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

Radiotherapy Technology

(B.Sc. RTT)

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

The Radiotherapy Technologist is the third member of the team responsible for the accurate delivery of radiotherapy to the cancer patient. Radiation therapy Technologists performs some or all of the following duties:

- Operate Linear Accelerators, Cobalt 60, X-ray and other radiation therapy equipment to administer radiation treatment prescribed by Radiation Oncologists
- Check radiation therapy equipment to ensure proper operation
- Assist Radiation Oncologists and Clinical Physicists with the preparation of radiation treatment plan
- Assist in the construction of devices such as plaster casts and acrylic moulds to assist with administration of radiation treatment
- Monitor the patient's physical and psychological well-being during the entire course of treatment
- Advise the patient regarding side effects of radiation
- May train and supervise student radiotherapy technologists or supervise Junior radiotherapy technologists.

Most of the Radiotherapy Technologists in India have the qualification of 10+2 or equivalent examination passed with science subjects from a recognized University and a two-year Diploma in Radiotherapy Technology. Radiotherapy has undergone a sea of changes in the last decade with the introduction of Volumetric Modulated Arc Therapy (VMAT), Intensity Modulated Radiotherapy (IMRT), Image Guided Radiotherapy(IRGT), Stereotactic Radiotherapy(SRT) and Radiosurgery (SRS), it is imperative that the technologists should have training of a very high calibre. The Diploma course is being withdrawn from many Centres and presently looking for Graduates in Radiotherapy Technology.

AIM AND OBJECTIVES

To educate and train the students to become a good Radiotherapy Technologist and enable them to independently manage all the machineries available in the field of radio therapy and help the medical practitioners in the proper treatment of malignant diseases, with minimum radiation hazards and quality patient care.

To promote continual learning and professional development for the benefit of students thereby increasing the effectiveness of health care delivery.

Professional Objectives:

By the end of the program students should be able to:

- Treat patients on Linear accelerators, Cobalt 60, X-ray and other radiation therapy equipment independently as prescribed by radiation oncologists under the supervision of experienced Radiotherapy Technologists
- Perform Treatment Planning in Simulator and image acquisition on CT scanner
- Prepare acrylic moulds for patient immobilization for the purpose of Radiotherapy.
- Monitor the patient's physical and psychological well-being during the entire course of treatment.
- Train and supervise student radiotherapy technologists.
- Promote, support and further advance the character, status and interests of medical Radiotherapy Technology
- Promote, advance scientific knowledge by means of lectures, demonstrations, discussions, and debates in all branches of radiotherapy.
- Work as a team to provide quality service.

ENTRY REQUIREMENTS

The candidate applying for admission to BSc RTT course should have passed 10+2 Science / PUC in Science with 50% marks in Physics, Chemistry, Mathematics as compulsory subjects with Biology or Statistics or Computer Science as an optional subject.

At the time of entry/admission to the first semester BSc RTT course the candidate should be of age 17 years or as per rules of the respective universities with regard to the entry age

2. PROGRAM EDUCATION OBJECTIVES (PEOs)

The overall objective of the learning outcome-based curriculum framework (LOCF) for B.Sc. Radiotherapy Technology Program are as follows:

PEO No.	Education Objective
PEO 1	Students will be able to use their fundamental knowledge and technical competence in Radiotherapy treatment as and when required to achieve professional excellence.
PEO 2	Students will demonstrate strong and well defined practical skills in Radiotherapy treatment.
PEO 3	Students will be able to practice the profession with 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 to identify, assess and formulate problems and execute the solution Radiotherapy treatment.
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 different modalities of Radiotherapy treatment 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 / Laboratory / practical skills**	Demonstrate **technical and practical 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 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 the 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 of a number of advanced and emerging issues in the field of Radiotherapy Technology; (ii) Procedural knowledge that creates different types of professionals related to the Radiotherapy Technology, including research and development, teaching and in government and public service; (iii) Professional and communication skills in the domain of Radiotherapy technology, including a critical understanding of the latest developments, and an ability to use established techniques in the domain of Radiotherapy Department.

b) Demonstrate comprehensive knowledge about Radiotherapy technology, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the Radiotherapy 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 relating to the program Radiotherapy Technology.

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 problems

5. PROGRAM OUTCOMES (POs):

After successful completion of Bachelor / BSc Radiotherapy 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**	Demonstrate high quality **evidence based practice** 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)

SCHEME OF CURRICULUM

SEMESTER - I

Course Code	Course Title	Credits Distribution L,T,P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
ANA1103	Anatomy	3	-	-	-	3	30	70	100
PHY1101	Physiology - I	2	-	-	-	2	30	70	100
CSK1001	Communication Skills	2	-	-	-	2	100	-	100
EIC1001	Environmental science and Indian constitution	2	-	-	-	2	100	-	100
RTT1101	Basic Physics	2	1	-	-	3	50	50	100
RTT1102	Basic and Applied Mathematics	3	1	-	-	4	100	-	100
RTT1121	Fundamentals of Computers and Computer Applications	2	-	4	-	4	100	-	100
	Total	**16**	**2**	**4**	**-**	**20**	**510**	**190**	**700**

Note:
ESE for ANA1103, PHY1101 will be conducted out of 50 and normalized to 70
ESE for RTT1101 will be conducted out of 100 and normalized to 50

SEMESTER - II

Course Code	Course Title	Credits Distribution L,T,P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
PHY1201	Physiology - II	2	-	-	-	2	30	70	100
GPY2204	General Psychology	2	-	-	-	2	100	-	100
RTT1201	Radiation Physics	3	1	-	-	4	50	50	100
RTT1202	Radiation Quantities and Detection	2	1	-	-	3	50	50	100
RTT1203	Radiobiology	3	1	-	-	4	50	50	100
RTT1204	Bioethics	2	1	-	-	3	100	-	100
RTT1205	Hospital Practice and Patient Care	2	-	-	-	2	50	50	100
	Total	**16**	**4**	-	-	**20**	**430**	**270**	**700**

Note:
ESE for PHY1201 will be conducted out of 50 and normalized to 70
ESE for RTT1201, RTT1202, RTT1203, will be conducted out of 100 and normalized to 50
ESE for RTT1205 will be conducted out of 50

SEMESTER - III

Course Code	Course Title	Credits Distribution L,T, P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
PAT2102	Pathology	2	-	-	-	2	100	-	100
RTT2101	Radiotherapy Equipments	3	1	-	-	4	50	50	100
RTT2102	Principles and Practice of Radiology Part I	2	1	-	-	3	50	50	100
RTT2103	Patient Positioning and Immobilization/ Mould Room Techniques	2	-	-	-	2	50	50	100
RTT2131	Clinical practice- Radiotherapy Equipment's	-	-	-	18	6	100	-	100
*** ****	Open Elective - I	-	-		-	3	S/NS		
	Total	**9**	**2**	**-**	**18**	**20**	**350**	**150**	**500**

Note:
ESE for RTT2101, RTT2102 will be conducted out of 100 and normalized to 50
ESE for RTT2103 will be conducted out of 50

SEMESTER IV

Course Code	Course Title	Credits Distribution L,T,P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
RTT2201	Physics of External Beam Radiotherapy	3	-	-	-	3	50	50	100
RTT2202	Principles and Practice of Radiology Part II	2	1	-	-	3	50	50	100
RTT2231	Clinical Practice- Radiation Beam therapy	-	-	-	33	11	100	-	100
RTT ****	Program Elective - I	3	-	-	-	3	50	50	100
	Total	**8**	**1**	**-**	**33**	**20**	**250**	**150**	**400**

Note:
ESE for RTT2201, RTT2202 will be conducted out of 100 and normalized to 50

SEMESTER - V

Course Code	Course Title	Credits Distribution L,T,P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
RTT3101	Principles and Practice of Radiotherapy Part I	3	-	-	-	3	50	50	100
RTT3102	Record Keeping	2	-	-	-	2	50	50	100
RTT3103	Radiation Protection, Standards and Regulations	3	-	-	-	3	50	50	100
RTT3111	Practical and Viva -I Radiotherapy Practice	-	-	4	-	2	100	-	100
RTT3131	Clinical practice-External Beam Radiotherapy	-	-	-	21	7	100	-	100
*** ****	Open Elective - II	-	-	-	-	3	S/NS		
	Total	**8**	**-**	**4**	**21**	**20**	**350**	**150**	**500**

Note:
ESE for RTT3102 will be conducted out of 50
ESE for RTT3101, RTT3103 will be conducted out of 100 and normalized to 50

SEMESTER - VI

Course Code	Course Title	Credits Distribution L,T,P, CL are Hours/week					Marks Distribution		
		L	T	P	CL	C	IAC	ESE	Total
BST3201	Biostatistics & Research Methodology	3	-	-	-	3	30	70	100
RTT3201	Principles and Practice of Radiotherapy Part II	3	-	-	-	3	50	50	100
RTT3211	Practical and Viva II Radiotherapy Practice	**-**	**-**	4	-	2	50	50	100
RTT3231	Clinical Practice-Advances in Radiation Beam Therapy	**-**	**-**	-	27	9	100	-	100
RTT ****	Program Elective - II	3		-	-	3	50	50	100
	TOTAL	**9**	**-**	**4**	**27**	**20**	**280**	**220**	**500**

Note:
ESE for BST3201 will be conducted out of 100 and normalized to 70
ESE for RTT3201, RTT3211 will be conducted out of 100 and normalized to 50

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	RTT2241	Physics of Brachytherapy	3	-	-	-	3
	RTT2242	Basics of Nuclear Medicine and safety	3	-	-	-	3
VI Semester	RTT3241	Recent Advances in Radiotherapy Technology	3	-	-	-	3
	RTT3242	Radiation Dosimetry and Quality Assurance	3	-	-	-	3

SEMESTER - VII and VIII

Internship (1 year, 48 hours/week)

Semester VII	Duration 6 months 48 hours in a week / 8 hours in a day
Semester VIII	Duration 6 months 48 hours in a week / 8 hours in a day

Summary of Credits and Marks distribution

Semester	Credit Distribution (L,T, P & CL are Hours per week)					Marks Distribution		Total
	L	T	P	CL	C	IAC	ESE	
Semester I	16	2	4	-	20	510	190	700
Semester II	16	4	-	-	20	430	270	700
Semester III	10	2	-	18	20	350	150	500
Semester IV	8	1	-	33	20	250	150	400
Semester V	8	-	4	21	20	350	150	500
Semester VI	9	-	4	27	20	280	220	500
Semester VII	-	-	-	48	NA	-	-	-
Semester VIII	-	-	-	48	NA	-	-	-
Total	**67**	**9**	**12**	**195**	**120**	**2170**	**1130**	**3300**

SEMESTER - I

COURSE CODE		COURSE TITLE
ANA1103	:	Anatomy
PHY1101	:	Physiology - I
CSK1001	:	Communication Skills
EIC1001	:	Environmental sciences and Indian constitution
RTT1101	:	Basic Physics
RTT1102	:	Basic and Applied Mathematics
RTT1121	:	Fundamentals of Computers and Computer Applications

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Anatomy**
Course Code	**ANA1103**
Academic Year	First Year
Semester	I
Number of Credits	3
Course Prerequisite	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) • Explain the Lateral wall of nasal cavity - features,	5

