior oblique • Posterior oblique • Upper airway: Anterior Posterior, Lateral	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	15
Unit 2: Shoulder girdle		
Basic Projection **Shoulder (non trauma)** • Anterior • Posterior (external rotation) • Anterior Posterior (internal rotation) • Superior-inferior (axial view) • Inferiosuperior axial (Lawrence method**)** **Shoulder (trauma routine)** • Anterior Posterior neutral rotation • Transthoracic lateral (Lawrence method) **Clavicle:** • Anterior Posterior • Anterior Posterior axial **Acromioclavicular joints:** • Anterior Posterior bilateral with and without weight **Sternoclavicular joints** • Posterior Anterior	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	15

Content	Competencies	Number of Hours
• Right Anterior Oblique • Left Anterior Oblique **Scapula** • Anterior Posterior • Scapula Y view • Lateral recumbent **Special Projection** **Shoulder (non trauma)** • Inferiosuperior shoulder projection(west point method) • Posterior oblique – glenoid cavity(Grashey method) • Intertubercular groove (Fisk method) **Shoulder (trauma routine)** • Tangential projection-supraspinatus outlet (Neer method) • Apical oblique projections (garth method)		
Unit 3: Humerus		
Basic Projection • Anterior Posterior • Lateral **Special Projection** • Horizontal beam • Proximal humerus views	• Explain the anatomy (C2). • Identify the part being radiographed (C1). • Prepare the patient for the radiograph (C3, P4, A3). • Demonstrate the steps involved in positioning (C3, P5, A2). • Select the appropriate technical factors (C3, P6). • Identify the structures seen on the radiograph (C2). • Employ radiation protection techniques (C3). • Use appropriate radiographic accessories for positioning (C3). • Recognize the abnormal radiograph (C3). • Review the obtained image for quality (C2). • Operate the radiographic equipment (C3, P5)	6
Unit 4: Elbow Joint		
Basic Projection • Anterior Posterior –fully extended, partially	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3,	9

Content	Competencies	Number of Hours
flexed • Anterior Posterior oblique- external and internal rotation • Lateral **Special Projection** • Acute flexion (jones method) • Trauma axial lateral (coyle method) • Radial head lateral	P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	
Unit 5: Forearm		
Basic Projection • Anterior Posterior • Lateral	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	6
Unit 6: Wrist Joint		
Basic Projection • Posterior Anterior • Anterior Posterior • Posterior Anterior oblique • Lateral **Special Projection** • Posterior Anterior scapula views • Radial deviation, ulnar deviation • Carpal canal-inferiosuperior (gaynor-hart method) • Carpel bridge	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2).	10

Content	Competencies	Number of Hours
	11. Operate the radiographic equipment (C3, P5).	
Unit 7: Hand		
Basic Projection • Posterior Anterior • Posterior Anterior oblique • Lateral • Lateral- flexion and extension **Special Projection** • Anterior Posterior bilateral oblique (norgaard method)	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5)	6
Unit 8: Fingers		
Basic Projection • Posterior Anterior • Oblique • Lateral	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	6
Unit 9: Thumb		
Basic Projection • Anterior Posterior • Posterior Anterior oblique • Lateral **Special Projection** • Anterior Posterior (Roberts method) • Skiers thumb (folio method)	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories	5

Content	Competencies	Number of Hours
	for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5)	
Unit 10: Femur		
Basic Projection **Mid and distal femur** • Anterior Posterior • Lateral **Mid and proximal femur** • Anterior Posterior\ • Lateral	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality(C2). 11. Operate the radiographic equipment (C3, P5).	7
Unit 11: Knee Joint		
Basic Projection • Anterior Posterior • Oblique- medial and lateral rotations • Lateral **Special Projection** • Skyline view • Anterior Posterior (weight bearing) • Knee- intercondylar fossa • Posterior Anterior axial(camp coventry and holmblad method) • Anterior Posterior axial	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	9
Unit 12: Leg		
Basic Projection • Anterior Posterior • Lateral	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2).	5

Content	Competencies	Number of Hours
	5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	
Unit 13: Ankle joint		
Basic Projection • Anterior Posterior • Lateral **Special Projection** • Anterior Posterior mortise (15° oblique) • Anterior Posterior stress	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	8
Unit 14: Foot		
Basic Projection • Anterior Posterior • Oblique • Lateral • Anterior Posterior and lateral weight bearing	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	5
Unit 14: Calcaneus		
Basic Projection • Planto-dorsal(axial) • Lateral	1. Explain the anatomy (C2). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in	5

Content	Competencies	Number of Hours
	positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques(C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5) .	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	117	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**117**	**-**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory and/or Practical)
Quiz	End Semester Exam (Theory and/or Practical)
Viva	Viva
Clinical assessment (OSCE, OSPE, WBPA)	Record Book
Clinical/Practical Log Book/ Record Book	-

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x	-	-	-	x
Quiz / Viva	-	x	x	x	-	-
Assignments/Presentations	x	-		x	x	-
Clinical/Practical Log Book/ Record Book	-	-	x	-	-	-
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Clarks Positioning in Radiography, R.A. Swallow, E. Naylor • Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D.
Additional References	• Skeletal Anatomy, Bryan Glenda J • Text Book of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P

SEMESTER - II

COURSE CODE	:	COURSE TITLE
ANA1201	:	Anatomy - II
PHY1201	:	Physiology - II
BIC1201	:	Biochemistry
MIT1201	:	Radiographic Positioning and Techniques - II
MIT1202	:	Digital Imaging & Image processing methods in Radiography
MIT1203	:	Image evaluation and Interpretation of Radiographs - II
MIT1231	:	Clinical aspect of Radiographic Positioning and Techniques - II

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Anatomy- II**
Course Code	**ANA1201**
Academic Year	First Year
Semester	II
Number of Credits	2
Course Prerequisite	Basic knowledge in Biology
Course Synopsis	Human anatomy is the study of the human body and relations of various structures of the body by dissection.
Course Outcomes (COs): At the end of the course student shall be able to	
CO1	Explain the musculoskeletal system related to the upper and lower extremities. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							

Course Content and Outcomes:

Content	Competencies	Number of Hours (Theory)
Unit 1:		
Pectoral region And Axilla	• Describe the pectoral muscles –pectoralis major, pectoralis minor, serratus anterior with attachments, nerve supply and actions (C1, C2) • Explain anatomical basis of winging of scapula (C2) • Describe the clavipectoral fascia (C1) • Describe the boundaries and contents of axilla (C1, C2) • Describe the axillary artery- extent, course and branches (C1, C2) • Describe the brachial plexus formation and branches (C1, C2) • Describe the Erb's point mentioning the clinical aspects (C2) • Describe the Klumpke's paralysis (C2)	3
Muscles of back and shoulder region	• Describe the muscles of back and shoulder region- trapezius, deltoid, latissimus dorsi, rhomboidus major and minor, supraspinatus, infraspinatus, teres major and minor (detailed) C1, C2) • Describe the deltoid with applied anatomy (C1, C2) • Describe the supraspinatus with applied anatomy (C1, C2) • Describe the subacromial bursa with applied anatomy (C1, C2) • Describe the rotator cuff with its role in limiting	2

Content	Competencies	Number of Hours (Theory)
	shoulder dislocation (C1, C2) • Describe each of the intermuscular spaces with boundaries and contents (C1, C2)	
Arm	• Describe the muscles of front of arm- biceps brachii, brachialis, coracobrachialis with attachments, nerve supply and actions (C1, C2) • Describe the boundaries and contents of cubital fossa (C1, C2) • Describe the brachial artery with mention of Volkmann's ischemic contracture and supracondylar fracture (C1, C2) • Describe the axillary nerve with applied anatomy (C1, C2) • Describe musculocutaneous nerve with applied anatomy (C1, C2) • Describe the triceps brachii with the nerve supply & actions (C1, C2) • Describe radial nerve with applied anatomy (C1, C2)	2
Forearm	• Name the superficial and deep muscles of front of forearm with nerve supply and actions (C1, C2) • Describe pronator teres and brachioradialis in detail (C1, C2) • Names the muscles of back of forearm with nerve supply and actions (C1, C2) • Describe the supinator in detail (C1, C2) • Explains tennis elbow (C1, C2) • Describe the extensor retinaculum with osseo-fascial compartments in detail (C1) • Describe the anatomical snuff box with boundaries and contents (C1, C2)	2
Palm	• Describe the flexor retinaculum with applied anatomy (C1, C2) • briefly Describe the palm -name thenar and hypothenar muscles with nerve supply and action (C1) • Describe adductor pollicis (C1) • Describe the lumbricals and interossei (detailed) with nerve supply and actions (C1, C2)	1
Nerves and vessels of upper limb	• Describe the ulnar nerve with applied anatomy (C1,C2) • Describe the median nerve in detail (C1, C2) • Explains carpal tunnel syndrome detailed (C1, C2) • Describe each radial and ulnar artery- extent, course and branches (C1, C2)	3
Joints of upper limb	• Describe the shoulder joint under type, articular surfaces, ligaments, relations, movements and muscles responsible with a note on applied anatomy (C1, C2)Describe the elbow joint (detailed) (C1, C2) • Describe the radioulnar joints (detailed) (C1)	3

Content	Competencies	Number of Hours (Theory)
	• Describe the wrist joint (detailed) (C1, C2) • Describe the first carpometacarpal joint (detailed) (C1)	
Venous and lymphatic drainage of upper limb	• Describe the median cubital vein with applied anatomy (C1, C2) • Describe the cephalic vein with applied anatomy (C1, C2) • Describe the basilic vein with applied anatomy (C1,C2) • Describe the lymphatic drainage of upper limb (C1,C2)	1
Sternocleidomastoid and Muscles of facial expression	• Describe the sternocleidomastoid with attachments, relations, nerve supply, actions and applied anatomy (C1, C2) • Enumerates the muscles of facial expression (C1) • Describe the orbicularis oculi, orbicularis oris and buccinator with nerve supply and actions (C1, C2)	1
Vertebrae & Vertebral column	• Describe the curvatures of the vertebral column mentioning lordosis, kyphosis, scoliosis C1, (C2) • Explains the structure, functions, regional characteristics of vertebrae (C1, C2) • Describe the parts and function of intervertebral disc with applied anatomy (C1, C2)	1
Unit 2:		
Thigh	• Describe the fascia lata, iliotibial tract, saphenous opening (C1, C2) • Describe the boundaries and content of femoral triangle (C1, C2), • Describe the femoral sheath, femoral canal with applied anatomy (C1, C2) • Describe great saphenous vein (detailed) with applied anatomy (C1, C2) • Describe the femoral artery- extent, course and branches (C1, C2) • Describe the femoral nerve with applied anatomy (C1, C2) • Describe the inguinal lymph nodes (C1) • Describe the muscles of front of thigh with attachment, nerve supply and actions (C1, C2) • Describe the adductor canal -boundaries and content with applied anatomy (C1, C2) • Describe the adductor compartment muscles with attachment, nerve supply and actions (C1, C2) • Describe the adductor magnus with attachment, nerve supply and actions (C1, C2) • Describe the obturator nerve with applied anatomy (C1, C2)	3
Gluteal region	• Describe the sensory innervation of the quadrants of gluteal region with a note on intramuscular injections (C1, C2)	1

Content	Competencies	Number of Hours (Theory)
	• Describe gluteus maximus with attachment, nerve supply and actions (C1, C2) • Describe the gluteus medius and minimus with actions and related applied anatomy (C1, C2) • Enumerate the structures under cover of gluteus maximus (C1) • Describe the relations of pyriformis with brief mention of attachment, nerve supply and actions (C1,C2)	
Back of thigh and Popliteal fossa	• Describe the hamstring muscles with attachments, nerve supply and actions (C1, C2) • Describe the popliteal fossa with boundaries and contents (C1, C2) • Describe the popliteus with emphasis on actions (C1, C2) • Describe the popliteal artery -extent, course and branches with a note on applied anatomy (C1, C2)	1
Leg	• Enumerates the anterior compartment muscles with attachment, nerve supply and actions with applied anatomy (C1, C2) • Describe the tibialis anterior in detail with emphasis on actions (C1, C2) • Describe the anterior tibial artery –extent, course and branches (C1, C2) • Enumerates the lateral compartment muscles with attachment, nerve supply and actions with applied anatomy (C1, C2) • Describe the peroneal artery (C1, C2) • Enumerates the posterior compartment muscles with attachment, nerve supply and actions (C1, C2) • Describe the soleus in detail with a note on applied anatomy (C1, C2) • Describe the gastrocnemius in detail with a note on applied anatomy (C1, C2) • Describe the tibialis posterior in detail with emphasis on actions (C1, C2) • Describe the posterior tibial artery (C1, C2)	2
Foot	• Describe the sensory innervation of the dorsum of foot (C1, C2) • Enumerates the muscles with nerve supply (C1) • Describe the dorsalis pedis artery with reference to peripheral pulse (C1, C2) • Enumerates the muscles of first and second layer of sole (C1) • Names the sensory innervation of the sole of foot (C1) • Describe the arches of foot in detail with applied anatomy (C1, C2)	2
Joints of lower limb	• Describe the hip joint under type, articular surfaces, ligaments, relations, movements and muscles	3

Content	Competencies	Number of Hours (Theory)
	responsible with a note on applied anatomy (C1, C2) • Describe the knee joint under – type, articular surfaces, ligaments, relations, movements and muscles responsible with a note on applied anatomy (C1, C2) • Describe the tibiofibular joint (detailed) (C1, C2) • Describe the ankle joint (detailed) (C1, C2) • Describe the subtalar joint (detailed) (C1)	
Nerves of lower limb	• Describe the sciatic nerve under origin, root value, course, branches with applied anatomy (C1, C2) • Describe the tibial nerve under origin, root value, course, branches with applied anatomy (C1, C2) • Describe the common peroneal nerve under origin, root value, course, branches with applied anatomy (C1, C2) • Describe the deep peroneal nerve under course, branches and applied anatomy (C1, C2) • Describe the superficial peroneal nerve under course, branches and applied anatomy (C1, C2)	2
Venous and lymphatic drainage of lower limb	• Describe the great saphenous vein (detailed) with applied anatomy (C1, C2) • Describe the small saphenous vein (C1) • Describe the lymphatic drainage of lower limb with a mention of elephantiasis (C1, C2)	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	34	102
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**34**	**102**

Learning Assessment Methods:	
Formative:	**Summative:**
Unit Test	Sessional Exam I and II
Quiz	End Semester Exam
Viva	
Assignments/Presentations	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Sessional Examination 1	x					
Sessional Examination 2	x					
End Semester Exam	x					
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	• B D Chaurasia, Human Anatomy, Volume I & II. 8th edition, CBS Publishers. • Vishram Singh. General anatomy, 3rd ed. • Handbook of General anatomy by B.D. Chaurasia.					
Additional References	• Text book of Anatomy, Vishram singh, 3rd edition • Manipal Manual of Anatomy for allied health students by Dr. Sampath Madyastha.					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Physiology - II**
Course Code	**PHY1201**
Academic Year	First Year
Semester	Semester II
Number of Credits	2
Course Prerequisite	Basic knowledge of general physiology
Course Synopsis	This module provides a comprehensive knowledge about normal functions of the organ systems of the body to understand the Physiological basis of health and disease required for health professionals.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Know the basic facts and concepts of Physiology (C1).
CO2	To have a knowledge of the normal functions of organ systems of the body to facilitate an understanding of physiological basis of health (C2).
CO3	To integrate the functions of various organ systems & to understand their functions as a body unit (C2).
CO4	Explain the physiological basis of disease processes (C2).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Course Content and Outcomes:

Topics	**Competencies**	**Number of Hours**
Unit 1: Central nervous System		
General organization of nervous system	• Outline the organization of nervous system (C1) • Outline the organization of autonomic nervous system(ANS) C1) • Enumerate the functions of ANS (C1) • Mention the functional areas of cerebral cortex and their functions (C1)	1
Receptors	• Classify sensory receptors according to type and location of stimulus, giving examples for each (C2) • Explain the property of 'specificity' and 'adequate stimulus' (C2) • Explain the property of 'adaptation' of sensory receptors (C2)	1
Synapse	• Define 'synapse' (C1)	1

Topics	Competencies	Number of Hours
	• Describe the structure of a synapse (C2) • Explain the events in synaptic transmission (C2)	
Reflexes	• Define reflex (C1) • Enumerate the components of a reflex arc with the help of a diagram (C1) • Describe the stretch reflex with the help of a diagram(C2) • Describe withdrawal reflex with the help of a diagram(C2) • Explain the importance of withdrawal reflex (C2)	2
Ascending pathways	• Outline the general organization of sensory pathways(C1) • Describe the dorsal column, lateral spinothalamic and anterior spinothalamic tracts with the help of labelled diagrams(C2) • Mention the different sensations that are carried by the above pathways (C1)	2
Descending pathways	• Describe the pyramidal/corticospinal tract with the help of a labelled diagram (C2) • Tabulate the differences between 'upper motor neuron lesion' and 'lower motor neuron lesion (C2)	1
Cerebellum	• Name the functional divisions of cerebellum (C1) • Enumerate the functions of each lobe of cerebellum(C1) • List the clinical features of cerebellar lesion (C1) • List the clinical features of cerebellar lesion (C2)	1
Basal ganglia	• Mention the components of basal ganglia (C1) • Enumerate the functions of basal ganglia (C1) • Explain the cause and clinical features Parkinson's disease (C2) • Explain the basis of treatment of Parkinson's disease (C2)	1
Thalamus and Hypothalamus	• Explain the functions of thalamus (C2) • List the different nuclei of hypothalamus (C1) • Explain the functions of hypothalamus (C2)	2
Cerebrospinal fluid	• Describe the formation, circulation, absorption and functions of CSF (C2) • Mention the method of collection of a sample of CSF and its indications (C1) • Explain the functions of higher centers of brain(C2)	1
Unit 2: Gastrointestinal system		
Salivary secretion & Deglutition	• Mention the composition of saliva (C1) • Explain the functions of saliva (C2) • Describe the regulation of salivary secretion (C2) • Describe the effects of Xerostomia (C2) • Define deglutition (C1)	1

Topics	Competencies	Number of Hours
	• Explain the stages of deglutition (C2) • Describe dysphagia (C2) • Describe Achalasia cardia (C2)	
Stomach	• Describe the functions of stomach (C2) • Mention the composition of gastric juice (C1) • Describe functions of gastric juice (C2) • Describe the mechanism of secretion of hydrochloric acid (C2) • Describe the regulation of gastric juice secretion(cephalic, gastric and intestinal phases) (C2)	1
Exocrine portion of Pancreas; Liver and biliary system	• Outline the composition of pancreatic juice (C1) • Describe the functions of pancreatic juice (C2) • Describe the neural and hormonal regulation of pancreatic juice (C2) • Outline the composition of hepatic bile(C1) • Describe the functions of bile(C2) • Enumerate the functions of gall bladder(C1)	1
Small intestine and large intestine	• Composition and functions of small intestinal secretions (C2) • Different types of Intestinal movements and their significance (C2) • Explain different types of small intestinal movements and their significance(C2) • List the functions of large intestine(C1)	1
Unit 3: Renal system		
Introduction & Glomerular filtration	• List the functions of kidneys (C1) • Draw a labelled diagram of a nephron (C1) • Mention the normal value of renal blood flow (C1) • Define glomerular filtration rate(GFR) (C1) • Mention the normal value of GFR (C1) • Explain the factors influencing GFR (C2) • List the substances used for the determination of GFR (C1)	1
Reabsorption and secretion in renal tubules	• Describe tubular reabsorption of sodium, glucose and water (C2) • Define tubular load, renal threshold and tubular/transport maximum (C1) • Mention the normal values for tubular load, renal threshold and tubular/transport maximum (C1)	1
Mechanism of concentration/dilution of urine	• Describe the role of counter current multiplier and counter current exchanger in the formation of urine (C2)	1
Physiology of micturition	• Describe the nerve supply to urinary bladder (C2) • Describe the micturition reflex (C2) • List the functions of skin	1

Topics	Competencies	Number of Hours
Unit 4: General principles of endocrinology		
Introduction and Pituitary gland	• Name the major endocrine glands and their secretions(C1) • Mention the chemical nature of hormones with examples (C2) • List the anterior pituitary hormones (C1) • Describe the actions of growth hormone (C2) • Describe the regulation of secretion of growth hormone(C2) • Describe the cause and clinical features of gigantism (C2) • Describe the cause and clinical features of acromegaly (C2) • Describe the cause and clinical features of dwarfism (C2) • List the hormones of posterior pituitary (C1) • Describe the actions of posterior pituitary hormones (C2) • Describe diabetes insipidus (C2)	1
Thyroid gland	• List the hormones of thyroid gland (C1) • Describe the actions of thyroid hormones(C2) • Describe the regulation of secretion of thyroid hormones (C2) • Describe the cause and clinical features of hyperthyroidism (C2) • Describe the cause and clinical features of cretinism (C2) • Describe the cause and clinical features of myxedema(C2) • Explain the actions of glucocorticoids (C2)	2
Adrenal cortex & Adrenal medulla	• Describe the regulation of secretion of glucocorticoids (C2) • Explain the cause and clinical features of Cushing's syndrome (C2) • Describe the actions of mineralocorticoids (C2) • Describe the cause and clinical features of Addison's disease (C2) • List the hormones of adrenal medulla (C1) • Describe the actions of adrenal medullary hormones (C2)	1
Parathyroid gland	• Describe the actions of PTH (C2) • Describe the regulation of secretion of PTH (C2) • Describe the effects of hyperparathyroidism (C2)	1
Endocrine Pancreas	• Describe the actions of insulin (C2) • Describe the regulation of secretion of insulin (C2) • Describe the cause and clinical features of diabetes mellitus (C2)	1

Topics	Competencies	Number of Hours
	• List the actions of glucagon (C1) • Describe the regulation of secretion of glucagon (C2)	
Unit 5: Reproductive system		
Male Reproductive system	• Describe the organization of male reproductive system(C2) • Describe the structure and functions of testes (C2) • Define spermatogenesis (C1) • Describe the stages of spermatogenesis (C2) • Mention the actions of testosterone (C1) • Describe the regulation of secretion of testosterone (C2)	1
Female Reproductive system	• Describe the structure of female reproductive system(C2) • Explain the actions of Estrogen and Progesterone (C2) • Describe the ovarian changes during menstrual cycle(C2) • Describe the uterine endometrial changes during menstrual cycle (C2) • Explain the hormonal control of ovarian functions (C2) • Describe the indicators of ovulation (C2)	2
Pregnancy and Lactation; Contraceptive methods	• Enumerate the functions of placenta (C1) • Describe milk ejection reflex (C2) • Mention various contraceptive methods in males (C1) • Mention various contraceptive methods in females (C1) • Explain the mechanism of action of various contraceptive methods (C2)	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	30	90
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**30**	**90**

Assessment Methods:						
Formative: NIL			**Summative:**			
			Sessional Examination I and II (Theory)			
			End Semester Exam (Theory)			
Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Sessional Examination 1	x	x				
Sessional Examination 2	x	x	x	x		
End Semester Exam	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Basics of Medical Physiology- 3rd Edition by D Venkatesh and HH Sudhaker 2. Manipal Manual of Medical Physiology,1st edition, C. N. ChandraShekar
Additional References	

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Biochemistry**
Course Code	**BIC1201**
Academic Year	First Year
Semester	Semester II
Number of Credits	3
Course Prerequisite	Basic knowledge of Biology and Chemistry
Course Synopsis	Biochemistry broadly deals with the chemistry of life and living processes. It helps in understanding the building blocks – proteins, carbohydrates, fats, nucleic acids and is necessary for allied health professions students to understand various biochemical mechanisms so as to correlate with or identify the pathological processes. Knowledge of biomolecules is necessary to understand the various laboratory investigations and their relevance in clinical practice

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the classification, composition and functions of macromolecules (C2)
CO2	Describe the process of digestion, absorption and metabolism of carbohydrates, lipids and proteins (C2)
CO3	Summarize the concepts of nutrition, balanced diet and role of macro and micronutrients in the maintenance of health (C2)
CO4	Summarize the features and investigations in diabetes mellitus and acid-base disorders (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Course Content and Outcomes:

Unit	**Content**	**Competencies**	**Number of Hours**
Unit 1: ENZYMES			
At the end of this chapter, a student should be able to 1. Define the term ‘enzyme’ (C1) 2. Classify enzymes based on reaction specificity (IUBMB classification) (C2) 3. Give one example (names of enzymes & reaction catalyzed) for each class of enzymes (C1) 4. Define the term ‘isoenzymes’ (C1) 5. Explain isoenzymes with examples (creatine kinase, lactate dehydrogenase) (C2)			2

Unit	Content	Competencies	Number of Hours
6. Define the term 'proenzyme or zymogen' with pepsinogen and trypsinogen as examples (C1) 7. Describe the utility of serum enzymes as diagnostic markers (C2) 8. Mention the diagnostic utility of following enzymes (C1) • CK • ALP • AST • ALT • LDH			
Unit 2: CARBOHYDRATE CHEMISTRY			
At the end of this chapter, a student should be able to 1. Define the term 'carbohydrates' (C1) 2. Classify carbohydrates with examples for each class (C2) 3. Classify monosaccharides with examples based on (C2) • Number of carbon atoms • Functional groups 4. Mention the source and composition of following disaccharides (C1) • Sucrose • Lactose • Maltose 5. Classify polysaccharides based on composition with examples (C2) 6. Explain the structure of starch and glycogen with schematic representation (C2 7. List the differences between starch and glycogen (C1) 8. Mention the occurrence and functions of heparin and chondroitin sulphate (C1)			2
Unit 3: CARBOHYDRATE DIGESTION AND ABSORPTION			
At the end of this chapter, a student should be able to 1. Describe the complete digestion of dietary polysaccharides (starch and glycogen) (C2) 2. Describe the reactions catalyzed by the following brush border enzymes (C2) • Maltase • Sucrase-isomaltase • Lactase 3. Illustrate the mechanisms of absorption of monosaccharides in the small intestine (C2) 4. Explain the significance of including sodium chloride along with glucose in the oral rehydration solution (C2)			2
Unit 4: CARBOHYDRATE METABOLISM			
A. Glycolysis At the end of this chapter, a student should be able to 1. Define aerobic and anaerobic glycolysis (C1) 2. Mention the site and subcellular site of glycolysis (C1) 3. Describe the steps of glycolysis with all the enzymes and coenzymes at each step (C2) 4. Mention the regulatory enzymes and list the names of hormones that regulate it in the well-fed state and starvation (C1) **5.** Calculate the energetics of aerobic and anaerobic glycolysis (C2)			**2**

Unit	Content	Competencies	Number of Hours
B. Gluconeogenesis At the end of this chapter, a student should be able to 1. Define gluconeogenesis (C1) 2. Mention the sites & subcellular sites of gluconeogenesis (C1) 3. List the precursors for gluconeogenesis (C1) 4. List the key enzymes of gluconeogenesis (C1) 5. Describe the synthesis of glucose from pyruvate and lactate (C2) 6. Mention the regulatory enzymes and list the names of hormones that regulate it in the well-fed state and starvation (C1) **7.** Explain the significance of gluconeogenesis (C2)			2
C. Citric acid cycle At the end of this chapter, a student should be able to 1. Recall the reaction catalyzed by pyruvate dehydrogenase complex and mention its coenzymes (C1) 2. Mention the site and subcellular site of citric acid cycle (C1) 3. Describe the reactions of citric acid cycle with all enzymes and coenzymes (C2) 4. Mention the regulatory enzymes of citric acid cycle (C1) 5. Calculate the energetics of citric acid cycle (C2)			2
D. Glycogen metabolism At the end of this chapter, a student should be able to 1. Mention the function of glycogen in liver and muscle (C1) 2. Define glycogenesis & glycogenolysis (C1) 3. Mention the site and subcellular site of glycogen metabolism (C1) 4. Mention the fate of end products of glycogenolysis in liver (role of glucose 6-phosphatase) and muscle (C1) 5. Mention the regulatory enzymes and the hormones involved in regulation in well-fed state and starvation (C1) 6. List the glycogen storage disorders mentioning their names, defects and tissues affected (Type I, V & VI) (C1)			1
Unit 5: ELECTRON TRANSPORT CHAIN AND OXIDATIVE PHOSPHORYLATION			
At the end of this chapter, a student should be able to 1. Define the electron transport chain (ETC) (C1) 2. Name the subcellular site of ETC (C1) 3. Describe the complexes of ETC (with their components and order of arrangement) and mention the mobile electron carriers (C2) 4. Name the inhibitors for each of the complexes of ETC (C1) 5. Define oxidative phosphorylation (C1)			1
Unit 6: LIPID CHEMISTRY			
At the end of this chapter, a student should be able to 1. Define lipids (C1) 2. Explain the functions of lipids in the body (C2) 3. Classify lipids with examples for all the subclasses (C2) 4. Classify fatty acids with examples-saturated, unsaturated (based on number of double bonds), essential fatty acids (C2)			1
Unit 7: LIPID DIGESTION, ABSORPTION AND ASSOCIATED DISORDERS			
At the end of this chapter, a student should be able to 1. Explain the process of emulsification of lipids (C2) 2. Describe the digestion of lipids in the stomach and intestine (C2)			2

Unit	Content	Competencies	Number of Hours
3. Illustrate the process of absorption of lipids (C2) 4. Define steatorrhea and list its causes (C1)			
Unit 8: LIPID METABOLISM			
A. De novo synthesis of fatty acids At the end of this chapter, students should be able to 1. Mention the site and subcellular site of de novo synthesis of fatty acids (C1) 2. List the sources of acetyl CoA for de novo synthesis of fatty acids (C1) 3. Explain the reaction catalyzed by acetyl CoA carboxylase (C2) 4. Mention the regulatory enzyme and the hormones involved in regulation in well-fed state and starvation (C1)			1
B. Synthesis of triacylglycerol (TAG) At the end of this chapter, students should be able to 1. Show the schematic structure of triacylglycerol (C1) 2. Mention the site and subcellular site of TAG synthesis (C1) 3. Describe the reactions of TAG synthesis (C2) 4. Mention the fate of TAG in liver and adipose tissue (C1)			1
C. Lipolysis At the end of this chapter, students should be able to 1. Mention the site and subcellular site of lipolysis (C1) 2. Describe the reactions of lipolysis (C2) **3.** Mention the regulatory enzymes and the hormones involved in regulation in well-fed state and starvation (C1)			1
D. Beta oxidation of fatty acids At the end of this chapter, students should be able to 1. Define beta-oxidation (C1) 2. List the site and subcellular site of beta-oxidation (C1) 3. Describe the activation of palmitic acid (C2) 4. Explain the transport of activated palmitic acid into mitochondria (carnitine shuttle) (C2) 5. Describe the reactions of beta oxidation (C2) 6. Calculate the energetics of beta oxidation of palmitic acid (C2)			2
E. Lipoproteins At the end of this chapter, student should be able to 1. Classify lipoproteins based on their electrophoretic mobility and ultracentrifugation properties (C2) **2.** Mention the site of synthesis and the functions of Chylomicrons, VLDL, LDL and HDL (C1)			1
Unit 9: AMINO ACID & PROTEIN CHEMISTRY			
At the end of this chapter, student should be able to 1. Recognize the general structure of D and L amino acids (C1) 2. Classify amino acids based on the following with examples (C2) • Presence in proteins (standard and non-standard amino acids) • Metabolic fate (glucogenic and ketogenic amino acids) • Nutritional requirement (essential and non-essential amino acids) 3. Classify proteins based on composition, functions and shape with examples (C2) 4. Describe the structure of mature collagen with diagram (C2) 5. Explain with illustrations the biosynthesis of mature collagen emphasizing			3

Unit	Content	Competencies	Number of Hours
		the importance of prolyl hydroxylase, lysyl hydroxylase and lysyl oxidase (C2)	
Unit 10: PROTEIN DIGESTION AND ABSORPTION			
		At the end of the chapter, a student should be able to 1. Outline the activation of zymogens in the GIT (C1) 2. List the endo and exopeptidases in the digestive juices (C1)	1
Unit 11: AMINO ACID METABOLISM			
		At the end of the chapter, a student should be able to 1. Explain transamination of amino acids with suitable examples (C2) 2. Describe the generation of ammonia by oxidative deamination using L-glutamate dehydrogenase. (C2) 3. Study urea cycle as follows a. Name its site and subcellular site (C1) b. Describe its reactions (C2) c. Mention its significance (C1) 4. Recall the physiologically important products derived from the following amino acids (C1) a. Glycine b. Tyrosine c. Methionine d. Tryptophan	2
Unit 12: GENERAL CONCEPTS OF NUTRITION			
		At the end of the chapter, a student should be able to 1. Define the term balanced diet (C1) 2. Define caloric value of food and list the caloric values of carbohydrates, proteins and fats (C1) 3. State the total daily caloric requirements of an adult male and female (for sedentary, moderate and heavy workers) and for pregnant and lactating women (C1) 4. Define recommended dietary allowance (RDA) (C1) 5. Study basal metabolic rate as follows a. Define (C1) b. List the normal values for men and women (C1) c. Explain the factors affecting BMR (C2) 6. Define thermic effect (SDA) of food and recall the values for macronutrients (C1)	2
Unit 13: CARBOHYDRATES, PROTEINS AND FATS IN NUTRITION			
		A. Carbohydrates At the end of the chapter, a student should be able to 1. Mention the RDA (C1) 2. Study dietary fibers as follows a. Define (C1) b. Mention its RDA (C1) c. List the examples with their sources (C1) d. Explain its beneficial effects (C2) **B. Proteins** At the end of the chapter, a student should be able to 1. Mention the RDA (C1)	2

Unit	Content	Competencies	Number of Hours
2. Define essential amino acids with examples (C1) 3. Study biological value as follows a. Define (C1) b. Name the protein used as standard for determining it (C1) c. List the protein sources with high and low biologic values (egg albumin, milk, fish, meat, rice, wheat and soy protein) (C1) 4. Define the term nitrogen balance (C1) 5. Explain positive and negative nitrogen balance with conditions during which they occur (C2) 6. Define the term limiting amino acids giving suitable examples (C1) 7. Explain mutual supplementation of proteins with examples (C2) **C. FATS** At the end of the chapter, a student should be able to 1. Mention the RDA (C1) 2. List the functions of cholesterol in the body (C1) 3. Study essential fatty acids as follows a. Define (C1) b. Mention its RDA (C1) c. Explain their functions and deficiency manifestations (C2) 4. Explain saturated and unsaturated (mono and poly) fatty acids with suitable examples, mentioning its sources and functions (C2)			
Unit 14: MINERALS			
At the end of this chapter, a student should be able to 1. Define the terms macro and micro minerals with examples. (C1) 2. Mention the sources and RDA for iron (C1) 3. Explain the functions, disorders of deficiency & excess for iron (C2) 4. Mention the sources, RDA and functions for calcium and phosphorus (C1) 5. Mention the normal serum levels of calcium and phosphorus and the hormones which regulate it **(**C1**)**			2
Unit 15: VITAMINS			
At the end of this chapter, a student should be able to 1. Define the term vitamins (C1) 2. List the classes of vitamins based on solubility (C1) 3. Study the water soluble vitamins mentioned below • Thiamine • Riboflavin • Niacin • Pantothenic acid • Pyridoxine • Biotin • Cobalamin • Folic acid • Ascorbic acid as follows ➢ List the RDA, sources and coenzyme forms (C1) ➢ Describe the biochemical functions (C2) ➢ List the features of disorders associated with their deficiencies (C1)			3