Content	Competencies	Number of Hours (Theory)
	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) • Explain the veins - branchiocephalic veins, superior vena cava (formation, course and termination) (C2)	4

Content	Competencies	Number of Hours (Theory)
	• 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:		
Male reproductive	• List the parts of male reproductive system (C1)	2

Content	Competencies	Number of Hours (Theory)
system	• 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)	
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 structure – in brief (C1)	12

Content	Competencies	Number of Hours (Theory)
	• 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: Nil	**Summative:**
Unit Test	Sessional Exam I / Sessional Exam II (Theory)
Quiz/ MCQ/MTF	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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Physiology I**
Course Code	**PHY1101**
Academic Year	First year
Semester	I
Number of Credits	2
Course Prerequisite	Basic knowledge of 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)	
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)	

Content	Competencies	Number of Hours
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 (BP)	• Define blood pressure (BP) (C1) • 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)	

Content	Competencies	Number of Hours
	• 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) • 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)	4

Content	Competencies	Number of Hours
	• 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)	
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	-	-
Revision	-	-
Assessment	-	-
Total	**33**	**99**

Assessment Methods:	
Formative: Nil	**Summative:**
	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 1	x	x	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:	Basics of Medical Physiology,4th edition, D.Venkatesh, H.H.Sudhakar
	Manipal Manual of Medical Physiology,1st edition, C. N. ChandraShekar

Manipal College of Health Professions	
Name of the Department	Department Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Communication Skills**
Course Code	**CSK1001**
Academic Year	First Year
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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Environmental Science**
Course Code	**EIC1001**
Academic Year	First Year
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, Ecosystem, Energy and natural resources	1. Classify the natural resources (C2) 2. List the renewable and non- renewable resources (C1)	4

Content	Competencies	Number of Hours
	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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Indian Constitution**
Course Code	**EIC1001**
Academic Year	First Year
Semester	I
Number of Credits	1
Course Prerequisite	Nil
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	3

Content	Competencies	Number of Hours
	constitutional 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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Basic Physics**
Course Code	**RTT1101**
Academic Year	First year
Semester	I
Number of Credits	3
Course Prerequisite	Students should have knowledge of basic physics
Course Synopsis	1. This course covers the basics physics needed for radiotherapy technology. 2. It assists the students to learn the basic physics in order to understand the concept in simple dose calculations and planning 3. This subject helps to bridge the gap between the knowledge obtained in basic courses in physics. 4. It provides fundamental knowledge of Units and measurements used in physics, conductors, fundamentals of electricity, laws of motion and electromagnetic radiation. 5. It provides sufficient knowledge to identify the fundamentals of Physics and their applications in day today life and in Radiation Physics.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the uses of fundamental formulae, units and measurements, rectifiers and their types (C2, A3)
CO2	Explain newton's first, second and third laws of motion, Friction, types of friction, laws of friction, transformer and the their types (C2, A3)
CO3	Explain kirchoff's law, electromagnetic induction, self and mutual induction, electromagnetic radiation, quantum theory of radiation (C2, A3)
CO4	Explain Fluorescence and phosphorescence, derive equations for 'ε', and solve the problems on units and measurements (C2, A3)
CO5	Define fundamental units, radioactivity, thermionic emission, linear momentum, electromotive force and voltage drop, inertia, and action reaction in day today life(C1, A2)

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							

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Units and measurements	• Explain Fundamental and derived units (C2) • Illustrate Length, mass and time measurements (C2) • Define all fundamental units(C1) • Define mole and write the unit. (C1) • Define meter and write the unit(C1) • Define kilogram and write the unit(C1) • Illustrate the uses of dimensional formulae for the different quantities(C2) • Why accuracy and precision of measuring instruments is required? (C1) • What are the errors in measurement? (C1)	6
Unit 2:		
Laws of motion	• Explain Newton‘s first, second and third law of motion(C2) • Give examples for action reaction pair in day to day life(C1) • Define force, impulse and impulsive force with SI unit and give examples for each. (C1) • Give examples for inertia(C1) • How do you explain the concept of inertia, force and momentum? (C1) • Define the law of conservation of linear momentum(C1) • Solve the problems related to law of conservation of linear momentum(C3) • State the condition for the equilibrium of a particle under the action of concurrent forces(C1) • Define friction(C1) • Explain the types of friction(C2) • Explain the laws of friction and the methods to reduce the friction(C2)	13
Unit 3:		
Fundamental of Electricity:	• Define electric charges and units of electric charge(C1) • What are the uses of heating effect of electric current?(C1) • What is electromotive force and and voltage drop in electric network? (C1) • Define Coulombs law (C1) • Define Electric induction (C1) • Define electric potential & potential difference(C1) • Define Capacitance and Capacitors with units(C1) • Define Resistance with unit(C1) • Explain Kirchoff’s first and second law(C2) • Define Conductors, Insulators and Semiconductors, Electric current (C1)	14

Content	Competencies	Number of Hours
	• Define Ohm's law(C1) • Explain Kirchoff's law, Circuit laws (Combination of Potential difference in series and parallel, meters, Electrical energy & Power, heating effect of a current) (C2) • Derive the equation for 'ε' in the case of rotating coil in magnetic field(C@) • Explain and derive the magnetic effects of an electric current (Electromagnetism). (C2) • Explain electromagnetic induction, (C2) • What is Mutual induction and Self-induction?(C1) • Derive equation for Mutual induction and Self-induction? (C2) • What is alternating current, the A.C. transformer theory, and construction? (C1) • Explain the types of transformers and its practical aspects?(C2) • Explain the laws of transformers? (C2) • Explain transformer losses and regulation and rating?(C2) • Explain types of transformers used in X-ray equipment? (C2) • What is thermionic emission?(C1) • What is vacuum diode, Variation of anode current with anode voltage and filament temperature in the vacuum diode, the effect of gas in the diode, the thermionic gas diode? (C1) • Define rectification (full wave & half wave rectification)(C1) • What are rectifiers? (C1) • Explain the types and working of rectifiers(C2) • Explain the principles of semiconductors, p-n junction diode, High voltage rectifier circuits (self-rectifying circuit, Half-wave pulsating voltage circuit, Full-wave pulsating voltage circuits, shock proofing. Advantages of semiconductor devices over thermionic devices(C2)	
Unit 4:		
Electromagnetic Radiation	• Illustrate electromagnetic radiation and electromagnetic spectrum. (C2) • Define atomic structure(C1) • Define inverse square law and write the equation(C1) • What is photoelectric emission, photocell, and intensity and quality of electromagnetic radiation(C1) • Define radioactivity with example (C1) • Write a note on quantum theory of radiation(C2) • Write a note on fluorescence and phosphorescence(C1)	6

Content	Competencies	Number of Hours
	• Define nucleus, atomic number, mass number, ionization, excitation, isotope and periodic table with examples(C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	87
Revision	5	10
Assessment	5	10
`Total	**39**	**107**

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

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Modern physics, er. Kiruthiga sivaprasath & r murugeshan s. Chand Publishing
Additional References	1. Basic Physics: A Self-Teaching Guide by Karl F. Kuhn 2.Fundamentals of Physics: Mechanics, Relativity, and Thermodynamics by R. Shankar 3.University Physics with Modern Physics by Hugh D. Young, Roger A. Freedman

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Basic and Applied Mathematics**
Course Code	**RTT1102**
Academic Year	First year
Semester	I
Number of Credits	4
Course Prerequisite	Students should have knowledge of basic mathematics
Course Synopsis	This course covers the basics of functions, set theory, trigonometry, integration, differentiation and differential equations.

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

CO1	Understanding graph representation (C3)
CO2	Understand different laws In medical physics which follows Exponential function (C2)
CO3	Applying formula to calculate area and volume (C3)
CO4	Explain differentiation and integration (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:		
Graphic representation of function.	• Solve simultaneous equations graphically. (C3) • Solve simultaneous equations algebraically. (C3) • Defining BODMAS (rule). (C1) • Solve quadratic equations: solution X = -b ±- Degree of a polynomial. (C3) • Defining Algebra: Basic formulae. (C1) • Solving equations by factorization method. (C3)	5
Unit 2:		
Functions	• Define (C1) - Constant function - Identity function - Linear function - Quadratic function - Absolute Value function + Graphic representation - Exponential function; Laws - Logarithmic function	5

Content	Competencies	Number of Hours
	- Increasing function - Decreasing function	
Unit 3:		
Set theory	• Define (C1) o Finite set o Infinite set o Null set o Subset o Equal set o Universal set o Complement of set o Venn diagram o Union, Intersection	5
Unit 4:		
Mensuration (formulae)	• Find (C1) o Area of Δ o Cylinder – area, volume o Cone – area, volume o Sphere – area, volume o Circle – area, perimeter o Sector of circle – area, perimeter o Semi-circle – area, perimeter	5
Unit 5		
Trigonometry	• Find (C1) o Formulae for Sin., Cos, Tan, Sec, Cosec, Cot values at = 0,30˚, 45˚, 60˚, 90˚, Sine curve, Cosine curve • Show Y = tan x graphic representation only. Y = mx + c (C2)	6
Unit 6		
Limits	• Definition and Defining / calculating limits (C1) • Derive xn, c; (C1) sin x; cos x; tan x; cot x, cosec x; Y = u+v; y= u-v; y= u.v Y= c.u; y= uvw, x k/2, Y = u/v; y= log x; y= x Y= 1/x ; y= x (differentiation) • Derive by 1st principle. (C1) • Derive by direct method, i.e. by formulae. (C1) • Show the Application: Slope of curve at a point. (C2) • Derive Rolle ‘s theorem (C1) • Derive Langrage‘s mean value theorem (C1)	10
Unit 7		
Integration	• Define integration (C1) Derive Standard formulas in basics integration (C1) - ex, xn, 1/x, Sin x; cos x; sec2.x; coses2x; sec x; tan x; cosec x; cot x, ax	8

Content	Competencies	Number of Hours
Unit 8		
Differential equation	Define differential equation. (C1) Define basic theory. (C1) How to use differential function in radioactive decay, Calculation of t½, etc (C1)	8

Learning Strategies, Contact Hours and Student Learning Time (SLT):							
Learning Strategies		**Contact Hours**		**Student Learning Time (SLT)**			
Lecture		42		80			
Revision		5					
Assessment		5					
Total		**52**		**80**			
Assessment Methods:							
Formative:		**Summative:**					
Unit Test		Mid Semester/Sessional Exam (Theory)					
Assignments							
Mapping of Assessment with COs:							
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**			
Mid Semester / Sessional Examination 1	x	x					
Assignments	x	x	x	x			
Class test	x	x	x	x			

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Basic Mathematics, G.R. Veena, New Age International Publishers 2. Text Book of B.Sc. Mathematics Part 1, Ranganath G K; Sampangiram C S, S Chand & Co. Ltd New Delhi
Additional References	1. Engineering and B.Sc. Mathematics, Shahane, Allies Book Stall 2. Text book of applied mathematics, Yeri Prakash, Eastern Book Promoters 3. Text book of Mathematics, Upadhyaya U S, Durga Prasad Publishers

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Fundamentals of Computers and Computer Applications**
Course Code	**RTT1121**
Academic Year	First year
Semester	I
Number of Credits	4
Course Prerequisite	Students should have basic knowledge of computer
Course Synopsis	This course covers the basics of operating system, Microsoft office, MS excel, MS-Access, HTML.

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

CO1	Understand the whole process of working of computer (C3,P4)
CO2	Explain different parts of the computer and its working (C2)
CO3	Use of Word, Excel and PowerPoint to prepare reports or data and Presentation for future conference (C3, P4)
CO4	Use internet (P2,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	x						

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Introduction	What are the types of computers? (C1) Name the characteristics of computers. (C1) What is RAM, ROM, PROM, EPROM, EEPROM, Flash Memory. Auxiliary Storage Devices? (C1)	4
Unit 2:		
Input Devices	What is the use of Keyboard, Mouse, Trackball, Joystick, Digitizing Tablet, Scanners, Digital Camera, Magnetic Ink Character Recognition, Optical Character Recognition, Optical mark recognition, Bar Code Reader, Speech Input Devices, Touch Screen, Touch Pad, Light Pen. (C1)	3
Unit 3:		
Output Devices and Operation Systems	Explain the use of Monitor (C2) Classify Monitors (C1)	4

Content	Competencies	Number of Hours
	List the characteristics of Monitors(C1) What is the use of Printers, Plotter, Sound Cards and Speakers (C1)? List the function of OS, and Classification of OS. (C1)	
Unit 4		
Microsoft Office	How to work with MS word, File operations, Creating, Opening, Editing, Formatting, Closing, Saving, Shortcut keys, Tables, Inserting objects, Page design, Mail Merge. (C1, C2) How to work with MS-Excel: Cell formatting, Fill handle, Range name, Graphic objects and charts, Database, Pivot tables & Data validation, Auditing, Templates. (C1,C2) How to work with MS-Access: Forms, Filters and Queries, Charts and Reports. Command button, Macros. Database maintenance (C1,C2)	12
Internet and HTML	How to use WWW, TELNET, FTP, TCP/IP, Electronic Mail, HTML (C3, P2)	3
Practical	Learning to use MS office: MS word, MS PowerPoint, MS Excel, MS-Access, Internet and HTML () To install different software. Data entry efficiency. (P4)	52

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	20	40
Practical	45	45
Revision	8	-
Assessment	5	-
Total	**78**	**85**

Assessment Methods:	
Formative:	**Summative:**
Unit Test	Mid Semester/Sessional Exam (Theory and/Practical)
Assignments	Record Book
Record Book	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**		
Mid Semester / Sessional Examination 1	x	x				
Assignments	x	x	x	x		
Record Book			x			

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Fundamentals of Computers, V.Rajaraman, Prentice-Hall Of

	India Pvt. Ltd; New Delhi.
	2. Introduction to Computers: Fundamentals of Computer Science Vol.1, Subramanian N, Tata Mcgraw Hill Publishing Company
	3. Computers in Medical Physics [Medical Physics Monograph No 17], Benedetto Anthony R, American Institute of Physics

SEMESTER - II

COURSE CODE		COURSE TITLE
PHY1201	:	Physiology- II
GPY2204	:	General Psychology
RTT1201	:	Radiation Physics
RTT1202	:	Radiation Quantities and Detection
RTT1203	:	Radiobiology
RTT1204	:	Bioethics
RTT1205	:	Hospital Practice and Patient Care

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Physiology - II**
Course Code	**PHY1201**
Academic Year	First Year
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	1

Topics	Competencies	Number of Hours
	receptors (C2)	
Synapse	• Define 'synapse' (C1) • Describe the structure of a synapse (C2) • Explain the events in synaptic transmission (C2)	1
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)	1

Topics	Competencies	Number of Hours
	• Define deglutition (C1) • 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
Unit 4: General principles of endocrinology		

Topics	Competencies	Number of Hours
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) • List the actions of glucagon (C1) • Describe the regulation of secretion of glucagon (C2)	1

Topics	Competencies	Number of Hours
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:	**Summative:**	

Nil			Sessional Examination I and II (Theory)			
Nil			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:	• Basics of Medical Physiology- 3rd Edition by D Venkatesh and HH Sudhaker					
	• Manipal Manual of Medical Physiology,1st edition, C. N. ChandraShekar					

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**General Psychology**
Course Code	**GPY2204**
Academic Year	First year
Semester	II
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 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) 5. Explain Monocular and Binocular cues in Perception (C2) 7. Explain types of motion perception (C2)	3

Content	Competencies	Number of Hours
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. 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	3

Content	Competencies	Number of Hours
	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)

Mapping of Assessment with COs:			
Nature of Assessment	**CO1**	**CO2**	**CO3**
Mid Semester/Sessional examination	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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiation Physics**
Course Code	**RTT1201**
Academic Year	First year
Semester	II
Number of Credits	4
Course Prerequisite	Students should have knowledge of basic physics
Course Synopsis	• This course deals with basic radiation physics concepts like Electromagnetic Radiation, Radioactivity, and Mechanism of interaction of electromagnetic radiation, Radiation quantities and units • To provide fundamental knowledge of radioactivity and interaction of ionizing radiation with matter • To provide fundamental knowledge of production of X-rays, and classify types of X-rays

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the properties of different types of radiations (C2)
CO2	Explain the various interaction of Radiation with matter (C2)
CO3	Explain the production of X rays and classify the types of X rays (C2)
CO4	Explain the components of X ray tube(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						x	
CO4	x						x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Electromagnetic radiation	• Explain the concept of electromagnetic radiation with their properties, Intensity and quality of electromagnetic radiation? (C1,C2) • How to calculate the energy of electromagnetic radiation? (C1,C2) • Explain the concept of inverse square law with equation(C2) • Explain quantum theory of radiation with the Planck's concept of quanta. (C2) • Explain electromagnetic spectrum with neat labelled diagram(C2)	9

Content	Competencies	Number of Hours
	• What is Fluorescence and Phosphorescence, classify each? (C1,C2) • Define luminescence? Explain the concept of fluorescence and phosphorescence with example. (C1,C2) • Define photo electric emission and explain photocell(C1,C2)	
Unit 2:		
structure of the Atom	• Define isotope, isomer , isobar Ionization & Excitation atomic number and mass number with example. (C1) • Explain the structure of an atom and explain atom models its components with the Symbolic representation. (C1,C2) • Explain the importance of periodic table. (C1,C2)	5
Unit 3:		
Radioactivity	• Define Specific activity, and derive expression for Specific activity (C1,C2) • Explain about the production of cobalt-60 and its decay scheme. (C1,C2) • Illustrate the the Properties of alpha, beta and gamma radiations. (C1,C2) • Explain in detail about the radioactive transformation processes with examples. (C2) • Define Exposure, half-life, mean-life(C1,C2) • Explain and Derive the general equation for law of successive disintegration and explain secular equilibrium(C2) • Define decay constant. Half-life, mean and Derive the equation. (C1,C2) • Explain Alpha decay & beta decay with example and mention the general equation for each. (C1,C2) • Explain and derive the equation $A=A_0e^{-\lambda t}$ .derive expression about radioactive disintegration law $N = N_0.e^{-\lambda t}$ Deduce relation of half-life with decay constant. (C2) • What are prominent radioactive isotopes used in radiotherapy? (C1) • What is photo nuclear reaction? Explain nuclear fission and fusion reaction Give an example. (C1,C2)	14
Unit 4:		
Interaction of electromagnetic radiation	• Define radioactivity, artificial radioactivity, half value layer, attenuation(C1) • Explain about attenuation coefficients and factors effecting attenuation. (C2) • Illustrate on interaction of electromagnetic radiation with matter. (C2) • explain in details about different interaction process	5

Content	Competencies	Number of Hours
	of photons with matter. (C2) • explain on elastic scattering and inelastic scattering of photons. (C2)	
Unit 5:		
Interaction of charged particles	• Explain in details about interaction of charged particles with matter and neutron interaction with matter. (C2)	5
Unit 6:		
X-ray Production	• Explain about the properties of x rays(C2) • Explain the concept of Bremsstrahlung radiation and Characteristic x-radiation(C2) • Explain in detail about the construction and working of x-ray tube with labeled diagram. (C2) • List the factors on which the x-ray spectra depends upon. Explain in detail with diagram continuous and characteristic x-ray(C1,C2) • Explain in detail about the physics of x-rays What is mean by quality and quantity of x-rays, what are the exposure factors depends on it? (C1,C2) • Define soft and hard X-rays explain the concept of space charge effect. (C1,C2) • What is saturation voltage? tube and filament current (C1) • Define electron volt. (C1) • What is filtration? Explain different types of filters used in X-ray tube (C1,C2) • Explain in detail about the apparent focus of x-ray tube and on factors it depends. (C2) • What is focusing cup. Write its significance? (C1) • Explain the concept of rotating anode X-ray tube and stationary anode X- ray tube. List the advantages and disadvantages (C1,C2) • Explain line focus principle and heel effect(C1,C2) • explain in detail about hooded anode therapy tube with a neat labeled diagram. (C2) • Explain about the cooling mechanism of x-ray tube. (C2) • explain about effect of filters on patient exposures. (C2) • What is the influence of heel effect on radiograph and how to reduce it(C1) • Explain about the physics of x-ray radiograph. And Define contrast and its dependent parameters(C1,C2)	14

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	42	126
Revision	5	10
Assessment	5	10
Total	**52**	**136**

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

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**		
Mid Semester / Sessional Examination 1	x	x				
Assignments/presentations	x	x	x	x		
Unit test	x	x	x	x		
End Semester Exam (Theory)	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Walter and Millers, Text Book of Radiotherapy, Radiation Therapy Physics, Therapy and Oncology. C.K. Bomford, 6th Edition, Churchill Livingstone. 2. Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby.
Additional References	1. Radiotherapy: Principles and Practice, A Manual for quality in Treatment delivery, Sue E. Griffith, Churchill Living stone.
	2. The Physics of Radiation Therapy- Faiz M Khan

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiation Quantities and Detection**
Course Code	**RTT1202**
Academic Year	First year
Semester	II
Number of Credits	3
Course Prerequisite	Students should have the basic knowledge of units used for measurements.
Course Synopsis	• Content is designed to provide the student with basic knowledge of the foundations of Radiation quantities, units and different types of detectors being used for measurement of radiation. • Fundamental radiation quantities and units, principle, construction and working of different types of detectors are emphasized along with their applications in medical radiation physics.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Define the different types of quantities & its units used in radiation physics and basic principle of different types of radiation detectors. (C2)
CO2	Explain the theory, construction and working of different types detectors (C2)
CO3	Explain the elementary principle and and the working of personnel monitoring devices and their applications in Radiotherapy and Radiodiagnosis. (C2)
CO4	Explain general principle and working of various Ionization chambers (C2)
CO5	Explain the advantages and disadvantages of various detectors and appropriateness of different types of detectors for different types of radiation measurement. (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							
CO4	x						x	
CO5	x						x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Radiation quantities and Units	• Define Activity, Specific activity, gamma ray constant, Kerma rate constant, Electronic equilibrium, Bragg-Gray principle (C1) • Explain in detail about dosimetric quantities, Radiometric quantities and Protection quantities	12