Unit	Content	Competencies	Number of Hours
4. Study the fat soluble vitamins A, D, E, K as follows ➢ List the RDA, sources and chemical forms. (C1) ➢ Describe the biochemical functions. (C2) ➢ List the features of disorders associated with their deficiencies and excess. (C1)			
16. MALNUTRITION			
At the end of this chapter, a student should be able to 1. Define the classes of protein energy malnutrition. (C1) 2. Compare the similarities and differences between marasmus and kwashiorkor (C2)			1
17. CLINICAL BIOCHEMISTRY			
A. GLUCOSE HOMEOSTASIS AND DIABETES MELLITUS At the end of this chapter, a student should be able to 1. Summarize the effect of the hormones involved in blood glucose homeostasis (C2) 2. Study diabetes mellitus as follows • Define (C1) • Classify and compare the types 1 and 2 (C2) • Mention the signs and symptoms (C1) • Mention the normal plasma levels of fasting, postprandial and random glucose & their utility in diagnosis (C1) • Explain the relevant investigations involved in the diagnosis and management (HbA_{1C}, procedure and interpretation of GTT, microalbuminuria) (C2) • Explain the biochemical basis for features of diabetic ketoacidosis (C2)			2
B. SIGNIFICANCE OF ESTIMATIONS OF VARIOUS BIOCHEMICAL PARAMETERS IN BLOOD At the end of this chapter, a student should be able to 1. Mention the normal serum levels of glucose, protein, urea, uric acid, bilirubin, cholesterol and creatinine and conditions in which they are altered **(**C1**)**			1
C. ACID BASE BALANCE AND DISTURBANCES At the end of this chapter, a student should be able to: 1. Define the terms acid, base, pH and pKa (C1) 2. Study buffers as follows • Define (C1) • Write the Henderson-Hasselbalch equation for different buffer systems (C1) • List the principal buffer systems in ECF, ICF and in urine (C1) • Mention the pKa value, normal ratio of base/acid in the plasma for bicarbonate and phosphate buffer systems (C1) 3. Study acid-base disorders as follows • Define the different classes (C1) • Explain the conditions causing acidosis & alkalosis (metabolic & respiratory) (C2) **4.** Mention the primary and compensatory changes in acid base disorders(C1)			1
Unit 18: MOLECULAR BIOLOGY			
At the end of this chapter, a student should be able to 1. Name the purine and pyrimidine bases (C1)			2

Unit	Content	Competencies	Number of Hours
2. Define nucleosides and nucleotides with examples (C1) 3. Illustrate the Watson and Crick model of B-DNA structure (C2) 4. List the different types of RNA (C1) 5. Recall the structural differences between DNA and RNA (C1) **6.** Define replication, transcription and translation (C1)			

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	45	135
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	4	16
Total	**49**	**151**

Assessment Methods:	
Formative:	**Summative:**
	Mid Semester/Sessional Exam (Theory)
	End Semester Exam (Theory)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**		
Mid Semester / Sessional Examination 1	x	x				
Sessional Examination 2	x	x	x	x		
End Semester Exam	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
Main Reference:	• Essentials of Biochemistry, U satyanarayana, U Chakrapani (2nd edition) • Handbook of Biochemistry for Allied & Nursing Students, Shivananda Nayak B (2nd edition)

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Radiographic Positioning and Techniques - II**
Course Code	**MIT1201**
Academic Year	First Year
Semester	Semester II
Number of Credits	3
Course Prerequisite	Student should have basic knowledge of physics and biology
Course Synopsis	• This module provides the basis for students to undertake radiographic practice within the clinical environment. • To provide fundamental knowledge of the various radiographic x-ray views (both standard and special views) for the Head, abdomen, pelvis and spine. • To identify the factors and characteristics of the radiographic image quality that affect the clinical application • To provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain about the related radiological anatomy. (C2)
CO2	Explain the clinical indications and preparation of the patient for the various radiological projections. (C2)
CO3	Explain the basic and special projections related to axial skeleton. (C2)
CO4	Select the appropriate radiographic factors to generate good radiographic quality image. (C3)
CO5	Identify and interpret the structures seen on the radiograph. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2		x		x				
CO3	x	x						
CO4		x				x		
CO5	x							

Course Content and Outcomes:

Content	**Competencies**	Number of Hours
Unit 1: Abdomen		
• Related radiological anatomy	1. Explain the related radiological anatomy of Abdomen (C2). 2. Classify the indications for Abdomen	1

Content	Competencies	Number of Hours
	radiography (C2).	
Basic Projection • Anterior Posterior supine • Erect Anterior Posterior	1. Explain the patient preparation required for basic abdomen radiographic projection (C2). 2. Explain the step wise process of positioning for basic abdomen projection (C2). 3. Identify appropriate centring for basic abdomen radiography (C2). 4. Select the appropriate radiographic exposure factors for basic abdomen radiography (C3). 5. Identify the structure seen on basic projection abdomen radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1
Special Projection • Posterior Anterior prone • Lateral decubitus • Dorsal decubitus • Lateral • Acute abdomen : three way series	1. Explain the patient preparation required for Special abdomen radiographic projection (C2). 2. Explain the step wise process of positioning for special abdomen projection (C2). 3. Identify appropriate centring for special abdomen radiography (C2). 4. Select the appropriate radiographic exposure factors for special abdomen radiography (C3). 5. Identify the structure seen on special projection abdomen radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	2
Unit 2: KUB		
• Related radiological anatomy	3. Explain the related radiological anatomy of KUB (C2). 4. Classify the indications for KUB radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	8. Explain the patient preparation required for AP and lateral projection of KUB (C2). 9. Explain the step wise process of positioning for AP and lateral projection of KUB (C2). 10. Identify appropriate centring for AP and lateral projection of KUB (C2). 11. Select the appropriate radiographic exposure factors for AP and lateral projection of KUB (C3). 12. Identify the structure seen on AP and lateral projection of KUB (C2). 13. Explain the image evaluation criteria (C2). 14. Outline the radiation protection method used (C2). 15. Explain the difference between abdomen AP	1

Content	Competencies	Number of Hours
	and KUB AP projection (C2).	
Unit 3: Cervical spine		
• Related radiological anatomy	3. Explain the related radiological anatomy of cervical spine (C2). 4. Classify the indications for Cervical spine radiography (C2).	1
Basic Projection • Anterior Posterior axial • Oblique • Lateral • Lateral-hyperflexion and hyperextension	8. Explain the patient preparation required for basic cervical spine radiographic projection (C2). 9. Explain the step wise process of positioning for basic cervical spine projection (C2). 10. Identify appropriate centring for basic cervical spine radiography (C2). 11. Select the appropriate radiographic exposure factors for basic cervical spine radiography(C3) 12. Identify the structure seen on basic cervical spine radiographic image (C2). 13. Explain the image evaluation criteria (C2). 14. Outline the radiation protection method used (C2).	2
Special Projection • Anterior Posterior open mouth (C1 and C2) • Trauma lateral (horizontal beam) • Cardiothoracic junction (swimmers view) • Anterior Posterior (fuchs method) • Posterior Anterior (judd method) • Anterior Posterior wagging jaw (ottonello method) • Anterior Posterior axial (pillars)	1. Explain the patient preparation required for Special cervical spine radiographic projection (C2). 2. Explain the step wise process of positioning for special cervical spine projection (C2). 3. Identify appropriate centring for special cervical spine radiography (C2). 4. Select the appropriate radiographic exposure factors for special cervical spine radiography (C3). 5. Identify the structure seen on special projection cervical spine radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	3
UNIT 4: Thoracic spine		
• Related radiographic anatomy	3. Explain the related radiological anatomy of thoracic spine (C2). 4. Classify the indications for thoracic spine radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral • Oblique	8. Explain the patient preparation required for basic thoracic spine radiographic projection (C2). 9. Explain the step wise process of positioning for basic thoracic spine projection (C2). 10. Identify appropriate centring for basic thoracic spine radiography (C2). 11. Select the appropriate radiographic exposure	1

Content	Competencies	Number of Hours
	factors for basic thoracic spine radiography (C3). 12. Identify the structure seen on basic thoracic spine radiographic image (C2). 13. Explain the image evaluation criteria (C2). 14. Outline the radiation protection method used (C2).	
UNIT 5: Lumbar spine, sacrum and coccyx		
• Related radiographic anatomy	1. Explain the related radiological anatomy of Lumbar spine, sacrum and coccyx (C2). 2. Classify the indications for Lumbar spine, sacrum and coccyx radiography (C2).	1
Basic Projection <u>*Lumbar spine*</u> • Anterior Posterior • Oblique • Lateral • Lateral (L5 - S1) • Anterior Posterior axial (L5 - S1) <u>*Sacrum and Coccyx*</u> • Anterior Posterior axial sacrum • Anterior Posterior axial coccyx • Lateral sacrum • Lateral coccyx	1. Explain the patient preparation required for basic Lumbar spine, sacrum and coccyx radiographic projection (C2). 2. Explain the step wise process of positioning for basic Lumbar spine, sacrum and coccyx projection (C2). 3. Identify appropriate centring for basic Lumbar spine, sacrum and coccyx radiography (C2). 4. Select the appropriate radiographic exposure factors for basic Lumbar spine, sacrum and coccyx radiography (C3). 5. Identify the structure seen on basic Lumbar spine, sacrum and coccyx radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	3

Special Projection
• Scoliosis series
  • Anterior Posterior or Posterior Anterior
  • Erect lateral
  • Anterior Posterior (Ferguson method)
  • Anterior Posterior – Right and Left bending
• Spinal fusion series
  • Anterior Posterior or Posterior Anterior – Right and Left bending
  • Lateral – hyper extension and hyper flexion
	1. Explain the patient preparation required for Special Lumbar spine, sacrum and coccyx radiographic projection (C2).
	2. Explain the step wise process of positioning for special Lumbar spine, sacrum and coccyx projection (C2).
	3. Identify appropriate centring for special Lumbar spine, sacrum and coccyx radiography (C2).
	4. Select the appropriate radiographic exposure factors for special Lumbar spine, sacrum and coccyx radiography (C3).
	5. Identify the structure seen on special projection Lumbar spine, sacrum and coccyx radiographic image (C2).
	6. Explain the image evaluation criteria (C2).
	7. Outline the radiation protection method used (C2).
		2

Content	Competencies	Number of Hours
<u>*Coccyx*</u> • Axial (Nolke Method)		
UNIT 6: Pelvic girdle and proximal femur		
• Related radiographic anatomy	1. Explain the related radiological anatomy of pelvic girdle (C2). 2. Classify the indications for pelvic girdle radiography (C2).	1
Basic Projection Pelvic girdle • Anterior Posterior pelvis Hip and proximal femur • AP unilateral hip Sacrioiliac joints • Anterior Posterior • Posterior oblique	1. Explain the patient preparation required for basic pelvic girdle radiographic projection (C2). 2. Explain the step wise process of positioning for basic pelvic girdle projection (C2). 3. Identify appropriate centring for basic pelvic girdle radiography (C2). 4. Select the appropriate radiographic exposure factors for basic pelvic girdle radiography (C3). 5. Identify the structure seen on basic pelvic girdle radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	2
Special Projection Pelvic girdle • Frog lateral(modified cleaves method) • Anterior Posterior axial for pelvic outlet (tayelor method) • Anterior Posterior axial for pelvic inlet (modified linienfield method) • Posterior oblique acetabulum (judet method) Hip and proximal femur • Axiolateral, inferosuperior (danelius– miller method) • Unilateral frog leg (modified cleaves method) • Modified axiolateral (clements-nakayama method)	1. Explain the patient preparation required for Special pelvic girdle radiographic projection (C2). 2. Explain the step wise process of positioning for special pelvic girdle projection (C2). 3. Identify appropriate centring for special pelvic girdle radiography (C2). 4. Select the appropriate radiographic exposure factors for special pelvic girdle radiography (C3). 5. Identify the structure seen on special projection pelvic girdle radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	3

Content	Competencies	Number of Hours
UNIT 7: Paediatric radiography		
• Positioning, care and radiation protection while handling babies	1. Explain about the technologist role while handling paediatric patients (C2). 2. Explain the role of technologist while performing paediatric radiograph (C2). 3. Explain the role of parent's or caregiver while performing paediatric radiograph (C2). 4. Name the various commercially available immobilization devices (C1). 5. Outline the names of the simplest and least expensive immobilization devices commonly found in most departments (C2). 6. Describe the method to use various commonly found immobilization devices while performing paediatric radiograph (C2). 7. Explain the pre-exam preparation of the room (C2). 8. Explain the patient preparation required for paediatric radiography (C2). 9. Explain the step wise process of positioning paediatric patient (C2). 10. Identify appropriate centring for paediatric radiography (C2). 11. Select the appropriate radiographic exposure factors for paediatric radiography (C3). 12. Identify the structure seen on paediatric radiographic image (C2). 13. Explain the image evaluation criteria (C2). 14. Outline the radiation protection method used (C2).	3
UNIT 8: Skull (cranial bones and facial bones)		
• Related radiological anatomy	1. Explain the related radiological anatomy of Skull (C2). 2. Classify the indications for Skull (cranial bones and facial bones) radiography (C2).	2
Basic and Special Projection • Cranium • Base of skull • Sella turcica • Mastoids • Optic foramina and Orbits • Nasal bone • TM joint • Facial bone • Zygomatic arches • Mandible • Para nasal sinuses	1. Explain the patient preparation required for basic and special skull radiographic projection (C2). 2. Explain the step wise process of positioning for basic and special skull projection (C2). 3. Identify appropriate centring for basic and special skull radiography (C2). 4. Select the appropriate radiographic exposure factors for basic and special skull radiography (C3). 5. Identify the structure seen on basic and special skull radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	6

Content	Competencies	Number of Hours
UNIT 9: Neck		
• Related radiological anatomy	1. Explain the related radiological anatomy of Neck (C2). 2. Classify the indications for Neck radiography (C2).	1
Basic Projection • Anterior Posterior • Lateral	1. Explain the patient preparation required for basic Neck radiographic projection (C2). 2. Explain the step wise process of positioning for basic Neck projection (C2). 3. Identify appropriate centring for basic Neck radiography (C2). 4. Select the appropriate radiographic exposure factors for basic Neck radiography (C3). 5. Identify the structure seen on basic Neck radiographic image (C2). 6. Explain the image evaluation criteria (C2). 7. Outline the radiation protection method used (C2).	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	3	6
Self-directed learning (SDL)	3	6
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	7	14
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory and/or Practical)
Quiz	End Semester Exam (Theory and/or Practical)
Viva	Viva
Assignments/Presentations	

Mapping of Assessment with COs:					
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester / Sessional Examination 1	x		x		
Sessional Examination 2	-	-	-	-	-
Quiz / Viva	x				x

Assignments/Presentations		x		x		
Clinical/Practical Log Book/ Record Book			x		x	
Any others: WPBA		-	-	-	-	-
End Semester Exam		x	x	x	x	x
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	• Clarks Positioning in Radiography, R.A. Swallow, E. Naylor • Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D.					
Additional References	• Skeletal Anatomy, Bryan Glenda J • Text Book of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Digital Imaging & Image processing methods in Radiography**
Course Code	**MIT1202**
Academic Year	First Year
Semester	II
Number of Credits	3
Course Prerequisite	Basic knowledge in physics
Course Synopsis	1. This module introduces students to components, principles and operation of conventional as well as modern medical imaging equipments. 2. The course provides an insight into the field of conventional radiology equipments used earlier including Films, intensifying screens, cassettes as well as manual and automatic processing of films. 3. This course also provides theoretical knowledge on image characteristics and photographic principles where students will be familiar with the conventional techniques utilized in earlier days. 4. To provide fundamental knowledge of currently used medical imaging equipments including computed radiography, digital radiography and macro-radiography. 5. To provide knowledge on picture archival communications system (PACS) and its role in medical imaging. It will also cover the fundamentals of computing, networking, DICOM, Image acquisition and workflow.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Define and explain various image characteristics. Summarize the formation of a latent image and identify factors affecting the quality of image and explain the photographic principles involved in image formation and explain the photographic performance using sensitometry and characteristic curve (C2)
CO2	Explain the components and functioning of various recording systems and its types. (C2)
CO3	Illustrate the requirements that need to be taken into consideration while designing a darkroom and Compare manual and automatic processing techniques in radiography. (C2)
CO4	Define and extend the principle and applications of Macroradiography. (C2)
CO5	What is the principle of CR and DR. Illustrate the components, workflow, image formation and artifacts associated with computed and digital radiography? (C2)
CO6	Show the role of PACS in medical imaging and explain the components, function and types of PACS. Review the function of DICOM (C2).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							

CO2	x							
CO3	x							
CO4	x							
CO5	x							
CO6	x							

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Image characteristics	• Define image characteristics (C1) • How is reflected, transmitted and emitted light image viewed?(C1) • Explain Noise, SNR, Contrast, optimum contrast, sharpness, Resolution(C2)	2
Unit 2:		
The Invisible x-ray image	• What is Latent image? Explain Characteristics of latent image (subject contrast, differential attenuation, sharpness) (C1,C2) • Illustrate the effects of scattering and how to control (C1,C2)	2
Unit 3:		
Photographic Principle	• What is Photographic effect? (C1) • Name the Photosensitive materials (C1) • Explain manufacture of light and x-ray sensitive emulsion (C2) • What is sensitometry and outline photographic performance: density, log, relative exposure (C1,C2) • Illustrate Characteristic curve C2)	3
Unit 4:		
The recording system: Film materials	• Illustrate the construction of films (base, subbing layer, emulsion ,super coat and backing layers) (C2) • Explain the effects of Crossover and irradiation on films and list out methods to prevent it. (C1,C2) • Compare types of films (screen and non-screen Films, Single & Duplitized films, CRT films) (C2) • List out various film artifacts and explain remedies (C1,C2) • What is the proper technique to store Film?(C1)	3
Unit 5:		
The recording system: Intensifying screens	• Define Luminescence (C1) • Explain Screen construction and classify types of Phosphors (C2) • Summarize types of screen (C2) • Explain Screen Unsharpness, Quantum detection , Quantum mottle (Intensifying factor) conversion efficiency (C2)	3

Content	Competencies	Number of Hours
	• Outline factors affecting speed and Unsharpness (C2) • How to care for intensifying screens (C1)	
Unit 6:		
Recording system (Cassettes)	• Define cassettes (C1) • Illustrate Cassette construction and discuss features (C2) • Compare types of cassettes and special cassettes (C2) • How do we care for cassettes (C1) • How to load &unload cassettes (C1)	2
Unit 7:		
Processing area	• Recall Siting and function of processing area (C1) • Summarize darkroom design, construction, illumination, equipments (manual & automatic processors) (C2) • What are the Health and safety precautions taken in Dark room (COSHH regulations) (C1)	3
Unit 8:		
Photographic processing: Manual Processing	• Define Acidity, alkalinity and pH (C1) • Explain the steps involved in manual processing: Developing, rinsing, fixing, washing & drying (C2) • List the Components of developer and fixer solution (C1)	3
Unit 9:		
Photographic Processing : Automatic Processors	• Translate steps in automatic processing and explain Film transport, Cycle time, capacity, feed section, developer, fixer, washing and drying section, and Replenishment by auto mixers(C2) • What is the Care & maintenance of the auto processors (C1)	3
Unit 10:		
Macroradiogaphy	• Definition Macroradiography (C1) • Explain the principle of magnification radiography (C2) • Illustrate Unsharpness related to Macroradiography (C2) • How is Scattered radiation reduced in Macroradiography (C1) • Outline the significance of cassette support (C2) • What are the applications of Macroradiography (C1)	3
Unit 11:		
Computed Radiography	• Recall sequence of activities involved in screen-film radiography (C1) • Define Photo-stimulable luminescence (C1)	5

Content	Competencies	Number of Hours
	• List the computer radiography terms (C1) • Explain construction of CR imaging plate (C2) • Illustrate various Digitizer components (C1,C2) • Relate the mechanical features, optical features and computer control involved in computed radiography reader.(C2) • Explain steps involved in Image formed in computed radiography? (C2) • Interpret the spatial resolution, contrast resolution and noise related to computer radiography (C2) • List out various artifacts seen in CR (C1) • Summarize the advantages and disadvantages of using CR (C2) • Outline patient radiation dose reduction with computer radiography (C2)	
Unit 12:		
Digital Radiography	• Outline the workflow in Digital Radiography (C2) • Define capture element, coupling element and collection element DR.(C1) • Explain and label Components (Direct & indirect DR) (C1,C2) • Explain Image formation in DR (C2) • Explain charged coupled device (C2) • Compare direct and indirect DR(C2) • List out Advantages and Disadvantages in DR (C1) • List out various artifacts seen in DR (C1)	4
Unit 13:		
Picture archival and communication system (PACS)	• Define PACS (C1) • Explain the PACS system and workflow (C2) • List out the various PACS System components (C1) • Compare types of PACS (C2) • What are the Advantages and Disadvantage of PACS (C1) • What is DICOM and its functions (C1)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Assignment	6	12
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	2	4
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-

Practical	-	-				
Revision	-	-				
Assessment	-	-				
Total	**39**	**78**				
Assessment Methods:						
Formative:	**Summative:**					
Unit Test	Mid Semester/Sessional Exam (Theory)					
Quiz	End Semester Exam (Theory)					
Assignments/Presentations	Record Book					
Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x	x			
Quiz / Viva	x	x	x	x	x	x
Assignments/Presentations	x	x	x	x	x	
End Semester Exam	x	x	x	x	x	x
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	• Chesney's Radiographic Imaging. John Ball & Tony Price • Radiologic science for technologists. 9th edition. Stewart Bushong • PACS Basic Principles & Applications. H. K. Huang					
Additional References	• Clarks Positioning In Radiography. R. A. Swallow, E Naylor • Essential Physics Of Medical Imaging. Jerrold T Bushberg					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Image evaluation and Interpretation of Radiographs - II**
Course Code	**MIT1203**
Academic Year	First Year
Semester	II
Number of Credits	2
Course Prerequisite	Basic knowledge in Anatomy
Course Synopsis	1. This module provides fundamental knowledge to interpret the radiological anatomy and structures seen on the radiographic image of Skull, Cranial bones, Facial bones, Neck, Abdomen, KUB, Spine, Pelvic girdle and proximal femur. 2. To provide fundamental knowledge to how radiographic image of Skull, Cranial bones, Facial bones, Neck, Abdomen, KUB, Spine, Pelvic girdle and proximal femur. can be evaluated by a using definable standard (evaluation criteria). 3. To provide fundamental knowledge to determine the radiographic view required for Skull, Cranial bones, Facial bones, Neck, Abdomen, KUB, Spine, Pelvic girdle and proximal femur. based on the medical history. 4. To provide fundamental knowledge of technique and exposure factors to obtain radiographs with optimum radiation and diagnostic image quality. 5. To provide fundamental knowledge of common faults in the radiographs and remedy

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	List the radiological anatomy and structures seen on the radiographic image. (C1)
CO2	Relate the radiological anatomy with radiographic image (C1, C2)
CO3	Identify the radiographic view required for the patient based on indication. (C3)
CO4	Make use of evaluation criteria format to identify the radiographic image quality. (C3)
CO5	Choose the appropriate remedy measures for fault radiograph. (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x	x						
CO3	x	x						
CO4	x	x						
CO5	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Image evaluation and Interpretation of Abdomen for basic and special views: AP—supine, PA—prone, Lateral decubitus, AP—erect, Dorsal decubitus, Lateral,	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3)	4
Acute abdominal series:	**6.** Identify and Summarize the basic and special projections with indication (C2, C3)	
Unit 2:		
Image evaluation and Interpretation of KUB: AP-supine	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3**)**	1
Unit 3:		
Image evaluation and Interpretation of Pelvic girdle and proximal femur for basic and special views: AP bilateral “frog-leg” (modified Cleaves method), AP axial outlet (Taylor method), AP axial inlet, Posterior oblique–acetabulum (Judet method), PA axial oblique–acetabulum (Teufel method), Hip and proximal femur, AP unilateral hip, Axiolateral, inferosuperior (Danelius-Miller method), Unilateral frog leg mediolateral (modified Cleaves method), Modified axiolateral–possible	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	5

Content	**Competencies**	**Number of Hours**
trauma (Clements-Nakayama method),		
Unit 4:		
Image evaluation and Interpretation of Cervical spine for basic and special views: Cervical spine (routine) AP open mouth (C1 and C2), AP axial, Anterior and posterior obliques, Lateral, erect, Trauma lateral, horizontal beam, Cervicothoracic lateral (swimmer's), Cervical spine (special), Lateral—hyperflexion and hyperextension, AP (Fuchs method) or PA (Judd method), AP wagging jaw (Ottonello method), AP axial (pillars)	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	3
Unit 5:		
Image evaluation and Interpretation of Thoracic spine for basic and special views: Thoracic spine (routine), AP, Lateral, Thoracic spine (special), Oblique	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	2
Unit 6:		
Image evaluation and Interpretation of Lumbar spine, sacrum and coccyx for basic and special views: Lumbar spine, AP or PA, Obliques, Lateral, Lateral L5-S1, AP axial L5-S1, Sacrum and coccyx,	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its	4

Content	**Competencies**	**Number of Hours**
AP axial sacrum, AP axial coccyx, Lateral sacrum and coccyx, Lateral coccyx, Sacroiliac joints, AP axial, Posterior obliques	remedy. (C3)	
Spinal fusion series, AP (PA) right and left bending, Lateral—hyperextension and hyperflexion Scoliosis series, PA (AP), Erect lateral, PA (AP) (Ferguson method), AP (PA) right and left bending	6. Identify and Summarize the basic and special projections with indication (C2, C3)	
Unit 7:		
Image evaluation and Interpretation of Skull and cranial bones and facial bones for basic and special views: AP axial (Towne method), Lateral, PA axial 15° (Caldwell method) or 25° to 30° CR, PA, Submentovertex (SMV), PA axial (Haas method), Facial Bones Lateral, Parietoacanthial (Waters method), PA axial (Caldwell method), Modified parietoacanthial (Waters method), Nasal Bones Lateral, Superoinferior Tangential (axial), Zygomatic Arches, Submentovertex (SMV), Oblique inferosuperior (Tangential), AP axial, Optic Foramina and Orbits Parieto-orbital oblique (Rhese method), Parietoacanthial (Waters method), Modified parietoacanthial	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	6

Content	Competencies	Number of Hours
(Waters method), Mandible Axiolateral oblique, PA or PA axial, AP axial (Towne method), SMV, Orthopantomography–panoramic, TMJs AP axial (modified Towne method), Axiolateral oblique (modified Law method), Axiolateral (Schuller method), Sinuses Lateral, PA (Caldwell method), Parietoacanthial (Waters method), SMV, Parietoacanthial transoral (open mouth Waters method		
Unit 8:		
Image evaluation and Interpretation of Neck for basic and special views: AP, LAT	1. What anatomic parts and structures should be clearly visualized on that image (radiograph). (C1) 2. Match the related radiological anatomy with radiographic image (C1, C2) 3. Explain placement of body part in relationship to the IR. (C2) 4. Identify how exposure factors or positioning technique affect the radiographic image quality (C3) 5. Identify faults in the radiographs and its remedy. (C3) 6. Identify and Summarize the basic and special projections with indication (C2, C3)	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-

Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	
Viva	
Assignments/Presentations	
Clinical assessment (OSCE, OSPE, WBPA)	
Clinical/Practical Logbook/ Record Book	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester / Sessional Examination 1	x	x	x	x	x
Sessional Examination 2					
Quiz / Viva					
Assignments/Presentations					
Clinical/Practical Log Book/ Record Book					
Any others: WPBA					

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Bontrager, K. L., & Lampignano, J. P. (2014). Textbook of radiographic positioning and related anatomy 2. Ballinger, P. W., Frank, E. D., & Merrill, V. (2003). Merrill's atlas of radiographic positions & radiologic procedures. St. Louis, Missouri: Mosby.
Additional References	**3.** Clarks Positioning In Radiography, R. A. Swallow, E Naylor

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical Aspect of Radiographic Positioning and Techniques - II**
Course Code	**MIT1231**
Academic Year	First Year
Semester	II
Number of Credits	5
Course Prerequisite	Student should have basic knowledge of physics and biology
Course Synopsis	• This module provides the basis for students to undertake radiographic practice within the clinical environment. • To provide fundamental knowledge of the various radiographic x-ray views (both standard and special views) for the Head, abdomen, pelvis and spine. • To identify the factors and characteristics of the radiographic image quality that affect the clinical application • To provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Make use of learned instructions to prepare the patient for the various radiological projections. (C2, P4, A3)
CO2	Demonstrate the positioning skills for various radiographic projections. (C3, P5, A2)
CO3	Select the appropriate radiographic factors to generate good radiographic quality image. (C3, P6)
CO4	Identify and interpret the structures seen on the radiograph. (C3)
CO5	Use appropriate radiographic accessories .(C3)
CO6	Operate the radiographic equipment. (C3, P5)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x			x				
CO2		x		x				
CO3		x				x		
CO4	x							
CO5		x				x		
CO6		x	x					

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1: Abdomen		
Basic Projection • Anterior Posterior supine • Erect Anterior Posterior **Special Projection** • Posterior Anterior prone • Lateral decubitus • Dorsal decubitus • Lateral • Acute abdomen : three way series	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	20
Unit 2: KUB		
Basic Projection • Anterior Posterior • Lateral	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	15
Unit 3: Cervical Spine		
Basic Projection • Anterior Posterior axial • Oblique • Lateral • Lateral-hyperflexion and hyperextension **Special Projection** • Anterior Posterior open mouth (C1 and C2) • Trauma lateral (horizontal beam) • Cardiothoracic junction	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3).	25

Content	Competencies	Number of Hours
(swimmers view) • Anterior Posterior (fuchs method) • Posterior Anterior (judd method) • Anterior Posterior wagging jaw (ottonello method) • Anterior Posterior axial (pillars)	10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	
Unit 4: Thoracic Spine		
Basic Projection • Anterior Posterior • Lateral • Oblique	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	15
Unit 5: Lumbar spine, sacrum and coccyx		
Basic Projection *Lumbar spine* • Anterior Posterior • Oblique • Lateral • Lateral (L5 - S1) • Anterior Posterior axial (L5 - S1) *Sacrum and Coccyx* • Anterior Posterior axial sacrum • Anterior Posterior axial coccyx • Lateral sacrum • Lateral coccyx **Special Projection** • Scoliosis series • Anterior Posterior or Posterior Anterior	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	25

Content	Competencies	Number of Hours

• Erect lateral
• Anterior Posterior (Ferguson method)
• Anterior Posterior – Right and Left bending
• Spinal fusion series
  • Anterior Posterior or Posterior Anterior – Right and Left bending
  • Lateral – hyper extension and hyper flexion
Coccyx
• Axial (Nolke Method)		

Unit 6: Pelvic girdle and proximal femur		
Basic Projection **Pelvic girdle** • Anterior Posterior pelvis **Hip and proximal femur** • AP unilateral hip **Sacrioiliac joints** • Anterior Posterior Posterior oblique **Special Projection** **Pelvic girdle** • Frog lateral(modified cleaves method) • Anterior Posterior axial for pelvic outlet (tayelor method) • Anterior Posterior axial for pelvic inlet (modified linienfield method) • Posterior oblique acetabulum (judet method) **Hip and proximal femur** • Axiolateral, inferosuperior (danelius– miller method) • Unilateral frog leg (modified cleaves method) • Modified axiolateral	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques(C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	25

Content	Competencies	Number of Hours
(clements-nakayama method)		
Unit 7: Paediatric radiography		
• Positioning, care and radiation protection while handling babies	1. Identify the part being radiographed (C1). 2. Prepare the patient for the radiograph (C3, P4, A3). 3. Demonstrate the steps involved in positioning (C3, P5, A2). 4. Use appropriate immobilization devices (C3, P6). 5. Select the appropriate technical factors (C3, P6). 6. Manipulate the technical factors pertaining to paediatric radiograph (C3, P6). 7. Identify the structures seen on the radiograph (C2). 8. Employ radiation protection techniques (C3). 9. Use appropriate radiographic accessories for positioning (C3). 10. Recognize the abnormal radiograph (C2). 11. Review the obtained image for quality (C2). 12. Operate the radiographic equipment (C3,P5).	25
Unit 8: Skull (cranial bones and facial bones)		
Basic and Special Projection • Cranium • Base of skull • Sella turcica • Mastoids • Optic foramina and Orbits • Nasal bone • TM joint • Facial bone • Zygomatic arches • Mandible • Para nasal sinuses	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5).	30
Unit 9: Neck		
Basic Projection • Anterior Posterior • Lateral	1. Explain the anatomy (C1). 2. Identify the part being radiographed (C1). 3. Prepare the patient for the radiograph (C3, P4, A3). 4. Demonstrate the steps involved in positioning (C3, P5, A2). 5. Select the appropriate technical factors (C3, P6). 6. Identify the structures seen on the	15

Content	Competencies	Number of Hours
	radiograph (C2). 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Recognize the abnormal radiograph (C3). 10. Review the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	195	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**195**	**-**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester (Theory and/or Practical)
Quiz	End Semester (Theory and/or Practical)
Viva	Viva
Clinical assessment (OSCE, OSPE, WBPA)	Record Book
Clinical/Practical Log Book/ Record Book	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x				x
Quiz / Viva		x	x	x		
Assignments/Presentations	x			x	x	
Clinical/Practical Log Book/ Record Book			x			
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Clarks Positioning in Radiography, R.A. Swallow, E. Naylor • Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D.
Additional References	• Skeletal Anatomy, Bryan Glenda J • Text Book of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P

SEMESTER - III

COURSE CODE	:	COURSE TITLE
PAT2103	:	Pathology
MCB2101	:	Microbiology
SUR4101	:	General Surgery
MIT2101	:	Orthopedics in Radiology
MIT2102	:	Radiographic Special Procedures
MIT2131	:	Clinical aspect of Radiographic Special Procedures
*** ****	:	Open Elective - I

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Pathology**
Course Code	**PAT2103**
Academic Year	Second Year
Semester	III
Number of Credits	3
Course Prerequisite	Nil
Course Synopsis	This module is devoted to the structural and functional changes in cells, tissues and organs that underlie disease. Pathology examines diseases and their mechanisms including the what, when, where, why and how of disease. It forms an integral part of clinical medicine and allied streams, as it is required to understand the symptoms and signs of disease, the modes of diagnosis and the rationale for clinical care.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	To demonstrate their understanding of the basic principles of pathology both as a medical science and as a clinical discipline (C2)
CO2	To explain the disease mechanisms, which include basic concepts, inflammation and neoplasms of specific systems and organs, and haematological conditions and understand the significance of the mechanisms in the health profession education (C2)
CO3	To use the principles of laboratory tests in the diagnosis of diseases (C4)
CO4	To apply the knowledge of Pathology to clinical situations for understanding the disease process along with clinical manifestations and relate the relevance of knowledge of pathology to the practice of health profession (C4)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x	x						
CO4	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1: Basic concepts and general pathology		
Introduction to pathology & basic terminologies	**Terminologies** 1. Introduction to pathology 2. Recognise the relevance of Pathology (C2) 3. Define the basic terminologies and branches of Pathology (C1)	1

Content	Competencies	Number of Hours
	a. Aaetiology b. Pathogenesis c. Pathological and clinical manifestations d. Complications & sequelae e. Prognosis f. Syndrome g. Lesion 4. Explain the scope of the following branches of pathology: (C2) a) Histopathology b) Cytopathology c) Haematology	
Cell injury & adaptation	**Cell adaptation** Define cell growth, differentiation and cell adaptation (C1) Describe the various cell adaptations with examples (C2) a) Hypertrophy b) Hyperplasia c) Atrophy d) Metaplasia e) Dysplasia **Necrosis** 1. Define necrosis(C1) 2. Describe the various types of necrosis with clinical examples (C2) a) Coagulative necrosis b) Colliquative necrosis/ Liquefactive necrosis c) Caseous necrosis d) Fibrinoid necrosis e) Fat necrosis f) Gangrene	2
Inflammation	Define inflammation. List the types with examples.(C1) Acute inflammation 1. Define acute inflammation. (C1) 2. Describe the causes and cardinal signs of acute inflammation. (C2) 3. Explain the vascular of acute inflammation. (C2) 4. Describe the cellular events in acute inflammation. (C2) 5. Explain the sequelae of acute inflammation. (C2) 6. Explain the beneficial, harmful and systemic effects of acute inflammation. (C2) Chronic inflammation 1. Define chronic inflammation. (C1) 2. List the causes of chronic inflammation. (C1) 3. Describe the macroscopic and microscopic features in chronic inflammation. (C2) 4. List the cells in chronic inflammation. (C1) 5. Define granulomatous inflammation. (C2)	3