Content	Competencies	Number of Hours
	with relevant expression and units. (C2) • Explain equivalent dose and effective dose. (C2) • Explain Roentgen, Linear Energy Transfer, Relative Biological Effectiveness, (C2) • Explain Radiation Weighting Factor and Tissue Weighting Factor(C2) • Explain in detail about Bragg-Gray principle and its conditions (C2)	
Unit 2:		
Radiation detectors	• Explain about V-I characteristic curve of gas filled detector with a neat diagram. (C2) • Explain about basic Principles of radiation detection and explain working and construction of GM counter. (C2) • Explain on semiconductor detector, Photomultiplier tube (C2) • Explain and Draw the characteristic curve of different regions of gas filled detectors. (C1, C2) • What are the ideal characteristics of scintillating crystal. (C1) • Explain p-type and n-type semiconductors. (C2) • Explain General principle and working of organic/inorganic scintillation detector and Semiconductor detector. (C2) • Explain advantages and disadvantages of scintillation detector. (C2) • Define resolving time of GM detector. (C1) • Explain why GM counter survey meter is not used in linear accelerator. (C2) • Explain about proportional counter. (C2) • Explain the ideal characteristics of scintillating crystal. (C2)	12
Unit 3:		
Radiation detectors and measuring devices	• Explain the advantages of using TLD detectors as personal monitoring device. (C2) • What is thermo luminescence? Briefly discuss about the TLD badge. (C2) • Define glow curve. (C1) • Explain free air ionization chamber. (C2) • Explain parallel plate chamber and Thimble chamber (C2)	10
Unit 4:		
Surveymeters	• Explain gamma zone monitor and surveymeters. (C2) • What are the ideal characteristic of a survey meters. (C1)	5

Learning Strategies, Contact Hours and Student Learning Time (SLT):							
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**					
Lecture	29	78					
Revision	5	10					
Assessment	5	10					
Total	**39**	**103**					
Assessment Methods:							
Formative:	**Summative:**						
Unit Test	Mid Semester/Sessional Exam (Theory)						
Assignments / Seminar	End Semester Exam (Theory)						
Mapping of Assessment with COs:							
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**		
Mid Semester / Sessional Examination 1	x	x	x				
Assignments	x	x	x	x	x		
Class test	x	x	x	x	x		
End Semester Exam	x	x	x	x	x		
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	1. Radiation detection and measurement-G F Knoll						
Additional References	2. The Physics of Radiation Therapy- Faiz M Khan 3. Radiation Therapy Physics- William Hendee, Mosby						

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiobiology**
Course Code	**RTT1203**
Academic Year	First year
Semester	II
Number of Credits	4
Course Prerequisite	Students should have knowledge of basic biology and chemistry
Course Synopsis	This course deals with the action of ionizing radiation on biological tissues and living organisms.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the structure and function of cell (C2)
CO2	Explain the action of radiation on living cells (C2)
CO3	Explain the dependence on dose, dose rate, type and energy of radiation, temperature. (C2)
CO4	Explain the Physical and biological factors affecting cell survival, tumour regrowth and normal tissue response (C2)
C05	Explain Time dose fractionation (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							
CO4	x						x	
CO5	x						x	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Cell Biology:	○ What is cell physiology and biochemistry? (C1) ○ Explain Structure of the cell - Types of cells and tissue, their structures and functions. (C2) ○ Explain organic constituents of cells ○ Carbohydrates, fats, proteins and nucleic acids - Enzy.mes and their functions (C2) ○ What is the functions of mitochondria, ribosomes, golg bodies and lysosomes (C1)? ○ Explain cell metabolism - DNA as concepts of gene and gene action - Mitotic and meiotic cell division - Semi conservative DNA synthesis, Genetic variation Crossing over, mutation, chromosome segregation - Heredity and its mechanisms. (C2)	10

Content	Competencies	Number of Hours
Unit 2:		
Interaction of Radiation with Cells	○ Explain action of radiation on living cells (C2) ○ Explain radiolytic products of water and their interaction with biomolecule - Nucleic acids, proteins, enzymes, fats (C2) ○ What is the influence of oxygen, temperature on Cellular effects of radiation (C1)? ○ Explain mitotic delay, chromosome aberrations, mutations and recombination's, Giant cell formation, cell death Recovery from radiation damage - Potentially lethal damage and sublethal damage recovery - Pathways for repair of radiation damage. (C1) ○ Explain Law of Bergonie and Tribondeau. (C2) ○ What are the survival curve parameters (C1)? ○ Explain model for radiation action - Target theory - Multihit, Multitarget - Repair misrepair hypothesis - Dual action hypothesis (C2) ○ What is modification of radiation damage - LET, RBE, dose rate, dose fractionation - Oxygen and other chemical sensitizers - Anoxic, hypoxic, base analogs, folic acid, and energy metabolism inhibitors - Hyperthermic sensitization - Radio-protective agents. (C1)	10
Unit 3:		
Biological Effects of Radiation	○ What is somatic effects of radiation (C1) ○ What are the physical factors influencing somatic effects (C1)? ○ Explain dependence on dose, dose rate, type and energy of radiation, temperature, anoxia (C2) ○ What is acute radiation sickness(C1) ○ What is LD *50* dose(C1) ○ What is effect of radiation on skin and blood forming organs, digestive tract – Sterility and cataract formation (C1) ○ What are the effects of chronic exposure to radiation(C2)? ○ What is induction of leukaemia, Radiation Carcinogenesis, Risk of carcinogenesis, Animal and human data, shortening of life span - In-utero exposure (C1) What are genetic effects of radiation (C1) ○ Explain factors affecting frequency of radiation induced mutations - Dose-effect relationship - first generation effects - Effects due to mutation of recessive characteristics - Genetic burden - Prevalence of hereditary diseases and defects - Spontaneous mutation rate - Concept of doubling dose and genetic risk estimate. (C2)	12

Content	Competencies	Number of Hours
Unit 4		
Biological Basis of Radiotherapy:	○ Explain physical and biological factors affecting cell survival, tumour regrowth and normal tissue response (C2) ○ Explain non-conventional fractionation scheme and their effect of reoxygenation, repair, redistribution in the cell cycle (C2) ○ Explain high LET radiation therapy (C2)	10
Unit 5		
Time Dose Fractionation	○ Explain time dose fractionation - Basis for dose fractionation in beam therapy (C2) ○ Explain concepts for Nominal Standard Dose (NSD), Roentgen equivalent therapy (RET), Time dose fractionation (TDF) factors and cumulative radiation effects (CRE), Gap correction, Linear and Linear Quadratic models. (C2)	10

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	42	60
Revision	5	20
Assessment	5	
Total	**52**	**80**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	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:	1. Introduction to radiation biology by Uma Devi. P, Satish Rao. B.S, Nagarathnamma 2. Textbook of Radiobiology, Eric J Hall 3. Handbook Of Radiobiology by Kuppusamy Thayalan
Additional References	1. Basic Clinical Radiobiology, 5th Edition by Michael C. Joiner, Albert J. van der Kogel 2. Basic Clinical Radiobiology for Radiation Oncologist, G. Gordon Steel, Edward Arnold, A Member of the Hodder Headline Group, London Boston Melbourne Auckland. 3. Basic Clinical Radiobiology 3rd Edition By Gordon Steel

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Bioethics**
Course Code	**RTT1204**
Academic Year	First year
Semester	II
Number of Credits	3
Course Prerequisite	Nil
Course Synopsis	• Creating awareness about broader global ethical issues in healthcare. • To improve the quality of patient care by identifying, analysing, and attempting to resolve the ethical problems that arise in practice.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify ethical issues within research and health care settings. (C1)
CO2	Identify the historical forces that have contributed to the current systems and these systems' consequences for humanity and/or the environment (C2)
CO3	Develop and use critical thinking skills to analyze information and situations in order to respond and act ethically with regard to research, practice, and technology (C2,P4)
CO4	Define bioethics and explain the fundamentals of the ethical theories and principles that apply to bioethical dilemmas. (C1)
C05	Explain medico legal aspects of medical records (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:		
Medical ethics	○ Define bioethics (C1) ○ List Goal and Scope of bioethics (C1) ○ What is Prayer, Oath, Covenants, Declarations, Guidelines (C1) ○ Explain history of Bioethics (C2) ○ What is code of conduct (C1) ○ Explain basic principles of medical ethics (C2) ○ What is confidentiality (C1)	10

Content	Competencies	Number of Hours
Unit 2:		
Organizational Ethics	○ What is malpractice and negligence (C1) ○ What is rational and irrational drug therapy (C1) ○ Explain risk benefit analysis and compensation (C2,P4) ○ What is the meaning of care of the terminally ill-Euthanasia (C1)? ○ Explain autonomy and informed consent - Right of patients, obtaining an informed consent. (C1) ○ Explain development of standardized protocol to avoid near miss or sentinel events (C2)	12
Unit 3:		
Medico legal aspects of medical records	○ What is medico legal case and its type (C1)? ○ Explain records and document related to MLC - ownership of medical records(C2) ○ What is confidentiality Privilege communication (C1)? ○ Explain release of medical information - Unauthorized disclosure - retention of medical records - other various aspects. (C2)	7
Unit 4		
Animal Ethics	○ Explain ethics in Eastern Philosophy (C2) ○ Explain ethics in Western Philosophy (C2) ○ Explain ethical Issues in Clinical Research (C2) ○ Explain ethical Issues in International Collaboration (C2)	10

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	30	60
Revision	5	
Assessment	4	
Total	**39**	**60**

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

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/Presentations		x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Introduction to ethics by Karen L Rich 2. An Introduction to Ethics Book by John Deigh
Additional References	1. Bio-Medical Ethics by Olinda Timms 2. Textbook of Medical Ethics by Erich H. Loewy

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Hospital Practice and Patient Care**
Course Code	**RTT1205**
Academic Year	First year
Semester	II
Number of Credits	2
Course Prerequisite	Students should have knowledge of basic patient care
Course Synopsis	This course deals with patient care, general procedures to be observed when patients attend for appointment and correct procedures when dealing with patients with infectious diseases, immuno-compromised patients

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain basic nursing care and patient safety. (C2)
CO2	Explain different procedures in Radiotherapy and its documentation (C2)
CO3	Able to take care of radiotherapy patients under specific circumstances (C2)
CO4	Explain patient management on treatment (C2)
CO5	Explain different legal aspects in patient care (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:		
General care of the patient	Explain different techniques of Lifting and moving for patient and staff safety (C2) Explain basic nursing procedures for patient care and emergency situations First Aid to include Cardio Pulmonary Resuscitation (C2)	7
Unit 2:		
Procedure in a radiotherapy department	What is room preparation (C1)? Explain treatment review and documentation necessity. (C2) Explain the importance of follow-up assistance with procedures or examinations (C2) Explain the importance of giving Instructions to patients (C2)	5

Content	Competencies	Number of Hours
Unit 3:		
Care under specific circumstances	Explain the following Terms-Care of the cancer patient; Patient privacy, Nutrition, Skin care, Universal precautions, Dietary advice, Laboratory investigations Catheter care, Stoma care Wound care, Unconscious patient, Bone metastases, Physically disabled, Mentally disturbed, Blind, deaf patients, Diabetics patients (C2)	5
Unit 4:		
Patient management on treatment	Explain the side effect related to radiation and dose, Acute, Late (C2) Explain the methods for monitoring of side effects (C2) Explain the steps for management of side effects (C2) Explain the ways to collect information and communication, Documentation of side effects (C2)	6
Unit 5:		
Legal aspects	What is confidentiality (C1) What is informed consent (C1) Explain data protection (C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	12	25
Clinic	6	
Revision	4	
Assessment	4	
Total	**26**	**25**

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

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

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. A Nurse 's Guide to Cancer Care, Brenda M. Nevidjon, Lippincott 2. Basic Medical techniques and patient care for Radiology Technologists, Second Edition.
Additional References	1. Fundamentals of Hospital Practice and Patient Care 2. Radiation Therapy: A Guide to Patient Care 1st Edition by Marilyn Haas

SEMESTER - III

COURSE CODE		COURSE TITLE
PAT2102		Pathology
RTT2101		Radiotherapy Equipments
RTT2102	:	Principles and Practice of Radiology Part I
RTT2103	:	Patient Positioning and Immobilization/ Mould Room Techniques
RTT2131	:	Clinical practice- Radiotherapy Equipments
*** ****	:	Open elective - I

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Pathology**
Course Code	**PAT2102**
Academic Year	Second Year
Semester	III
Number of Credits	2
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 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 heamtological conditions and understand 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 & Terminologies basic terminologies	1. Introduction to pathology 2. Recognise the relevance of Pathology (C2) 3. Define the basic terminologies and branches of Pathology (C1) a) Aaetiology b) Pathogenesis c) Pathological and clinical manifestations d) Complications & sequelae	1

Content	Competencies	Number of Hours
	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) 6. List the components of a granuloma and describe its morphology (C2) 7. List the causes of granulomatous inflammation.(C1)	3

Content	Competencies	Number of Hours
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) 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)	4

Content	Competencies	Number of Hours
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 WBCs	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. Describe the clinical features and laboratory diagnosis of CLL (C2)	2

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	4	12
Assignment	-	-
Total	**30**	**90**

Assessment Methods:	
Formative:	**Summative:**
Quiz/Unit Test / Viva - Nil	First Sessional Exam (SEQ) Second sessional exam (MTF)

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Sessional Examination 1	x	x	x	x		
Sessional Examination 2	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	• Essential Pathology for Dental students, Harsh Mohan, 3rd edition,2010 Jaypee.
	• General and systemic pathology, JCE Underwood and S S Cross, 7thedition, 2018, Churchill Livingstone.

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiotherapy Equipments**
Course Code	**RTT2101**
Academic Year	Second year
Semester	III
Number of Credits	4
Course Prerequisite	Students should have knowledge of basic measurements and quantities using in radiation physics.
Course Synopsis	This course covers the instrumentation, principle and working of different radiotherapy equipment's.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Understand structure of X ray tube, each part of it and its working. (C2)
CO2	Understand different types of accelerators and its working (C2)
CO3	Explain working of teletherapy machines and its different parts. (C2)
CO4	Principle and functioning of brachytherapy and simulator machine. (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							

Course Content and Outcomes:

Content	**Competencies**	Number of Hours
Unit 1:		
X ray tube	• What is filtration (C1) • Explain different parts of X ray tubes (C2) • Explain quality of X ray (C1) • What is angular distribution of X-rays (C1) • Explain the function and parts of anode tubes (C2) • Explain CT and DSA applications (C2)	10
Unit 2:		
Accelerators	Explain the structure and working of (C2) • Van de Graaff generator • Cyclotron • Microtron • Klystron • Magnetron	12
Unit 3:		
Teletherapy Machines & Accessories	• Explain working and accessories of Isotope machines (C2) ○ Cesium 137 Units ○ Cobalt 60 teletherapy units	10

Content	Competencies	Number of Hours
	• Explain Cobalt 60 source specification (C2) • Explain source housing and movements (C2) • Explain different types of units, beam collimation and penumbra, electron contamination (C2) • Explain the principle and working of Medical linear accelerators (C2) • Explain beam modifying and defining devices (C2)	
Unit 4:		
Brachytherapy	• Explain about different Radiation sources using in brachytherapy (C2) • Define HDR, PDR, LDR with properties. (C1)	10
Unit 5		
Principles and functioning of simulators	• Explain CT Simulator (C2) • Explain different types of phantoms used in radiotherapy (C2) • Explain different imaging and patient verification systems in Radiotherapy (C2)	10

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	40	80
Revision	6	
Assessment	6	
Total	**52**	**80**

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

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

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Khan's The Physics of Radiation Therapy by Faiz M. Khan 2. Basic Radiological Physics by Thayalan Kuppusamy
Additional References	1. Image Processing in Radiation Therapy (Imaging in Medical Diagnosis and Therapy)" by Kristy K Brock
	2. Radiation Therapy Physics (Medical Radiology)" by W L Brady and H P Heilmann

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Principles and Practice of Radiology Part I**
Course Code	**RTT2102**
Academic Year	Second year
Semester	III
Number of Credits	3
Course Prerequisite	Students should have the basic knowledge of radiation physics.
Course Synopsis	1. This module helps to understand the basic physics underpinning diagnostic radiography and imaging science 2. To understand the mechanisms describing production and interactions of ionizing radiation 3. To discuss the component and working principle of imaging and treatment equipment used for the clinical care of patients. 4. To provide fundamental knowledge of the skeletal system and the different part of the bones. 5. To provide fundamental knowledge of the various radiographic x-ray basic views for the head, neck, thorax, abdomen, pelvis, upper limb, lower limb and spine. 6. 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	Discuss the production and interactions of x-ray and the equipment used for the production of x-ray and beam limiting devices used in radiology. (C3)
CO2	Explain the principle of CR and DR. Illustrate the components, workflow, and image formation associated with computed and digital radiography (C2)
CO3	Explain about the PACS in medical imaging and explain the components, function and types of PACS. Review the function of DICOM (C2).
CO4	Explain about the related radiological anatomy. (C2)
CO5	Explain the basic projections related to appendicular skeleton (head, neck, thorax, abdomen, pelvis, upper limb, lower limb and spine). (C2)
CO6	Explain the clinical indications and preparation of the patient for the various radiological projections. (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		x	

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Introduction to radiology	• List the various modality used in radiology. (C1) • What are the advantage and disadvantage of various modality used in radiology? (C1)	1
Unit 2:		
Ionizing Radiation: Production of X-ray	• Explain the history invention of x-ray. (C2) • Explain the properties of x-ray(C2) • Explain the production of x-rays(C2) • Classify the interactions between electron and target. (C2) • Illustrate the continuous and characteristic X-Ray spectrum. (C2) • Identify the factor affecting the quality and quantity of x-rays(C3) • Explain the thermionic emission (C1)	**2**
Interaction of X-ray with matter	• Define the interactions between x-rays and Matter(C1) • Classify the interactions between x-rays and Matter(C2) • Explain coherent scattering, photoelectric effect, compton scattering, pair production and photodisintegration. (C2) • Identify the effect of Interactions between x-rays and matter in diagnostic radiology(C3)	**3**
Unit 3:		
X- ray tube	• Outline the parts and working principle of Stationary anode x-ray tube and rotating anode X-ray tube. (C2) • Explain the heel effect and line focus principle (C2) • Explain the modern x-ray tube(C2)	**3**
Unit 4:		
Beam limiting devices used in radiology • Filter	• Define the filtration and filters(C1) • Classify the different level the x-ray is filtered after the production in x-ray tube (inherent filtration, added filter, and patient). (C2) • Explain wedge filters and K-Edge filters. (C2) • Explain the molybdenum filters. (C2) • How the filters effect the patient exposure(C1) • Explain the effect on exposure factors(C2)	**2**
• Beam restrictors	• Define X-Ray Beam Restrictors(C1) • Classify the different type of x-ray beam Restrictors (aperture diaphragms, cones, and cylinders, collimators). (C2) • Interpret the testing of x-ray beam and light beam alignment. (C2)	**1**
• Grid	• Define grids(C1) • Explain grid ratio(C2) • List the grid pattern (linear grid, crossed grid, focused	**2**

Content	Competencies	Number of Hours
	grid, parallel grid). (C1) • Explain the evaluation of grid performance (primary transmission, bucky factor, and contrast improvement factor) (C2) • Define the grid cut-off(C1) • List the grid cut-off (focused grids used upside down, lateral decentring, focus-grid distance decentring and combined lateral and focus-grid distance decentring). (C1) • Choose the grid for proper image quality in radiography(C1) • Define the air gap techniques(C1)	
Unit 5:		
Computed Radiography	• Recall sequence of activities involved in screen-film radiography (C1) • Define Photo-stimulable luminescence (C1) • 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) • Summarize the advantages and disadvantages of using CR (C2)	**3**
Unit 6:		
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) • Compare direct and indirect DR(C2) • List out Advantages and disadvantages in DR (C1)	**3**
Unit 7:		
Picture Archival Communication (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)	**1**
Unit 8: Radiographic technique:		
Introduction • General terms • Body planes, sections, and lines,	• Explain the various anatomical body planes, sections, lines, body surfaces and parts. (C2) • Explain the various radiographic positions and Terminology. (C2) • Explain the various radiographic projections and	**1**

Content	Competencies	Number of Hours
• Body surfaces and parts, • Radiographic projections, • Body positions, • Terms related to movements	terminology. (C2)	
Related radiological anatomy and pathology chest	• Explain the related radiological anatomy of Chest**.** (C2). • Classify the indications for Chest radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP), Posterior Anterior (PA) • Lateral	• Explain the patient preparation required for basic chest radiographic projection (C2). • Explain the step wise process of positioning for basic chest projection (C2). • Identify appropriate centring for basic chest radiography (C2). • State the radiographic exposure factors for basic chest radiography (C1). • Identify the structure seen on basic projection chest radiographic image (C2).	
Related radiological anatomy and pathology Shoulder girdle	• Explain the related radiological anatomy of Shoulder (C2). • Classify the indications for shoulder radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP), • Axial	• Explain the patient preparation required for basic shoulder radiographic projection (C2). • Explain the step wise process of positioning for basic shoulder projection (C2). • Identify appropriate centring for basic shoulder radiography (C2). • State the radiographic exposure factors for basic shoulder radiography (C1). • Identify the structure seen on basic projection shoulder radiographic image (C2).	
Related radiological anatomy and pathology Humerus	• Explain the related radiological anatomy of humerus. (C2). • Classify the indications for humerus radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP), • Lateral	• Explain the patient preparation required for basic humerus radiographic projection (C2). • Explain the step wise process of positioning for basic humerus projection (C2). • Identify appropriate centring for basic humerus radiography (C2). • State the radiographic exposure factors for basic humerus radiography (C1). • Identify the structure seen on basic projection humerus radiographic image (C2).	