Content	Competencies	Number of Hours
	6. List the components of a granuloma and describe its morphology (C2) 7. List the causes of granulomatous inflammation. (C1)	
Healing & repair	Wound healing 1. Define granulomation tissue and describe the formation of granulation tissue. (C2) 2. Describe the following: (C2) a. Healing by first intention. b. Healing by second intention. c. Wound organization, contraction and scarring. 3. Explain the factors which modify (influence) healing and repair. (C2)	1
Fluid & haemodynamic derangements	Oedema 1. Define oedema. (C1) 2. List the types of oedema. (C1) 3. Describe the pathogenesis and clinical features of the different types of oedema. (C2) Shock 1. Define shock. (C1) 2. List the various types of shock. (C1) 3. Describe the pathogenesis of septic and hypovolemic shock. (C2) Thrombosis (Arterial & Venous) 1. Define thrombosis. (C1) 2. Describe the factors influencing pathogenesis of thrombosis. (C2) 3. List causes of arterial and venous thrombosis. (C1) 4. List the fates of thrombus. (C1) Embolism 1. Define embolism. List the types of embolism with examples. (C1) 2. Describe the clinicopathologic consequences of pulmonary thromboembolism (C2) Infarction 1. Define infarction. (C1) 2. Describe the types and clinical significance of infarction. (C2)	4
Neoplasia	1. Define neoplasia (C1) 2. Describe the nomenclature of tumours with examples (C2) 3. Define dysplasia and anaplasia (C1) 4. Describe the differences between benign and malignant tumours (C2) 5. Define carcinogenesis. List the types of carcinogens with example of each (C1) 6. Describe the aetiology & predisposing factors of tumours (C2) 7. Define metastasis. (C1)	4

Content	Competencies	Number of Hours
	8. Describe the routes of metastasis with examples (C2) 9. Describe the prognostic factors of tumours with emphasis on staging & grading (C2) 10. Describe the various modalities for diagnosis of cancer (C2)	
Infectious diseases	Tuberculosis 1. Describe the aaetiology and mode of transmission of tuberculosis (C2) 2. Describe the clinical features of tuberculosis. (C2) 3. Describe the morphology of primary, secondary and miliary tuberculosis. (C2) Leprosy 1. List the aetiological factors of leprosy (C1) 2. Classify leprosy (C1) 3. Describe the morphology of lepromatous and tuberculoid leprosy (C2)	4
Genetics	1. Describe the basic concepts of genetics (C2) 2. Define with suitable examples (C1) a. Autosomal dominant b. Autosomal recessive c. X-linked recessive d. Chromosomal abnormalities 3. Define karyotyping (C1)	1
Unit 2: Haematology		
Diseases of RBCs	1. Define anaemia (C1) 2. Classify anaemia based on aaetiology and morphology (C4) 3. Describe the clinical features, aaetiology and basic investigation of (C2) a. Nutritional anaemias(B12/folate deficiency, iron deficiency) b. Haemolytic anaemias(thalassemia, sickle cell anaemia)	3
Bleeding disorders	1. List the types of bleeding disorders (C1) 2. Describe the clinical features and basic investigation of haemophilia (C2) 3. List the causes of thrombocytopenia (C1) 4. Describe the clinical features and basic investigation of immune thrombocytopenia (C2)	1
Diseases of WBC	1. Define leukemia (C1) 2. List the types of leukemia (C1) Acute Leukaemia (AML, ALL) 1. Describe the clinical features of AML & ALL. (C2) 2. Describe the laboratory diagnosis of AML and ALL (C2) **Chronic leukaemia (CML, CLL)** 1. Describe the clinical features, blood findings and chromosomal abnormality in CML (C2)	2

Content	Competencies	Number of Hours
	2. Describe the clinical features and laboratory diagnosis of CLL (C2)	
Unit 3: Systemic Pathology		
Blood vessels & heart	**Hypertension** 1. Define hypertension (C1) 2. Classify hypertension (C4) 3. Describe the effects of hypertension on various organs (C2) **Atherosclerosis** 1. Define atherosclerosis (C1) 2. List the sites of involvement by atherosclerosis(C1) 3. Describe the predisposing factors, complications & clinical effects of atherosclerosis (C2) **Ischemic heart disease/Coronary artery disease** 1. Define ischemic heart disease (C1) 2. Describe the clinical spectrum of the disease (with reference to angina and myocardial infarction)(C2) **Aneurysm** 1. Define aneurysm (C1) 2. List the causes, types and complications of aneurysms (C1) **Rheumatic heart disease** 1. Define rheumatic heart disease (C1) 2. Describe its aaetiology & clinical features (C2) **Cardiac failure** 1. Define cardiac failure (C1) 2. List the causes of cardiac failure (C1) 3. Describe its pathophysiology & clinical features (C2)	5
Respiratory system	**Pneumonia** 1. Define pneumonia (C1) 2. List the types of pneumonia(C1) 3. Describe the aetiology and clinical features of pneumonia (C2) **Chronic obstructive airway disease** 1. Define chronic obstructive airway disease. (C1) 2. List the types of chronic obstructive airway disease.(C1) **Emphysema** 1. Define emphysema(C1) 2. List the types of emphysema (C1) 3. Describe the aetiology and clinical features of emphysema (C2) **Chronic bronchitis** 1. Define chronic bronchitis (C1) 2. Describe the aetiology and clinical features of chronic bronchitis (C2) **Bronchiectasis** 1. Define bronchiectasis (C1) 2. List the types of bronchiectasis. (C1)	4

Content	Competencies	Number of Hours
	3. Describe the aetiology and clinical features of bronchiectasis (C2) **Asthma** 1. Define asthma (C1) 2. List the types of asthma (C1) 3. Describe the aetiology and clinical features of asthma (C2) **Pneumoconiosis** 1. Define pneumoconiosis (C1) 2. List the types of pneumoconiosis (C1) **3.** Describe the aetiology and clinical features of pneumoconiosis (C2)	
Gastrointestinal tract & liver	**Gastric & duodenal ulcers** 1. Definition gastric and duodenal ulcer (C1) 2. Describe the aetiology, gross pathology and clinical features of gastric and duodenal ulcer (C2) **GIT malignancies** 1. List the types of common GIT malignancies (C1) 2. Describe their predisposing factors & clinical features (C2) **Jaundice** 1. Define jaundice (C1) 2. List the types of jaundice with examples (C1) **Viral hepatitis** 1. Describe the aetiology of viral hepatitis (C2) 2. List the modes of infection (C1) 3. Describe the clinical features of viral hepatitis (C2) **Cirrhosis of liver** 1. Define cirrhosis (C1) 2. List the causes of cirrhosis (C1) **Liver failure** 1. Define liver failure (C1) 2. List the causes of liver failure (C1) 3. Describe its pathophysiology & clinical features(C2)	4
Renal system	Define nephrotic syndrome & nephritic syndrome with suitable examples (C1) **Renal failure** 1. Define renal failure (C1) 2. List its types & describe the clinical features (C2)	1
Endocrine system	1. Define hyperthyroidism & hypothyroidism (C1) 2. Describe the causes, clinical features and laboratory diagnosis of hyperthyroidism and hypothyroidism (C2) 3. Describe the types, causes & clinical features of goitre (C2) Describe types, clinical features, complications & laboratory diagnosis of diabetes (C2)	2
Nervous system	Define Cerebrovascular diseases (C1) Describe its causes and clinical features (C2)	1

Content	Competencies	Number of Hours
Musculoskeletal system	**Fracture** 1. Define fracture (C1) 2. List the types of fracture (C1) 3. Describe the process of fracture healing (C2) 4. List the factors influencing fracture repair (C1) **Osteomyelitis** 1. Define osteomyelitis (C1) 2. Describe the aetiology, types and clinical features of osteomyelitis (C2) Define and list the clinical features of Rheumatoid arthritis, osteoarthritis and osteoporosis (C1)	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	45	135
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**45**	**135**

Assessment Methods	
Formative:	**Summative:**
Unit Test - Nil	1st Sessional Exam - SEQ (theory) 2nd sessional exam - MTF (theory)
Quiz - Nil	University exam – SEQ (theory)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester /Sessional Examination 1	x	x	x	x	-	-
Sessional Examination 2	x	x	x	x	-	-
End Semester/University Exam	x	x	x	x	-	-

Feedback Process:	Mid semester feedback End-Semester Feedback
Main Reference:	1. Essential Pathology for Dental students, Harsh Mohan, 3rd edition, 2010 Jaypee. 2. General and systemic pathology, JCE Underwood and S S Cross, 7th edition, 2018, Churchill Livingstone.
Additional References	

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Microbiology**
Course Code	**MCB2101**
Academic Year	Second Year
Semester	III
Number of Credits	2
Course Prerequisite	Nil
Course Synopsis	This course focuses on acquiring the knowledge pertaining to basics of medical microbiology, host immune response, healthcare associated infections and aseptic measures to prevent infections

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the process of disease causation by infectious agents and appraise the role of microbiology laboratory in the diagnosis, management and control of infectious diseases (C2)
CO2	Explain the development of immune response, its relation to infection and other diseases with an immunological basis (C2)
CO3	Explain the implications of antibiotic susceptibility (C2)
CO4	Understanding the principles of asepsis and infection control in clinical practice (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Introduction To Medical Microbiology	i) Historical introduction to microbiology a. Describe the contributions of: (C1) • Louis Pasteur • Robert Koch ii) Classify the microorganisms (C2) iii) List the branches of microbiology and their significance (C1)	1
Bacterial Anatomy And Classification	i) Explain the bacterial cell structure, organelles and their functions (C2) ii) Explain the bacterial envelope of gram positive and gram negative bacteria (C2)	2

Content	Competencies	Number of Hours
	iii) Explain the following bacterial structure and their significance (C2) a. Cytoplasm b. Ribosomes c. Mesosomes d. Nucleoid e. Inclusion granules f. Flagella g. Pili h. Capsule i. Plasmid j. Spores iv) Classify bacteria based on morphology and nutrition (C2)	
Growth, Cultivation And Identification Of Bacteria	i) Explain the following: (C2) a. Bacterial growth curve b. Cultivation of bacteria • Culture media • Culture methods c. Identification of bacteria • Microscopy and Staining techniques • Biochemical reactions • Serology • Molecular techniques	2
Antimicrobial susceptibility	i) Explain the disc diffusion methods – Kirby Bauer's and E - test (C2)	1
Introduction to virology, mycology & parasitology	i) Explain the following: (C2) a. General features of viruses b. Virion structure c. Classification of viruses d. Diagnosis of viral diseases e. General properties and classification of fungi (morphological classification) f. Infections produced by fungi and their diagnosis g. General properties and classification of parasites h. Parasitic infections and their diagnosis	3
Sterilization And Disinfection	i) Classify sterilization methods (C2) ii) Explain the following (C2) a. Physical: Heat b. Sterilization by heat c. Dry heat sterilization – • Hot air oven and incinerator d. Moist heat sterilization • Below 100 ^{o}C, • At 100 ^{o}C • Above 100 ^{o}C e. Classification of disinfectants used in hospital and their mechanism of action	3

Content	Competencies	Number of Hours
Infection & Immunity	i) Define infection (C1) a. List the types, sources, routes and spread of infectious diseases (C1) ii) Define and classify immunity (C1) iii) Explain the following: (C2) a. Types of immunity b. Types of vaccines iv) List the immunization schedule in India (C1)	2
Antigen & Antibody	i) Define antigen (C1) ii) Define(C1) and classify antibodies (C2) iii) Explain the following (C2) a. Functions of antibodies b. Diagnostic importance of antigen-antibody reactions • Agglutination • Immunofluorescence • ELISA	1
Immune Response	i) List the cells of immune system (C1) ii) Explain the following: (C2) a. Humoral Immunity - Primary and secondary immune response b. Cell mediated Immunity -Constituents and significance	2
Hypersensitivity	i) Define (C1) and classify hypersensitivity (C2) Explain the following: (C2) a. Immediate hypersensitivity • Mechanisms and mediators of Anaphylaxis and atopy b. Cytotoxic hypersensitivity - Mechanism and associated disorders c. Immune complex hypersensitivity- • Arthus reaction, serum sickness and immune complex diseases d. Delayed type hypersensitivity- Mechanism and clinical importance of • Contact dermatitis and tuberculin type hypersensitivity	2
Autoimmunity	i) Define autoimmunity (C1) ii) Explain the mechanisms of autoimmunity (C2) iii) List the diseases involving predominantly one type of cell or organs (C1) iv) List the diseases involving multiple organs (systemic) (C1)	1
Healthcare Associated Infections	i) List the common Healthcare associated infections (C1) ii) Explain the following: (C2) a. Causes	1

Content	Competencies	Number of Hours
	b. Sources c. Routes of spread d. Host risk factors e. MRSA and its importance **f.** Prevention **g.** Investigation	
Standard Precautions And Overview Of Laboratory Diagnosis Of Microbial Infections	i) Explain the following (C2) **a.** Hand hygiene **b.** Personal protective equipment (PPE) **c.** Respiratory hygiene **d.** Sharp safety **e.** Sterile instruments and devices. **f.** Clean and disinfected environmental surfaces ii) Explain laboratory diagnosis of microbial infections (C2) a. Specimen Collection b. Specimen transport c. Specimen processing and handling d. Identification of microbes	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	24	72
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	2	6
Assessment	4	12
Total	**30**	**90**
Assessment Methods:		
Formative:	**Summative:**	
Unit Test- Nil	Mid Semester- First Sessional Examination SEQ (theory) Second Sessional Examination – MTF (theory)	
Quiz - Nil	**University Examination – SEQ theory**	
Viva - Nil	Viva - Nil	
Assignments/Presentations- Nil	Record book - Nil	
Clinical assessment (OSCE, OSPE, WBPA) - Nil	Nil	
Clinical/Practical Log Book/ Record Book - Nil	Nil	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	**x**	**x**	**x**	**x**	**-**	**-**
Sessional Examination 2	**x**	**x**	**x**	**x**	**-**	**-**
End Semester / University Exam	**x**	**x**	**x**	**x**	**-**	**-**
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	1. Textbook of Microbiology for Dental students, Prof: C.P. Baweja 2. Medical Parasitology, D. R. Arora and D. Arora					
Additional References	1. Review of Medical Microbiology and Immunology by Warren Levinson, 15th Edition					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**General Surgery**
Course Code	**SUR4101**
Academic Year	Second Year
Semester	Third Semester
Number of Credits	3
Course Prerequisite	Knowledge of Anatomy, physiology, pathology and biochemistry
Course Synopsis	The course is intended to provide knowledge about 1. Various surgical procedures related to common general conditions, conditions such as cardiothoracic, vascular, ENT, ophthalmic, cancers and plastic surgery 2. Management of these surgical conditions – Conservative and surgical management 3. Common and specific complications arising due to these surgeries and their prevention and further management

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the common indications and lists down the common investigations used for the surgical procedures (C2)
CO2	Explain the surgical management of common surgical conditions and post-surgical care (C2)
CO3	Explain the complications of common surgical procedures (C2)
CO4	Outline the prevention strategies and precautions to be taken for common surgical complications (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Course Content and Outcomes:

Content	Competencies	Number of Hours
GENERAL SURGERY		
Unit 1: Effects of Anesthesia on body systems		
Emphasizing on Cardiopulmonary and Metabolic systems	1. Define Anaesthesia (C1) 2. Classify types of Anaesthesia (C2) **3.** Explain the effects of anaesthesia on different body systems with emphasis on cardiopulmonary and metabolic system (C2)	1
Unit 2:		
Introduction to Blood	1. Define blood transfusion? (C1)	1

Content	Competencies	Number of Hours
Transfusion	2. Outline the types of blood products used in blood transfusion (C2) 3. List the indications and contraindications for blood transfusions (C1) 4. List down the precautions taken during blood transfusion (C1) 5. Explain the complications of blood transfusion (C2)	
Unit 3:		
Wound Management	1. Explain different types of wounds (C2) 2. Summarize the stages of Wound Healing (C2) 3. What are surgical Sinuses and Trophic ulcers (C1) 4. Explain gangrene (C2) 5. Describe the principles of Treatment and Methods of Wound Management (C2)	2
Unit 4:		
General Surgical procedures	1. Describe the incisions used in general surgery including abdominal surgery and amputations (C1) 2. List the indications for common general surgical procedures (C1) 3. List down the diagnostic procedures used in general surgical procedures (C1) 4. Summarize the general surgical procedures (muscles cut/muscles split, drains used) (C2) 5. Outline immediate and late complications of general surgery (Hemorrhage, shock, fluid and electrolyte imbalance, pulmonary system, cardiovascular system, musculoskeletal, metabolic system related complications and complications to specific general surgery) (C2) 6. Explain amputation care (C2) 7. Explain the management of Hernia (C2) 8. Explain colostomy care (C2)	5
Unit 5		
Hemorrhoids, incontinence and rectal prolapse	1. Explain the causes of hemorrhoids, incontinence and rectal prolapse (C2) 2. List down the investigations used for the diagnosis (C1) 3. Outline the surgical procedures for hemorrhoids, incontinence and rectal prolapse (C2)	1
ENT		
Unit 6		
Sinusitis and infections of parotid glands	1. List down the causes of sinusitis and parotid gland infections (C1) 2. List down the symptoms of sinusitis and	1

Content	Competencies	Number of Hours
	parotid gland infections (C1) 3. List down the investigations used for the diagnosis (C1) 4. Outline the surgical procedures for sinusitis and parotid gland infections (C2)	
Unit 7		
Otitis media	1. Define Otitis Media? (C1) 2. List down the causes of Otitis media (C1) 3. Classify types of Otitis media (C2) 4. List down the symptoms of Otitis media (C1) 5. List down the investigations used for the diagnosis (C1) 6. Outline the management of Otitis media (C2)	1
Unit 8		
Benign paroxysmal positional vertigo and vestibular dysfunction	1. Define BPPV? (C1) 2. Explain the pathophysiology of BPPV (C2) 3. Explain management of BPPV (C2) 4. Classify vestibular dysfunction (C2) 5. Explain the causes of various vestibular dysfunction and their types (C2) 6. List down the investigations used for the diagnosis (C1) 7. Explain the management of vestibular dysfunction (C2)	2
Unit 9		
Tracheostomy	1. Desribe tracheostomy? (C2) 2. List down the indications for tracheostomy (C1) 3. List down the surgical procedure of tracheostomy (C1) 4. Explain tracheostomy care (C2) 5. Explain the complications of tracheostomy (C2) 6. Explain decanulation? (C2) 7. List down the indications for decanulation (C1)	1
OPHTHALMOLOGY		
Unit 10		
Conditions affecting visual acuity	1. List down the conditions affecting visual acuity (C1) 2. List down the causes of visual acuity (C1) 3. Explain the pathophysiology of conditions causing visual acuity (C2) 4. Explain the management of conditions affecting visual acuity (C2)	2
Unit 11		
Common Ophthalmic Surgeries	1. Outline common ophthalmic surgeries (C2)	1

Content	Competencies	Number of Hours
Unit 12		
Visual Field and Refraction Testing	1. Explain various visual field testing (C2) 2. Explain refraction testing in adults and children (C2)	1
CARDIOTHORACIC SURGERY		
Unit 13		
Overview of investigations and diagnostic procedures	1. Lists the various investigations commonly used in the preoperative work up for a patient undergoing elective and emergency cardiothoracic & vascular surgery (C1) 2. Recalls the various diagnostic procedures that are performed (both invasive and minimally invasive) (C1) 3. Recalls various indications for emergency cardiothoracic and vascular surgery (C1)	1
Unit 14		
Chest Trauma and Intercostal drains	1. Recalls the various trauma that can occur to the chest wall (lung contusion, haemothorax, penumothorax, rib fracture and flail chest) and its management (C1) 2. Explains the indications, insertion, functioning, care and precautions of the intercostal drain (C2)	2
Unit 15		
Pulmonary surgeries	1. Lists the various indications and approaches (traditional, minimally invasive and video assisted) for pulmonary surgery (C1) 2. Describes the various thoracic incisions and the related complications (C2) 3. Explains the procedure and recalls the complications specific to various procedure like lung resections, pneumonectomy, pleural resection and diaphragm repair (C2)	2
Unit 16		
Cardiac surgeries	1. Lists the various indications and approaches (traditional, minimally invasive, robotic) for cardiac surgery in both the adult and child (C1) 2. Explains the procedure and recalls the complications specific to various procedures like coronary artery bypass graft surgery, valve replacement and cardiopulmonary bypass (C2) 3. Outlines the various procedures carried out for congenital heart disease repair (C2)	3
Unit 17		
Vascular surgery	1. Lists the various surgical procedures (I.e., fistula formation, endarterectomy and	1

Content	Competencies	Number of Hours
	bypass), their approaches (open vs. Endovascular) and complications (C1)	
PLASTIC SURGERY		
Unit 18		
Burns:	1. Classify types of Burn(C2) 2. List out the causes of burns (C1) 3. List out the clinical features of burns(C1) 4. Outline immediate and late complications(Cardiac,Pulmonary,Metabolic, Renal, Skin and Musculoskeletal) of burns(C2) 5. Explain the acute and long-term management of burns (C2)	3
Unit 19		
Skin Grafts and Flaps	1. Classify types of Skin grafts and Flaps(C2) 2. Explain Post-operative management of skin grafts and flaps (C2) 3. List the various indications for cosmetic surgery(C1) 4. List out the criteria for grafts and flap selection(C1)	3
SURGICAL ONCOLOGY		
Unit 20: Palliative and Reconstructive Surgeries in Head and Neck Cancer		
Emphasizing on Tongue, Buccal Mucosa, Floor of Mouth, Mandible, Maxilla, Pharynx, Larynx Surgical Indications, Procedures like Functional Neck Dissection and Excision and Flap Reconstruction - Post Operative Management and Complications	1. List the surgical indications for head and neck cancer surgeries. (C1) 2. Classify the types of head and neck dissections in patients with head and neck cancer (C2) 3. List down the diagnostic investigations (C1) 4. Explain the post-operative management after neck dissections (C2) 5. List the various post- operative complications in patients with head and neck cancer. (C1)	3
Unit 21: Carcinoma Breast and gynaecological cancers		
Surgical Indications, Procedure, Post-Operative Management and Complications	**1.** List the surgical indications in different types of breast cancer and gynaecological cancers (C1) 2. Classify the types of surgical procedures performed in breast cancer surgery and gynaecological cancer surgeries (C2) 3. List the post-operative complications after a breast cancer surgery and gynaecological cancer surgeries (C1) 4. List down the investigations used in the diagnosis (C1) 5. Explain the post-operative management after breast cancer surgery and gynaecological cancer surgeries (C2)	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	39	121
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Revision	-	-
Assessment	-	-
Total	**39**	**121**

Assessment Methods:	
Formative:	**Summative:**
Quiz	Mid Semester / Sessional Exam (Theory)
	End Semester Examination (Theory)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x	x		
Presentations						
End Semester Exam	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Bailey and Love's short practice of Surgery, 27th edition 2. Sabiston Textbook of Surgery, 20th Edition 3. Dutta's textbook of gynaecology
Additional References	1. On-Pump and Off-Pump Coronary Artery Bypass Grafting by Shekar PS https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.105.566737 2. Surgical Intervention for Peripheral Arterial Disease by Gaudino M et al. https://www.ahajournals.org/doi/epub/10.1161/CIRCULATIONAHA.118.035956 3. Surgical Intervention for Peripheral Arterial Disease by Vartanian MS et al. https://www.ahajournals.org/doi/full/10.1161/circresaha.116.303504

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Orthopaedics in Radiology**
Course Code	**MIT2101**
Academic Year	Second Year
Semester	III
Number of Credits	2
Course Prerequisite	Students should have basic knowledge in Anatomy and Physiology
Course Synopsis	1. This module provides knowledge on Anatomy of Bones and joints. 2. To provide fundamental knowledge on classification of fractures and its complications. 3. This module emphasis on various inflammatory diseases of the bones and joints. 4. This module helps imaging technologists in providing necessary care to handle trauma patients.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify and explain the anatomy of bones and joints (C1,C2)
CO2	Explain the types of fractures, handling of patients with fracture and orthopaedic hardware used for stabilisation of fractures (C2)
CO3	Explain the types, etiology, radiological features and complications of spinal disorders(C2)
CO4	Explain the types, etiology, radiological features and complications of Inflammatory diseases of bones and joints(C2)
CO5	Explain the types, etiology, radiological features and complications of infectious diseases of bones and joints(C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x	x						
CO3	x	x						
CO4	x	x						
CO5	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1: Normal skeleton		
Anatomy, Identification of Bones & introduction to Orthopaedics	1. Classify the skeletal system (C2) 2. Recall the constituents of appendicular and axial skeletal system (C1) 3. Classify the bones (C2) 4. Explain the Anatomy and identification of	3

Content	Competencies	Number of Hours
	following bones - clavicle, scapula, humerus, radius, ulna, hip bone, femur, tibia fibula and vertebra (C2)	
Unit 2		
Fractures	1. Define Fracture (C1) 2. List the types of fracture-open and closed (C1) 3. Classify the fractures based on fracture line (C2) 4. Outline the radiology of fractures and related injuries (C2)	3
Unit 3		
Spinal Disorders	1. Define scoliosis (C1) 2. Outline the etiology (C2) 3. List the complications of scoliosis (C1) 4. Explain the radiographic assessment of scoliosis patient (C2) 5. Define kyphosis (C1) 6. Outline the etiology (C2) 7. List the complications of kyphosis(C1) 8. Explain the radiographic assessment of kyphosis patient (C2)	3
Unit 4		
Orthopaedic hardware	1. List the indications for internal and external fixation(C1) 2. Illustrate the External fixation devices (Fracture fixation) (C2) 3. Illustrate the Internal fixation devices (screws, plates, wires and pins, intramedullary rods and nails, spinal fixation devices) (C2)	3
Unit 5		
Splints and casts	**1.** Outline the Care during radiography of patients with splint and cast (C2)	1
Unit 6		
Infectious Diseases of Bone	**A. Osteomyelitis** 1. Define osteomyelitis (C1) 2. Explain the etiology of osteomyelitis (C2) 3. Outline the radiographic findings (Sequestrum and Involucrum) (C2) **B. Skeletal TB** 1. Define skeletal TB (C1) 2. Explain the etiology and pathogenesis of Skeletal TB (C2) 3. List the commonly involved bones and joints (C1) 4. Explain the stages of TB arthritis (C2) 5. Explain the radiological features of TB hip, knee and Spine (C2)	5

Content	Competencies	Number of Hours
	C. Septic Arthritis 1. Define septic arthritis (C1) 2. List the clinical and radiological features (C1) 3. List the complications of Septic arthritis (C1)	
Unit 7		
Inflammatory diseases of bone and Joint	**A. Arthritis** 1. Define Arthritis (C1) 2. Classify Arthritis (C2) 3. Explain the radiological features of arthritis (C2) 4. List the complications of arthritis (C1) **B. Spondylitis** 1. Define spondylitis (C1) 2. Classify spondylitis (C2) 3. Which are the radiological features of spondylitis (C1)	3
	C. Osteoporosis 1. Define osteoporosis(C1) 2. Explain the etiology (C2) 3. Classify osteoporosis (C2) 4. Infer the conditions causing osteoporosis in children, adults and elderly (C2) 5. Demonstrate the radiological features of osteoporosis of spine (C2) 6. List complications of osteoporosis (C1)	3
	D. Perthe's disease 1. Define perthes disease (C1) 2. Explain the etiology of perthe's disease (C2) 3. Demonstrate the radiological appearance of perthes disease (C2)	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:						
Formative:	**Summative:**					
Unit Test	Mid Semester/Sessional Exam (Theory)					
Mapping of Assessment with COs:						
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester Examination		x	x	x	x	x
Quiz / Viva						
Assignments/Presentations						
Clinical/Practical Log Book/ Record Book						
Any others: WPBA						
End Semester Exam						
Feedback Process:	Mid-Semester Feedback					
Main Reference:	• Orthopedics And Traumatology -Prof M Natarajan, Prof Mayil.V. Natrajan					
	• Essential Orthopedic And Trauma - Davids J Edward, Dennis J Edward					

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Radiographic Special Procedure**
Course Code	**MIT2102**
Academic Year	Second Year
Semester	III
Number of Credits	4
Course Prerequisite	Basic knowledge in Anatomy and Physiology
Course Synopsis	• This module provides the guideline for the imaging technology students a basic working knowledge of various radiological procedures routinely performed in Medical Imaging. • Each topic is designed for the students to familiarize themselves with special procedures pertaining to body systems and takes the students through various details of the procedures highlighting the indication, contraindications, preparation, techniques, complications and after care related to each procedure

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Define and classify the various contrast media used for radiological procedures and relate its toxicity to various contrast reactions. Summarize how these reactions are managed and listing out emergency drugs and its uses. (C2)
CO2	Explain in detail the anatomy, indications, contraindications, preparation, equipments used, procedure, filming techniques, complications and aftercare for various radiological procedures pertaining to the urinary system.(C2)
CO3	Illustrate various contrast media used in GIT studies and explain in detail the anatomy, indications, contraindications, preparation, equipments used, procedure, filming techniques, complications and aftercare for various radiological procedures pertaining to the Gastrointestinal tract.(C2)
CO4	Explain in detail the anatomy, indications, contraindications, preparation, equipments used, procedure, filming techniques, complications and aftercare for various radiological procedures pertaining to female reproductive system.(C2)
CO5	Explain in detail the anatomy, indications, contraindications, preparation, equipments used, procedure, filming techniques, complications and aftercare for radiological procedures related to salivary glands and nasolacrimal duct system. (C2)
CO6	Define and Illustrate various catheters used for interventional radiological procedures. Explain in detail the anatomy, indications, contraindications, preparation, equipments used, procedure, filming techniques, complications and aftercare for vascular radiological procedures. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x					x		
CO2	x					x		
CO3	x					x		

CO4	x					x		
CO5	x					x		
CO6	x					x		

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Introduction to Special Radiographic procedures	• Define and outline diagnostic and therapeutic procedures (C1,C2)	1
Unit 2:		
Contrast media	• Define and Classify contrast media (C1,C2) • What are the features of ideal contrast media? (C1) • Illustrate the chemical composition of water soluble iodinated contrast media (C2) • Explain the physiological effects of administratin contrast media(C2) • Explain contrast media toxicity and Classify the severity of reactions. (C2) • Define anaphylactic and anaphylactoid Reaction (C1) • Which group of people are considered to have a higher risk of contrast media reactions? (C1) • Outline pre-medications required based on patient history. (C2) • Explain how are contrast media reactions managed? Illustrate the functions of of various emergency drugs. (C1, C2)	5
Unit 3:		
Intravenous urogram (IVU/IVP)	• Recall anatomy of urinary system(C1) • What are the indications and contraindications of the procedure? (Adults & children) (C1) • Outline the patient preparation for the procedure (Adults & children) (C2) • What is the type, quantity and mode of administration of contrast media for IVU? (Adults & children) .(C1) • List out the equipments required. (C1) • Explain the procedure and filming techniques (Adults & children). (C2) • Relate the modifications of Urogram (C2) • Relate the various pathologies seen in Intravenous Urogram. (C2) • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2)	3
Unit 4:		
Retrograde Pyeloureterography	• Define Retrograde Pyeloureterography(C1)	2

Content	Competencies	Number of Hours
	• What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation for the procedure (C2) • What is the type, quantity and mode of administration of contrast media? (C1) • Explain the procedure and filming techniques (C2) • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2)	
Unit 5:		
Micturating cystourethrography (MCU)	• Define Micturating cystourethrography (C1) • What are the indications and contraindications of the procedure?(C1) • What is the type, quantity and mode of administration of contrast media? (C1) • Explain the procedure and filming techniques. (C2) • What are the complications of the procedure? (C1) • List out the advantages and disadvantages of excretion MCU (C1)	2
Unit 6:		
Ascending Urethrogram (ASU)	• Define Ascending urethrogram (C1) • Recall anatomy of male urethra (C1) • What are the indications and contraindications of the procedure?(C1) • What is the type, quantity of contrast media used? (C1) • List out the equipments required (C1) • Explain the procedure and filming techniques. (C2) • What are the complications of the procedure? (C1) • Compare ASU and MCU. (C2)	2
Unit 7:		
Contrast media in GIT	What is the reason for choosing barium sulphate for GI studies? (C1) • List out the properties of ideal Ba sulphate.(C1) • Explain the manufacture of Barium. (C2) • How to describe a concentration of a solution? (C1) • What is the various formulations of commercially prepared Barium? (C1) • How do we prepare Barium suspension (C1) • Explain the various characteristics influencing coating. (C2)	4

Content	Competencies	Number of Hours
	• Outline the adverse effects of Barium sulphate. (C2) • Which are the other contrast media used for GI studies and why is it used?(C1) • Summarize contrast media used for GIT computed tomography (C2)	
Unit 8:		
Barium swallow	• Define Barium swallow (C1). • Recall anatomy of the upper GI tract. (C1) • What are the indications and contraindications of the procedure?(C1) • Name the contrast media used along with its concentration for single contrast and double contrast studies. (C1) • Explain the procedure and filming techniques for single contrast and double contrast studies.(C2) • Demonstrate Ba swallow for specific conditions (Severe Dysphagia, Pharyngeal webs, Foreign body impaction, carcinoma, Motility disorders, Achalasia, Tracheo- esophageal fistula, Hiatus hernia , Gastro esophageal reflux and esophageal varices) (C2) • What are the complications of the procedure?(C1)	3
Unit 9:		
Barium meal	• Define Barium meal.(C1) • Recall anatomy of GIT tract.(C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation for the procedure (C2) • Name the contrast media used along with its concentration for single contrast and double contrast studies (C1). • Explain the procedure and filming techniques for single contrast and double contrast studies.(C2) • Illustrate High kV technique for barium meal(C1) • List out advantages and disadvantages for single contrast study. (C1) • List out advantages and disadvantages for double contrast study. (C1) • Explain in detail Biphasic study. (C2) • Compare Tubeless method of Hypotonic Duodenography with tube method.(C2) • List out advantages and disadvantages of Hypotonic Duodenography.(C1)	3

Content	Competencies	Number of Hours
	• What are the complications of the procedure? (C1) • Explain the after care of the patient (C2) • Compare endoscopy with Barium meal. (C2)	
Unit 10:		
Barium meal follow through	• Define Barium meal follow through (C1). • Recall anatomy of GIT tract.(C1) • List out differences between jejunum and Ileum.(C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation for the procedure (C2) • Name the contrast media used along with its concentration for single contrast and double contrast studies (C1). • Explain the procedure and filming techniques for single contrast and double contrast studies.(C2) • List out methods to increase Gastric Peristalsis.(C1) • What are the advantages and disadvantages of BMFT(C1) • Summarize Peroral Pneumocolon and Retrograde small bowel examination.(C2) • What are the complications of the procedure? (C1)	4
Unit 11:		
Enteroclysis	• Define enteroclysis.(C1) • What are the indications and contraindications of the procedure?(C1) • List out the equipments required. (C1) • Name the contrast media used along with its concentration for single contrast and double contrast studies (C1). • Outline the patient preparation for the procedure (adult and infants)(C2) • Explain the procedure and filming techniques for single contrast and double contrast studies.(C2) • Explain air double contrast enteroclysis(C2) • Compare air enteroclysis with Methyl cellulose enteroclysis (C2). • What are the advantages and disadvantages of BMFT(C1) • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2). • Compare enteroclysis and BMFT (C2).	3

Content	Competencies	Number of Hours
Unit 12:		
Barium enema	• Define Barium Enema (C1). • Recall anatomy of the lower GI tract. (C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation for the procedure (C2) • When should patient preparation not be done?(C1) • List out the equipments required. (C1) • Explain the procedure and filming techniques for single contrast and double contrast studies.(C2) • List out advantages of single contrast study over double contrast study.(C1) • Relate special barium enema studies (C2). • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2).	4
Unit 13:		
Hystersosalpingography	• Define Hysterosalpingography (C1) • Recall anatomy of Female reproductive system (C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation and ideal timing for the procedure (C2) • List out the equipments required. (C1) • Explain the procedure and filming techniques for catheter and canula method (C2) • List out advantages and disadvantages using Foley s catheter.(C1) • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2).	3
Unit 14:		
Fallopian tube recanalisation	• Define fallopian tube recanalisation(C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation and ideal timing for the procedure (C2) • List out the equipments required. (C1) • Explain the procedure of fallopian tube recanalisation.(C2) • Compare various methods for fallopian tube recanalisation(C2) • What are the complications of the procedure? (C1)	2

Content	Competencies	Number of Hours
	• Explain the after care of the patient (C2).	
Unit 15:		
Sialography	• Define sialography (C1) • Recall anatomy of salivary glands (C1) • What are the indications and contraindications of the procedure?(C1) • List out the equipments required. (C1) • Outline the patient preparation for the procedure (C2) • Explain the procedure and filming techniques (C2). • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2). • List out disadvantages of sialography.(C1)	2
Unit 16:		
Dacrocystography	• Define Dacrocystography (C1) • Recall anatomy of Nasolacrimal duct system (C1) • What are the indications and of the procedure?(C1) • List out the equipments required. (C1) • Explain the procedure and filming techniques (C2). • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2). • What are the other methods to study nasolacrimal duct system? (C1)	2
Unit 17:		
Catheters	• Define catheters (C1) • Classify catheters (C2) • List out advantages of side holes in catheters.(C1) • Outline function of micro catheters, drainage catheter and balloon catheters (C2) • Illustrate catheters used for aortogram, cerebral, visceral coronary and renal studies. (C2) • Classify Central venous catheter (C2) • How is catheter sterilized? (C1)	3
Unit 18:		
Angiography	• Define angiography (C1) • Recall anatomy of the vascular system (C1) • What are the indications and contraindications of the procedure?(C1) • Outline the patient preparation and	4

Content	Competencies	Number of Hours
	precautions for the procedure (C2) • List out the equipments required.(C1) • What is the type, quantity and mode of administration of contrast media for Angiography (C1) • Explain direct needle puncture technique and seldinger technique.(C2) • What are the complications of the procedure? (C1) • Explain the after care of the patient (C2). • Define Percutaneous transluminal angioplasty (C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	39	78
Seminar	-	-
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	4	8
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	4	8
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**52**	**104**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Assignments/Presentations	Record Book

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x			x	
Sessional Examination 2						
Quiz / Viva	x	x	x	x	x	x
Assignments/Presentations	x	x	x			x
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Radiological procedures. N Bhushan • Fundamentals of special radiographic procedures. Albert M. Snopek
Additional References	• Guide to radiological procedures. Chapman & Nakielny.