Content	Competencies	Number of Hours
Related radiological anatomy and pathology Elbow Joint	• Explain the related radiological anatomy of elbow joint (C2). • Classify the indications for elbow joint radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP), • Lateral • Oblique-lateral (external, internal) rotation	• Explain the patient preparation required for basic elbow joint radiographic projection (C2). • Explain the step wise process of positioning for basic elbow joint projection (C2). • Identify appropriate centring for basic elbow joint radiography (C2). • State the radiographic exposure factors for basic elbow joint radiography (C1). • Identify the structure seen on basic projection elbow joint radiographic image (C2).	
Related radiological anatomy and pathology Forearm	• Explain the related radiological anatomy of forearm (C2). • Classify the indications for forearm radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP), • Lateral • Oblique	• Explain the patient preparation required for basic forearm radiographic projection (C2). • Explain the step wise process of positioning for basic forearm projection (C2). • Identify appropriate centring for basic forearm radiography (C2). • State the radiographic exposure factors for basic forearm radiography (C1). • Identify the structure seen on basic projection forearm radiographic image (C2).	
Related radiological anatomy and pathology Hand	• Explain the related radiological anatomy of hand. (C2). • Classify the indications for hand radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Posterior Anterior (PA) • Lateral • Oblique	• Explain the patient preparation required for basic hand radiographic projection (C2). • Explain the step wise process of positioning for basic hand projection (C2). • Identify appropriate centring for basic hand radiography (C2). • State the radiographic exposure factors for basic hand radiography (C1). • Identify the structure seen on basic projection hand radiographic image (C2).	
Related radiological anatomy and pathology Pelvic girdle and femur	• Explain the related radiological anatomy of pelvic girdle and femur (C2). • Classify the indications for pelvic girdle and femur radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Laterral • AP bilateral	• Explain the patient preparation required for basic pelvic girdle and femur radiographic projection (C2). • Explain the step wise process of positioning for basic pelvic girdle and femur projection (C2). • Identify appropriate centring for basic pelvic girdle	

Content	Competencies	Number of Hours
"frog-leg"	and femur radiography (C2). • State the radiographic exposure factors for basic pelvic girdle and radiography (C1). • Identify the structure seen on basic projection pelvic girdle and radiographic image (C2).	
Related radiological anatomy and pathology Knee Joint	• Explain the related radiological anatomy of knee joint**.** (C2). • Classify the indications for knee joint radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Lateral	• Explain the patient preparation required for basic knee joint radiographic projection (C2). • Explain the step wise process of positioning for basic knee joint projection (C2). • Identify appropriate centring for basic knee joint radiography (C2). • State the radiographic exposure factors for basic knee joint radiography (C1). • Identify the structure seen on basic projection knee joint radiographic image (C2).	
Related radiological anatomy and pathology Leg	• Explain the related radiological anatomy of leg**.** (C2). • Classify the indications for leg radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Lateral • Oblique	• Explain the patient preparation required for basic leg radiographic projection (C2). • Explain the step wise process of positioning for basic leg projection (C2). • Identify appropriate centring for basic leg radiography (C2). • State the radiographic exposure factors for basic leg radiography (C1). • Identify the structure seen on basic projection leg radiographic image (C2).	
Related radiological anatomy and pathology Ankle joint and Foot	• Explain the related radiological anatomy of ankle joint and foot**.** (C2). • Classify the indications for ankle joint and foot radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Lateral • Oblique	• Explain the patient preparation required for basic ankle joint and foot radiographic projection (C2). • Explain the step wise process of positioning for basic ankle joint and foot projection (C2). • Identify appropriate centring for basic ankle joint and foot radiography (C2). • State the radiographic exposure factors for basic ankle joint and foot radiography (C1). • Identify the structure seen on basic projection ankle joint and foot radiographic image (C2).	
Related radiological anatomy and pathology	• Explain the related radiological anatomy of abdomen and KUB. (C2). • Classify the indications for abdomen and KUB	**1**

Content	Competencies	Number of Hours
Abdomen and KUB	radiography (C2).	
Basic Projection • Anterior Posterior (AP)	• Explain the patient preparation required for basic abdomen and KUB radiographic projection (C2). • Explain the step wise process of positioning for basic abdomen and KUB projection (C2). • Identify appropriate centring for basic abdomen and KUB radiography (C2). • State the radiographic exposure factors for basic abdomen and KUB radiography (C1). • Identify the structure seen on basic projection abdomen and KUB radiographic image (C2).	
Related radiological anatomy and pathology Cervical spine and Neck	• Explain the related radiological anatomy of cervical spine and neck**.** (C2). • Classify the indications for cervical spine and neck radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Lateral	• Explain the patient preparation required for basic cervical spine and neck radiographic projection (C2). • Explain the step wise process of positioning for basic cervical spine and neck projection (C2). • Identify appropriate centring for basic cervical spine and neck radiography (C2). • State the radiographic exposure factors for basic cervical spine and neck radiography (C1). • Identify the structure seen on basic projection cervical spine and neck radiographic image (C2).	
Related radiological anatomy and pathology Thoracic spine	• Explain the related radiological anatomy of thoracic spine (C2). • Classify the indications for thoracic spine radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Lateral • Oblique	• Explain the patient preparation required for basic thoracic spine radiographic projection (C2). • Explain the step wise process of positioning for basic thoracic spine projection (C2). • Identify appropriate centring for basic thoracic spine radiography (C2). • State the radiographic exposure factors for basic thoracic spine radiography (C1). • Identify the structure seen on basic projection thoracic spine radiographic image (C2).	
Related radiological anatomy and pathology Thoracic spine, Lumbar spine, sacrum and coccyx	• Explain the related radiological anatomy of thoracic spine**,** lumbar spine, sacrum and coccyx. (C2). • Classify the indications for thoracic spine, lumbar spine, sacrum and coccyx radiography (C2).	**2**
Basic Projection • Anterior Posterior (AP) • Lateral	• Explain the patient preparation required for basic thoracic spine, lumbar spine, sacrum and coccyx radiographic projection (C2). • Explain the step wise process of positioning for basic	

Content	Competencies	Number of Hours
	thoracic spine, lumbar spine, sacrum and coccyx projection (C2). • Identify appropriate centring for basic thoracic spine, lumbar spine, sacrum and coccyx radiography (C2). • State the radiographic exposure factors for basic thoracic spine, lumbar spine, sacrum and coccyx radiography (C1). • Identify the structure seen on basic projection thoracic spine, lumbar spine, sacrum and coccyx radiographic image (C2).	
Related radiological anatomy and pathology Skull	• Explain the related radiological anatomy of skull. (C2). • Classify the indications for skull radiography (C2).	**1**
Basic Projection • Anterior Posterior (AP) • Posterior Anterior (PA) • Lateral	• Explain the patient preparation required for basic skull radiographic projection (C2). • Explain the step wise process of positioning for basic skull projection (C2). • Identify appropriate centring for basic skull radiography (C2). • State the radiographic exposure factors for basic skull radiography (C1). • Identify the structure seen on basic projection skull radiographic image (C2).	
Radiation protective measures during routine radiography	• List the radiation protection method used radiography (C1).	**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	10
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	Record Book
Clinical assessment (OSCE, OSPE, WBPA)	
Clinical/Practical Log Book/ 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					x	x
Quiz / Viva						
Assignments/Presentations				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:	• 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. • Text Book of Radiography Positioning and Related Anatomy, Bontrager Kenneth L; Lampignano John P
Additional References	• Merrill's Atlas of Radiographic Positioning and Radiologic Procedure, Vol 1,2,3 Ballinger Philip W; Frank Eugene D. • Clarks Positioning in Radiography, R.A. Swallow, E. Naylor • Radiologic science for technologists. 9th edition. Stewart Bushong

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Patient Positioning and immobilization/ Mould room techniques**
Course Code	**RTT2103**
Academic Year	Second year
Semester	lll
Number of Credits	2
Course Prerequisite	Students should have knowledge of basic Anatomy
Course Synopsis	1. Acquires knowledge and understanding of the basic sciences as well as the interaction between the technology used in radiotherapy and the site within the body that is irradiated. 2. Upon completion of the course the student would have acquired enough knowledge in the principles of positioning of the patient for different anatomical sites throughout the treatment. 3. The preparation of the Immobilization device as well as in the practical aspects of the immobilization devices. Immobilization methods - Method of beam Alignment - Treatment Execution-Treatment verification -changes in patient position, target volume and critical volume during course of treatment.

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

CO1	Explain concept, Objective, preparation and characteristics of various immobilization devices.(C2)
CO2	Explain the concept of breathing control and real time tracking in motion management techniques, types of lasers used in patient positioning, determination of Isocenter and reference points (C2)
CO3	Explain different modalities of image acquisition for planning, different modalities for image acquisition, different types of simulators, their need and functions and Preparation of brachytherapy mould. (C2)
CO4	Explain about different beam shaping devices (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:		
Introduction	• Define immobilization(C1) • List patient positioning devices (C1) • Explain thermoplastic masks.(C2) • What are the advantages of thermoplastic mould (C1) • What are the objective .the immobilization devices (C1) • Briefly explain the concept of immobilization diaphragm (C2) • What are the different immobilization devices used in treatment of breast (C2) • What are the objective of the immobilization devices. (C2) • List the Objective and characteristics of the immunization devices(C1) • List the disadvantages of acrylic mould (C1) • List the different patient elevation systems (C1**)** • Explain shoulder retractor (C2) • List different patient elevation system and explain any three (C1,C2)	5
Unit 2:		
Internal organ motion control	• Briefly explain individual malignancies immobilization in oral cavity (C2) • Explain the concept of breathing control and real time tracking (C2) • Briefly explain the respiratory motion management technique for chest and abdominal radiotherapy (C2) • List the different lasers used in patient positioning in radiotherapy (C1**)** • Explain on laser (C2)	6
Unit 3:		
Image acquisition for planning (and/or verification)	• Explain 4DCT simulator (C2) • Explain video based portal imaging. (C2) • Explain the function of radiotherapy simulator (C2) • Explain brachytherapy mould(C2) • Briefly explain the concept of patient verification systems. What are the different patient verification system explain each (C2) • Explain KV-CBCT (C2) • Explain the function of need of radiotherapy simulator .write a short note on MV-CBCT (C2) • Explain electronic portal imaging system. • Explain acquisition of patient data (C2) • Explain (C2) a .CT-simulator b. X-ray simulator	7
Unit 4:		
Beam shaping devices	• What is wedge angle (C1)	8

Content	Competencies	Number of Hours
	• Explain tissue compensator (C2). • Define wedge factor (C1) • List the density of lead and cerrebond (C1) • Name the different types of wedges (C1) • Explain shielding block (C2) • What are the different types of wedges explain in detail (C1) • List melting point lead and Cerro bend (C1) • Explain the composition of cerrebond (C1) • Define divergent block(c1) • What are the types of block (C1) • What are different types of compensator (C1)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	18	50
Revision	4	10
Assessment	4	10
Total	**26**	**70**

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

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Patient Positioning and Immobilization in Radiation Oncology by Gunilla Carleson Bentel. 2. Basics of Planning and Management of Patients during Radiation Therapy by Mukherji, Ashutosh

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Clinical practice- Radiotherapy Equipments**
Course Code	**RTT2131**
Academic Year	Second year
Semester	III
Number of Credits	6
Course Prerequisite	Students should have basic knowledge of basic science subjects, radiation physics, and Radiotherapy Equipment's.
Course Synopsis	This course will give introduction for the candidate about the radiotherapy equipment's for clinical applications in Radiotherapy department, expose them to the different imaging procedures, to maintain documentations, stock inventory and to get acquainted about Radiation safety .

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Understand the handling of radiation generating equipment's and practice radiation safety (C3, P3)
CO2	Understand the importance of patient identification and positioning for immobilization Radiotherapy practice (C3, P3)
CO3	Understand the basic requirements of immobilization devices and its usage in Radiotherapy practice (C3, P3)
CO4	Understand different imaging protocols for Radiotherapy imaging (C3, P3)
CO5	To maintain documentations and stock inventory (C3, P3)
CO6	Learn the importance of effective communication, team work, ethical values and professionalism(C3, P3)

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	x			

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Patient identification and Documentation	1. To identify the right patient for the purpose with name and hospital number (C1, P3) 2. To document patient details and maintain registers (C2, P3) 3. To explain procedures to patient and to practice as per regulatory guidelines (C2, , P3)	60

Content	Competencies	Number of Hours
Unit 2:		
Patient positioning and Immobilization	1. To locate and identify stock inventory (C2, P3) 2. To observe operating various non-imaging device and radiation generating equipment's (C3, P3) 3. To record the patient position (C3) 4. To understand preparation mould and placing reference markers (C3) 5. To write and maintain registers (C3)	60
Unit 3:		
Patient Imaging	1. To arrange imaging room for daily activities (C1, P3) 2. To practice daily QC of imaging and other accessory devices (C3, P3) 3. To explain procedures to patient and to practice as per regulatory guidelines (C2, P3) 4. To observe scans and processing techniques (C3, P3) 5. To observe registration of patient details in R&V system 6. To write and maintain registers (C3)	60
Unit 4:		
Radiation Therapy Practices	1. To locate and identify stock inventory (C2, P3) 2. To observe and practice the functional checks of radiation generating equipment's (C3, P3) 3. To express procedures to patient and to practice as per regulatory guidelines (C2) 4. To learn and practice the use of personal monitoring devices (C3) 5. To write and maintain registers (C3, P3)	54

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)		60
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic	160	
Practical		
Revision	9	
Assessment	5	
Total	**174**	**60**
Formative:	**Summative:**	
Viva	Viva	
Clinical assessment	Log Book	
Clinical Log Book	End Semester Exam: NA	

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

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Walter and Millers, Text Book of Radiotherapy, Radiation Therapy Physics, Therapy and Oncology. C.K. Bomford, 6th Edition, Churchill Livingstone.
	2. Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby.
Additional References	1. The Physics of Radiation Therapy- Faiz M Khan 2. Radiation Therapy Physics- William Hendee, Mosby 3. Radiation detection and measurement-G F Knoll

SEMESTER - IV

COURSE CODE		COURSE TITLE
RTT2201	:	Physics of External Beam Radiotherapy
RTT2202	:	Principles and Practice of Radiology Part II
RTT2231	:	Clinical Practice- Radiation Beam therapy
RTT ****	:	Program Elective - I

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Physics of External Beam Radiotherapy**
Course Code	**RTT2201**
Academic Year	Second year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have knowledge of basic radiation physics and equipment's.
Course Synopsis	This course deals with depth dose distribution, dose calculation and treatment planning in Tele therapy machines using photon and electron beams

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

CO1	Explain the physics and Explains the characteristics of Clinical Photon Beams; Dose Distribution and Scatter Analysis used in tele therapy machine for the treatment purpose.(C2)
CO2	Explain the concept of system of dosimetric calculation, dose parameters and isodose distribution used in the external beam radiotherapy (C2)
CO3	Explain patient Data, Corrections, Setup, Field Shaping, Skin Dose, and Field Separation technique. Combination of radiation field, using beam modifying device, factors affecting the dose distribution (C2)
CO4	Explain the physics behind the Clinical Electron Beams treatment and its Depth dose distribution and its calculation (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	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Units1 Clinical Photon Beams	• Explain Clinical Photon Beams characteristics (C2) • Explain Dose Distribution and Scatter Analysis of photon beam (C2) • Explain radiation treatment parameters (C2) • Define (C1) • Field size • SSD, • SAD, • SCD, • Explain Field collimators (C2) • Explain Phantom, Tissue Equivalent material (C2)	2

Content	Competencies	Number of Hours
Unit2 Point dose calculations	• Explain on dose calculation parameters (C2) • Explain Percentage Depth dose (PDD) (C2) • Explain the Conversion of Percent Depth Dose from One SSD to Another (C2) • Explain the Relationship between TAR and PDD • Explain the Relationship between TMR and PDD (C2) • Explain Scatter Factor (PSF) (C2) • Explain (C2) • Tissue Air Ratio (TAR), • Tissue Maximum Ratio(TMR), • Define Scatter Function, • Define Scatter Air Ratio (SAR), • Scatter Maximum Ration	3
Unit 3 Factors and Isodose distribution	• Define (C1) • Collimator Factor • Relative Dose Factor, • Explain Off Axis Ratio, and beam profiles (C2) • Define the treatment monitor unit calculation (C1) • Explain about Treatment time and monitor unit calculations for a fixed source to surface distance set-up (C2) • Explain the Monitor unit and treatment time calculations for isocentric set-ups (C2) • Explain Treatment time calculation for orthovoltage and cobalt-60 units (C2) • Explain Calculation of Dose in Rotation Therapy (C2) • Explain the method of calculating the depth dose distribution in irregular field, off axis, under the block, outside the field (C2) • Define Normalization of dose distributions (C1) • Explain Dose Calculation in Irregular Fields—Clarkson's Method (C1) • Explain Isodose distribution (C2) • Explain Isodose curves (C2) • Explain the Parameters of Isodose Curves (C2)	4
Unit 4 Combination of Radiation Fields	• Explain Combination of Radiation beam and its clinical applications (C2) • Explain Multiple Fields technique Isocentric Techniques, Rotation therapy (C2) • Explain about the treatment plan evaluations (C2) • Define Integral Dose (C1) • Define lateral edge effect (C1) • Explain Wedge filters (C2) • Explain Wedge Field Techniques (C2)	5
Unit 5 Acquisition of Patient Data	• What are the methods of Acquisition of Patient Data and Explain Ct, MRI, ultrasound, acquisition? (C1) • Explain Manual method of contouring (C2) • Explain CT simulator (C2)	5

Content	Competencies	Number of Hours
	• Explain about conventional treatment Simulation (C2) • Explain about computer tomography based conventional treatment simulation (C2) • Explain computed tomography based Virtual simulation (C2) • Explain MRI and CT based treatment planning (C2) • Explain the Tumour Dose Specification for External Photon Beams (C2) • Explain Treatment Verification system and its advantages (C2) • Explain port film ,gamma camera, EPID, CBCT,MVCT (C2)	
Unit 6 Field shaping devices	• Explain about Tissue compensators (C2) • Explain (C2) • Field block • Shielding blocks, • Explain (C2) • Filters • Field Shaping, how and why • Skin Dose, and sparing • Explain the different Methods of Field Separation (C2) • Explain the dosimetric and guideline in field separation (C2)	6
Unit 7 Basic clinical dosimetry and correction methods	• Explain the Corrections methods irregular contours and oblique beam incidence for body inhomogeneity; effective ssd, TMR method, isodose shift method (C2) • Explain the Corrections for Tissue In homogeneities (C2) • Explain the Corrections for Beam Attenuation and Scattering-TAR method, power law method, equivalent TAR method, isodose shift method (C2) • Explains Contour shapes and beam obliquity effects. (C2) • Explain the absorbed Dose within an Inhomogeneity (C2) • Explain about Bone tissue interface (C2) • Explains the Factors affecting dosimetry quantities (C2) • Explain irregular fields dosimetry (C2) • Define collimator and phantom corrections (C1)	6
Unit 8 Clinical Electron Beams	• Define Clinical Electron Beams properties (C1) • Explain Electron interaction (C2) • Explain Energy Specification and Measurement (C2) • Explain the Determination of Absorbed Dose (C2) • Explain the Characteristics of Clinical Electron Beams (C2)	8

Content	Competencies	Number of Hours
	• Explain the central axis depth dose distributions of electron in water (C2) • Explain the dosimetric parameters of electron beams (C2) • Explain the Electron treatment planning (C2) • Explain the clinical consideration in electron beam therapy (C2) • Explain Corrections for Air Gaps and Beam Obliquity (C2) • Explain the Tissue in homogeneities for electron (C2) • Explain about electron beam combination techniques (C2) • Explain the field shaping methods (C2) • Explain the electron arc therapy (C2) • Explain the Depth dose distribution (C2)	

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	25	75
Revision	7	
Assessment	7	
Total	**39**	**75**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**		
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations		x	x	x		
Unit test	x	x	x	x		
End Semester Exam (Theory)	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1 Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby
	2 Radiotherapy: Principles and Practice, A Manual for quality in Treatment delivery, Sue E. Griffith, Churchill Living stone. 3 The Physics of Radiation Therapy- Faiz M Khan

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Principles and Practice of Radiology Part II**
Course Code	**RTT2202**
Academic Year	Second year
Semester	**IV**
Number of Credits	3
Course Prerequisite	Nil
Course Synopsis	1. This module provides the students to understand the History, Invention of CT scanner, and MRI scanner 2. To provide the fundamental knowledge of the basic working principle of computed tomography and also the principle of the reconstruction algorithms 3. To provide the knowledge of Generations of the evolution of CT 4. To provide fundamental knowledge about the various part that compromise the CT scanner, including detector technology. 5. To provide fundamental knowledge about MRI and Safty in MRI.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the principle of fluoroscopy. Illustrate the components, and workflow digital Fluoroscopy? (C2)
CO2	Explain the principle of digital subtraction angiography and its type. (C2)
CO3	Explain the physics of computed tomography and Compare various generations of computed tomography (C2).
CO4	List and identify the components of computed tomography instrument, Categories ,detector technology and acquisition of data (C3).
CO5	Explain the process of image formation and post-processing (C2).
CO6	Explain the basic principle of MRI and MRI safety (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						x	
CO4	x						x	
CO5	x						x	
CO6	x							

Course Content and Outcomes:

Content	Competencies	Number of Hours
UNIT 1:		
Digital fluoroscopy	• Outline the workflow in Digital fluoroscopy (C2) • Explain and label components of digital fluoroscopy. (C2, C1) • List out Advantages and disadvantages in digital fluoroscopy (C1) • Explain the basic principle and technique of Digital Subtraction Angiography (DSA). (C2)	3
UNIT 2:		
Introduction to CT.	• Knowledge about the history and Invention of CT (C2). • Explain the differences between CT technology with other imaging Modalities (C2). • Explain the advantages of CT (C2).	2
UNIT 3:		
CT Principle	• Explain the basic principle of CT (C2). • Define CT numbers (C2). • List the CT numbers of the various tissues/organs of the body (C1). • Explain the significant and clinical application of CT numbers (C2).	3
UNIT 4:		
CT Generations	• Explain 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 5:		
CT Detectors Technology	• Explain CT detector Technology (C2). • Classify the types of CT detectors (C2). • Explain the working principle of the different types of CT detectors (C2).	4
UNIT 6:		
Image reconstruction	• Explain the basic principle of various reconstruction algorithms (C2). • Explain the different types of reconstruction algorithms (C2). • Compare the types of reconstruction algorithms(C2). • Outline advantages and disadvantages of various reconstruction algorithms (C2).	4
UNIT 7:		
Instrumentation	• Explain about the X-ray tubes used in CT (C2).	5