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical aspect of Radiographic Special Procedures**
Course Code	**MIT2131**
Academic Year	Second Year
Semester	III
Number of Credits	3
Course Prerequisite	Basic knowledge in Anatomy and Physiology
Course Synopsis	• This module will enable the students to integrate their newly gained knowledge and abilities on radiological procedures in a hands on manner in a professional health care setting. • This will also facilitate them to understand the departmental protocols and familiarize themselves with the equipment used. • The clinical experience will enable them to gain additional skills in clinical procedures, interaction with patients, professional personnel and develop team work.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify the various contrast media used for radiological procedures and relate their theoretical knowledge on adverse reactions to these contrast media. Summarize how these reactions are managed and listing out the emergency drugs and equipment used in the radiology department.(C3,P2)
CO2	Identifying and reviewing the anatomy, indications, and contraindications, for various radiological procedures. (urinary system, Gastrointestinal system, female reproductive system, salivary glands and nasolacrimal duct system) (C3)
CO3	Explain patient preparation and identifying list of equipments used, for various radiological procedures. (urinary system, Gastrointestinal system, female reproductive system, salivary glands and nasolacrimal duct system) (C2,P1)
CO4	Explain procedure, filming techniques, and aftercare for various radiological procedures pertaining to the urinary system, Gastrointestinal system, female reproductive system, salivary glands and nasolacrimal duct system.(C2,P3,A3)
CO5	Applying principles of ALARA to minimize exposure to patient, self and others. Summarizing aseptic techniques for various radiological procedures.(C2,P5)
CO6	Illustrate various catheters used for interventional radiological procedures. (C1,P2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2	x	x						
CO3	x			x				
CO4		x			x			
CO5		x		x				
CO6	x	x						

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Contrast media	• Identify positive contrast media used for radiological procedures.(C3) • Identify negative contrast media used for radiological procedures.(C3) • Identify contrast media used for Gastrointestinal studies.(C3) • List out emergency drugs and equipments used in radiology department.(C1) • Identify contrast induced adverse reactions(C3) • Summarize departmental protocols for Management of contrast media reactions. (P2)	20
Unit 2:		
Intravenous urogram (IVU/IVP)	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (Adults & children) (C3) • Recall the patient preparation for the procedure (Adults & children) (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Identify the procedure and filming techniques (Adults & children). (P3) • Plan the after care of the patient **(A3)** • Assess measures taken for radiation protection (P5) • Outline the aseptic techniques adopted. (C2)	15
Unit 3:		
Micturating cystourethrography	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (Adults & children) (C3) • Recall the patient preparation for the procedure (Adults & children) (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Identify the procedure and filming techniques (Adults & children). (P3) • Plan the after care of the patient **(A3)** • Assess measures taken for radiation protection (P5)	15

Content	Competencies	Number of Hours
	• Outline the aseptic techniques adopted. (C2)	
Unit 4:		
Ascending Urethrogram	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques (P2) • Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2) • Outline the aseptic techniques adopted. (P2)	3
Unit 5:		
Barium swallow	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure.(C3) • Recall the patient preparation for the procedure (P1). • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Identify the procedure and filming techniques (Adults & children). (P3) • Plan the after care of the patient **(A3)** • Assess measures taken for radiation protection (P5)	15
Unit 6:		
Barium meal	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P2)	12

Content	Competencies	Number of Hours
	• Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2)	
Unit 7:		
Barium meal follow through	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P2) • Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2)	8
Unit 8:		
Enteroclysis	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P2) • Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2)	2
Unit 9:		
Barium enema	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (Adults & children) (C3) • Recall the patient preparation for the procedure (Adults & children) (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Identify the procedure and filming techniques (Adults & children). (P3) • Plan the after care of the patient (A3)	5

Content	Competencies	Number of Hours
	• Assess measures taken for radiation protection (P5)	
Unit 10:		
Hystersosalpingography	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Identify the procedure and filming techniques (Adults & children). (P3) • Plan the after care of the patient (A3) • Assess measures taken for radiation protection (P5) • Outline the aseptic techniques adopted. (C2)	13
Unit 11:		
Fallopian tube recanalisation	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure. (C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P1) • Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2) • Outline the aseptic techniques adopted. (C2)	2
Unit 12:		
Sialography	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure.(C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P2)	2

Content	Competencies	Number of Hours
	• Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2)	
Unit 13:		
Dacrocystography	• Recall the anatomy of the area(C1) • Identify the indications and contraindications of the procedure.(C3) • Recall the patient preparation for the procedure (P1) • Outline the type and quantity of contrast media used.(C2) • What is the method of introduction of the contrast agent? (C1) • List out the equipments required. (C1) • Explain choice of exposure factors.(P2) • Explain the procedure and filming techniques(P2) • Explain the after care of the patient (P2) • Illustrate measures taken for radiation protection (P2)	1
Unit 14:		
Catheters	• Explain catheters used in radiology department (P2) • Recall catheters used for various radiological procedures (P1) • How is catheter sterilized? (C1) • Illustrate catheter size and shape. (P2)	4

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Assignment	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinics	156	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**156**	**104**
Assessment Methods:		
Formative:	**Summative:**	
Unit Test	Mid Semester/Sessional Exam (Theory)	
Quiz	End Semester Exam (Theory)	

Assignments/Presentations	Record Book						
Mapping of Assessment with COs:							
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination		x	x	x	x	x	
Clinical/Practical Log Book/ Record Book		x	x	x	x	x	x
End Semester Exam		x	x	x	x	x	x
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	• Radiological procedures. N Bhushan • Fundamentals of special radiographic procedures. Albert M. Snopek						
Additional References	• Guide to radiological procedures. Chapman & Nakielny.						

SEMESTER - IV

COURSE CODE	**:**	**COURSE TITLE**
PHC2203	**:**	**Pharmacology**
GPY2201	**:**	**General Psychology**
MED3201	**:**	**General Medicine**
MIT2201	**:**	**Radiation Safety in Radio diagnosis**
MIT2231	**:**	**Clinical aspect of Radiography and Fluoroscopy**
MIT****	**:**	**Program Elective - I**

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Pharmacology**
Course Code	**PHC2203**
Academic Year	Second Year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have basic knowledge of Anatomy, Physiology, Biochemistry, Microbiology and Pathology
Course Synopsis	The course briefly addresses the classes of drugs acting on various systems of human body. This module will be delivered through lectures. Theory examination will be used to assess the students' transferable skills and learning outcomes. This module helps the students to understand the kinetics, dynamics and therapeutics of drugs that are relevant to allied health practice. Emphasis is laid on drugs that are commonly used by allied health practioners. This module provides the background for decision making and treatment based on basic knowledge of drugs.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain indications, rationale, pharmacological actions, pharmacokinetic features, adverse effects, contraindications and drug interactions of commonly used medications in allied health practice (C1)
CO2	Describe mechanism of action, uses, adverse effects, contraindications and drug interactions of clinically important drugs that are used in allied health practice which may directly or indirectly influence management of health and diseases by allied heath practioners (C1)
CO3	Apply fundamental pharmacology knowledge in allied health sciences (C2)
CO4	Use pharmacology knowledge in decision making of patient/client management. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1		
General Pharmacology	**A. Introduction:** 1. Define the following terms: pharmacology, pharmacokinetics, pharmacodynamics,	7

Content	Competencies	Number of Hours
	pharmacotherapeutics, clinical pharmacology and toxicology (C1) 2. Define drug with examples. (C1) 3. Describe the following with examples: chemical name, non- proprietary/generic name and proprietary (brand) name of a drug. (C2) 4. List various sources of drug information. (C1) 5. List different sources of drugs with examples. (C1) 6. Explain different parts of a prescription. (C2) 7. Describe the various standard abbreviations used in prescription. (C1)	
	B. Routes of drug administration: 1. Explain the advantages and disadvantages of the following routes of drug administration with examples of drugs administered by these routes: oral, sublingual, subcutaneous, intramuscular, intravenous, intradermal, topical, transdermal, inhalational and rectal. (C2)	
	C. Pharmacokinetics: 1. Describe drug transport mechanisms. (C2) 2. Explain the factors affecting drug absorption. (C2) 3. Define bioavailability. (C1) 4. Explain first pass metabolism with examples of drugs having high first pass metabolism. (C2) 5. Define volume of distribution. (C1) 6. Explain the factors affecting volume of distribution. (C2) 7. Define biotransformation. (C1) 8. List the organs involved in biotransformation. (C1) 9. List the types of biotransformation reactions. (C1) 10. List different routes of drug excretion. (C1) 11. Define the following terms: plasma half-life, first order kinetics and zero order kinetics (C1)	
	D. Pharmacodynamics: 1. Describe the different types of non-receptor mediated mechanisms of drug action with examples. (C2) 2. List different types of receptors with examples. (C1) 3. Define the following terms: affinity, intrinsic activity, efficacy, potency, agonist and antagonist. (C1) 4. Define the following terms with examples: competitive antagonist and non-competitive antagonist. (C1) 5. Explain synergism with an example. (C2) 6. Explain the following factors modifying drug action with examples:age, genetics, psychological states, pathological states, presence of other drugs and tolerance (C2)	
	E. Drug toxicity and safety: 1. Define therapeutic index. (C1) 2. Define adverse drug reactions. (C1) 3.Describe the following terms with examples:	

Content	Competencies	Number of Hours
	predictable adverse drug reactions, unpredictable adverse drug reactions, side effects, toxic effects, idiosyncrasy,hypersensitivity, teratogenicity, iatrogenic disease, photosensitivity, dependence (C2)	
Unit 2		
Autonomic nervous system including skeletal muscle relaxants	**A. Cholinergic drugs:** 1. Name the parasympathetic neurotransmitter. (C1) 2. List the types of different cholinergic receptors. (C1) 3. Name the locations of different cholinergic receptors. (C1) 4. Describe the responses mediated through different cholinergic receptors at various sites. (C2) 5. Tell the classification of cholinergic drugs based on their mechanism of action. (C1) 6. Describe the mechanism of action of anticholinesterases. (C2) 7. List the therapeutic uses of anticholinesterases. (C1) **8.** List the adverse effects of anticholinesterases. (C1)	7
	B. Anticholinergic drugs: 1. Tell the classification of anticholinergic drugs based on their source. (C1) 2. Describe the pharmacological actions of atropine. (C2) 3. List the therapeutic uses of atropine and its substitutes. (C1) **4.** List the adverse effects of anticholinergic drugs. (C1)	
	C. Neuromuscular blocking drugs: 1. Tell the classification of skeletal muscle relaxants based on their mechanism of action. (C1) 2. List the uses of the following: centrally acting skeletal muscle relaxants, peripherally acting skeletal muscle relaxants. (C1) 3. List the adverse effects of the following: centrally acting skeletal muscle relaxants, peripherally acting skeletal muscle relaxants. (C1)	
	D. Adrenergic drugs: 1. Name the sympathetic neurotransmitters. (C1) 2. List the types of different adrenergic receptors. (C1) 3. Name the locations of different adrenergic receptors. (C1) 4. Describe the responses mediated through different adrenergic receptors at various sites. (C2) 5. Describe the effects of adrenaline on: CVS, smooth muscle, eye, metabolism (C2) 6. List commonly used adrenergic drugs. (C1) **7.** List the common therapeutic uses of adrenergic drugs. (C1)	
	E. Adrenergic receptor antagonists: 1. Tell the classification of adrenergic receptor antagonists based on their receptor selectivity. (C1)	

Content	Competencies	Number of Hours
	2. Describe the pharmacological actions of propranolol on: CVS, respiratory system and eye. (C2) 3. List the important uses of α-blockers. (C1) 4. List the important uses of β-blockers. (C1) 5. List the adverse effects of β-blockers. (C1)	
Unit 3		
Central nervous system	**A. General anaesthetics (GAs) :** 1. Define general anaesthetics. (C1) 2. Tell the classification of general anaesthetics based on their route of administration. (C1) 3. List indications of general anaesthetics. (C1) 4. List the complications of general anaesthesia. (C1) 5. Describe preanaesthetic medication. (C1) 6. List the drugs used in preanaesthetic medication. (C1)	9
	B. Local anaesthetics (LAs) : 1. Define local anaesthetics. (C1) 2. Explain the mechanism of action of LAs. (C2) 3. List the LAs. (C1) 4. List the indications of LAs. (C1) **5.** List the different techniques of local anaesthetics. (C1)	
	C. Sedative & hypnotics : 1. Define the following terms with examples: sedative and hypnotics. (C1) 2. List the benzodiazepines. (C1) 3. List the therapeutic uses of benzodiazepines. (C1) **4.** List the adverse effects of benzodiazepines. (C1)	
	D. Opioids: 1. List the commonly used opioids. (C1) 2. Explain the pharmacological actions of morphine. (C2) 3. List the uses of morphine. (C1) 4. List the adverse effects of morphine. (C1) 5. List the contraindications of morphine. (C1) 6. Mention the antidote used for the opioid poisoning. (C1)	
	E. NSAIDs : 1. Tell the classification of NSAIDs based on their selectivity to COX. (C1) 2. Explain the mechanism of action of NSAIDs. (C2) 3. Explain the pharmacological actions of aspirin. (C2) 4. List the uses of aspirin. (C1) 5. List the adverse effects of aspirin. (C1) 6. List the contraindications of aspirin. (C1) 7. Explain the advantages and disadvantages of selective COX-2 inhibitors over aspirin. (C2) 8. Explain the mechanism of action of paracetamol. (C2) 9. List the uses of paracetamol. (C1) 10. Mention the differences between aspirin and paracetamol. (C2)	

Content	Competencies	Number of Hours
	F. Drug treatment of rheumatoid arthritis (RA): 1. List NSAIDs, DMARDs and steroids used in the treatment of RA. (C1) 2. Explain the mechanism of action of methotrexate. (C2) 3. List the adverse effects of methotrexate. (C1)	
	G. Drug treatment of gout: 1. List the drugs used for acute and chronic gout. (C1) 2. Explain the mechanism of action of the following: Allopurinol, probenecid, sulfinpyrazone (C2) 3. List the adverse effects of the following: Allopurinol, probenecid, sulfinpyrazone (C1)	
	H. Psychopharmacology : 1. List the antipsychotics. (C1) 2. Explain the mechanism of action of chlorpromazine. (C2) 3. List the uses of chlorpromazine. (C1) 4. List the adverse effects of chlorpromazine. (C1)	
	I. Parkinsonism : 1. List antiparkinsonian drugs. (C1) 2. List the adverse effects of levodopa. (C1) 3. Explain the pharmacological basis for combining levodopa with carbidopa. (C2)	
	J. Alcohol : 1. Explain the management of methanol poisoning. (C2)	
	K. Antiepileptic drugs : 1. List the drugs used in various types of seizures. (C1) 2. List the adverse effects of phenytoin. (C1)	
Unit 4		
GIT	**A. Drugs for peptic ulcer :** 1. Tell the classification of drugs used in peptic ulcer based on their mechanism of action. (C1) 2. Explain the mechanism of action of the following: proton pump inhibitors (PPIs), H_2 blockers, antacids and ulcer protectives. (C2) 3. List the therapeutic uses of the following: proton pump inhibitors (PPIs), H_2 blockers, antacids and ulcer protectives. (C1) 4. List the adverse effects of the following: proton pump inhibitors (PPIs), H_2 blockers, antacids and ulcer protectives. (C1)	2
	B. Antiemetics: 1. List various classes of antiemetics with examples. (C1) 2. List the therapeutic uses of the following: prokinetics, 5-HT_3 antagonists, anticholinergics and H_1 antihitaminics. (C1) 3. List the adverse effects of the following: prokinetics, 5-HT_3 antagonists, anticholinergics and H_1	

Content	Competencies	Number of Hours
	antihitaminics. (C1)	
	C. Laxatives and antidiarrhoeals : 1. List various classes of laxatives with examples. (C1) 2. List the therapeutic uses of laxatives. (C1) 3. List the composition of WHO-ORS. (C1) 4. List the antimotility and antisecretory agents used in diarrhea. (C1)	
Unit 5		
Blood	**A. Haematinics :** 1. List oral and parenteral iron preparations. (C1) 2. List the therapeutic and prophylactic uses of oral and parenteral iron preparations. (C1) 3. List the adverse effects of oral and parenteral iron preparations. (C1) 4. List various preparations of vitamin B_{12} and folic acid. (C1) 5. Mention the therapeutic uses of the following: vitamin B_{12} and folic acid. (C1)	3
	B. Anticoagulants : 1. Tell the classification of anticoagulants based on their routes of administration. (C1) 2. Explain the mechanism of action of the following: heparin and warfarin. (C2) 3. List the therapeutic uses of the following: heparin and warfarin. (C1) 4. List the adverse effects of the following: heparin and warfarin. (C1)	
	C. Antiplatelet drugs : 1. List antiplatelet drugs. (C1) 2. Explain the antiplatelet action of the aspirin. (C2) 3. List the therapeutic uses of antiplatelet drugs. (C1)	
	D. Fibrinolytics and antifibrinolytics: 1. List fibrinolytics and antifibrinolytics. (C1) 2. List the therapeutic uses of fibrinolytics and antifibrinoytics. (C1)	
Unit 6		
Cardiovascular system	**A. Diuretics:** 1. Define the term diuretics. (C1) 2. Tell the classification of diuretics based on their mechanism of action. (C1) 3. Explain the mechanism of action of following: loop diuretics, thiazides, potassium sparing diuretics and carbonic anhydrase inhibitors. (C2) 4. List the important therapeutic uses and adverse effects of the following: loop diuretics, thiazides, osmotic diuretics and potassium sparing diuretics. (C1)	5
	B. Drugs used in congestive heart failure (CHF): 1. Tell the classification of drugs used in the treatment of congestive heart failure based on their mechanism of	

Content	Competencies	Number of Hours
	action. (C1) 2. Explain the mechanism of action of cardiac glycosides. (C2)	
	C. Antihypertensives: 1. Tell the classification of antihypertensive agents based on mechanism of action (C1) 2. Explain the antihypertensive action of the following: ACEIs/ARBs, calcium channel blockers, thiazides, beta blockers (C2) 3. List the uses of the following: ACEIs and calcium channel blockers. (C1) 4. List the adverse effects of the following: ACEIs and calcium channel blockers. (C1)	
	D. Antianginal drugs: 1. List the drugs used for acute attack and chronic prophylaxis of angina. (C1) 2. Explain the mechanism of action of nitrates. (C2) 3. List the therapeutic uses of nitrates (C1) 4. List the adverse effects of nitrates (C1)	
	E. Hypolipidemics: 1. Tell the classification of hypolipidemics based on their mechanism of action. (C2) 2. Explain the mechanism of action of the following: statins and fibrates. (C2) 3. List the uses and adverse effects of the following: statins and fibrates. (C1)	
Unit 7		
Respiratory System	**A. Pharmacotherapy of bronchial asthma :** 1. Tell the classification of drugs used in the treatment of bronchial asthma based on their mechanism of action. (C1) 2. Explain the antiasthmatic action of the following: β_2-agonists, anticholinergics, mast cell stabilizers and inhaled glucocorticoids. (C2) 3. List the adverse effects of the following: β_2 agonists, anticholinergics, mast cell stabilizers and inhaled glucocorticoids. (C1)	3
	B. Pharmacotherapy of cough : 1. List drugs used in dry and productive cough. (C1) 2. Define the following terms with examples: mucolytics, expectorants, antitussives (C1)	
	C. Antihistaminics : 1. List first generation and second generation antihistaminics. (C1) 2. List the uses of H_1 antihistaminics. (C1) 3. List the adverse effects of H_1 antihistaminics. (C1) 4. Describe the advantages of second generation antihistaminics over the first generation antihistaminics. (C2)	

Content	Competencies	Number of Hours
Unit 8		
Chemotherapy	**A. General aspects:** 1. Define the following terminologies with examples: antimicrobial agents (AMAs), antibiotic, bacteriostatic, bactericidal, chemoprophylaxis and suprainfection.(C1) 2. List the problems that arise from using AMAs with examples. (C1)	7
	B. Beta lactam antibiotics: 1. List the groups of beta lactams with examples. (C1) 2. Explain the mechanism of action of beta lactam antibiotics. (C2) 3. Tell the classification of penicillins with examples (C1) 4. List the uses of penicillins (C1) 5. List the adverse effects of penicillins (C1)	
	C. Cotrimoxazole: 1. Explain the mechanism of action of cotrimoxazole(C2) 2. List the uses of cotrimoxazole (C1) 3. List the adverse effects of cotrimoxazole (C1)	
	D. Macrolides : 1. List macrolides (C1) 2. List the uses of macrolides (C1) 3. List the adverse effects of macrolides (C1)	
	E. Fluoroquinolones: 1. List commonly used fluoroquinolones (C1) 2. List the uses of fluoroquinolones (C1) 3. List the adverse effects of fluoroquinolones (C1)	
	F. Antifungal agents: 1. List azole anifungals. (C1) 2. List the uses of azoles. (C1) 3. List the adverse effects of azoles. (C1)	
	G. Antiviral drugs : 1. List classes of anti-retroviral drugs (anti-HIV) with examples. (C1) 2. List the commonly used antiviral drugs with examples. (C1) 3. Explain the mechanism of action of acyclovir. (C1) 4. List the uses of acyclovir. (C1) 5. List the adverse effects of acyclovir. (C1)	
	H. Antitubercular drugs : 1. Tell the classification of antitubercular drugs with examples. (C1) 2. Explain the mechanism of action of the following: isoniazid, rifampicin, pyrazinamide, ethambutol (C2) 3. List the adverse effects of the following: isoniazid, rifampicin, pyrazinamide, ethambutol. (C1) 4. Explain the pharmacological basis for short course chemotherapy. (C2) 5. List the drugs used for short course chemotherapy of	

Content	Competencies	Number of Hours
	pulmonary TB. (C1)	
	I. Antileprotic drugs : 1. List antileprotic drugs. (C1) 2. List the drugs used for multidrug therapy (MDT) for paucibacillary and multibacillary leprosy. (C1)	
	J. Aminoglycosides: 1. List aminoglycosides. (C1) 2. Mention the common features of aminoglycosides.(C1) 3. List the uses of aminoglycosides. (C1) 4. List the adverse effects of aminoglycosides. (C1)	
	K. Antiamoebic drugs: 1. List antiamoebic drugs. (C1) 2. List the uses of nitroimidazoles. (C1) 3. List the adverse effects of nitroimidazoles. (C1)	
	L. Anthelmintics: 1. List anthelmintic drugs. (C1) 2. List the uses of the following: albendazole, mebendazole and DEC. (C1) 3. List the adverse effects of the following: albendazole, mebendazole and DEC. (C1)	
	M. Anticancer drugs: 1. Give examples for anticancer drugs. (C1) 2. List the general toxicities of anticancer agents. (C1)	
	N. Antimalarial drugs: 1. List antimalarial drugs. (C1) 2. List the uses of chloroquine. (C1) 3. List the adverse effects of chloroquine. (C1)	
Unit 9		
Hormones and related drugs	**A. Glucocorticoids**: 1. List glucocorticoids based on their duration of action. (C1) 2. Explain the anti-inflammatory and immunosuppressant actions of glucocorticoids. (C2) 3. List the therapeutic uses of glucocorticoids. (C1) 4. List the adverse effects of glucocorticoids. (C1)	2
	B. Antidiabetic drugs: 1. List insulin preparations based on their duration of action. (C1) 2. List the adverse effects of insulin. (C1) 3. Tell the classification of oral antidiabetic drugs based on their chemistry. (C1) 4. List the adverse effects of various classes of oral antidiabetic drugs. (C1)	
	C.Thyroid and anti-thyroid drugs: 1. List the thyroid hormone preparations. (C1) 2. List the uses of thyroid hormone preparations. (C1) 3. List the antithyroid drugs acting at different steps of	

Content	Competencies	Number of Hours
	thyroid hormone synthesis. (C1) 4. List the uses of antithyroid drugs. (C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):					
Learning Strategies		**Contact Hours**		**Student Learning Time (SLT)**	
Lecture		45		90	
Seminar		-		-	
Small group discussion (SGD)		-		-	
Self-directed learning (SDL)		-		-	
Problem Based Learning (PBL)		-		-	
Case Based Learning (CBL)		-		-	
Clinic		-		-	
Practical		-		-	
Revision		-		-	
Assessment		-		-	
Total		**45**		**90**	
Assessment Methods:					
Formative:	**Summative:**				
Unit Test	Sessional I & Sessional II Exam (Theory)				
Quiz	End Semester Exam (Theory)				
Mapping of Assessment with COs:					
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**
Mid Semester / Sessional Examination 1		x	x	x	x
Sessional Examination 2		x	x	x	x
Quiz		x	x		
Unit Test		x	x	x	x
End Semester Exam		x	x	x	x
Feedback Process:	Mid-Semester Feedback				
	End-Semester Feedback				
Main Reference:	• Essentials of Medical Pharmacology, K.D. Tripathi, Jaypee brothers medical publishers (P) Ltd., 8th edition, 2018 • Pharmacology for medical graduates, Tara Shanbag and Smita Shenoy, Elsevier Publications, 4th edition, 2019				
Additional References	• Principles of Pharmacology: H L Sharma and K. K Sharma, Paras Medical Publishers, 3rd edition, 2017 • Lippincott Illustrated Reviews: Pharmacology, Karen Whalen, Wolters Kluwer, 7th edition, 2018				

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**General Psychology**
Course Code	**GPY2201**
Academic Year	Second year
Semester	4
Number of Credits	2
Course Prerequisite	Nil
Course Synopsis	1. Orients and familiarises students towards the basic psychological processes 2. Enables the students to understand how psychological principles are applied in day to day life.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the basic concepts in Psychology. (C2)
CO2	Explain how the processes of perception , learning, memory , thinking and intelligence contributes to the uniqueness of the individual (C2)
CO3	Outline the role of motivation , emotion and personality in shaping human behaviour (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x						x	
CO2						x	x	
CO3						x	x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction to Psychology	1. Define Psychology(C1) 2. Outline the evolution of Psychology as a scientific discipline (C2) 3. Summarise the modern schools of Psychology(C2) 4. Enumerate the different branches of Psychology(C1) 5. What is Introspection? List the merits and demerits of introspection (C1) 6. Explain the importance of Experimental method in the field of Psychology(C2) 7. Explain the observation method in Psychology (C2)	3
Unit 2:		
Perception	1. Define Perception (C1) 2. Describe the various principles of Perceptual groupings (C2) 3.Illustrate the Gestalt laws of perception (C2) 4.Define Perceptual constancy and explain its types(C2)	3

Content	Competencies	Number of Hours
	5.Explain Monocular and Binocular cues in Perception (C2) 7.Explain types of motion perception (C2)	
Unit 3:		
Learning	1. Define Learning (C1) 2.Explain Pavlov's Classical Conditioning(C2) 3.Summarize the various processes of Classical Conditioning with examples (C2) 4.Explain the applications of Classical Conditioning(C2) 5. What is Operant Conditioning (C1) 6. Compare the types of reinforcement and Punishment(C2) 7. Explain with the examples the schedules of Reinforcement (C2) 8. Explain the applications of Operant Conditioning(C2) 8. Explain observation learning with its classic experiment (C2) 9. Illustrate the processes in observation learning (C2)	3
Unit 4:		
Memory	1. Define Memory (C1) 2. List the processes that underlie memory (C1) 3. Explain the characteristics of different types of memory(C2) (sensory, STM, LTM) 4. Summarise the different theories of forgetting (C2) (Decay, motivated forgetting, interference, cue dependant displacement) 5. List the various strategies to improve memory (C1)	3
Unit-5:		
Thinking & Problem solving	1. Define thinking (C1) 2. How thoughts are represented (C1) 3. Define concepts(C1) 4. Compare the different types of concept (C2) 5. Enumerate the steps in creative thinking (C1) 6. List the steps involved in problem solving (C1) 7. What are the different strategies used to solve problems (C1) (Trial & error, Heuristics, Algorithm)	2
Unit-6:		
Intelligence	1. Define Intelligence (C1) 2. Summarise the various theories of Intelligence (C2) (Two factor, Crystallised and Fluid, Multiple intelligence) 3. List the different types of Intelligence tests (C1) 4. Define Emotional Intelligence (C1) 5. What are the different components of emotional intelligence? (C1)	3
Unit-7:		
Motivation & Conflict	1. Define Motivation (C1) 2. Summarize the biological theories of Motivation (C2) (Drive reduction theory, Optimal arousal theory, Instinct theory)	3

Content	Competencies	Number of Hours
	3. Explain the Psychological theories of Motivation (C2) (Maslow's hierarchy theory) 4. Define Conflict (C1) 5. Explain the types of Conflict with examples (C2) (Approach- Approach conflict, Avoidance-Avoidance conflict, Approach- Avoidance conflict and Double Approach- Avoidance conflict) 6. Summarise the different ways to handle conflict (C2)(Task and defense oriented)	
Unit-8:		
Emotion	1. Define Emotion (C1) 2. List the characteristics of Emotion (C1) 3. Explain the various theories of Emotion (C2) (James-Lange, Cannon- Bard, Schatcher- Singer)	2
Unit-9:		
Personality	1. Define Personality(C1) 2. Explain the Psychodynamic theory of Personality (C2) 3. Explain the trait approach towards Personality (C2) 4. Summarize Rogers' humanistic approach in understanding Personality (C2) 5. Enumerate the various assessment methods in studying Personality (C1)	4

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	78
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**78**

Assessment Methods:	
Formative:	**Summative:**
Nil	Mid Semester/Sessional Exam (Theory)
Nil	End Semester exam (Theory)

Mapping of Assessment with COs:			
Nature of Assessment	**CO1**	**CO2**	**CO3**
Mid Semester/Sessional examination	x	x	
End semester exam	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback

Main Reference:	1. Baron, R. A., Byrne, D., & Mankowitz, B. H. (1977). *Psychology: Understanding behaviour.* Philadelphia: W.B. Saunders Co. 2. Feldman, R. S. (1993). *Understanding Psychology*. New York: McGraw-Hill.
Additional References	1. Myers, D. G. (2005). *Exploring psychology*. New York, NY: Worth Publishers.

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**General Medicine**
Course Code	**MED3201**
Academic Year	Second year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have basic knowledge of Anatomy, Physiology, Biochemistry, Pathology, Microbiology and pharmacology
Course Synopsis	This module provides the knowledge about pathophysiology, etiology, clinical features, investigations, management and complications of medical conditions in dermatology, rheumatology, and cardio respiratory and Pulmonary medicine in order to rationalize and apply the knowledge gained about various medical conditions in the clinical setup.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Explain the pathophysiology of various medical conditions (C2)
CO2	Explain the clinical features and management of various medical conditions (C2)
CO3	Outline the clinical assessment of cardiovascular and respiratory systems (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							

Course Content and Outcomes:

Content	Competencies	Number of Hours
GENERAL MEDICINE		
Unit 1		
Infections	1. Define infection (C1) 2. List the clinical features of infection (C1) 3. Outline the investigations (C2) 4. Explain the management and complications of bacterial (streptococcus, staphylococcus aureus) and viral (HIV, Hepatitis A, B, C, herpes simplex) infections (C2) 5. Recall the Universal precautions in ICU (Infection control) (C1)	2
Unit 2		
Poisoning	1. Explain organophosphorus poisoning (C2) 2. Recall snake bite (C1)	1

Content	Competencies	Number of Hours
	3. List the clinical manifestations and medical management (C1)	
Unit 3		
Diseases of blood	1. Classify blood disorders (C2) 2. Explain management of Anemia, thalassemia, leukemia, thrombocytopenia, hemophilia and thrombosis (C2)	1
Unit 4		
Nutritional deficiency diseases in adults:	1. Explain the causes, clinical features and management of vitamin deficiencies – B complex, A and D deficiency (C1)	1
Unit 5		
Endocrine diseases	2. Classify endocrine disorders (C2) 3. List clinical features and management of Hypo and hyper pituitary, thyroid and adrenocortical disease (C2)	1
Unit 6		
Metabolic diseases	1. Define Diabetes Mellitus (C1) 2. Classify Diabetes Mellitus (C2) 3. List the clinical features of Diabetes Mellitus (C2) 4. Outline the diagnosis and management of Dyslipidemia and obesity (C1)	2
Unit 7		
Lymph related disorders	1. Define Lymphedema (C1) 2. Outline the etiology of Lymphedema (C2) 3. List the clinical features of Filariasis (C1)	1
Unit 8		
Diseases of the digestive system and its management	1. Explain the causes, clinical features and management of Gastro-oesophageal reflux disease (C1) 2. Explain the causes, clinical features and management of Crohn's diseases(C2) 3. Explain the causes, clinical features and management of Jaundice (C2) 4. Outline etiology, clinical features, management and complications of Cirrhosis (C2)	1
RHEUMATOLOGY		
Unit 9		
Rheumatoid arthritis, Felty's Syndrome and Juvenile RA	1. Define perthes disease, Felty's syndrome, and Juvenile RA (C1) 2. Explain the etiology of perthes disease, Felty's syndrome, and Juvenile RA (C2) 3. Outline the clinical features and management of perthes disease, Felty's syndrome, and Juvenile RA (C2)	1
Unit 10		
Systemic Lupus	1. Define Systemic Lupus Erythematous (C1)	1

Content	Competencies	Number of Hours
Erythematosus (SLE)	2. Explain the etiology of Systemic Lupus Erythematous (C2) 3. Outline the clinical features and management of Systemic Lupus Erythematous (C2)	
Unit 11		
Spondyloarthropathies and Ankylosing Spondylitis	1. Define Spondyloarthropathies and Ankylosing Spondylitis (C1) 2. Explain the etiology of Spondyloarthropathies and Ankylosing spondylitis (C2) 3. Outline the clinical features and management of Spondyloarthropathies and Ankylosing spondylitis (C2)	1
Unit 12		
Psoriatic Arthritis, Reiter's Syndrome and Enteropathic Arthritis	1. Define Psoriatic Arthritis, Reiter's Syndrome and Enteropathic Arthritis (C1) 2. Explain the etiology of Psoriatic Arthritis, Reiter's Syndrome and Enteropathic Arthritis (C2) 3. Outline the clinical features and management of Psoriatic Arthritis, Reiter's Syndrome and Enteropathic Arthritis (C2)	1
Unit 13		
Gout and Pseudo gout	1. Define Gout and Psuedo gout (C1) 2. Explain the etiology of gout and pseudogout (C2) 3. Outline the clinical features and management of gout and pseudo gout (C2)	1
Unit 14		
Septic Arthritis, Polymyositis and Dermatomyositis	1. Define Septic Arthritis, Polymyositis and Dermatomyositis (C1) 2. Explain the etiology of Septic Arthritis, Polymyositis and Dermatomyositis (C2) 3. Outline the clinical features and management of Septic Arthritis, Polymyositis and Dermatomyositis (C2)	1
Unit 15		
Sarcoidosis and Sjogren's Syndrome	1. Define Sarcoidosis and Sjogren's Syndrome (C1) 2. Explain the etiology of Sarcoidosis and Sjogren's Syndrome (C2) 3. Outline the clinical features and management of Sarcoidosis and Sjogren's Syndrome (C2)	1
Unit 16		
Calcium Metabolism, Tetany / Osteomalacia / Osteoporosis	1. Define Calcium Metabolism, Tetany / Osteomalacia / Osteoporosis (C1) 2. Explain the etiology of Calcium Metabolism, Tetany / Osteomalacia / Osteoporosis (C2) 3. Outline the clinical features and management of Calcium Metabolism, Tetany / Osteomalacia / Osteoporosis (C2)	1

Content	Competencies	Number of Hours
CARDIO-RESPIRATORY CONDITIONS		
Unit 17		
Cardiac Evaluation	1. Explain the clinical assessment of Cardiovascular system (C2) 2. Outline ECG, Echo, Treadmill test and other investigations (C2)	1
Unit 18		
Cardiovascular diseases	1. Explain etiological classification, symptoms, sequel, chest radiograph findings, ECG, Complications, exercise limitations and medical management in case of: • Coronary artery diseases- • Angina and Myocardial infarction • Congestive cardiac failure • Rheumatic fever and its complications • Valvular heart diseases (C2) 2. Classify congenital heart diseases (C2) 3. Outline the clinical presentation of common disorders such as acynotic shunts and Tetrology of Fallot (C2)	4
Unit 19		
Hypertension	1. Define hypertension (C1) 2. Classify hypertension (C2) 3. Outline the medical management of hypertension (C2)	1
Unit 20		
Peripheral vascular diseases	1. List the medical management of peripheral vascular diseases, arterial and venous thromboembolism and peripheral arterial obstructive disease (C1)	1
Unit 21		
Medical conditions in critical care	1. Define ARDS, Tetanus, Pulmonary Embolism and Shock (C1) 2. Explain the etiology of ARDS, Tetanus, Pulmonary Embolism and Shock (C2) 3. Outline the clinical features and management of ARDS, Tetanus, Pulmonary Embolism and Shock (C2)	2
DERMATOLOGY CONDITIONS		
Unit 22		
Diseases of the Skin-Leprosy, Trophic Ulcers, and Psoriasis	1. Define ARDS, Tetanus, Pulmonary Embolism and Shock (C1) 2. Explain the etiology of ARDS, Tetanus, Pulmonary Embolism and Shock (C2) 3. Outline the clinical features and management of ARDS, Tetanus, Pulmonary Embolism and Shock (C2)	1

Content	Competencies	Number of Hours
PULMONARY MEDICINE		
Unit 23		
Introduction to Pulmonary diseases	1. Outline the clinical manifestations and clinical assessment of pulmonary diseases (C2)	2
Unit 24		
Investigations in Pulmonology	1. Discuss the Chest radiographs, ABG analysis, PFT and Bronchoscopy (C2)	2
Unit 25		
Infective lung conditions- Pulmonary Tuberculosis, Pneumonia and Lung abscess	1. Define Pulmonary Tuberculosis, Pneumonia and Lung abscess (C1) 2. Explain the etiology of Pulmonary Tuberculosis, Pneumonia and Lung abscess (C2) 3. Outline the clinical features and management of Pulmonary Tuberculosis, Pneumonia and Lung abscess (C2)	2
Unit 26		
Obstructive lung conditions	1. Define Bronchial Asthma, COPD and Bronchiectasis (C1) 2. Explain the etiology of Bronchial Asthma, COPD (C2) 3. Outline the clinical features and management of Pulmonary Tuberculosis, Pneumonia and Lung abscess (C2)	3
Unit 27		
Restrictive lung Diseases-Interstitial Lung Diseases and Pleural Diseases (Pneumothorax, Emphysema and Pleural Effusion)	1. Define Interstitial Lung Diseases and Pleural Diseases (Pneumothorax, Emphysema and Pleural Effusion) (C1) 2. Explain the etiology of Interstitial Lung Diseases and Pleural Diseases (Pneumothorax, Emphysema and Pleural Effusion) (C2) 3. Outline the clinical features and management of Interstitial Lung Diseases and Pleural Diseases (Pneumothorax, Emphysema and Pleural Effusion) (C2)	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	39	78
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-

Revision	-	-
Assessment	-	-
Total	**39**	**78**

Assessment Methods:						
Formative:	**Summative:**					
Quiz	Mid Semester Examination (Theory)					
	End Semester Examination (Theory)					
Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x	x			
End Semester Exam	x	x	x			

Feedback Process:	Mid-Semester Feedback End-Semester Feedback
Main Reference:	1. Pre Manual For Undergraduates K. George Mathew, Praveen Aggarwal 2. Davidson"s Principles and practice of Medicine 22nd edition 3. Golwalla – Medicine For Students Aspi Golwalla & Sharukh A Golwall

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Radiation Safety in Radiodiagnosis**
Course Code	**MIT2201**
Academic Year	Second Year
Semester	IV
Number of Credits	4
Course Prerequisite	Students should have basic knowledge of Radiation Physics
Course Synopsis	1. This module provides insight into the biological effects of radiation 2. This module provides fundamental knowledge of aim and need for radiation protection 3. This module provides details about units of measurement of radiation 4. This module emphasis on Principles and objectives of Radiation safety

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	List the sources of radiation and explain its risk and benefits (C1,C2)
CO2	Explain the biological effects of radiation (C2)
CO3	List the units of radiation and describe the instruments used to detect radiation. (C1, C2)
CO4	Explain basic principle, aim and need for radiation protection (C2)
CO5	Explain the Rules and Regulations and guidelines of Radiation Protection. (C2)
CO6	Explain the various radiation protective measures used in Diagnostic Radiography (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2	x							
CO3	x							
CO4	x	x						
CO5	x						x	
CO6		x					x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction to Radiation Protection	1. Define radiation protection (C1) 2. Explain the need for radiation protection (C2) **3.** Explain the aim of radiation protection (C2)	2

Content	Competencies	Number of Hours
Unit 2:		
Radiation Quantities and Units	1. Name the Radiation quantities and units (C1) 2. Define the following terms - Activity (Becquerel & Curie) - Exposure (C/kg &Roentgen), - Air kerma - Absorbed dose (Gray & rad) - Radiation Weighting factors(WR) - Tissue weighting factors(WT) - Equivalent dose (Sievert & rem) - Effective dose (Sievert & rem) (C1)	3
Unit 3		
Biological Effects of Radiation	1. What are direct and indirect actions of radiation (C1) 2. Define the terms LET, RBE and OER (C1) 3. Explain the Interaction of radiation with cells, chromosome aberrations, mutations, potentially lethal and sub-lethal damages (C2) 4. Compare stochastic and deterministic effects of radiation (C2) 5. Explain somatic and genetic effects of radiation (C2) 6. Illustrate acute radiation syndrome (C2) 7. What is LD50/60 (C1) 8. Define the prenatal effect (C1) 9. What are the effects of radiation on skin, blood forming organs, digestive tract and reproductive system (C1) 10. List out the effects of chronic and acute exposure to radiation (C1)	9
Unit 4		
Radiation exposure limits	1. Outline the Radiation dose to individuals from natural radioactivity in the environment and manmade sources (C1) 2. Explain the basic concepts of radiation protection standards (C2) 3. Describe the recommendations of ICRP and AERB (C2) 4. Define Maximum Permissible Dose (MPD)(C1) 5. Explain the dose limits for occupational workers, general public, comforters and trainees (C2) 6. Explain the exposure in pregnancy and children (C2)	7
Unit 5		
Radiation Detection and Measurement	1. Outline the basic principles of radiation detection (C1) 2. List the types of radiation monitoring devices (C1)	7

Content	Competencies	Number of Hours
	3. Describe the construction, working, advantages and disadvantages of area monitoring devices (ionization chamber, proportional counter and GM counter) (C2) 4. Describe the construction, working, advantages and disadvantages of personnel monitoring devices (Film badge, pocket dosimeter, TLD and OSLD) (C2)	
Unit 6		
Protection in Diagnostic Radiology	1. Explain time, Distance & Shielding principle of radiation protection. (C2) 2. Define workload (W), use factor (U), occupancy factor (T) (C1) 3. Illustrate Primary and secondary barriers (C2) 4. Outline the design and shielding requirements for diagnostic X-ray facilities (C2) 5. List the radiation protective devices in radiography (C1) **6.** What are the radiation signage's for diagnostic X-ray facilities(C1)?	8
Unit 7		
Technical Protective Consideration During Radiography	1. Illustrate the immobilization technique and devices during radiography (C2) 2. Explain the effects of beam limiting devices on radiation (C2) 3. Explain the effect of filtration on radiation (C2) 4. Interpret the effect of exposure factors (kVp and mAs) on radiation protection (C2) 5. Explain the technical protective consideration in: - General Radiography - Mobile radiography - Mammography - Fluoroscopy - Angiography - CT scan (C2)	10
Unit 8		
Dose indices in imaging modalities	1. Define the following terms in Computed Tomography - CT Dose Index (CTDI) Multiple Scan Average Dose (MSAD) - Dose Length Product (DLP) - Dose Profile - Effective Dose (C1) 2. Discuss the dose for different CT application protocols (C1) 3. Define Dose area product in fluoroscopy and angiography systems(C1) 4. Define AGD in mammography (C1)	6

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	39	78
Seminar	-	-
Small group discussion (SGD)	4	8
Self-directed learning (SDL)	3	6
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	6	12
Total	**52**	**104**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Assignments/Presentations	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x	x	x	x
Sessional Examination 2						
Quiz / Viva			x	x		
Assignments/Presentations	x				x	x
Clinical/Practical Log Book/ Record Book						
Any others: WPBA						
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Radiation protection in Medical Radiography- Fifth Edition Paula J. Visconti PhD, E. Russell Ritenour PhD , Keli Welch Haynes 2. Radiation safety: Management and programs- Haydee Domenech 3. Radiation protection in Diagnostic X-Ray Imaging - Euclid Seeram, Patrick C. Brennan
Additional References	1. ICRP Manual

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical Practice in Radiography and Fluoroscopy**
Course Code	**MIT2231**
Academic Year	Second year
Semester	IV
Number of Credits	5
Course Prerequisite	Basic knowledge in Anatomy, Radiography and Fluoroscopy
Course Synopsis	1. This module will enable the students to integrate their newly gained knowledge and abilities on radiological procedures in a hands-on manner in a professional health care setting. 2. This will also facilitate them to understand the departmental protocols and familiarise themselves with the equipment used. 3. The clinical experience will enable them to gain additional skills in clinical procedures, interaction with patients, professional personnel and develop teamwork.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Develop knowledge on operating radiographic imaging equipment independently and demonstrate skills to manage patients in radiography for various procedures (C3, P5, A3)
CO2	Identify various aspects of room preparation and equipments/ instruments used for various radiography procedures. (C3, P3)
CO3	Take part in image processing and evaluate images for technical quality in radiography. (C5, P6)
CO4	Develop knowledge on operating fluoroscopic imaging equipment independently and demonstrate skills to manage patients for fluoroscopy procedures. (C3, P5, A3)
CO5	Identify various aspects of room preparation and equipments/ instruments used for various fluoroscopic procedures. (C3, P3)
CO6	Take part in image processing and evaluate images for technical quality in fluoroscopy. (C5,P6)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x		x					
CO2		x			x			
CO3		x				x		
CO4	x		x					
CO5		x			x			
CO6		x				x		

Course Content and Outcomes:

Content	Competencies	Number of Hours
Clinical Practice in Radiography		
Unit 1:		
General considerations for the conduct of radiographic examinations in radiography	1. Make use of the operation of RIS and HIS. (C3, P3) 2. Explain steps involving sequencing radiographic Examination. (C2) 3. Illustrate the need and process for proper documentation. (C2)	10
Unit 2:		
Operation aspect of radiographic equipment	1. Identify the type of X-ray systems. (C3) 2. Take part in Starting Up of System and Shutdown the System. (C4, P4) 3. Inspect the general safety of equipment. (C4,P3) 4. Develop knowledge about the machine with the help of manual provided by system manufacturer. (C3) 5. Identify common faults in radiographic equipment and remedy. (C3,P3) 6. Take part in operating and oversee the operation of radiographic equipment. (C4,P6) 7. Identify Breakdown -& how to report a breakdown of imaging and processing systems. (C3)	25
Unit 3:		
Patient Care, handling & Department Management in Radiography	1. Take part in preparing the patient and room for the radiographic procedure. (C4, P4, A3) 2. Identify the need and describe the process for obtaining informed consent. (C3) 3. Identify the need for preprocedural equipment preparation. (C3,P3,A3) 4. Explain procedure to the patient. (C2) 5. Illustrate the patient's postprocedural care. (C2) 6. How to handle: pediatric, Adult, and geriatric patient. (C1) 7. Demonstrate how to transfer patients safely and dealing with uncooperative patients during radiological examinations. (C2,P3)	20
Unit 4:		
Infection control in radiography	1. Identify sterilization techniques to reduce the chances of infection in work practices in radiography. (C3) 2. Explain immediate measures following an exposure to needle sticks and cuts. (C2) 3. Explain Bio medical Waste management in radiology. (C2) 4. Explain disposal of bio-medical waste –	10

Content	Competencies	Number of Hours
	color coding, types of containers, transportation of waste, etc (C2) 5. Explain importance of proper and safe disposal of bio-medical waste. (C2) **6.** Demonstrate proper and safe disposal of bio-medical waste. (C5)	
Unit 5:		
Trauma radiography	1. Find out the part being examined (C1) 2. Explain to the patient to prepare for radiograph (C2) 3. Demonstrate the steps involved in positioning (C2, P5, A3). 4. Choose the appropriate technical factors (C1,P6). 5. Identify the structures seen on the radiograph (C3). 6. Apply radiation protection techniques (C3). 7. Make use of appropriate radiographic accessories for positioning (C3). 8. Identify the abnormal radiograph (C3). 9. Relate the obtained image for quality (C2). 10. Take part in operating the radiographic equipment (C3,P5).	15
Unit 6:		
Mobile radiography	1. Find out the part being examined (C1) 2. Explain to the patient to prepare for radiograph (C2) 3. Demonstrate the steps involved in positioning (C2, P5,A3). 4. Choose the appropriate technical factors (C1P6). 5. Identify the structures seen on the radiograph (C3). 6. Apply radiation protection techniques (C3). 7. Make use of appropriate radiographic accessories for positioning (C3). 8. Identify the abnormal radiograph (C3). 9. Relate the obtained image for quality (C2). 10. Take part in operating the radiographic equipment (C3,P5).	15
Unit 7:		
Postprocessing technique in radiography	1. What are the post processing options in radiography. (C1) 2. List the basic tools required for postprocessing. (C1) 3. Interpret the image quality in radiological images. (C1) **4.** Analyze the images are properly marked “right” or “left” with permanent lead markers. (C4,P4)	17

Content	Competencies	Number of Hours
Unit 8:		
General considerations for the conduct of radiographic examinations in fluoroscopy	1. Make use of the operation of RIS and HIS. (C3, P3) 2. Explain steps involving sequencing fluoroscopic Examination. (C2) 3. Illustrate the need and process for proper documentation. (C2)	10
Unit 9:		
Operation aspect of fluoroscopic equipment	1. Identify the type of fluoroscopic systems. (C3) 2. Take part in Starting Up of System and Shutdown the System. (C4,P4) 3. Inspect the general safety of equipment. (C4,P3) 4. Develop knowledge about the machine with the help of manual provided by system manufacturer. (C3) 5. Identify common faults in fluoroscopic equipment and remedy. (C3) 6. Take part in operate and oversee the operation of fluoroscopic equipment.(C4,P6) 7. Identify Breakdown -& how to report a breakdown of imaging and processing systems. (C3)	25
Unit 10:		
Patient Care, handling & Department Management in fluoroscopy	1. Take part in preparing the patient and room for the fluoroscopic procedure. (C4,P4,A3) 2. Identify the need and describe the process for obtaining informed consent. (C3) 3. Identify the need for preprocedural equipment preparation. (C3,P3,A3) 4. Explain procedure to the patient. (C2) 5. Illustrate the patient's postprocedural care. (C2) 6. How to handle: pediatric, Adult, and geriatric patient. (C1) 7. Demonstrate how to transfer patients safely and dealing with uncooperative patients during fluoroscopic examinations. (C2,P3)	20
Unit 11:		
Infection control in fluoroscopic	1. Identify sterilization techniques to reduce the chances of infection in work practices in fluoroscopy. (C3) 2. Explain immediate measures following an exposure to needle sticks and cuts. (C2) 3. Explain Bio medical Waste management in fluoroscopy. (C2) 4. Explain disposal of bio-medical waste – color coding, types of containers, transportation of waste, etc (C5)	10

Content	Competencies	Number of Hours
	5. Explain importance of proper and safe disposal of bio-medical waste. (C2) 6. Demonstrate proper and safe disposal of bio-medical waste. (C5)	
Unit 12:		
Postprocessing technique in fluoroscopy	1. What are the post processing options in fluoroscopy. (C1) 2. List the basic tools required for postprocessing. (C1) 3. Interpret the image quality in fluoroscopic images. (C1) 4. analyze the images are properly marked “right” or “left” with permanent lead markers. (C4, P4) 5. Identify the Fluoro-time for procedures.(C3,P3)	18

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	195	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**195**	**-**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Practical)
Quiz	End Semester Exam (Practical)
Viva	Viva
Assignments/Presentations	Record Book
Clinical assessment (OSCE, OSPE, WBPA)	-
Clinical/Practical Log Book/ Record Book	Logbook

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x			
Sessional Examination 2						
Quiz / Viva	x	x	x	x	x	x

Assignments/Presentations							
Clinical/Practical Log Book/ Record Book			x			x	
Any others: WPBA							
End Semester Exam		x	x	x	x	x	x
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	• Radiological procedures. N Bhushan • Fundamentals of special radiographic procedures. Albert M. Snopek • Text Book of Radiographic Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P						
Additional References	• Guide to radiological procedures. Chapman & Nakielny. • Merrill's Atlas of Radiographic Positions and Radiologic Procedures Vol 1,2,3, Ballinger Philip W; Frank Eugene D • Clarks Positioning In Radiography, R. A. Swallow, E Naylor						

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Advanced image guided procedures**
Course Code	**MIT2241**
Academic Year	Second Year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have basic knowledge of Anatomy, Radiographic positioning and Radiographic special procedures
Course Synopsis	1. This module provides knowledge on Indications, contraindications, procedure, pre and post procedural care of various image guided procedures done in Radiology department 2. The student shall be able to acquire basic knowledge required to assist radiologist in image guided procedures

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the anatomy involved in the image guided procedure. (C1,C2)
CO2	Explain the indications and contraindications of image guided procedures. (C2)
CO3	Describe the patient preparation and list the equipment required for the procedure (C1, C2)
CO4	Explain the procedure and filming techniques of the guided procedures (C2)
CO5	Ilustrate the various complications and after care of the guided procedure (C1,C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2		x						
CO3	x	x						
CO4		x						
CO5		x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1		
Introduction to Image guided procedures	1. Outline the Image guided procedures in various modalities of Radiology (C1,C2)	1
Unit 2		
T-tube cholangiography	1. Define T-tube cholangiography (C1) 1. Recall the anatomy related to T-tube cholangiography (C1)	2

Content	Competencies	Number of Hours
	2. What are the indications and contraindications of the procedure? (C1) 3. Outline the patient preparation for the procedure (C2) 4. List the equipment's required for the procedures(C1) · 5. Explain the procedure and filming techniques (C2) 6. What are the complications of the procedure? (C1) 7. Explain the after care of the patient (C2)	
Unit 3		
Percutaneous transhepatic cholangiography (PTC)	1. Define PTC (C1) 2. Recall the anatomy related to PTC (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	2
Unit 4		
Percutaneous Transhepatic Biliary Drainage (PTBD)	1. Define PTBD (C1) 2. Recall the anatomy related to PTBD (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	2
Unit 5		
Phlebography	1. Define Phlebography(C1) 2. Recall the anatomy related to Phlebography (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure(C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	2
Unit 6		
Pig tail Insertion	1. What is Pig tail insertion? (C1) 2. Recall the anatomy related to Pig tail insertion (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) ·	2

Content	Competencies	Number of Hours
	6. Explain the procedure and filming techniques (C2) 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	
Unit 7		
Interventional Angiogram	1. Define Angiogram. (C1) 2. Recall the anatomy of blood vessels (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. Explain the types of catheters used in each type of angiogram. (C2) 6. List the equipment's required for the procedures(C1) · 7. Explain the procedure and filming techniques (C2) 8. What are the complications of the procedure? (C1) 9. Explain the after care of the patient (C2)	6
Unit 8		
Balloon Angioplasty	1. Define Angioplasty. (C1) 2. What are the indications and contraindications of the procedure? (C1) 3. Outline the patient preparation for the procedure (C2) 4. List the equipment's required for the procedures(C1) · 5. Explain the procedure and filming techniques (C2) 6. What are the complications of the procedure? (C1) 7. Explain the after care of the patient (C2)	3
Unit 9		
Stenting	1. Define stent (C1) 2. Name the types of stents (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) · 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	3
Unit 10		
Coiling	1. Define Embolization, Embolic agent (coils) (C1) 2. Name the types of coil (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) · 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	3

Content	Competencies	Number of Hours
Unit 11		
Embolization • Uterine artery embolization • Bronchial artery embolization • Intracranial AVM embolization	1. Define embolization (C1) 2. Name the types and classification of embolic agents (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) · 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	5
Unit 12		
Nerve blocks	1. What is Nerve block? (C1) 2. What are the indications and contraindications of the procedure? (C1) 3. Outline the patient preparation for the procedure (C2) 4. List the equipment's required for the procedures(C1) · 5. Explain the procedure and filming techniques (C2) · 6. What are the complications of the procedure? (C1) 7. Explain the after care of the patient (C2)	3
Unit 13		
Vertebroplasty and kyphoplasty	1. Define Vertebroplasty and kyphoplasty (C1) 2. What are the indications and contraindications of the procedures? (C1) 3. Outline the patient preparation for the procedure (C2) 4. List the equipment's required for the procedures(C1) · 5. Explain the procedure and filming techniques (C2) · 6. What are the complications of the procedure? (C1) 7. Explain the after care of the patient (C2)	2
Unit 14		
Transarterial chemoembolization (TACE)	1. What is TACE? (C1) 2. What are the indications and contraindications of the procedure? (C1) 3. Outline the patient preparation for the procedure (C2) 4. List the equipment's required for the procedures(C1) · 5. Explain the procedure and filming techniques (C2) · 6. What are the complications of the procedure? (C1) 7. Explain the after care of the patient (C2)	1
Unit 15		
Transjugular intrahepatic portosystemic shunt (TIPS)	1. What is TIPS? (C1) 2. Recall the anatomy related to TIPS (C2) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures (C1)	1

Content	Competencies	Number of Hours
	6. Explain the procedure and filming techniques (C2) · 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	
Unit 16		
IVC Filter placement	1. Define IVC filter (C1) 2. Name the types of IVC filter (C1) 3. What are the indications and contraindications of the procedure? (C1) 4. Outline the patient preparation for the procedure (C2) 5. List the equipment's required for the procedures(C1) · 6. Explain the procedure and filming techniques (C2) · 7. What are the complications of the procedure? (C1) 8. Explain the after care of the patient (C2)	1

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	5	8
Self-directed learning (SDL)	4	6
Assessment	4	12
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)

Mapping of Assessment with COs:					
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester Examination	x	x	x	x	x
Quiz / Viva	x	x			
Assignments/Presentations			x	x	x
End Semester Exam	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Current Techniques in Interventional Radiology - Cope , Constantin • Interventional Radiology - A Practical Guide - Anthony Watkinson and Andreas Adam

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Imaging Informatics**
Course Code	**MIT2242**
Academic Year	Second Year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have basic knowledge of Digital Imaging & Image processing methods in Radiography
Course Synopsis	1. This module provides fundamental knowledge of information technology and clinical image management. 2. This module provides details about handling of issues that arise on the day to day basis for imaging informatics professionals. 3. This module provide insight into clinical environment in which images are used and interpreted. 4. This model also provides insights into administrative issues of PACS.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Describe system components of PACS. (C1, C2)
CO2	Plan radiology workflow and make use of workflow analysis. (C3)
CO3	Take part in image archival and import / export. (C4)
CO4	Design, develop, implement, evaluate and follow-up of user training (C6)
CO5	Adapt the mechanisms for improving performance in the digital imaging department. (C6)
CO6	Explain team building and project management (C5)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2			x					
CO3	x							
CO4					x			
CO5							x	
CO6			x					

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Digital Images	1. Define digital images. (C1) 2. Explain the process of digital image formation in medical imaging department. (C2)	1

Content	Competencies	Number of Hours
Unit 2:		
Computers and Networking	1. Illustrate basics of hardware elements and software of computer. (C2) 2. Explain computer networking in radiology department. (C2) 3. Outline client-server architecture and database applications. (C2)	3
Unit 3:		
Introduction to PACS	1. Explain goals of PACS. (C2) 2. List components of PACS. (C1) 3. Demonstrate workflow element to be supported by PACS and informatics team (C2) 4. Summarize professional roles for maintenance and administration of PACS(C2)	3
Unit 4:		
Workflow Steps in Radiology	1. Build documentation and process flow in radiology. (C3) 2. Plan key steps of radiology workflow (C3) 3. Explain IHE workflow models. (C2) 4. Make use of workflow analysis. (C3)	3
Unit 5:		
Standards and Interoperability	1. List information technology standards relevant to imaging. (C1) 2. Outline internet standards, DICOM, and HL7. (C2) 3. Explain integrating healthcare enterprise (IHE). (C2)	2
Unit 6:		
Viewing Images and image processing	1. Outline display hardware, software considerations and human computer interface. (C2) 2. Make use of image processing techniques. (C3)	3
Unit 7:		
Image Distribution	1. Illustrate functional Requirements and technology Strategies for image distribution (C2) 2. Describe infrastructure considerations for image distribution (C2) 3. Identify specific workflow considerations for image distribution. (C3) 4. Take part in image archival and import / export. (C4)	2
Unit 8:		
Reporting and Dictation	1. Demonstrate new reporting methods (C2) 2. Illustrate lexicons (C2)	1
Unit 9:		
PACS Customer Relations	1. Classify customer groups and their concerns. (C4) 2. Make use of tools of the trade (C3)	1
Unit 10:		
User Training	1. Assess the need of the user training (C5) 2. Design, develop, implement, evaluate and follow-up of user training (C4, C5, C6)	2

Content	Competencies	Number of Hours
Unit 11:		
Quality Assurance	1. Organize quality assurance of digital imaging. (C3) 2. Explain processes and product in the imaging department. (C2) 3. Demonstrate measurable indicators of quality of imaging services (C2) 4. Adapt the mechanisms for improving performance in the digital imaging department. (C6) 5. Explain roles and responsibilities of QA team members and committee. (C2)	1
Unit 12:		
Data Storage and Disaster Recovery	1. Discuss the philosophy of storing electronic protected health information (ePHI). (C6) 2. Explain data centres. (C2) 3. Explain different types of medical data. (C2) 4. Explain storage requirements for ePHI (C2) 5. Explain retention and destruction requirements of ePHI. (C2) 6. Make use of different storage technology. (C3) 7. Explain compression of medical images. (C2) 8. Plan disaster recovery and business continuance. (C6) 9. Support migration of medical images and related data. (C5)	4
Unit 13:		
Downtime Procedures and Departmental Policies	1. Describe downtime considerations and types (C2) 2. Demonstrate downtime policies and procedures (C3) 3. Minimize downtime (C5)	1
Unit 14:		
Reading Room Design	1. Explain the challenges of reading room design.(C2)	1
Unit 15:		
Workflow Testing and Workflow Engineering	1. Illustrate workflow testing (C2) 2. Explain workflow engineering (C2)	1
Unit 16:		
Policy Management and Regulatory Compliance	1. Explain HIPAA (C2) 2. Explain MQSA (C2) 3. Illustrate imaging informatics professional certification.(C2)	1
Unit 17:		
Billing and Coding	1. Explain terminology and standards of billing and coding (C2) 2. Illustrate required practices for billing and coding (C2) 3. Outline information transfer (C2)	1

Content	Competencies	Number of Hours
Unit 18:		
Preparing for PACS	1. Describe value for information technology investments (C2) 2. Illustrate return on investment (C2) 3. Describe financing PACS and other IT expenditures (C2) 4. Assess PACS readiness (C5) 5. Assess issues and process of changing management from conventional system to PACS (C5) 6. Choose a vendor (C5) 7. Explain acceptance testing (C5)	4
Unit 19:		
PACS Administration	1. Explain vendor selection process (C5) 2. Evaluate organization and technology (C5) 3. Explain team building and project management (C5) 4. Describe long range planning (C2)	4

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	3	6
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	6	12
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	4	8
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Assignments/Presentations	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x	x		
Sessional Examination 2						
Quiz / Viva	x	x	x	x		
Clinical/Practical Log Book/ Record Book			x	x	x	x
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• *Practical Imaging Informatics: Foundations and Applications for PACS Professionals* - Barton Branstetter (2010).
	• PACS and Imaging Informatics: Basic Principles and Applications - H. K. Huang 2nd edition (2010).
Additional References	• Clark's Essential PACS, RIS and Imaging Informatics - Alexander Peck (2017).

SEMESTER - V

COURSE CODE	:	COURSE TITLE
MIT3101	:	Physics of ultrasound
MIT3102	:	Computed tomography - I
MIT3103	:	Magnetic Resonance Imaging - I
MIT3104	:	Specialized imaging Modalities
MIT3105	:	Patient care and Ethics in Radio diagnosis
MIT3131	:	Clinical aspect of Specialized Imaging modalities
*** ****	:	Open elective - II

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Physics of Ultrasound**
Course Code	**MIT3101**
Academic Year	Third year
Semester	Fifth semester
Number of Credits	3
Course Prerequisite	Basic Knowledge of Physics
Course Synopsis	• This module provides fundamental knowledge about ultrasound imaging which include basic of computer science, basic physics of ultrasound, and clinical application of ultrasonography in medical imaging. • To provide fundamental knowledge about advanced technology of USG applied in the medical imaging. • To provide fundamental knowledge about bio effects and safety of ultrasound.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Describe the basic principle of ultrasound and Doppler imaging (C1)
CO2	Discuss the equipment and the components used for the ultrasound imaging (C2)
CO3	Illustrate the bio effects and safety of ultrasound(C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x	x						
CO3	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction	1. Define properties of sound wave(C1) 2. Define basic principle of ultrasound (C1) 3. Define basic principle of Doppler imaging (C1) 4. Explain the advantage and disadvantage of ultrasound (C1)	3
Unit 2:		
Ultrasound	1. Describe Sound (C1) 2. Define properties of sound wave (C1) 3. Define basic principle of ultrasound (C1) 4. Explain the interaction of ultrasound with matter (C1)(C2)	3
Unit 3:		
Ultrasound Instrumentation	1. Explain the working of ultrasound equipment (C2)	4

Content	Competencies	Number of Hours
	2. Define the functioning of image display systems and CRT (C1) 3. Explain the construction of USG probes (C2) 4. List the different types of probes (C1) 5. Describe and classify Contrast agents (C1, C2) 6. List types of contrast agents (C1)	
Unit 4:		
Piezoelectric effect	1. Define piezoelectric effect (C1) 2. Describe piezoelectric crystal (C1) 3. Explain the formation of piezoelectric crystal (C2) 4. List types of piezoelectric crystal (C1) 5. Describe the characteristic of piezoelectric crystal (C1) 6. Classify the uses of piezoelectric crystal (C2)	3
Unit 5:		
Transducers	1. Define ultrasound transducer (C1) 2. Illustrate the construction of transducer (C2) 3. Explain the functioning of various components of transducer (C2) 4. Classify various types of transducer (C2) 5. Explain generation of ultrasound pulses(C1,C2) 6. Describe how sound beams are focused and scanned through anatomy (C1) 7. Define resolution (C1) 8. Identify the factors affecting resolution (C3)	4
Unit 6:		
USG Display	1. Describe the image formats used in USG(C1) 2. Explain the various display modes and their application (C2) 3. List the advantages and disadvantages of various display modes(C1) 4. Explain gray scale imaging and its advantage (C2) 5. Illustrate the scan converters (C2) 6. Define gain controls (C1) 7. Illustrate TGC controls (C2)	5
Unit 7:		
Doppler	1. Define Doppler and its application in medical imaging (C1) 2. Describe Doppler principle (C1) 3. Explain Doppler equation(C2) 4. Explain Doppler effect, Doppler shift and Doppler angle (C2) 5. List and compare various kinds of flow encountered in blood circulation (C1,C2) 6. Explain how blood flow detected using Doppler imaging (C2)	4

Content	Competencies	Number of Hours
Unit 8:		
Doppler Instrumentation	1. Describe different types of Doppler techniques (C1) 2. Explain the working of continuous wave doppler (C2) 3. Illustrate the instrument controls for continuous wave doppler (C2) 4. Describe wall filter (C1) 5. Explain the working of pulsed wave doppler(C2) 6. Illustrate the instrument controls for pulsed wave doppler (C2) 7. Explain how flow detection is localized using pulsed doppler (C2) 8. Describe sample and hold technique (C1) 9. Explain Color doppler technique (C2) 10. Describe duplex scanner (C1) 11. Compare different types of doppler imaging technique (C2)	6
Unit 9:		
Artifacts	1. Define artifact (C1) 2. Classify the artifacts (C2) 3. Identify different types of artifact (C3) 4. Compare different types of artifact(C2) 5. Illustrate the cause of artifact (C2) 6. Identify and apply remedy for artifact (C3)	4
Unit 10:		
Bio effects and safety	1. Illustrate the biological effects of ultrasound(C2) 2. Explain the mechanism for production of biological effects (C2) 3. Outline the approaches to reduce the bio effects (C2,C3) 4. Explain the safety requirements for clinical use of ultrasound (C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	8	16
Total	**39**	**78**

Assessment Methods:			
Formative:	**Summative:**		
Unit Test	Mid Semester/Sessional Exam (Theory)		
Quiz	End Semester Exam (Theory)		
Viva	Viva		
Assignments/Presentations			
Mapping of Assessment with COs:			
Nature of Assessment	**CO1**	**CO2**	**CO3**
Mid Semester / Sessional Examination	x	x	x
Quiz / Viva	x	x	x
Assignments/Presentations	x	x	x
Clinical/Practical Log Book/ Record Book			
Any others: WPBA			
End Semester Exam	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	List 02 main references and 03 additional reference for your course separately 1. James A. Zagzebski. (1996)Essentials of ultrasound physics 2. Fredrick W Kremkau., Fleming Forsberg. (2011) Sonography principles and instruments
Additional References	1. Christensen, E. E., Curry, T. S., Dowdey, J. E., & Murry, R. C. (1984). Christensen's Introduction to the physics of diagnostic radiology. Philadelphia: Lea & Febiger. 2. P.E.S. Palmer.(1995) Manual of Diagnostic Ultrasound

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Computed Tomography - I**
Course Code	**MIT3102**
Academic Year	Third year
Semester	V
Number of Credits	2
Course Prerequisite	Student should have basic knowledge of Radiation Physics
Course Synopsis	• This module provides the students to understand the History, Invention of CT scanner • To provide the knowledge of Generations of evolution of CT • To provide the fundamental knowledge of the basic working principle of computed tomography and also the principle of the reconstruction algorithms • To provide fundamental knowledge about the various part that compromise the CT scanner including detector technology. • To provide fundamental knowledge about workflow and image formation in computed tomography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the physics of computed tomography (C2).
CO2	Compare various generations of computed tomography (C2).
CO3	Explain the detector technology and data acquisition (C2).
CO4	Explain the various reconstructions algorithms (C2).
CO5	List the components of computed tomography instrument (C4).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x						x	
CO3	x						x	
CO4	x						x	
CO5	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
UNIT 1: Introduction to CT		
• History • Advantage of CT Comparisons with other imaging modalities.	• Recall the history and Invention of CT (C2). • Explain the differences between CT technology with other imaging Modalities (C2). • Outline the advantages of CT (C2).	2
UNIT 2: CT Principle		

Content	Competencies	Number of Hours
• Basic principle • CT number	• Explain the basic principle of CT (C2). • Define CT numbers (C2). • Outline the CT numbers of the various tissues/organs of the body (C2). • Explain the significant and clinical application of CT numbers (C2).	2
UNIT 3: CT Generations		
• First generation • Second generation • Third generation • Fourth generation • Fifth generation • Six generation • Seventh generation • Slip ring technology • Electron beam CT • Multi-slice technology	• Describe the concept and principle of the various generation of CT (C2). • Compare various generation of CT (C2). • Explain Slip Ring Technology (C2). • Explain Electron beam CT (C2). • Discuss Multi-slice technology (C2). • Outline advantages and disadvantages of various generation of CT (C2).	5
UNIT 4: Instrumentation		
• CT X ray tube • Image display • Image storage, • Recording • CT control console Options • Accessories for CT systems	• Explain about the X-ray tubes used in CT (C2). • Explain various components of imaging system and computer system (C2). • Explain CT image display, image storage and recording system (C2). • Explain the various application of CT control console (C2). • Explain the various accessories equipment in CT room (C2). • List the functions of the various components in CT (C4)	3
UNIT 5: CT Detectors Technology		
• Types • Principles of detector • Construction	• Explain CT detector Technology (C2). • Classify the types of CT detectors (C2). • Explain the working principle of the different types of CT detectors (C2). • Outline pros and cons of different types of detectors (C2).	4
UNIT 6: Acquisitions		
• Basic scheme for data acquisition • Data acquisition and sampling	• Explain data acquisitions (C2). • Explain the types of data (C2). • Explain nyquist theorem (C2). • Explain the work flow during data acquisition and sampling (C2).	3
UNIT 7: Reconstruction		
• Basic principle • Image reconstruction from projections	• Explain the basic principle of various reconstruction algorithms (C2). • Explain pre-processing techniques (C2).	4

Content	Competencies	Number of Hours
• Reconstruction algorithms	• Explain the different types of reconstruction algorithms (C2). • Outline advantages and disadvantages of various reconstruction algorithms (C2).	
UNIT 8: Three Dimensional Computed Tomography: Basic concepts		
• Fundamental Three-Dimensional Concepts	• Explain the fundamental of three-dimensional concepts (C2). • Explain the technical aspects of Three-Dimensional Imaging in Radiology (C2).	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Viva	Viva
Assignments/Presentations	-

Mapping of Assessment with COs:					
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester / Sessional Examination 1	x	x	x	-	-
Sessional Examination 2	-	-	-	-	-
Quiz / Viva	x	x	x	x	x
Assignments/Presentations	-	-	-	-	-
Clinical/Practical Log Book/ Record Book	-	-	-	-	-
Any others: WPBA	-	-	-	-	-
End Semester Exam	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback

	End-Semester Feedback
Main Reference:	• Seeram CT by Dr Euclid Seeram • Christensen's Physics Of Diagnostic Radiology Thomas curry, James E Dowdey, Robert C Murry
Additional References	• Essential Physics of Medical Imaging, Jerrold T Bushberg, J Antony Seibert, Edvin M Leidholdt

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Magnetic Resonance Imaging - I**
Course Code	**MIT3103**
Academic Year	Third Year
Semester	Fifth semester
Number of Credits	2
Course Prerequisite	Student should have basic knowledge of Anatomy and Pathology
Course Synopsis	• This module provides fundamental knowledge of principals, instrumentation and functioning of Magnetic Resonance Imaging. • This module provides details about handling of MRI system, Image acquisition techniques, patient care and safety aspects. • This module provide insight into image weighting and contrast, basic pulse sequences, image encoding, data collection and image formation. • This modules also provides details of parameters and trade-offs.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Outline background and history of clinical MR imaging. (C2)
CO2	Make use of different intrinsic and extrinsic contrast parameters in clinical MR imaging (C3)
CO3	Choose basic MRI pulse sequence for imaging in clinical practice. (C3)
CO4	Interview patient before MRI examination for safety aspects and patient comfort. (C3)
CO5	Outline MRI instrumentation for clinical imaging. (C2)
CO6	Adapt the techniques and practices for safety from main magnetic field, gradient magnetic field, RF field and acoustic noise. (C4,C6)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2		x						
CO3		x						
CO4					x			
CO5	x							
CO6				x				

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Basic principle of MRI: • Introduction • MR active nuclei • Effect of strong static magnetic field on MR active nuclei • Precession • Larmor equation • Effect of application and withdrawal of RF pulse • Pulse timing parameters • MR signal	1. Outline background and history of clinical MR imaging (C2) 2. Define MR active nuclei and explain MR active nuclei with suitable examples (C1, C2) 3. Explain hydrogen nuclei as MR active nuclei (C2) 4. Explain effect of main magnetic field on MR active nuclei inside the human body while placing in the magnetic field. (C2) 5. Define Larmor equation and extend its significance in MRI. (C1, C2) 6. Explain the effect of application and withdrawal of RF pulse in MRI. (C2) 7. Illustrate different pulse timing parameters. (C2) 8. When and how MRI signal produce (C1)	3
Unit 2:		
Image weighting and contrast • Image contrast parameters in MRI • contrast mechanisms • Relaxation in different tissues • T1 contrast • T2 contrast • Proton density contrast • Image weighting • T2* decay	1. Explain different contrast parameters. (C2) 2. Make use of different intrinsic and extrinsic contrast parameters in clinical MR imaging (C3) 3. Explain contrast mechanism in MR imaging. (C2) 4. Illustrate relaxation in different tissues. (C2) 5. Illustrate T1, T2 and Proton density contrast in MRI (C2) 6. Demonstrate T1, T2 and Proton density weighting in clinical MRI. (C2) **7.** Illustrate T2* weighting (C2)	3
Unit 3:		
Introduction to pulse sequences: • Spin echo sequences • Gradient echo sequences	1. Define pulse sequence. (C1) 2. Explain formation, timing parameters and application of Spin echo in clinical imaging. (C2) 3. Contrast on advantage and disadvantage of spin echo sequence. (C2) 4. Summarize different spin echo sequences. (C2) 5. Define gradients in MRI (C1) 6. Outline how gradients rephase and dephase.(C2) 7. Explain formation, timing parameters and application of Gradient echo. (C2) 8. Illustrate different weighting and contrast in gradient echo imaging. (C2) 9. Contrast on advantage and disadvantage of gradient echo imaging. (C2) 10. Choose basic MRI pulse sequence for imaging in clinical practice. (C3)	3

Content	Competencies	Number of Hours
Unit 4:		
Image Encoding and Sampling • Introduction • Gradients • Slice selection • Frequency encoding • Phase encoding • Sampling	1. Define image encoding. (C1) 2. Illustrate different MRI gradients and its directions with respect to bore of MRI machine. (C2) 3. Illustrate mechanism of slice selection including direction and timing of application of slice selection gradient during the pulse sequence.(C2) 4. Extend the selection of slice thickness for image acquisition. (C2) 5. Illustrate mechanism of frequency encoding including direction and timing of application of frequency encoding gradient during the pulse sequence. (C2) 6. Illustrate mechanism of phase encoding including direction and timing of application of phase encoding gradient during the pulse sequence. (C2) 7. Select different image encoding directions appropriately for image acquisition. (C3) 8. Explain sampling in MRI. (C2)	2
Unit 5:		
Data collection and Image formation:	1. Define K space. (C1) 2. Describe K space (C2) 3. Explain K space feeling. (C2) 4. Outline use of Fast Fourier transformation for MRI image formation. (C2) 5. Illustrate resolution data and signal data in K space. (C2) 6. Illustrate parameters affecting scan time in typical acquisition. (C2) 7. Explain K space traversal and gradients. (C2) 8. Make use of different options to fill K space. (C3) 9. Demonstrate different types of acquisition. (C2)	2
Unit 6:		
Parameters and Trade-offs: • Introduction • Signal to Noise Ratio (SNR) • Contrast to Noise Ratio (CNR) • Spatial resolution • Scan time • Trade-offs and decision making • Volume imaging	1. Define SNR, CNR, Spatial resolution and scan time. (C1) 2. Choose factors affecting SNR appropriately to enhance SNR. (C3) 3. Make use of different techniques to increase CNR. (C3) 4. Select suitable FOV, image matrix, and pixel dimension to enhance spatial resolution. (C3) 5. Choose appropriate parameters to optimize scan time. (C3) 6. Select appropriate parameters to acquire images with appropriate SNR, CNR, spatial resolution and scan time. (C6) 7. Explain trade-offs and decision making in MRI.(C2) 8. Illustrate volume imaging. (C2)	3

Content	Competencies	Number of Hours
Unit 7:		
Instrumentation and Equipment • Magnetism and MRI Magnets • Fringe field • Magnetic shielding • Shim coils • Gradient coils • RF coils • Patient Transportation system • MR computer system and user interface	1. Define magnetism and magnetic susceptibility.(C1) 2. Illustrate different magnetic substances. (C2) 3. Outline MRI magnets and its types for clinical imaging. (C2) 4. Define fringe field. (C1) 5. Illustrate magnetic shielding, shim coils and gradient coils. (C2) 6. Explain different types of RF coil and its care.(C2) 7. Demonstrate patient transportation system, MR computer system and user inter interface. (C2)	5
Unit 8:		
MRI Safety: • Introduction • Safety from Main magnetic field • Safety from gradient magnetic field • Safety from Radiofrequency field • Safety from Acoustic noise • Implants and Prosthesis • Claustrophobia • Quenching • Patient monitoring • Medical emergencies • Monitors and devices in MRI • MRI personal • MRI Facility zones • Consent • Safety Education	1. Interview patient before MRI examination for conforming safety aspects and patient comfort. (C3) 2. Categorize and communicate MRI safe MRI conditional and MRI unsafe substances. (C4) 3. Make use of screening devices for patient and personal screening before entering MRI room. (C3) 4. Adapt the techniques and practices for safety from main magnetic field, gradient magnetic field, RF field and acoustic noise. (C6) 5. Discuss patient care and safety for claustrophobic patient and during medical emergencies. (C6) 6. Analyse situation for quenching and adopt quenching process as per institutional/statutory protocol. (C4) 7. Explain MRI personal and MRI facility Zones. (C2) 8. Illustrate safety education and its significance in MRI setup. (C2)	5

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	13	26
Seminar		
Small group discussion (SGD)	6	18
Self-directed learning (SDL)	7	21
Problem Based Learning (PBL)		

Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment		
Total	**26**	**65**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Viva	
Assignments/Presentations	Record Book
Clinical assessment (OSCE, OSPE, WBPA)	
Clinical/Practical Logbook/ Record Book	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination		x		x	x	x
Assignments/Presentations	x	x	x	x	x	x
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Catherine Westbrook, Carolyn Kaut Roth, John Talbot (2011). MRI in practice, fourth edition. 2. Elmaoğlu, Muhammed, Çelik, Azim (2012). MRI handbook: MRI physics, patient positioning and protocols
Additional References	1. Michael L. Lipton, Emanuel Kanal (2008). Totally Accessible MRI 2. Haris S. Chrysikopoulos. Clinical MR Imaging and Physics: A Tutorial 3. Catherine Westbrook (2008). Handbook of MRI technique, 3rd edition

Manipal College of Health Professions	
Name of the Department	Department of Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Specialized Imaging Modalities**
Course Code	**MIT3104**
Academic Year	Third Year
Semester	V Semester
Number of Credits	3
Course Prerequisite	Basic Knowledge in Digital Imaging & Image processing methods in Radiography
Course Synopsis	• This module helps to understand the basic physics and Imaging science underpinning the Specialized Imaging Modalities and their application. • This module will help to understand the mechanisms describing physics behind the specialized Imaging modalities. • This module will help to discuss the components and working principle of these specialized equipment's and treatment equipment's used for the clinical care of patients. • This module will help to apply the principle and knowledge to optimize the protocols, using minimal exposure to reach the image quality level needed for the task

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Identify and Explain the basic Anatomy related to different procedures performed using various Specialized Imaging Modalities. (C1)
CO2	Explain the physics and principles of Image formation from various specialized modalities. (C2)
CO3	List various indications , contraindications , patient preparation, and imaging techniques of various procedures using specialized Imaging Modalities.(C2)
CO4	List the equipment and the components used for the image production and demonstrate the ability to optimize the protocols using minimal exposures to obtain the adequate image quality. (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2	x					x		
CO3		x				x		
CO4	x					x		

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
MAMMOGRAPHY Introduction	1. Explain the Anatomy & Pathology of Breasts.(C1) 2. Define Mammography (C1) 3. List the mammography techniques. (C1) 4. Compare Screening and Diagnostic mammography (C2) **5.** Which are the basic preparations followed for mammography (C2)	7
Unit 2:		
Mammography instrumentation • Tube construction • Compression technique • Automatic Exposure control • Grids used in mammography	1. Explain mammographic x ray tube in detail (C2) 2. Illustrate the characteristic x ray spectrum produced with various target –filter combination used in mammography(C2) 3. Infer the importance of Grids and Automatic Exposure control used in mammography(C2) **4.** Illustrate the importance of compression and magnification techniques used in mammography (C2)	7
Unit 3:		
Mammographic Techniques	1. List the basic views and special views taken in Mammography (C1) 2. Explain the basics and special views in mammography along with its clinical indications (C2) 3. Outline Male mammography and projections (C2) 4. Explain the BIRADS classification in mammography (C2)	4
Unit 4:		
Dental Radiography Equipment's	1. Explain the instrumentation of General Dental Radiography equipment (C2) 2. Explain Specialized Dental Radiography equipment - Cephalostats - Pantomographic equipment.(C2)	4
Unit:5		
Dental Radiography	1. Define Dental Radiography (C1) 2. Explain the-Dental Anatomy.(C1) 3. List the various Dental Terminologies.(C1) 4. Outline the-Dental formula.(C2) 5. List the types of dental Radiography.(C1) 6. Explain Intra oral radiography (C2) - Bite wing technique. - Periapical radiography - Occlusal radiography 7. Explain Extra oral radiography (C2) - oblique lateral technique - Cephalometry - Orthopantomogram	7

Content	Competencies	Number of Hours
Unit: 6: Instrumentation of DSA		
- Angiographic room layout - C arm - Flat panel detector - Subtraction techniques - Accessories	1. Define Digital Subtraction Angiography.(C1) 2. Explain the Room layout and design of Digital subtraction Angiography.(C2) 3. Explain the types of subtraction Techniques used in DSA (C2) 4. Outline the instrumentation and its working principle used DSA (C2) 5. List out the accessories used in DSA (C1)	7
Unit 7:		
DEXA (Dual Energy X-Ray Absorptiometry)	1. Define DEXA .(C1) 2. Explain The room layout and design of DEXA.(C2) 3. Explain the Instrumentation of DEXA.(C2) 4. Explain the Application and uses of DEXA.(C2) 5. Explain the various clinical Procedures in DEXA.(C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	25	50
Seminar	-	-
Small group discussion (SGD)	7	14
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	7	14
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester Exam (Theory)
Assignments/Presentations	End Semester Exam (Theory)

Mapping of Assessment with COs:				
Nature of Assessment	**CO1**	**CO2**	**C03**	**C04**
Mid Semester Examination	x	x	x	x
Assignments/Presentations	x	x	x	x
End Semester Exam	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Christensen, E. E., Curry, T. S., Dowdey, J. E., & Murry, R. C. (1984). Christensen's Introduction to the physics of

	diagnostic radiology. Philadelphia: Lea & Febiger. • Bushberg, J. T. (2002). The essential physics of medical imaging. Philadelphia: Lippincott Williams & Wilkins
Additional References	• Allisy-Roberts, P. J., Williams, J. R., & Farr, R. F. (2008). Farr's physics for medical imaging. Edinburgh: Saunders Elsevier. • Holmes, K., Clark, K. C., Elkington, M., & Harris, P. (2014). Clark's essential physics in imaging for radiographers. Boca Raton, FL: CRC Press, Taylor & Francis Group.

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science inMedical Imaging Technology
Course Title	**Patient Care and Ethics in Radio-diagnosis**
Course Code	**MIT3105**
Academic Year	Third year
Semester	V
Number of Credits	2
Course Prerequisite	Student should have basic knowledge of Microbiology, Pharmacology and Radiation protection
Course Synopsis	• This module provides the basis for students to preform patient care • To provide fundamental knowledge about patient care in radio-diagnosis. • To provide fundamental knowledge of the various ethical consideration in radio-diagnosis. • To provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Provide excellent patient care during radiography (C3).
CO2	Understand the need of good communication and demonstrate good communication techniques (C3).
CO3	Identify contrast reaction and their treatment (C2).
CO4	Apply radiation safety and MRI safety measures (C3).
CO5	Practice radiography ethically and legally including understanding and distinguishing various types of consent (C4)
CO6	Explain infection control in radiology department (C2).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x						
CO2		x			x			
CO3	x	x						
CO4		x		x				
CO5	x			x				
CO6	x						x	

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1: Introduction to Patient care		
• Patient care role in Imaging • Health Care delivery team • Professional organization	1. Explain about the patient care role in imaging (C2). 2. Identifying the need of patient care in imaging (C1). 3. Explain the role of healthcare delivery team (C2). 4. Classify the role of healthcare delivery team (C2). 5. Explain the role of professional organization (C2).	3

Content	Competencies	Number of Hours
Unit 2: Role of Imaging Technologist in Patient assessment		
• Communication with the patient • Patient Assessment • Precaution while dealing with female patient in radiography	1. Outlining the role of communication in radiography (C4). 2. Demonstrating communication skills (C3). 3. Identifying the need of patient assessment (C1). 4. Take part in patient assessment process (C4). 5. Interview the patient as a part of patient assessment before the radiographic examination (C3). 6. Explain various precautions while dealing with female patient in radiography (C2).	4
Unit 3: Patient care during radiographic procedures, CT and MRI		
• Acute situations and environments • Patient transfers • Immobilization devices • Handling for contrast reactions • Pre and post procedural care in radiological examination • Radiation Safety measures • MRI safety • Medical emergency during radiological procedures.	1. Explain acute situation and environment (C2). 2. Explain various patient transfer method (C2). 3. Select appropriate patient transferring techniques according to the patient condition (C3). 4. Make use of appropriate immobilization devices(C3) 5. Distinguish different contrast reaction (C4). 6. Examine patient history and lab report for safe administration of contrast media (C4). 7. Explain Premedication protocol for allergic reaction (C2). 8. Explain various treatment for contrast reaction(C2). 9. Recall biological effect of radiation (C1). 10. Outline various radiation safety measures (C2). 11. Identify the need of radiation safety (C3). 12. Explain MRI safety (C2). 13. Outline various MRI safety measures (C2). 14. Identify the need for MRI safety (C3). 15. Identify medical emergency during radiological procedures (C3).	7
Unit 4: Infection control in radiology Department		
• Nosocomial infection • Preventing disease transmission • Protocol for accidental exposure • Safe injection practices • Disposal of biological waste and safe handling of spills	1. Explain nosocomial infection (C2). 2. Carrying out various preventing techniques for disease transmission (C3). 3. Explain the protocol of accidental exposure (C2). 4. Explain safe injection practices (C2). 5. Practicing proper disposal of biological waste and safe handling of spills (C3).	4
Unit 5: Introduction to Ethics		
• History • Radiography as a professionalism • Patients' rights	1. Explain the history of ethics (C2). 2. Explain the universal principles of bio-ethics (C2). 3. Demonstrate professional behaviour during radiography (C3). 4. Explain patients' rights (C2).	4

Content	Competencies	Number of Hours
• Legal consideration ➢MLC cases ➢PCPNDT Act • Moral and Ethics	5. Outline various legal consideration while dealing with patients (C2). 6. Explain MLC cases and PCPNDT act (C2). 7. Identify MLC cases (C3). 8. Distinguish between moral and ethics (C4).	
Unit 6: Ethics in Radio-diagnosis		
• Standard of Ethics for Radiographers • Duties of Radiographer • Ethical Judgement and Conflicts • Consent and its types • Record keeping of documents	1. Explain standard of ethics for radiographers (C2). 2. Practice standard of ethics (C3). 3. Explain duties of radiographers (C2). 4. Explain ethical judgement and conflict (C2). 5. Explain consent and its types (C2). 6. Distinguish between different types of consent (C4).	4

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	
Assignments/Presentations	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x	x	x	x
Sessional Examination 2						
Quiz / Viva			x			x
Assignments/Presentations			x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback

Main Reference:	• Patient Care in Radiography by Ruth Ann Ehrlich • Ellen Double, McCloskey, Joan A. Daly
	• ICMR Guidelines – 2017 • https://main.icmr.nic.in/sites/default/files/guidelines/ICMR_Ethical_Guidelines_2017.pdf

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical aspects of Specialized Imaging Modalities**
Course Code	**MIT3131**
Academic Year	Third Year
Semester	V
Number of Credits	5
Course Prerequisite	Basic Knowledge of Digital Imaging & Image processing methods in Radiography
Course Synopsis	• This module provides the basis for students to undertake radiographic practice in various specialized imaging modalities within the clinical environment. • This module provides fundamental knowledge of the various radiographic procedures in equipment's like Mammography, Dental Radiography, DSA, CT, MRI and DEXA. • This module provides knowledge to identify the factors and characteristics of the radiographic image quality that affect the clinical application. • This module provides provide knowledge about patient care while handling patient and radiation protection during radiography.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Make use of learned instructions to prepare the patient for the various radiological projections. (C3, P4, A3).
CO2	Demonstrate the positioning skills for various Radiographic Examinations. (C4, P5, A2).
CO3	Select the appropriate radiographic factors to generate good radiographic quality image. (C5, P6).
CO4	Identify and interpret the structures seen on the Radiographic Image. (C5)
CO5	Make Use of appropriate Radiographic Image accessories. (C3).
CO6	Operate the radiographic equipment. (C6 ,P5)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x			x				
CO2		x		x				
CO3		x				x		
CO4	x		x					
CO5		x				x		
CO6		x	x					

Course Content and Outcomes:

Content	Competencies	Number of Hours
Part A: Computed Tomography (65hrs)		
Unit 1: Patient Preparations and Safety during CT scan - Before the procedure - During the CT scan - Post procedure care - Paediatric patient scan	- Evaluate the requisition forms and medical records (C5) - Evaluate of the patients(C5) - Assessment of Radiopaque materials prior to CT Examination. (C4) - Explain the procedure for patient education(C2) - Interpret the Indication and contraindications(C2) - Preparing the patient for CT examination(C3 ,P4 ,A3) - Make use of immobilization techniques (C3) - Select appropriate protocol (C3) - Select appropriate parameters(C3 , P6) - Apply radiation protection techniques (C3) - Evaluate the patient for any complications after the CT Scan examination(C3)	15
Unit 2: Patient Positioning for CT scans - CT Head (Routine & Trauma) - CT OMC - CT Neck - CT Thorax - CT Abdomen & Pelvis - CT Spines - CT Upper & Lower Extremities - CT Angiogram	- Relate the anatomical landmarks for positioning(C1) - Demonstration of the operation of gantry controls (C3, P5 ,A2) - Make use of- appropriate CT accessories to aid positioning (C3) - Take part in patient positioning (C4) - Demonstrate proper instruction to the patient pertaining to the scan (C2)	25
Unit 3: Radiation safety measures during CT scan - Application of principle of Radiations Protection in CT scan	- Make use of various shielding devices for patients(C3) - Make use of various shielding devices for by stander (C3) - Choose appropriate scan parameters with minimum radiation dose (C3) - Follow radiation safety measures for imaging personnel protection (C3)	10
Unit 4: Care and maintenance of CT Machine - Air calibration - Switch on/ off the machine - CT room temperature - CT room humidity rate	- Demonstrate the step by step procedure for air calibration (C2) - Demonstrate the step by step procedure to switch on and off the machine(C2) - Identify CT room temperature for maintenances(C3) - Identify CT room humidity for maintenances(C3)	5
Unit 5: CT brain Protocol • Facial bone • Cranial bone	- Explain the anatomy of Skull bones.(C2) - Evaluate the requisite and medical History (C5)	10

Content	Competencies	Number of Hours
• Temporal bone • Sinuses	- Identify the right patients(C3) - Assessment of safety screening (C4) - Explain the procedure for patient education(C2) - Explain the Indication and contraindications(C2) - Prepare the patient for CT examination(C3) - Demonstrate patients positioning(C3) - Select appropriate protocol (C3) - Select appropriate parameters(C3) - Perform post processing techniques, image batching, display and archiving (C3) - Apply radiation protection techniques (C3)	
Part B: Magnetic Resonance Imaging (65hrs)		
Unit 6: Patient Care during MRI scan - Before the Scan Procedure - During the MRI scan - After the MRI scan - Paediatric patient scan	1. Interview patient before MRI examination for conforming safety aspects and patient comfort. (C3) 2. Judge if patient can be taken for MR imaging or not depending on patient history. (C5) 3. Utilize screening device / metal / magnet detector. (C3) 4. Take part in taking consent. (C4) 5. Demonstrate patient preparation for the MRI examination. (C3 , P5 , A2) 6. Evaluate the MRI room before shifting the patient for examination. (C3) 7. Choose appropriate technique for patient transfer to MRI couch for scan and from MRI couch after the scan. (C3, P6) 8. Apply different safety precaution while positioning patient and RF coil for examination. (C3) 9. Inspect patient during examination for safety and comfort. (C4) 10. Apply safety precautions and techniques for patient with claustrophobia and other medical conditions. (C3) 11. Adapt safety precautions and techniques for paediatric patient. (C6)	25
Unit 7: MRI Routine Protocols - MRI brain - MRI spine - MRI Abdomen & pelvis - MRI Upper & Lower extremities - MRA	1. Identify right patient for examination. (C3) 2. Assess requisition forms and medical record for MRI examination. (C5) 3. Choose appropriate RF coil for MR imaging of different body parts. (C6) 4. Select appropriate patient positioning for MR imaging. (C3) 5. Select appropriate pulse sequences and scan parameters for MR imaging of different body parts. (C3)	20

Content	Competencies	Number of Hours
	6. Demonstrate Plain routine MR examinations of different body parts. (C3) 7. Demonstrate Archival of acquired images and / or films of acquired MRI images. (C3, P5 ,A2) 8. Demonstrate the post-processing techniques of MRA(C3 ,P5 ,A2)	
Unit 8: Contrast media administration in MRI - Oral contrast media - Intravenous contrast media	1. Identify the types of MRI contrast Media.(C2) 2. Classify the types of MRI Contrast Media.(C3) 3. Preparing the Patient for the Contrast based MRI.(C3, P4 ,A3) 4. Interview patient before MRI examination.(C3) 5. Explain the procedure for patient education. (C2) 6. Assess the procedure performed and patient data in appropriate record. (C4)	10
Unit 9: Care and maintenance of MR Machine - Cleaning of MR coils - Checking Helium levels - MR room temperature Infection control	1. Demonstrate maintenance of machine room and record keeping. (C2) 2. Take part in cleaning of accessories (C4) 3. Assessment of Helium Levels.(C6) 4. Assessment of MRI Scan Room temperature.(C6) **5.** Take part in the infection Control Measures.(C4)	10
Part C: Mammography/ Dental Radiography / Digital Subtraction Angiography/ DEXA (Dual Energy X-Ray Absorptiometry) (65hrs)		
Unit 10: Equipment's used in Mammography	1. List the Accessories used in Mammography.(C1) **2.** List the equipment used in Mammography.(C1)	5
Unit 11 : Positioning Techniques in Mammography	1. Describe the anatomy of Breast. (C1) 2. List views in Mammography (C3) 3. Preparing the patient for the radiograph (C3) 4. Demonstrate the steps involved in positioning (C3 ,P5, A2) 5. Choose the appropriate technical factors (C3 ,P6) 6. Identify the structures seen on the radiograph (C2) 7. Apply radiation protection techniques during Mammography.(C3). 8. Use appropriate radiographic accessories for positioning of breast.(C3). 9. Identify the abnormal radiograph (C3). 10. Relate the obtained image for quality (C2). 11. Make use of- the radiographic equipment (C3)	20

Content	Competencies	Number of Hours
Unit 12: Positioning techniques in Dental Radiography	1. Relate the Dental Anatomy & Dental Formula.(C1) 2. Identify the part being radiographed (C3) 3. Preparing the patient for Dental radiography. (C3 ,P4 ,A3) 4. Demonstrate the steps involved in positioning of the part being examined. (C3,P5 ,A2) 5. Choose the appropriate technical factors (C3, P6) 6. Identify the structures seen on the radiograph (C3) 7. Employ radiation protection techniques (C3). 8. Use appropriate radiographic accessories for positioning (C3). 9. Relate the abnormal radiograph (C3). 10. List the obtained image for quality (C2). 11. Operate the radiographic equipment (C3, P5)	20
Unit 13: Equipment used in interventional radiology	1. List the Accessories used in Angiography.(C1) 2. List the equipment used in Angiography.(C1)	5
Unit 14: Angiography procedures • Seldinger's Technique • Four Vessel Cerebral Angiography • Aortography	1. Recall the anatomy of arterial supply (C1). 2. Recall the vessel Anatomy of Aorta.(C1) 3. Find the parts of Angiography. (C1). 4. Demonstrate the patient preparation for the Angiography Procedure(C3,P4,A3) 5. Identify the equipment's required for the Angiography procedure.(C2) 6. Demonstrate the steps involved in positioning. (C3 ,P5 ,A2) 7. Choose the appropriate technical factors (C3 ,P6) 8. Identify the structures seen on the Angiography Image.(C3) 9. Demonstrate the radiation protection techniques during the Angiography procedure.(C3) 10. Use appropriate radiographic accessories for positioning (C3). 11. Distinguish the abnormal radiograph (C4). 12. Analyse the obtained image for quality (C2). 13. Operate the radiographic equipment (C3, P5)	10
Unit 15: Patient positioning for various BMD scans • Whole Body Scan (X-Ray Absorptiometry) • Bone Mineral Density (Upper Extremity, Spine, Pelvis, Lower Extremity)	1. Describe the anatomy for the BMD study (C1). 2. Identify the part being examined (C1). 3. Preparing the patient for the BMD study (C3, P4, A3) 4. Demonstrate the steps involved in positioning (C3, P5 ,A2) 5. Choose the appropriate technical factors (C3,P6)	5

Content	Competencies	Number of Hours
• Post-Processing of the Acquired Data	6. Identify the structures seen on the BMD Image (C3). 7. Demonstrate radiation protection techniques during the BMD scan (C3). 8. Make Use of appropriate radiographic accessories for positioning (C3). 9. Assess the abnormal radiograph (C6). 10. Analyse the obtained image for quality (C2). 11. Operate the radiographic equipment (C3,P5).	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	195	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**195**	-

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Practical)
Quiz	End Semester Exam (Practical)
Viva	Viva
Assignments/Presentations	Record Book
Clinical assessment (OSCE, OSPE, WBPA)	
Clinical/Practical Logbook/ Record Book	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x				x
Quiz / Viva		x	x	x		
Assignments/Presentations	x			x	x	
Clinical/Practical Logbook/ Record Book			x			
Any others: WPBA						
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback

Main Reference:	Clarks Positioning in Radiography, R.A. Swallow, E. Naylor
	1. Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D. 2. Bone Densitometry for Technologists , Third Edition, Sydney Loh Bonnick ;Lori Ann Lewis. 3. Bone Densitometry in Clinical Practice ; Third Edition, Sydney Loh Bonnick ;Lori Ann Lewis. 4. CT & MRI PROTOCOL ; A practical Approach , Satish K Bhargava 5. Textbook in Diagnostic Radiology; G.H. Whitehouse
Additional References	1. Skeletal Anatomy, Bryan Glenda J 2. Textbook of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P

SEMESTER - VI

COURSE CODE	:	COURSE TITLE
BST3201	:	Biostatistics and Research Methodology
MIT3201	:	Computed Tomography - II
MIT3202	:	Magnetic Resonance Imaging - II
MIT3203	:	Cross-sectional Anatomy in CT & MRI
MIT3231		Clinical Aspect of CT & MRI
MIT****	:	Program Elective - II

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Biostatistics and Research Methodology**
Course Code	**BST3201**
Academic Year	Third Year
Semester	VI
Number of Credits	3
Course Prerequisite	Nil
Course Synopsis	1. To provide necessary foundation on • Introductory level biostatistics • Demography, vital statistics and epidemiology • Survey sampling methods • Fertility, morbidity, and mortality indices 2. To introduce the steps involved in research process

Course Outcomes (Cos): **At the end of the course student shall be able to:**	
CO1	Explain characteristics of statistical data, types of variables, scales of measurement, presentation of data, normal distribution. (C2)
CO2	Apply measures of location and variation for statistical data (C3)
CO3	Outline the sources of demographic data and vital statistics, merits and demerits of probability and non-probability sampling techniques. (C2)
CO4	Explain the indices of fertility, morbidity and mortality, Epidemiology, observational study designs (C2)
CO5	Explain the concept of correlation and regression. (C2)
CO6	Summarize the steps involved in a research process (C2)

Mapping of Course Outcomes (Cos) to Program Outcomes (POs):

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4		x						
CO5	x							
CO6	x							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction to Biostatistics	• Define biostatistics (C1) • Describe the characteristics of statistical data (C2) • Explain the role of statistics in health sciences (C2)	2

Content	Competencies	Number of Hours
Variables	• Distinguish between qualitative & quantitative with appropriate examples (C2) • Distinguish between continuous & discrete variables with appropriate examples (C2) • Distinguish between nominal & ordinal variables with appropriate examples (C2)	4
Scales of Measurement	• Describe nominal scale of measurement of variables with appropriate examples (C2) • Describe ordinal scale of measurement of variables with appropriate examples (C2) • Describe interval scale of measurement of variables with appropriate examples (C2) • Describe ratio scale of measurement of variables with appropriate examples (C2)	4
Unit 2:		
Tabular presentation of data	• Describe the three types of class intervals – inclusive, exclusive, and open ended (C2) • Explain the concepts of relative and cumulative frequencies (C2) • Construct the frequency table (C2)	2
Graphical presentation of data	• Explain the concepts of Histogram, Frequency Polygon, Frequency Curve (C2) • Construct Histogram, Frequency Polygon, Frequency Curve for statistical data (C2)	2
Diagrammatic presentation of data	• Explain the concepts of Bar diagram and Pie diagram (C2) • Construct Bar diagram and Pie diagram for statistical data (C2)	2
Unit 3:		
Measures of Location	• Explain the concepts of Mean, Median, Mode (C2) • Explain the concepts of Quartiles and Percentiles (C2)	2
Unit 4:		
Measures of Variation	• Describe the concepts of Range, Inter-quartile range, Variance, Standard deviation and Coefficient of variation (C2)	2
Unit 5:		
Sampling	• Explain sampling and non-sampling error (C2) • Define and distinguish probability and non-probability sampling methods (C1) • Explain each sampling technique by stating their merits and demerits (C2)	4
Unit 6:		
Normal Distribution	• Explain the characteristics of normal distribution (C2) • Compute the area under the normal	2

Content	Competencies	Number of Hours
	distribution curve (C3)	
Skewness and Kurtosis	• Explain the concept of skewness and describe three types of skewness (C2) • Explain the concept of kurtosis and describe three types of kurtosis (C2)	2
Unit 7:		
Correlation	• Define correlation (C2) • Explain positive and negative correlation with appropriate examples (C2) • Explain the Pearson's correlation coefficient and outline its properties (C2) • Explain the Spearman's correlation coefficient and outline its properties (C2) • Illustrate using scatter plot the different types of correlation (C3)	2
Regression	• Distinguish between dependent and independent variables. (C2) • Explain the simple linear regression model along with the assumptions involved. (C2) • Identify the slope and intercept coefficient from the model. (C2) • Predict the dependent variable from the model for a given set of independent variables. (C2)	2
Unit 8:		
Demography and Vital statistics	• Define Demography and Vital statistics (C1) • What are the sources of demographic data and vital statistics (C1) • Define and distinguish rate, ratio and proportion (C1)	2
Morbidity, mortality and fertility rates	• Explain prevalence and incidence (C2) • Explain each measure of morbidity, mortality and fertility rates by stating the formula (C2)	4
Unit 9:		
Research	• Explain sampling and non-sampling error (C2) • Define and distinguish probability and non-probability sampling methods (C1) • Explain each sampling technique by stating their merits and demerits (C2)	3
Unit 10:		
Epidemiology	• Define Epidemiology (C1) • Explain the observational study designs (case report, case series, cross-sectional, ecological) (C2)	**4**

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	45	135
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**45**	**135**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
	End Semester Exam (Theory)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination I	x	x				
Sessional Examination II	x	x	x	x	x	x
Quiz / Viva						
Assignments/Presentations						
Clinical/Practical Log Book/ Record Book						
Any others: WPBA						
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Lwanga SK, Tye CY, Ayeni O. Teaching health statistics: lesson and seminar outlines. World Health Organization, Marketing and Dissemination, 1211 Geneva 27, Switzerland; 1999. 2. Health research methodology: a guide for training in research methods. World Health Organization; 2001. 3. Bonita R, Beaglehole R, Kjellström T. Basic epidemiology. World Health Organization; 2006. 4. Campbell MJ, Swinscow TD. Statistics at square one. John Wiley & Sons; 2011.
Additional References	5. Degu G, Tessema F. Biostatistics [Internet]. Gondor: University of Gondar; January 2005. Available from: http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/ln_biostat_hss_final.pdf 6. Kebede Y. Epidemiology [Internet]. Gondor: University of Gondar; 2004. Available from: http://www.cartercenter.org/resources/pdfs/health/ephti/library/l

	ecture_notes/env_occupational_health_students/Epidemiology.pdf 7. Degu G, Yigzaw T. Research Methodology [Internet]. Gondor: University of Gondar; 2006. Available from: http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/ln_research_method_final.pdf 8. Morris JN. Uses of epidemiology. Edinburgh, UK: Churchill Livingstone; 1975. 9. Campbell MJ, Machin D, Walters SJ. Medical statistics: a textbook for the health sciences. John Wiley & Sons; 2010. 10. Rao PS, Richard J. An Introduction to Biostatistics: A manual for students in health sciences. Prentice/Hall of India; 1996. 11. Mahajan BK, Khanal AB. Methods in biostatistics: for medical students and research workers. Jaypee Brothers Medical Publishers; 2010.

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Computed Tomography - II**
Course Code	**MIT3201**
Academic Year	Third Year
Semester	VI
Number of Credits	3
Course Prerequisite	Student should have the knowledge of Computed Tomography- I
Course Synopsis	• This module provides the students to understand in detail about fundamental knowledge about the characteristics of CT image quality. • To provides the knowledge of the various factors affecting image quality and the techniques used to optimize the image quality without an increment in radiation dose. • To provide fundamental knowledge about various CT guided procedures protocol, safety consideration and also the documentation of the CT images and files. • To provide knowledge about patient care while handling patient and radiation dose calculation and protection during CT scan.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the process of image display in computed tomography (C2).
CO2	Explain the various characteristics of image quality in computed tomography (C2).
CO3	Identify CT contrast media, allergic reaction of contrast media and management of contrast reaction (C3).
CO4	Explain the techniques to perform CT guided procedures (C2).
CO5	Modify the technical factors to reduce radiation dose in computed tomography (C6).
CO6	Identify their role as a technologist and safely plan the CT examination (C3).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x						x	
CO3	x			x				
CO4		x			x			
CO5						x	x	
CO6			x					x

Course Content and Outcomes

Content	Competencies	Number of Hours
UNIT 1: Image display		
• Image formation • Image processing • Pixel and voxel • Window level • Window width	• Explain the process of image formation and processing (C2). • Define pixel and voxel and their significances(C1). • Define window width and window level and their significances (C1).	3
UNIT 2: Image quality		
• Geometric shape & size • Resolution • Contrast • Sharpness • Noise • Factors affecting image quality	• Explain the various characteristics of CT image quality (C2). • Outline the effect of the various technical factors on CT image quality and also radiation dose (C2).	5
UNIT 3: Post Processing Techniques		
• **Principle of the various** - Multi Planar Imaging - Volume rendering - Surface rendering - Maximum Intensity Projection (MIP) - Minimum Intensity Projection (MinIP) - Curve Planar imaging - Fat assessment - Panoramic view - Virtual endoscopy - Virtual Colonoscopy	• Explain the principle and also the applications of the various post processing techniques (C2)	3
UNIT 4: CT Artefacts		
• Classification • Types • Causes • Remedies	• Define CT artefacts (C1). • Classify the CT artefacts (C2). • Explain the causes and remedy for CT artefacts (C2).	4
UNIT 5: Basic diagnostic aspects		
• Role of the CT technologist • Patient management • Patient preparations	• Outline the role of the CT technologist (C2). • Explain the various aspect on patient management and preparations before and after CT scan (C2).	3
UNIT 6: CT contrast media		
• Types • Dosage • Mode of administration • Contraindications • Contrast allergies protocol	• Define CT contrast media (C1). • Classify the types of CT contrast media (C2). • Explain the mode of administration of CT contrast media (C2). • List the contra –indication for usage of CT contrast media (C1).	5

Content	Competencies	Number of Hours
• Contrast media reactions and management	• Explain the various adverse reaction of Contrast media and also their management (C2). • Explain Contrast allergies protocol (C2).	
UNIT 7: CT guided procedures		
• Biopsy • FNAC • Drainage procedures • RF Ablation	• Explain the procedures indication, contraindication, preparation, equipment's, protocol, the advantages, disadvantages and complications protocol and also the advantages and disadvantages (C2).	5
UNIT 8: Radiation Dose in CT		
• CT Dosimetry • Factors affecting dose in CT	• Explain the various CTDI (C2). • Outline various factors affecting radiation dose in CT (C2). • Should have the knowledge to modify the technical factors to reduce radiation dose without degrading image quality (C6).	3
UNIT 9 : Dose Optimization techniques in Computed Tomography		
• Dose reduction techniques	• What is CT dose optimization (C1). • Explain the various techniques used to reduce the radiation dose without degrading the image quality (C2). • Explain Automatic tube current Modulation (C2).	3
UNIT 10: Safety consideration		
• Staff safety • Patient safety • Universal precautions	• Explain the techniques and principle for staff and patient safety (C2). • Explain Universal Precautions (C2).	3
Unit 11: Documentation		
• Documentation of patient information and final outcome	• Explain documentation of patient information's and outcome (C2).	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	3	6
Case Based Learning (CBL)	5	10
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**39**	**78**

Assessment Methods:							
Formative:		**Summative:**					
Unit Test		Mid Semester/Sessional Exam (Theory)					
Quiz		End Semester Exam (Theory)					
Viva		Viva					
Assignments/Presentations		-					
Mapping of Assessment with COs:							
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination		x	x	x	-	-	-
Quiz / Viva		-	-	-	x	x	x
Assignments/Presentations		-	x	x	x	x	
Clinical/Practical Log Book/ Record Book		-	-	-	-	-	-
Any others: WPBA		-	-	-	-	-	-
End Semester Exam		x	x	x	x	x	x
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	• Computed Tomography: Physical Principles, Clinical Applications, and Quality Control by Dr. Euclid Seeram.						
	• Christensen's Physics of Diagnostic Radiology Thomas curry, James E Dowdey, Robert C Murry.						
Additional References	• Essential Physics of Medical Imaging, Jerrold T Bushberg, J Antony Seibert, Edvin M Leidholdt.						

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Magnetic Resonance Imaging - II**
Course Code	**MIT3202**
Academic Year	Third
Semester	VI
Number of Credits	3
Course Prerequisite	Student should have basic Knowledge in Magnetic Resonance Imaging - I
Course Synopsis	1. This module provides knowledge of appearance, cause and remedy of different MRI artifacts. 2. This module provides details about different basic and advanced pulse sequences for clinical MR imaging. 3. This module provide insight into flow phenomena and their compensation techniques in clinical MR imaging. 4. This module explains respiratory gating, cardiac gating and vascular MR imaging techniques. 5. This model provides details about clinical MR imaging of different body parts.

Course Outcomes (Cos): **At the end of the course student shall be able to:**	
CO1	Utilize devices and equipment for MR imaging. (C3)
CO2	Plan image acquisition and acquire appropriate MR Images for diagnosis. (C6)
CO3	Identify MRI artefact and choose appropriate remedial measure in clinical practice. (C3)
CO4	Explain documentation for MRI examinations. (C2)
CO5	Explain advanced pulse sequences and fat saturation techniques. (C2)
CO6	Apply evidence-based practice to select MRI pulse sequences for clinical imaging. (C3)

Mapping of Course Outcomes (Cos) to Program Outcomes (Pos):

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4				x				
CO5	x							
CO6						x		

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Artifacts and their compensation	1.Define MRI artefact (C1) 2.Classify MRI artefacts (C2)	3

Content	Competencies	Number of Hours
	3.Explain appearance, cause and remedy of different MRI artefacts. (C2) 4.Identify MRI artefact and choose appropriate remedial measure in clinical practice. (C3)	
Unit 2: Spin echo sequences		
• Conventional spin echo • Fast spin echo • Inversion recovery ○ STIR ○ FLAIR • Advancements and acronyms	1.Explain mechanism, clinical application, parameters, advantages and disadvantages of conventional spin echo, and fast spin echo sequences. (C2) 2.Outline modifications, advancements, and acronyms of spin echo sequences. (C2) 3.Explain mechanism, clinical application, parameters, advantages and disadvantages of inversion recovery sequences. (C2) 4.Outline modifications, advancements and acronyms of inversion recovery sequences. (C2)	4
Unit 3: Gradient echo pulse sequences		
• Conventional gradient echo • The steady state • Coherent gradient echo • Incoherent gradient echo • SSFP • Balance gradient echo • Advancements and acronyms	1.Explain mechanism, clinical application, parameters, advantages, and disadvantages of conventional gradient echo sequence. (C2) 2.Outline steady state and echo formation. (C2) 3.Explain mechanism, clinical application, parameters, advantages and disadvantages of coherent gradient echo, incoherent gradient echo, steady state free precession, and balanced gradient echo sequences. (C2) 4.Outline modifications, advancements, and acronyms of gradient echo sequences. (C2)	4
Unit 4: Fast MRI sequences and techniques		
• K space filling in fast MRI sequences. • Centric k space filling • Keyhole filling • Single shot k space filling • Echo planar imaging • Spiral K space filling • Parallel imaging techniques	1.Illustrate fast MRI sequences and acquisition techniques including their clinical applications and limitations. (C2)	3
Unit 5: Flow phenomena		
• Introduction • The mechanisms of flow • Time of flight phenomenon • Entry slice phenomena • Intra- voxel dephasing	1.Define flow phenomena. (C1) 2.Outline mechanisms of flow. (C2) 3.Illustrate time of flight phenomena in spin echo and gradient echo pulse sequences. (C2) 4.Illustrate entry slice phenomenon. (C2) 5.Illustrate intra-voxel dephasing. (C2)	2

Content	Competencies	Number of Hours
Unit 6: Flow phenomena compensation		
• Introduction • Gradient moment nulling • Even echo rephasing • Spatial Pre saturation	1.Explain flow phenomena compensation techniques. (C2) **2.**Apply appropriate compensation technique for flow phenomena in clinical imaging. (C3)	**2**
Unit 7: Vascular imaging		
• Introduction • Conventional vascular imaging techniques ○ Black blood imaging ○ Bright blood imaging • MRA techniques ○ Digital subtraction MRA ○ TOF MRA ○ PC MRA ○ Contrast enhanced MRA • Advancements and acronyms	1.Contrast MR vascular imaging techniques in comparison to other imaging modalities. (C2) 2.Classify MR vascular imaging techniques. (C2) 3.Explain pulse sequence used, parameters, clinical application, advantages and disadvantages of different conventional vascular imaging techniques. (C2) 4.Illustrate digital subtraction MRA technique.(C2) 5.Explain mechanism, parameters, clinical application, advantages and disadvantages of TOF MRA. (C2) 6.Contrast 2D and 3D TOF MRA techniques.(C2) 7.Outline the techniques for overcoming the disadvantages of TOF MRA. (C2) 8.Explain MOTSA (C2) 9.Outline MRA image reformation. (C2) 10. Explain mechanism, parameters, clinical application, advantages and disadvantages of PC MRA. (C2) 11. Choose suitable velocity encoding and flow encoding axes for clinical imaging optimization. (C3) 12. Contrast 2D and 3D PC MRA techniques.(C2) 13. Illustrate velocity encoding technique. (C2) 14. Explain contrast enhanced MRA including pulse sequences, parameters, contrast media used, dosage of contrast media, injection method, scan timing, clinical application, advantages and disadvantages. (C2)	3
Unit 8:		
Respiratory and cardiac gating	1.Which are the types of respiratory gating. (C1) 2.Outline different types of cardiac gating techniques (C2) 3.Which are the types of cardiac gating techniques. (C1) 4.Outline different types of cardiac gating techniques. (C2)	1
Unit 9:		
Contrast agents in MRI	1.Outline the contrast agents in MRI. (C2) 2.Explain mechanism of action of contrast agents. (C2) 3.Classify contrast agents used for MRI. (C2)	1

Content	Competencies	Number of Hours
	4.Outline relaxivity of MR contrast. (C2) **5.**Explain T1 agents and T2 agents including their clinical application, administration techniques, dosage, and safety aspects. (C2)	
Unit 10:		
Advancements in MRI instrumentation	1.Outline recent advancements and developments in MRI instrumentation. (C2)	1
Unit 11:		
Diffusion imaging	1.Outline principle, mechanism, parameters and clinical applications of diffusion weighted imaging. (C2) 2.Illustrate diffusion trace images and ADC map and their significance. (C2) **3.**Explain DTI, DKI and other advancements including their clinical use. (C2)	2
Unit 12:		
Perfusion imaging	1.Illustrate principle, mechanism, parameters and clinical applications of perfusion imaging.(C2)	1
Unit 13:		
Spectroscopy	1.Illustrate principle, mechanism, parameters and clinical applications of different types of MRS. (C2)	1
Unit 14:		
Functional imaging	1.Outline functional MR imaging. (C2) 2.Illustrate principle, mechanism, parameters and clinical applications of BOLD Imaging. (C2)	1
Unit 15:		
Advanced pulse sequences and techniques	1.Explain advanced pulse sequences such as SWI, IDEAL, LAVA etc. (C2) 2.Explain different fat saturation techniques. (C2)	2
Unit 16:		
Clinical Imaging and image evaluation • Neuro MR imaging • Musculoskeletal MR imaging • Face and Neck MR imaging • Body MR imaging ○ Chest ○ Abdomen ○ Pelvis • Interventional MRI	1.List indication and patient condition for MR imaging. (C4) 2.Utilize devices and equipment for MR imaging. (C3) 3.Explain patient positioning and care before, during and after MRI examination. (C2) 4.Choose appropriate pulse sequences and scan parameters for MR imaging of different body parts and clinical conditions. (C5) 5.Plan image acquisition and acquire appropriate MR images for diagnosis. (C6) 6.Evaluate image and archive for diagnosis. **7.**Explain documentation for MRI examinations. (C2)	8

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	48
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	5	15
Problem Based Learning (PBL)	3	
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	3	**-**
Assessment	2	30
Total	**39**	**93**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Viva	Viva
Assignments/Presentations	Record Book
Clinical assessment (OSCE, OSPE, WBPA)	
Clinical/Practical Logbook/ Record Book	

Mapping of Assessment with Cos:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination	x	x	x	x		
Quiz / Viva					x	
Assignments/Presentations					x	x
Clinical/Practical Logbook/ Record Book		x				
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main References	1. Catherine Westbrook, Carolyn Kaut Roth, John Talbot (2011). MRI in practice, fourth edition. 2. Catherine Westbrook (2008). Handbook of MRI technique, 3rd edition
Additional References	1. Elmaoğlu, Muhammed, Çelik, Azim (2012). MRI handbook: MRI physics, patient positioning and protocols. 2. Gary Liney (2006). MRI in clinical practice 3. Michael L. Lipton, Emanuel Kanal (2008). Totally Accessible MRI

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Cross Sectional Anatomy In CT And MRI**
Course Code	**MIT3203**
Academic Year	Third
Semester	VI
Number of Credits	2
Course Prerequisite	Students should have basic Knowledge of Anatomy
Course Synopsis	1. This module provides knowledge on Anatomy of Human system. 2. To comprehend the radiological cross-sectional anatomy. 3. This module also provides knowledge on analysis and interpretation of images. 4. This module helps imaging technologists to get oriented with CT, MRI cross sectional anatomy to become skilled imaging technologists.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify and explain the anatomy in the axial, sagittal, coronal planes on CT and MR images (C1,C2)
CO2	Explain the anatomical structural relationships (C2)
CO3	Explain the arterial and venous anatomy of the entire body's vascular system (C2)
CO4	Illustrate the CT, MRI cross sectional anatomy (C2)
CO5	Explain normal anatomy and build a resource system for future study (C2)
CO6	Describe the various sections of anatomical regions and their associated parts (C2)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1		x						
CO2		x						
CO3		x						
CO4		x						
CO5	x							
CO6	x							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1		
Introduction	1. Recall the anatomy and terminology of sectional planes (C1, C2) 2. Outline the anatomical relationships/terminology (C1)	1

Content	Competencies	Number of Hours
Head and neck	1. Explain the cross sectional CT/MRI anatomy of skull and facial bones (C2) 2. Explain the cross sectional CT/MRI anatomy of Paranasal sinuses (C2) 3. Explain the Cross sectional CT/MRI anatomy of Salivary glands (C2) 4. Explain the cross sectional anatomy of CT/MRI anatomy of Ear (C2) 5. Explain the cross sectional CT/MRI anatomy of Larynx and Pharynx (C2) 6. Explain the cross sectional CT/MRI arterial and venous supply of head and neck (Circle of willis ,carotid supply) (C2)	5
Unit 2		
Central nervous and Peripheral nervous system	1. Explain the cross sectional CT/MRI anatomy of cerebral cortex (C2) 2. Explain the cross sectional CT/MRI anatomy of basal ganglia (C2) 3. Explain the cross sectional CT/MRI anatomy of Midbrain (C2) 4. Explain the cross sectional CT/MRI anatomy of Cerebellum (C2) 5. Explain the cross sectional CT/MRI anatomy of Pituitary gland (C2) 6. Explain the cross sectional MRI anatomy of cranial nerves (C2) 7. Explain the cross sectional MRI anatomy of Brachial plexus , Thoraco abdominal nerves, Lumbar and sacral plexus (C2)	8
Unit 3		
Spinal Column and its contents	**1.** Explain the cross sectional CT/MRI anatomy of Cervical, thoracic and lumbar Vertebrae (C2)	1
Unit 4		
Thorax	1. Explain the cross sectional CT/MRI anatomy of sternum (C2) 2. Explain the cross sectional CT/MRI anatomy of Bronchopulmonary segments (C2) 3. Explain the cross sectional CT/MRI anatomy of Heart and its blood supply(C2) **4.** Explain the cross sectional CT/MRI anatomy of pulmonary arteries and great vessels of thorax (C2**)**	4
Unit 5		
Abdomen	1. Explain the cross sectional CT/MRI anatomy of oesophagus and stomach (C2) 2. Explain the cross sectional CT/MRI anatomy of small and large intestine (C2) 3. Explain the cross sectional CT/MRI anatomy of liver segments (C2) 4. Explain the cross sectional CT/MRI anatomy of	4

Content	Competencies	Number of Hours
	Biliary system (C2) 5. Explain the cross sectional CT/MRI anatomy of pancreas and spleen (C2) 6. Explain the cross sectional CT/MRI anatomy of Portal venous system (C2) 7. Explain the cross sectional CT/MRI anatomy of Kidney Ureter and Bladder (C2) 8. Explain the cross sectional CT/MRI anatomy of Abdominal aorta and IVC (C2)	
Unit 6		
Pelvis	1. Explain the cross sectional CT/MRI anatomy of Bony Pelvis (C2) 2. Explain the cross sectional CT/MRI anatomy of prostate (C2) **3.** Explain the cross sectional CT/MRI anatomy of male and female reproductive system (C2)	2
Unit 7		
Upper limb	1. Explain the cross sectional CT/MRI anatomy of bones of upper limb (C2) 2. Explain the cross sectional CT/MRI anatomy of Joints of upper limb (C2) **3.** Explain the cross sectional CT/MRI arterial and venous supply of upper limb (C2)	2
Lower limb	1. Explain the cross sectional CT/MRI anatomy of bones of lower limb (C2) 2. Explain the cross sectional CT/MRI anatomy of Joints of lower limb (C2) **3.** Explain the cross sectional CT/MRI arterial and venous supply of lower limb (C2**)**	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**26**	**52**

Assessment Methods:							
Formative:		**Summative:**					
Unit Test		Mid Semester/Sessional Exam (Theory)					
Mapping of Assessment with COs:							
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Examination		x	x	x	x	x	x
Quiz / Viva							
Assignments/Presentations							
Clinical/Practical Log Book/ Record Book							
Any others: WPBA							
End Semester Exam							
Feedback Process:	Mid-Semester Feedback						
Main Reference:	1. Anatomy for Diagnostic Imaging – Stephen Ryan						

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Clinical Aspects of CT & MRI**
Course Code	**MIT3231**
Academic Year	3rd Year
Semester	VI
Number of Credits	6
Course Prerequisite	Student should have knowledge of Basic sciences and Clinical subjects including Radiation Protection, Patient Care, Ethics, Computed Tomography - I and MRI - I
Course Synopsis	• This module provides the students to understand in detail about the indications, contraindications, protocol selection, and parameter selection, post processing techniques, image batching, and display and archiving. • This module provides the CT scan protocol for Head, Neck, Thorax, Abdomen, Upper limb, Lower limb, and Angiography. • This module provides the details of practical aspects of instrumentation, clinical practices, and safety aspects of MRI. • This module explains the protocol and scanning techniques of different anatomical regions and modification of scanning protocol specific to indication, age group and patient condition.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Make use of CT & MRI Equipment, miscellaneous devices, and accessories for scanning patient effectively. (C3, P4, A3).
CO2	Follow practices of care and maintenance methods for CT & MRI.(P3)
CO3	Make use of learned instructions to prepare the patients for various CT & MRI Examinations. (C3, P4 A3).
CO4	Demonstrate the ability to communicate to the patient , Attendee , Nursing personnel , radiologists , referring physician and fellow technologists for effective patient care.(C2 ,P5, A4)
CO5	Select appropriate examination protocol and parameters specific to indications, age group , and patient condition to generate good quality images in MRI and low radiation dose in CT. (C5 , P4).
CO6	Identify and interpret the structures seen on the CT & MRI images and its artefacts. (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2	x	x						
CO3	x				x			
CO4			x		x			

CO5				x				
CO6	x						x	

Course Content and Outcomes:

Content	Competencies	Number of Hours
UNIT 1: Contrast Media in CT.		
• Oral contrast media • Rectal contrast media • Intravenous contrast media • Contrast Allergic protocol • Medication for contrast reactions	• Identify the types of contrast media used in CT (C3). • Explain various modes of administration of contrast media (C2). • Make use of learned instruction for the preparation of Contrast media (C3). • Explain the contraindications for contrast study (C2). • Explain Contrast Allergic protocol (C2). • Identify the medication for various contrast reactions (C3).	10
UNIT 2: Head		
• Brain Contrast study	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Relate the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C2, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identify the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Make use of post processing techniques, image batching, display and archiving (C3, P5) • Ultilize radiation protection techniques(C3, P2,A2) • Evaluate the image quality (C5)	15
UNIT 3: Neck		
• Soft Tissue	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3)	12

Content	Competencies	Number of Hours
	• Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	
UNIT 4: Thorax		
• Respiratory System • Ribs	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	15
UNIT 5: Abdomen and Pelvis		
• Hepatobiliary system • Gastrointestinal system • Urinary system • Female reproductive system • Male reproductive system	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the	20

Content	Competencies	Number of Hours
	examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	
UNIT 6: Musculoskeletal		
• Upper limb • Lower limb	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	15
UNIT 7: Spine		
• Cervical Spine • Thoracic spine • Lumbar Sacral spine	• Evaluate the requisition form and medical records (C6). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications(C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2).	15

Content	Competencies	Number of Hours
	• Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	
UNIT 8:Angiography		
• Cerebral • Neck • Pulmonary • Coronary • Abdominal • Renal • Aortogram • Upper limb • Lower limb	• Evaluate the requisition form and medical records (C5). • Explain the procedure for patient education (C2, P2, A2) • Explain the Indication and contraindications (C2) • Prepare the patient for CT examination (C3, P5). • Identify the region of interest to be scan (C1). • Demonstrate patient positioning for the examination (C3, P5, A3) • Planning of the examination by selecting appropriate protocol and parameters (C3, P5). • Identity the contrast media used for the examination (C3). • Explain the mode of contrast media administration (C2). • Choose contrast volume required for the examination (C3, P1). • Perform post processing techniques, image batching, display and archiving (C3, P5) • Employ radiation protection techniques (C3, P2, A2) • Evaluate the image quality (C5)	15
NIT 9		
Review of instrumentation and clinical practice in MRI	1. Explain features of given MRI machine. (C2) 2. Assess control of given MRI system. (C5) 3. Make use of available MRI accessories. (C3, P4) 4. Apply practices for care and maintenance of MRI. (P3) 5. Evaluate requisition form and medical record of patient referred for MRI examination. (C5) 6. Apply safety practices for patients and other individuals in MRI. (C3) 7. Demonstrate the ability to communicate patient, patient party, nursing staff, radiologist, referring physician and fellow technologist for patient care. (C2, A4) 8. Demonstrate the ability to schedule and prepare patient for MRI examination. (P4) 9. Create appropriate environment for paediatric patient. (C6, A4) 10. Discuss role of MRI technologist before, during	20

Content	Competencies	Number of Hours
	and after the MRI examination requiring sedation and anaesthesia. (C6) 11. Demonstrate the ability to monitor patient during MRI examination. (C2) 12. Adapt the techniques and procedures suitable for paediatric, old age and ill patients. (C6, P4) 13. Discuss safety approach during emergency situations in MRI. (C6)	
UNIT 10: Neuro MR Imaging		
• Brain • Spine • Paediatric imaging	1. Demonstrate understanding of cross-sectional anatomy of brain and spine. (C2) 2. Outline common indications and pathologies of brain and spine. (C2) 3. Select appropriate patient positioning and make use of accessory devices and /or equipment for MRI examination as and when required. (C3, P4) 4. Select appropriate pulse sequences, scan parameters, imaging plane and plan for image acquisition as per indication for the examination. (C5, P4) 5. Plan contrast media administration and post contrast image acquisition for neuro imaging. (C3, P4) 6. Select appropriate vascular imaging technique, scan parameters and plan for vascular imaging acquisition. (C3, P3) 7. Demonstrate ability to annotate, archive and print acquired images. (C2, P4)	27
UNIT 11: Musculoskeletal MR imaging		
Upper limb ○ Shoulder ○ Humerus ○ Elbow ○ Forearm ○ Wrist and hand • Lower limb ○ Hips ○ Thigh ○ Knee ○ Leg ○ Ankle ○ Foot • Vascular imaging • Paediatric imaging	1. Demonstrate understanding of cross sectional anatomy of extremities and joints. (C2) 2. Outline common indications and pathologies of extremities and joints. (C2) 3. Select appropriate patient positioning and make use of accessory devices for MRI examination. (C3, P4) 4. Select appropriate pulse sequences, scan parameters, imaging plane and plan for image acquisition as per indication for the examination. (C5, P4) 5. Plan contrast media administration and post contrast image acquisition for musculoskeletal MR imaging. (C3, P4) 6. Select appropriate vascular imaging technique, scan parameters and plan for vascular imaging acquisition. (C3, P3) 7. Demonstrate ability to archive and print acquired images. (C2, P4)	25
UNIT 12		

Content	Competencies	Number of Hours
Face and Neck MRI • Face ○ Orbits ○ Paranasal sinuses ○ Pharynx and larynx ○ TM joints • Neck ○ Thyroid and parathyroid glands ○ Salivary glands • Vascular imaging	1. Demonstrate understanding of cross-sectional anatomy of face and neck. (C2) 2. Outline common indications and pathologies of face and neck. (C2) 3. Select appropriate patient positioning and make use of accessory devices for MRI examination. (C3, P4) 4. Select appropriate pulse sequences, scan parameters, imaging plane and plan for image acquisition as per indication for the examination. (C5, P4) 5. Plan contrast media administration and post contrast image acquisition for face and neck MR imaging. (C3, P4) 6. Select appropriate vascular imaging technique, scan parameters and plan for vascular imaging acquisition. (C3, P4) 7. Demonstrate ability to archive and print acquired images. (C2, P4)	10
UNIT 13		
Chest MRI • Lungs and mediastinum • Heart and great vessels • Thymus • Breast • Axilla • Brachial plexus • Paediatric imaging	1. Demonstrate understanding of cross-sectional anatomy. (C2) 2. Outline common indications and pathologies. (C2) 3. Select appropriate patient positioning and make use of accessory devices and / or equipment for MRI examination. (C3, P4) 4. Select appropriate pulse sequences, scan parameters, imaging plane and plan for image acquisition as per indication for the examination. (C5. P4) 5. Plan contrast media administration and post contrast image acquisition for MR imaging. (C3, P4) 6. Select appropriate vascular imaging technique, scan parameters and plan for vascular imaging acquisition. (C3, P3) 7. Demonstrate ability to annotate, archive and print acquired images. (C2, P4)	15
UNIT 14: MRI abdomen and pelvis		
• Abdomen ○ Liver and biliary system ○ Kidneys and adrenal glands ○ Pancreas • Pelvis ○ Male pelvis ○ Female pelvis ○ Obstetrics	1. Demonstrate understanding of cross-sectional anatomy of abdomen and pelvis (Male and Female). (C2) 2. Outline common indications and pathologies of abdomen and pelvis (Male and Female). (C2) 3. Select appropriate patient positioning and make use of accessory devices and /or equipment for MRI examination as and when required. (C3, P4) 4. Select appropriate pulse sequences, scan	20

Content	Competencies	Number of Hours
• Vascular imaging • Paediatric imaging	parameters, imaging plane and plan for image acquisition as per indication for the examination. (C5, P4) 5. Plan contrast media administration and post contrast image acquisition for abdomen and pelvis (Male and Female) MRI. (C3, P4) 6. Select appropriate vascular imaging technique, scan parameters and plan for vascular imaging acquisition. (C3, P3) 7. Demonstrate the ability to archive and print acquired images. (C2, P4)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	-	-
Seminar	-	-
Small group discussion (SGD)	-	-
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	234	200
Practical	-	-
Revision	-	-
Assessment	-	-
Total	**234**	**200**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Practical)
Quiz	End Semester Exam (Practical)
Viva	Viva
Clinical assessment (OSCE, OSPE, WBPA)	Record Book
Clinical/Practical Logbook/ Record Book	-

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester Exam	x	x	x	x	x	x
Quiz / Viva	-	-	-	-	-	-
Assignments/Presentations	-	-	x	-	-	-
Clinical Record Book	-	-	x	x	x	
Any others: WPBA	-	-	-	-	-	-
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Computed Tomography: Physical Principles, Clinical Applications, and Quality Control by Dr. Euclid Seeram. • Christensen's Physics Of Diagnostic Radiology Thomas curry, James E Dowdey , Robert C Murry • Catherine Westbrook (2008). Handbook of MRI technique, 3rd edition. • Elmaoğlu**, Muhammed,** Çelik**, Azim (2012). MRI handbook: MRI physics, patient positioning, and protocols.**
Additional References	• Essential Physics of Medical Imaging, Jerrold T Bushberg, J Antony Seibert, Edvin M Leidholdt • Gary Liney (2006). MRI in clinical practice • Michael L. Lipton, Emanuel Kanal (2008). Totally Acessible MRI

Manipal College of Health Professions	
Name of the Department	Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Quality Assurances in Diagnostic Equipment's**
Course Code	**MIT3241**
Academic Year	Third year
Semester	VI
Number of Credits	3
Course Prerequisite	Basic knowledge of all diagnostic imaging equipment's
Course Synopsis	• This module provides fundamental knowledge about the objectives of quality control and knowledge about quality assurance activities. • To provide fundamental knowledge about various quality assurance tests for various types of diagnostic equipment's and also the care and maintenance of diagnostic equipment's.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Define and describe the objectives of quality assurance (C1)
CO2	Explain the activities involved in quality assurance (C2)
CO3	Classify the various quality assurance tests (C2)
CO4	Illustrate the equipment and the components used for the quality assurance tests (C2)
CO5	Apply quality control procedures for all diagnostic equipment's (C3)
CO6	Analyse and compare the results of quality assurance tests (C5)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x							
CO2	x							
CO3	x							
CO4	x	x						
CO5		x				x		
CO6						x	x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction	1. Define quality assurance test (C1) 2. Explain quality management system(QMS),quality assurance(QA) and quality control (QC) (C2) 3. Explain frequency of QA test performed (C1) 4. Describe daily/weekly/monthly QC procedures (C1)	2

Content	Competencies	Number of Hours
	5. Outline the rules and regulation for quality assurance (C2) 6. Illustrate the documentation process in QA (C2)	
Unit 2:		
Quality assurance activities Equipment selection phase Equipment installation Acceptance phase Operational phase Preventive maintenance	1. Explain the steps involved in equipment selection process (C2) 2. Explain the installation process (C2) 3. Illustrate the acceptance test (C2) 4. Classify the operational phases(C2) 5. Outline the preventive measures taken (C2)	1
Unit 3: QA programme test of Radiography / Digital Radiography/Fluoroscopy/Intervention radiology		
1. Congruence of radiation and optical field 2. Central Beam Alignment 3. Effective focal spot measurement FFD= 60 cm 4. Accuracy of Operating Potential (kV) 5. Accuracy of Irradiation Time(sec.) 6. Total filtration\ 7. Linearity of mA/mAs loading Stations 8. Consistency of radiation Output 9. Low contrast resolution 10 High contrast resolution 11 Exposure Rate at Table top 12 Radiation leakage level at 1m from tube housing and Collimator Additional test for DR Image Quality 1. Threshold Contrast Detail Detectability (TCDD) 2. Image Noise	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Illustrate daily/weekly/monthly QC procedures (C2) 4. Apply the knowledge of radiographic imaging to the production of radiographs and the assessment of quality (C3) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 6. Illustrate various QA tests performed (C2) 7. Outline the documentation process for each test result (C2) 8. Make use of available documents of QA report (C3) 9. Compare the test result with pre-set standards (C4) 10. Analyse the test result (C4) 11. Interpret and justify the QA test result (C5) 12. Explain various care and maintenance steps (C2) 13. Explain steps involved in routine cleaning of equipment's (C2) 14. Outline the record and log book maintenance process (C2) 15. Develop an SOP (C3)	9

Content	Competencies	Number of Hours
3. Signal to Noise Ratio (SNR) and Contrast to Noise Ratio 4. (CNR) 5. Limiting (spatial) Resolution/Resolution Uniformity 6. Spatial Accuracy/ Spatial Linearity/ Laser Beam Function 7. Automatic Exposure Control (AEC) Detectors Performance 1. Linearity 2. Dose Efficiency 3. Uniformity		
Unit 4: QA programme test of Mammography		
1. Accuracy of Operating Potential 2. Accuracy of Timer 3. Linearity of tube current 4. Reproducibility of output 5. Radiation Leakage level from X Ray tube housing kV &mA 6. Total Filtration 7. Measurement at maximum kV 8. Performance of imaging phantom	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Illustrate daily/weekly/monthly QC procedures (C2) 4. Apply the knowledge of radiographic imaging to the production of radiographs and the assessment of quality (C3) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 3. Illustrate various QA tests performed (C2) 4. Outline the documentation process for each test result (C2) 5. Make use of available documents of QA report (C3) 6. Compare the test result with pre-set standards (C4) 7. Analyse the test result (C4) 8. Interpret and justify the QA test result (C5) 9. Explain various care and maintenance steps (C2) 10. Explain steps involved in routine cleaning of equipment's (C2) 11. Outline the record and log book maintenance process (C2) 12. Develop an SOP (C3)	4
Unit 5: QA programme test of Dental X-ray		
1. Accuracy of operating potential/accuracy of timer 2. Linearity of ma loading station	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Illustrate daily/weekly/monthly QC procedures (C2) 4. Apply the knowledge of radiographic imaging to the production of radiographs and the	4

Content	Competencies	Number of Hours
3. Minimum total filtration 4. Reproducibility of radiation output 5. Tube housing leakage Additional test for CBCT 1. Low Contrast Sensitivity 2. High Contrast Sensitivity 3. CT dose index ($CTDI_W$) (*If manufacture specify $CTDI_W$ value then perform this test)	assessment of quality (C3) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 6. Illustrate various QA tests performed (C2) 7. Outline the documentation process for each test result (C2) 8. Make use of available documents of QA report (C3) 9. Compare the test result with pre-set standards (C4) 10. Analyse the test result (C4) 11. Interpret and justify the QA test result (C5) 12. Explain various care and maintenance steps (C2) 13. Explain steps involved in routine cleaning of equipment's (C2) 14. Outline the record and log book maintenance process (C2) 15. Develop an SOP (C3)	
Unit 6: QA programme test of Computed Tomography		
1. Average computed tomography number of water 2. Standard deviation of computed tomography number in water 3. High contrast resolution 4. Low contrast resolution 5. Accuracy of distance measuring device 6. Uniformity of computed tomography number 7. Hard copy output 8. Accuracy of localization device 9. Bed index 10. Bed backlash 11. Light field accuracy 12. Slice width (Nonspiral/Nonhelical scanner) 13. Pitch and slice width 14. Computed tomography number versus patient position 15. Computed tomography number versus patient size	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Describe the types of phantoms used (C1) 4. Illustrate daily/weekly/monthly QC procedures (C2) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 6. Illustrate various QA tests performed (C2) 7. Outline the documentation process for each test result (C2) 8. Make use of available documents of QA report (C3) 9. Compare the test result with pre-set standards (C4) 10. Analyse the test result (C4) 11. Interpret and justify the QA test result (C5) 12. Explain various care and maintenance steps (C2) 13. Explain steps involved in routine cleaning of equipment's (C2) 14. Outline the record and log book maintenance process (C2) 15. Develop an SOP (C3)	6

Content	Competencies	Number of Hours
16. Computed tomography number versus algorithm 17. Computed tomography number versus slice width 18. Noise characteristics 19. Radiation scatter and leakage		
Unit 7: QA programme test of Ultrasonography		
1. Transducer choice 2. System Sensitivity(Depth of penetration/ visualization) 3. Photography and gray scale hard copy 4. Scan image uniformity 5. Distance measurement accuracy 6. Spatial Resolution Tests: - Axial resolution - Lateral resolution - Slice thickness	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Describe the types of phantoms used (C1) 4. Illustrate daily/weekly/monthly QC procedures (C2) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 6. Illustrate various QA tests performed (C2) 7. Outline the documentation process for each test result (C2) 8. Make use of available documents of QA report (C3) 9. Compare the test result with pre-set standards (C4) 10. Analyse the test result (C4) 11. Interpret and justify the QA test result (C5) 12. Explain various care and maintenance steps (C2) 13. Explain steps involved in routine cleaning of equipment's (C2) 14. Outline the record and log book maintenance process (C2) 15. Develop an SOP (C3)	5
Unit 8: QA programme test of Magnetic resonance imaging		
1. Visual Checklist 2. Geometric accuracy measurement 3. Uniformity 4. Linearity and distortion 5. High contrast spatial resolution 6. Slice parameters - Slice Thickness - Slice position - Slice separation 7. Signal to noise ration 8. Contrast to noise ratio 9. Percent-signal ghosting 10. Low contrast object	1. Classify the various QA test (C2) 2. List the equipment's used for QA (C1) 3. Describe the types of phantoms used (C1) 4. Illustrate daily/weekly/monthly QC procedures (C2) 5. Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3) 7. Illustrate various QA tests performed (C2) 8. Outline the documentation process for each test result (C2) 9. Make use of available documents of QA report (C3) 10. Compare the test result with pre-set standards (C4)	6

Content	Competencies	Number of Hours
detectability 11. Centre frequency	11. Analyse the test result (C4) 12. Interpret and justify the QA test result (C5) 13. Explain various care and maintenance steps (C2) 14. Explain steps involved in routine cleaning of equipment's (C2) 15. Outline the record and log book maintenance process (C2) 16. Develop an SOP (C3)	
Unit 9: Quality assurance of film and image recording devices		
1. checking cassette for poor film- screen contact 2. Testing cassette for light leakage 3. Relative speed test - Film - Screens - Film-Screen combinations 4. Laser printer calibration	1. Classify the test performed for films and recording devices (C2) 2. Describe the test tools used for QA (C1) 3. Illustrate the various QA tests performed (C2) 4. Outline the documentation process for each test result (C2) 5. Compare the test result with pre-set standards (C4) 6. Analyse the test result (C4) 7. Interpret and justify the QA test result (C5) 8. Explain various care and maintenance steps (C2) 9. Explain steps involved in routine cleaning of equipment's (C2) 10. Illustrate daily/weekly/monthly/quarterly/annual maintenance program (C2) 11. Outline the record and log book maintenance process (C2) 12. Develop an SOP (C3)	**2**

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	4	8
Self-directed learning (SDL)	2	4
Problem Based Learning (PBL)	-	-
Case Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	7	14
Total	**39**	**78**
Assessment Methods:		
Formative:	**Summative:**	

Unit Test	Mid Semester/Sessional Exam (Theory)
Quiz	End Semester Exam (Theory)
Viva	Viva
Assignments/Presentations	Record Book

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x	x	x		
Sessional Examination 2						
Quiz / Viva	x	x	x	x	x	x
Assignments/Presentations	x	x	x	x	x	x
Clinical/Practical Log Book/ Record Book						
Any others: WPBA						
End Semester Exam	x	x	x	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Stewart C.Bhushong Radiologic science for Technology 2. John Ball Chesney's Radiographic Imaging 3. James A. Zagzebski. (1996)Essentials of ultrasound physics 4. Euclid Seeram (2016) Computed tomography Physical principle, Clinical application and Quality control. 5. Donald W. McRobbie (2006) MRI From Picture to Proton
Additional References	1. AERB Guidelines 2. Aikaterini-Lampro N. Digital Radiographic Systems Quality Control Procedures

Manipal College of Health Professions	
Name of the Department	Department of Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Basics In Nuclear Medicine Technology**
Course Code	**MIT3242**
Academic Year	Third
Semester	VI
Number of Credits	3
Course Prerequisite	Basic knowledge of Atomic and Nuclear Physics
Course Synopsis	1. This module helps to understand the basic physics underpinning Nuclear and imaging science 2. To understand the mechanisms describing production and interactions of ionizing radiation 3. To discuss the component and working principle of equipment used for the diagnostic and therapeutic procedure in Nuclear Imaging 4. To apply radiation Protective measures for patients and Imaging Personnel.

curse Outcomes (COs): At the end of the course student shall be able to:	
CO1	Describe the basics of Nuclear Medicine Physics and the Formation of Radionuclide. (C1)
CO2	Discuss Components and working principles of various types of equipment used for nuclear Imaging in healthcare. (C2)
CO3	To provide an outline about the Transport of radioactive materials, waste management in nuclear medicine laboratory and management of nuclear event causalities in the Nuclear Medicine Department (C3)

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x					x		
CO2		x					x	
CO3	x	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1		
Basics of nuclear medicine physics	1. Define the atomic structure. (C1) 2. Define Radioactivity(C1) 3. Explain the types of radioactivity(C2) 4. List the modes of radioactive decay(C2) 5. Define the properties of alpha, beta and gamma rays(C1) 6. Explain different modes of radioactive decay(C2)	4
Unit 2		
Interaction of radiation with matter	1. Define Excitation and ionization (C1) 2. What is the interaction of X-ray with the matter?(C1)	2

Content	Competencies	Number of Hours
	3. Explain the following (C2) - Photoelectric effect - Compton scattering - Pair production - Photodisintegration - Annihilation reaction 4. Identify the effect of Interactions Between radiation and matter in nuclear medicine(C3)	
Unit 3		
Production of radionuclides	1. Define basic types of equipment that are used to make medical nuclides(C1) 2. Explain • Reactor produced radionuclide • Accelerated produced radionuclide • The generator produced radionuclide (C2). 3. What are the Radionuclides for Nuclear medicine (C1) **4.** List out different Radiopharmaceuticals for Nuclear medicine (C1)	3
Unit 4		
Non-scintillation detectors	1. Define Non-scintillation detectors (C1) 2. List the basic types of Non-scintillation detectors (C1). 3. Explain the working principle of the following - Ionization chambers, - Proportional counters - Geiger counters (C2).	2
Unit 5		
Scintillation Detectors	1. Define scintillation detectors (C1) 2. List the basic types of scintillation detectors (C2). 3. Explain the Thyroid probe and well counter (C2).	2
Unit 6		
Imaging Instrumentation: Gamma camera	1. Define Gamma camera (C1) 2. Explain the components of a Gamma camera (C2). 3. Explain the working principle of the Gamma camera (C2).	2
Unit 7		
Single-photon emission computed tomography	1. Define Single-photon emission computed tomography (C1) 2. Explain the components of Single-photon emission computed tomography (C2). 3. Explain the working principle of Single-photon emission computed tomography (C2)	2
Unit 8		
Positron emission tomography	1. Define Positron emission tomography (C1) 2. Explain the component Positron emission tomography (C2). 3. Explain the working principle of Positron emission computed tomography (C2)	2

Content	Competencies	Number of Hours
Unit 9		
Hybrid Imaging Systems	1. Define Hybrid Imaging Systems (C1) 2. Explain the working principle of PET-CT and its application(C2) 3. Explain the working principle of SPECT-CT and its application (C2).	2
Unit 10		
Radiation safety in nuclear medicine	1. Define Radiation safety in nuclear medicine (C1) 2. Explain the Radiation safety measures in nuclear medicine (C2)	3
Unit 11		
Planning of Nuclear medicine laboratories	1. List out the components required for Nuclear medicine laboratories (C1). 2. outline the layout of Nuclear medicine laboratories (C2)	3
Unit 12		
Radiation hazards evaluation and control in Nuclear medicine laboratories	1. Define radiation hazards in Nuclear medicine laboratories (C1). 2. Classify the types of radiation hazards in Nuclear medicine laboratories(External and Internal Radiation hazards) (C2) 3. Explain the evaluation and control of Nuclear medicine laboratories (C2)	3
Unit 13		
Transport of radioactive material	1. List out various methods used for the Transport of radioactive materials-(C1). 2. Outline the hazards associated with the Transport of radioactive material (C2).	2
Unit 14		
Radioactive waste management in nuclear medicine laboratory	1. Radioactive waste management in nuclear medicine laboratory (C1). 2. Classify the Radioactive waste in nuclear medicine laboratory(C2) 3. Explain the different methods for the disposal of Radioactive waste (C2) 4. Outline the basic guidelines for disposal of Radioactive waste (C2)	2
Unit 14		
Nuclear Imaging of Skeletal System, Urinary Tract, Thyroid, Parathyroid, and Adrenal Gland Imaging	1. Define the Nuclear Imaging of Skeletal System, Urinary Tract, Thyroid, Parathyroid, and Adrenal Gland Imaging (C1). 2. Explain the Nuclear Imaging of (C2) - Urinary Tract, - Skeletal System, - Thyroid, - Parathyroid, - Adrenal Gland	5

Learning Strategies, Contact Hours, and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	26	52
Seminar	-	-
Small group discussion (SGD)	5	10
Self-directed learning (SDL)	-	-
Problem Based Learning (PBL)	-	-
Case-Based Learning (CBL)	-	-
Clinic	-	-
Practical	-	-
Revision	-	-
Assessment	8	16
Total	**39**	**78**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester Exam (Theory)
	End Semester Exam (Theory)
Assignments/Presentations	

Mapping of Assessment with COs:			
Nature of Assessment	**CO1**	**CO2**	**CO3**
Mid Semester / Sessional Examination 1	x	x	
Sessional Examination 2			
Quiz / Viva			
Assignments/Presentations	x	x	x
Clinical/Practical Log Book/ Record Book			
Any others: WPBA			
End Semester Exam	x	x	x

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Rachel A. Powsner, Matthew R. Palmer, and Edward R. Powsner(2013).Essentials of Nuclear Medicine Physics and Instrumentation, 3rd ed. John Wiley and Sons. • Wernick MN, Aarsvold JN(2004). Emission Tomography: The Fundamentals of PET and SPECT. London: Elsevier.
Additional References	• Bushberg, J. T. (2002). The essential physics of Medical Imaging. Philadelphia: Lippincott Williams & Wilkins. • Cherry SR, Sorenson JA, Phelps ME(2012). Physics of Nuclear Medicine, 4th edn. Saunders • Knoll GF(2000). Radiation Detection and Measurement, 3rd edn. Hoboken, NJ: John Wiley and Sons.

INTERNSHIP

(VII and VIII Semester)

Manipal College of Health Professions	
Name of the Department	Department of Medical Imaging Technology
Name of the Program	Bachelor of Science in Medical Imaging Technology
Course Title	**Internship**
Academic Year	**Fourth**
Semester	VII & VIII
Number of Credits	Duration (1 year; 48 hours / week)
Course Prerequisite	Students should have knowledge of basic science subjects, Medical Imaging Instrumentation and physics, Radiation Safety, Medical Imaging Procedures, general hospital practice and patient care
Course Synopsis	This course will give training and confidence for the trainees to prepare as well as to safely handle radiopharmaceuticals, perform various Nuclear Medicine diagnostics and therapeutic procedures, perform various quality control procedures, record keeping and stock inventory.

Course Outcomes (COs):
At the end of the course student shall be able to:

CO1	Perform various quality control checks of equipment and address trouble shooting (C3, P4)
CO2	Perform various Medical Imaging procedures (C3, P5, A2)
CO3	Practice radiation safety for self, patient and patient attendees (C3, P6).
CO4	Maintain record keeping and learn the importance of effective communication, team work, ethical values and professionalism (C3, A4)
CO5	Display leadership and mentorship skills to practice independently as well as in collaboration with the interdisciplinary health care team (C3, A3).

Mapping of Course Outcomes (COs) to Program Outcomes (POs):

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	x	x						
CO2			x				x	
CO3		x				x		
CO4				x	x			
CO5							x	x

Course Content and Outcomes:

Content	**Competencies**

Area 1: Radiography

1. To prepare imaging room for the daily activities (P2)
2. To carry out daily QC of imaging and other accessory devices (C3, P4)
3. To assist in taking required patient history for the procedure (P5, A3)
4. To prepare the patient for the procedure (P5, A4)
5. To perform scans and processing techniques (C3, P5, A2)
6. To detect issues related to poor image quality (C5)
7. To operate the radiographic equipment (C3, P6)
8. To practice radiation protection to self, patients and the patients attendees (C3, P6)
9. To demonstrate leadership and mentorship skills (C3, A3)
10. To practise Record keeping and Documentation (C3)

Area 2: Fluoroscopy
1. To prepare imaging room for the daily activities (P2) 2. To carry out daily QC of imaging and other accessory devices (C3, P4) 3. To assist in taking required patient history for the procedure (P5, A3) 4. To prepare the patient for the procedure (P5, A4) 5. To perform scans and processing techniques (C3, P5, A2) 6. To detect issues related to poor image quality (C5) 7. To operate the fluoroscopic equipment (C3, P6) 8. To practice radiation protection to self, patients and the patients attendees (C3, P6) 9. To demonstrate leadership and mentorship skills (C3, A3) 10. To practise Record keeping and Documentation (C3)
Area 3: Computed Tomography
1. To prepare imaging room for the daily activities (P2) 2. To carry out daily QC of imaging and other accessory devices (C3, P4) 3. To assist in taking required patient history for the procedure (P5, A3) 4. To prepare the patient for the procedure (P5, A4) 5. To perform scans and processing techniques (C3, P5, A2) 6. To detect issues related to poor image quality (C5) 7. To operate the computed tomography equipment (C3, P6) 8. To practice radiation protection to self, patients and the patients attendees (C3, P6) 9. To demonstrate leadership and mentorship skills (C3, A3) 10. To practise Record keeping and Documentation (C3)
Area 4: Magnetic Resonance Imaging
1. To prepare imaging room for the daily activities (P2) 2. To carry out daily QC of imaging and other accessory devices (C3, P4) 3. To assist in taking required patient history for the procedure (P5, A3) 4. To prepare the patient for the procedure (P5, A4) 5. To perform scans and processing techniques (C3, P5, A2) 6. To detect issues related to poor image quality (C5) 7. To operate the MRI equipment (C3, P6) 8. To practice MRI safety to self, patients and the patients attendees (C3, P6) 9. To demonstrate leadership and mentorship skills (C3, A3) 10. To practise Record keeping and Documentation (C3)
Area 5: Mammography
1. To prepare imaging room for the daily activities (P2) 2. To carry out daily QC of imaging and other accessory devices (C3, P4) 3. To assist in taking required patient history for the procedure (P5, A3) 4. To prepare the patient for the procedure (P5, A4) 5. To perform scans and processing techniques (C3, P5, A2) 6. To detect issues related to poor image quality (C5) 7. To operate the radiographic equipment (C3, P6) 8. To practice radiation protection to self, patients and the patients attendees (C3, P6) 9. To demonstrate leadership and mentorship skills (C3, A3) 10. To practise Record keeping and Documentation (C3)
Area 6: Dental Radiography
1. To prepare imaging room for the daily activities (P2) 2. To carry out daily QC of imaging and other accessory devices (C3, P4) 3. To assist in taking required patient history for the procedure (P5, A3) 4. To prepare the patient for the procedure (P5, A4) 5. To perform scans and processing techniques (C3, P5, A2) 6. To detect issues related to poor image quality (C5)

7. To operate the radiographic equipment (C3, P6) 8. To practice radiation protection to self, patients and the patients attendees (C3, P6) 9. To demonstrate leadership and mentorship skills (C3, A3) 10. To practise Record keeping and Documentation (C3)
Area 7: Nuclear Medicine
1. To set imaging room for daily activities (P2) 2. To practice and evaluate daily QC of imaging and other accessory devices (C3, A3) 3. To take required patient history for the procedure (C2) 4. To express procedures to patient and to practice as per regulatory guidelines (C2) 5. To perform scans and processing techniques (C3, P5, A2) 6. To practise Record keeping and Documentation (C3)
Learning Strategies: Small group discussion (SGD), Case Based Learning (CBL), Clinics.
Formative Assessment: Clinical assessment (OSCE, OSPE, WBPA), Clinical Log Book Interns will be evaluated periodically i.e. in every quarter of 12 months and aggregate marks of all assessments will be used to issue internship completion certificate.

7. Mapping of program outcomes and course learning outcomes

Sem	Course Coode	Credits	Course Title	Program outcomes							
				PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
I	ANA1101	3	Anatomy - I	CO1 CO2	-	-	-	-	-	-	-
I	PHY1101	2	Physiology - I	CO1 CO2 CO3 CO4	-	-	-	-	-	-	-
I	EIC1001	2	Environmental science	CO1 CO2 CO3	-	CO4 CO5	CO2	-	CO1 CO3 CO5	CO4	-
			Indian Constitution	CO1	-	CO3	CO2 CO5	CO2	CO4	CO1 CO3 CO5	C04
I	CSK1001	2	Communication skills	-	CO3	CO4	-	C01 CO2	-	CO1 CO2 CO3 CO4	-
I	MIT1101	3	Radiation physics	CO1 CO2	CO2 CO3	-	-	-	CO1	CO3	-
I	MIT1102	3	Radiographic positioning and techniques	CO1 CO3 CO5	CO2 CO3 CO4	-	CO2	-	CO4	-	-
I	MIT1103	2	Image evaluation and interpretation - I	CO1 CO2 CO3 CO4 CO5	CO2 CO3 CO5	-	-	-	-	-	-
I	MIT1131	3	Clinical aspect of radiographic positioning and techniques - I	CO1 CO4	CO2 CO3 CO5 CO6	CO6	CO1 CO2	-	CO3 CO5	-	-
II	ANA1201	2	Anatomy - II	CO1	-	-	-	-	-	-	-
II	PHY1201	2	Physiology - II	CO1 CO2 CO3 CO4	-	-	-	-	-	-	-
II	BIC1201	3	Biochemistry	CO1 CO2 CO3 CO4	-	-	-	-	-	-	-
II	MIT1201	3	Radiographic positioning and techniques - II	CO1 CO3 CO5	CO2 CO3 CO4	-	CO2	-	CO4	-	-
II	MIT1202	3	Digital Imaging & image processing methods in radiography	CO1 CO2 CO3 CO4 CO5 CO6	-	-	-	-	-	-	-

Sem	Course Coode	Credits	Course Title	Program outcomes							
				PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
II	MIT1203	2	Image evaluation and interpretation of radiography - II	CO1 CO2 CO3 CO4 CO5	CO2 CO3 CO4 CO5	-	-	-	-	-	-
II	MIT1231	5	Clinical aspect of radiographic positioning and techniques - II	CO1 CO4	CO2 CO3 CO5 C06	CO6	CO1 CO2	-	CO3 CO5	-	-
III	PAT2103	3	Pathology	CO1 CO2 CO3 CO4	CO3 CO4	-	-	-	-	-	-
III	MCB2101	2	Microbiology	CO1 CO2 CO3 CO4	CO4	-	-	-	-	-	-
III	SUR4101	3	General surgery	CO1 CO2 CO3 CO4	-	-	-	-	-	-	-
III	MIT2101	2	Orthopaedics in Radiology	CO1 CO2 CO3 CO4 CO5	CO2 CO3 CO4 CO5	-	-	-	-	-	-
III	MIT2102	4	Radiographic special procedure	CO1 CO2 CO3 CO4 CO5 CO6	-	-	-	-	CO1 CO2 CO3 CO4 CO5 CO6	-	-
III	MIT2131	3	Clinical aspect of radiographic special procedures	CO1 CO2 CO3 CO6	CO1 CO2 CO4 CO5 CO6	-	CO3 CO5	CO4	-	-	-
III	*** ****	3	*Open elective is credited, choice-based and is graded as satisfactory / not satisfactory (S/NS). Students make a choice from pool of electives offered by MAHE institution / Online courses as approved by the department*								
IV	PHC2203	3	Pharmacology	CO1 CO2 CO3 CO4	-	-	-	-	-	-	-
IV	GPY2201	2	General Psychology	CO1	-	-	-	-	CO2 CO3	CO1 CO2 CO3	-
IV	MED3201	3	General Medicine	CO1 CO2 CO3	-	-	-	-	-	-	-
IV	MIT2201	4	Radiation safety in Radio-diagnosis	CO1 CO2 CO3	CO1 CO4 CO6	-	-	-	-	CO5 CO6	-

Sem	Course Coode	Credits	Course Title	Program outcomes							
				PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
				CO4 CO5							
IV	MIT2231	5	Clinical aspect of radiography and fluoroscopy	CO1 CO4	CO2 CO3 CO5 CO6	CO1 CO4	-	CO2 CO5	CO3 CO6	-	-
IV	MIT2241	3	Advanced image guiding procedures	CO1 CO3	CO1 CO2 CO3 CO4 CO5	-	-	-	-	-	-
IV	MIT2242	3	Imaging informatics	CO1 CO3	-	CO2 CO6	-	CO4	-	CO5	-
V	MIT3101	3	Physics of Ultrasound	CO1 CO2 CO3	CO2 CO3	-	-	-	-	-	-
V	MIT3102	2	Computed Tomography - I	CO1 CO2 CO3 CO4 CO5	CO5	-	-	-	-	CO2 CO3 CO4	-
V	MIT3103	2	Magnetic Resonance Imaging - I	CO1 CO5	CO2 CO3	-	CO6	CO4	-	-	-
V	MIT3104	3	Specialized imaging modalities	CO1 CO2 CO4	CO1 CO3	-	-	-	CO2 CO3 CO4	-	-
V	MIT3105	2	Patient care and ethics in Radio-diagnosis	CO1 CO3 CO5 CO6	CO1 CO2 CO3 CO4	-	CO4 CO5	CO2	-	CO6	-
V	MIT3131	5	Clinical aspect of specialized imaging modalities	CO1 CO4	CO2 CO3 CO5 CO6	CO4 CO6	CO1 CO2	-	CO3 CO5	-	-
V	*** ****	3	*Open elective is credited, choice-based and is graded as satisfactory / not satisfactory (S/NS). Students make a choice from pool of electives offered by MAHE institution / Online courses as approved by the department*								
VI	BST3201	3	Biostatistics and Research Methodology	CO1 CO2 CO3 CO5 CO6	CO4	-	-	-	-	-	-
VI	MIT3201	3	Computed tomography-II	CO1 CO2 CO3	CO4	CO6	CO3	CO4	CO5	CO2 CO5	CO6
VI	MIT3202	3	Magnetic Resonance Imaging- II	CO1 CO5	CO2 CO3	-	CO4	-	CO6	-	-
VI	MIT3203	2	Cross sectional anatomy in CT & MRI	CO5 CO6	CO1 CO2 CO3 CO4	-	-	-	-	-	-

Sem	Course Coode	Credits	Course Title	Program outcomes							
				PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
VI	MIT3231	6	Clinical aspects of CT & MRI	CO1 CO2 CO3 CO6	CO1 CO2	CO4	CO5	CO3 CO4	-	CO6	-
VI	MIT3241	3	Quality assurance in diagnostic equipment's	CO1 CO2 CO3 CO4	CO4 CO5	-	-	-	CO5 CO6	C06	-
VI	MIT3242	3	Basics in nuclear medicine technology	CO1 CO3	CO2 CO3	-	-	-	CO1	CO2	-
VII	-	6 Months	Internship	CO1	CO1 CO3	CO2	CO4	CO4	CO3	CO2 CO5	CO5
VIII	-	6 Months	Internship	CO1	CO1 CO3	CO2	CO4	CO4	CO3	CO2 CO5	CO5

8. PROGRAM REGULATIONS

1. Program Structure

1.1. The program is a choice based credit system.
1.2. An academic year consists of two semesters – Odd semester (July - December) and Even semester (January – June)
1.3. Each semester shall extend over a minimum period of 13 weeks (a maximum up to 15 weeks) of academic delivery excluding examination days, semester breaks, declared holidays and non-academic events.
1.4. Medium of instruction shall be in English

2. Credit Distribution

2.1 Each semester would consist of 20 credits.
2.2 The credit distribution hours for Lecture, Tutorial, Practical, and Clinics are as follows:
Lecture (L) : 1 Hour /week = 1 credit = 13 hours
Tutorial (T) : 1 Hour /week = 1 credit
Practical (P) : 2 Hours/week = 1 credit
Clinics (CL) : 3 Hours/week = 1 credit
Note: For Basic sciences & Biostatistics course, 1 credit =15 hours (maximum)
2.3 A semester has courses structured as theory, practical, and clinics. Each course is of minimum 2 credits. The maximum credits for theory course is 4; theory and practical combined is 5.
2.4 Internship is not credited.
2.5 Abbreviations / Symbols used in the credit distribution table:
L - Lectures, T - Tutorials, P -Practical, CL - Clinics, C - Total credits, IAC - Internal assessment component, ESE - End-Semester Exam, * Open Elective, # Program Elective

3. Weightage for Internal Assessment Component (IAC) and End Semester Exam (ESE)

3.1. Any one or a combination of marks distribution criteria applicable to a course.

IAC Weightage (%)	ESE Weightage (%)
30	70
50	50
100	Nil
Nil	100

3.2 The IAC component weightage for theory & practical is:
- 50% from Mid-semester examination
- 50% through Continuous assessment (as applicable to course)

3.3 For courses without continuous evaluation components, two sessional exams are conducted and the average of both sessional exams shall be considered as the final IAC.

4. Attendance

4.1 Minimum attendance requirements for each course is:
i. Theory : 75 %
ii. Clinics / Practical : 85 %
4.2 As per the directives of MAHE, there will be no consideration for leave on medical grounds. The student will have to adjust the same in the minimum prescribed attendance. No leverage will be given by the department for any attendance shortage.

4.3 Students requiring **leave** during the academic session should apply for the same through a formal application to the Head of Department through their respective Class In-charge/ Coordinator. The leave will be considered as absent and reflected in their attendance requirements.

4.4 No leverage will be given by the department for any attendance shortage.

4.5 Students, Parents/ guardians can access the attendance status online periodically. Separate intimation regarding attendance status would not be sent to parents/students.

4.6 Students having attendance shortage in any course (theory & practical) will not be permitted to appear for the End-semester exam of the respective course.

5. Examination

5.1 Exams are in two forms – Sessional examination (conducted as a part of internal assessment) and End semester examination.

5.2 The final evaluation for each course shall be based on Internal Assessment Components (**IAC**) and the End-semester examinations **(ESE)** based on the weightage (as indicated in clause 3.1) given for respective courses.

5.3 IAC shall be done on the basis of a continuous evaluation after assessing the performance of the student in mid semester exam, class participation, assignments, seminars or any other component as applicable to a course (as indicated in clause 3.2).

5.4 All the ESE for the odd semesters **(regular ESE)** will be conducted in November-December. All the ESE for the even semesters **(regular ESE)** will be conducted in May-June.

5.5 For those whose failed to clear any course during regular ESE, a **supplementary exam** is conducted 2 weeks immediately after the ESE result declaration to enable him / her to earn those lost credits. When a student appears for supplementary examination, the **maximum grade awarded is "C"** grade or below irrespective of their performance.

5.6 For core courses, the duration of ESE for a 2 credit course would be 2 hours (50 marks) and for a course with 3 or more credits, 3 hours (100 marks).

5.7 For pre / para clinical course and program elective, irrespective of credit (2 or 3), the ESE is conducted out of 50.

5.8 For non-core courses such as Communication skills, Open electives, Indian constitution, Environmental sciences or courses as specified in curriculum, only internal assessment is conducted.

6. Minimum Requirements for Pass

6.1. Pass in a course will be reflected as grades. No candidate shall be declared to have passed in any course unless he/she obtains not less than **"E" grade**

6.2. For core courses (theory / practical), candidate should obtain a minimum of 50% (IAC + ESE or as applicable to course) to be declared as pass.

6.3. For non-core including psychology, pre and para clinical course, a candidate should secure a minimum of 40% in ESE to be declared as pass.

6.4. For students who fail to secure a minimum of 'E' grade for a course, an **improvement examination** is conducted to improve their IAC marks. The student can appear for these examination along with the subsequent batches' mid semester / sessional exams. The marks obtained in other components of IAC can be carried forward without reassessment.

7. **Calculation of GPA and CGPA**

7.1. Evaluation and Grading (**Relative Grading**) of students shall be based on GPA (Grade Point Average) & CGPA (Cumulative Grade Point Average).

7.2. The overall performance of a student in each semester is indicated by the Grade Point Average (GPA). The overall performance of the student for the entire program is indicated by the Cumulative Grade Point Average (CGPA).

7.3. A ten (10) point grading system **(credit value)** is used for awarding a letter grade in each course.

Letter Grade	A+	A	B	C	D	E	F/I/DT
Grade points	10	9	8	7	6	5	0

DT – Detained/Attendance shortage, I – Incomplete

7.4 Calculation of GPA & CGPA: An example is provided

Course code	**Course**	**Credits (a)**	**Grade obtained by the student**	**Credit value (b)**	**Grade Points (a x b)**
AHS 101	Course - 1	4	B	8	32
AHS 103	Course - 2	4	B	8	32
AHS 105	Course - 3	3	A+	10	30
AHS 107	Course - 4	4	C	7	28
AHS 109	Course - 5	5	A	9	45
	TOTAL	**20**	**-**	**-**	**167**

1st Semester GPA = Total grade points / total credits
167/20 = **8.35**

Suppose in **2nd semester GPA** = **7** with respective course credit 25

Then, $\textbf{1st Year CGPA} = \frac{(8.35 \text{ x } 20) \ + \ (7 \text{ x } 25)}{20 \ + \ 25} = 7.6$

8. Progression Criteria to higher semesters

8.1 The eligibility for promotion to the next academic year is subject to securing the minimum academic performance as specified below:

- First to second year: a minimum of 70% of the credits at the end of the first year (includes first and second semester)
- Second to third year: a cumulative minimum of 80% of the credits at the end of the second year (includes first, second, third and fourth semester)
- Third year to Internship/externship: Student will be eligible for internship/externship only after successful completion of the entire course work, i.e. 100% credits to be accrued by the end of the third year.

8.2 First year students who have failed to secure a minimum credit (as specified in 8.1), will be on **probation for next one year.** During that period, he / she will not be permitted to attend the second year / III semester classes and have to appear only for exam (during December / May) in order to acquire the missing credits. In the event of failure to acquire the required credits even by the end of second year (70%), he / she has to **exit the program**. Exit from the program is applicable only for first year students failing to acquire the required credits.

8.3 From second year onwards, in the event of failing to acquire required credits (80% or 90%), the students will be on probation. During that period, he / she will not be permitted to attend the classes and have to appear only for exam (during December / May) in order to acquire the missing credits. From second year onwards, failure to acquire the required credits by the end of subsequent year will not result in exit from program.

8.4 However, the student must complete all the course work requirements and credits by a **maximum of double the program duration**. For e.g. 4 years' program, all the academic course work needs to be completed within 8 years. Failure to do so will result in exit from the program.

9. Semester Break

9.1 Students will have a semester break following their odd and even end-semester examinations.

10. Internship

10.1 Internship will not carry any credits and marks

10.2 Any components/ activities that need to be evaluated as part of internship will be assigned a grade without reflecting it in the CGPA.

10.3 The intern should abide by the rules and regulations of the organization during the period of internship.

10.4 An internship certificate with details of clinical/relevant areas of postings with hours will be issued to a candidate on completion of the Internship. The certificate must be authenticated by the HOD/Coordinator and HOI.

10.5 **Degree is awarded** only on successful completion of internship.

Head of the Department **Dean**

Deputy Registrar - Academics **Registrar**