Content	Competencies	Number of Hours
	• 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). • Identify the procedures for troubleshooting and maintenance of imaging and processing systems (C3)	
UNIT 8:		
Image display and Post Processing Techniques	• Define pixel and voxel and their significances (C1) • Define window width and window level and their significances (C1). • Explain the principle and also application of the various post processing techniques in CT such as Volume rendering, Surface rendering, MIP, MinIP, fats assessment, panoramic view, virtual endoscopy etc) (C2).	5
UNIT 9:		
Introduction to MRI	• Explain about the history and Invention of MRI (C2). • Explain the differences between MRI technology with other imaging Modalities (C2). • Explain the advantages of MRI (C2).	3
UNIT 10:		
Basics of MRI	• Explain the basic principle of MRI(C2). • Explain MRI safety (C2). • Outline various MRI safety measures (C2).	5

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time**
Lecture	26	78
Seminar		
Small group discussion (SGD)	4	8
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	9	18
Total	**39**	**102**

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 Log Book/ 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				x	x		
Quiz / Viva							
Assignments/Presentations						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:	• Seeram CT by Dr Euclid Seeram						
	• Christensen's Physics Of Diagnostic Radiology Thomascurry, 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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Clinical Practice- Radiation Beam therapy**
Course Code	**RTT2231**
Academic Year	Second year
Semester	IV
Number of Credits	11
Course Prerequisite	Students should have knowledge of clinical Practice - Radiotherapy Equipments
Course Synopsis	This course will give introduction for the candidate about the scheduling for treatment, preparation of beam modifying devices, patient positioning and verification. Patient preparation for conventional RT.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Understand the importance of scheduling the patient treatment(C3, P3)
CO2	Understand the use and procedures to prepare beam modifying devices like bolus, electron cutouts etc. (C3, P3)
CO3	Understand different ways of patient positioning according to the area of treatment (C2, P3).
CO4	Understand the importance of reproducing patient positioning and its verification using different devices available in Radiotherapy Department(C3, P3)
CO5	To maintain documentations and stock inventory (C3, P3)
CO6	Learn the importance of effective communication, team work, ethical values and professionalism(C3, P3)

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:		
Patient treatment registration and scheduling	1. To identify the right patient, region of treatment. (C1, P3) 2. To register patient in R & V system with clinical details. 3. To document patient details and maintain registers (C2, P3)	130

Content	Competencies	Number of Hours
	4. To schedule planned and approved radiotherapy Treatment in Record and Verify system (C2, , P3)	
Unit 2:		
Preparation and application of different beam modifying devices	1. To understand patient anatomy (C2, P3) 2. To prepare electron cutouts according to Radiotherapy planning chart (C2, P3) 3. To place bolus according to Radiotherapy planning chart (C2, P3) 4. To observe operating various imaging device and radiation generating equipment's (C3, P3) 5. To arrange inbuilt beam modifying devices (C1, P3)	150
Unit 3:		
Patient positioning	1. To understand different patient positions and set patient according to the requirement using different devices (C1, P3) 2. To fix different immobilization devices used for conventional RT (C3, P3) 3. To verify patient position before starting treatment using imaging devices (C2, P3) 4. To write and maintain registers (C3)	150

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)		200
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic	210	
Practical		
Revision	15	
Assessment	4	
Total	**229**	**200**
Formative:	**Summative:**	
Viva	Viva	
Clinical assessment	Log Book	
Clinical Log Book		

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

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Walter and Millers, Text Book of Radiotherapy, Radiation Therapy Physics, Therapy and Oncology. C.K. Bomford, 6th Edition, Churchill Livingstone. 2. Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby.
Additional References	1. The Physics of Radiation Therapy- Faiz M Khan 2. Radiation Therapy Physics- William Hendee, Mosby 3. Radiation detection and measurement-G F Knoll

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Physics of Brachytherapy**
Course Code	**RTT2241**
Academic Year	Second year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have knowledge of basics of Radiation physics and equipment's
Course Synopsis	• This course deals with radioisotopes used in brachytherapy, dose calculation and treatment planning using brachytherapy machine and the radiation treatment using gamma rays. • This course also deals with different techniques used in brachytherapy and QA procedures for brachytherapy machines

Course Outcomes (COs): At the end of the course student shall be able to:	
CO1	Explain laws of motion and friction, transformers and the their types (C2)
CO2	Explain kirchoff's law, electromagnetic induction and electromagnetic radiation, quantum theory of radiation (C2,)
CO3	Explain Fluorescence and phosphorescence, derive equations for 'ε', and solve the problems on units and measurements (C2)
CO4	Define fundamental units and other basic definitions in physics (C1)

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							

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Basic Physical characteristics	• Define (C1) ▪ Activity Conversion ▪ Decay formula ▪ Mean life ▪ Average energy ▪ Specification of Source Strength ▪ Activity ▪ Exposure Rate at a Specified Distance ▪ Equivalent Mass of Radium ▪ Apparent Activity	8

Content	Competencies	Number of Hours
	▪ Air Kerma Strength ▪ Milligram Radium Equivalent- mgRaeq	
Unit 2:		
Radio nuclides used in Brachytherapy	• Explain the criteria for source selection (C2) • List characteristics of radium and radium substitutes (C1) • List characteristics of (C1) o Cesium-137 o Cobalt-60 o Iridium-192 o Iodine-125 sources	10
Unit 3:		
Calibration of Brachytherapy Sources	• What are the different methods to calculate dose distributions? (C1)	5
Unit 4:		
Systems of Implant Dosimetry	• Explain Paterson-Parker or Manchester system (C2) • Explain the Quimby System (C2) • Explain Paris System (C2)	5
Unit 5:		
Implantation Techniques	• Define surface Moulds (C1) • Explain interstitial Therapy(C2) • What is intraluminal Therapy (C1) • What is Intracavitary Therapy (C1) • Explain dose specification: Cancer of the Cervix (C2)	5
Unit 5:		
The principles of pre-loaded or after loaded techniques	• What are the principles of HDR, LDR, PDR (C1)? • What are dose-rate effects in Brachytherapy – HDR Brachytherapy (C1)	3
Unit 7:		
Quality Assurance	• Explain all QA in Brachytherapy (C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	80
Revision	5	10
Assessment	5	10
Total	**39**	**107**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1 Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby
Additional References	2 Radiotherapy: Principles and Practice, A Manual for quality in Treatment delivery, Sue E. Griffith, Churchill Living stone.
	3 The Physics of Radiation Therapy- Faiz M Khan

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Basics of Nuclear Medicine and safety**
Course Code	**RTT2242**
Academic Year	Second year
Semester	IV
Number of Credits	3
Course Prerequisite	Students should have knowledge in Basics of Nuclear Medicine and safety
Course Synopsis	• This course covers the basics in Nuclear Medicine and safety needed for nuclear medicine technology. • The course Explains the effects of ionizing radiation on living organisms. • To assist the students to learn the basic Nuclear Medicine in order to understand the concept of the sealed and unsealed radioisotopes and their uses in the treatment of cancer • The course emphasizes radiation Safety Consideration in Radionuclide therapy • To deal with the different imaging techniques used in nuclear medicine and physics behind detectors and to identify the fundamentals of nuclear medicine facilities and their applications in day today life.

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

CO1	Explain the basic principles of radiation protection, the fundamental factors by which radiation hazards can be controlled, the nuclear medicine facilities laboratories and to solve related problems(C3)
CO2	Explain about contamination and means to detect radiation, dose limitations for occupational worker and public, I-131 (C2)
CO3	Explain about transport of radioactive material(C2)
CO4	Explain about radioactive waste disposal,contaminations, duties of RSO, employer, radiation worker and the license, and radiation emergencies, and decontamination 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				

Course Content and Outcomes:

Content	Competencies	Number of Hours
Unit 1:		
Radiation Hazards Evaluation and control	• Explain effective Half- life, surface contamination, control of Radiation Hazards in Nuclear Medicine Laboratories. (C2) • Define HVL and TVL in radiation shielding and explain relation between two. (C1,C2) • Explain in detail about the system of radiological protection(C2) • What is External Radiation Hazard, Internal Radiation Hazard? (C1) • Explain the three fundamental factors by which external radiation hazard can be controlled(C2) • What are the three principles of radiation protection? Explain in detail(C1,C2) • Summarize on Time concept in control of external radiation hazard(C1,C2) • Explain Area Monitoring, Personal Monitoring and decontamination procedures, Radiation safety with PET Imaging. (C1)	4
Unit 2:		
Operational Limits	• Define Annual Limit of Intake and Derived Air Concentration(C1) • Explain and mention is the annual dose limits prescribed by the IAEA-BSS and the ICRP for occupational and public exposure? Do these limits include the exposure due to natural background? (C2) • Explain the Principle of Radiation Protection. (C2)	3
Unit 3		
Radiation Safety Consideration in Radionuclide therapy:	• Explain different radionuclide administration techniques. (C2) • Explain in detail about the radiation safety precautions taken during pre and post I-131 therapy (C2) • Explain patient monitoring and discharging criteria for a I-131 therapy patients (C2) • Illustrate how to Optimize the Radiation Dose to Non-Target Tissues in I-131 Therapy. (C2) • Explain in detail about the Radiation safety aspects to be considered during I-131 ablation therapy? (C1,C2) • Explain and mention the safety measures considered while handling bedridden therapy patients (C1,C2) • Explain about the nursing care in radionuclide therapy(C2)	5
Unit 4:		

Content	Competencies	Number of Hours
Radiation Dosimetry	• Explain how to calculate the internal and external dose. (C2) • What is classical dosimetry mechanism. (C1) • Explain MIRD formulation, radiation dosimetry and protection. (C2)	5
Unit 5:		
Calibration and performance check	• Explain the working of (C2) ○ Radiation monitoring instruments ○ area and environmental monitoring ○ external contamination monitoring. • Explain about the working principle of Survey meters(C2) • Explain in detail about contamination monitoring. (C2)	3
Unit 6:		
Disposal of Radioactive Waste	• What are the objectives of radioactive waste management? (C1) • How the radioactive waste is managed in practice and what are the basic approaches in the management? (C1) • List the three general approaches for dealing with radioactive waste. Explain each with practical example in each case. (C1,C2) • Explain how is radioactive waste managed in NM department? (C1,C2) • List the types of radioactive wastes and explain each. (C1,C2) • What is direct and indirect surface contamination monitoring? (C1) • What is fixed and loose contamination? What is the contamination limit for alpha and beta? (C1)	5
Unit 7:		
Planning of Nuclear medicine Laboratories	• Explain different types of laboratories, Requirement of space, Equipment, Facilities, Staff . (C2) • Explain the requirements for Planning of various categories of NM laboratories such as Diagnostic and High Dose therapy, PET CT and Cyclotron Installation. (C2) • Explain Shielding calculation for planning of NM laboratories. (C2) • Explain the requirement for a category I,II, III and category IV nuclear medicine laboratories in respect of staff, area, equipment and monitoring facilities? Explain with a line diagram (C1,C2) • What is occupancy factor? (C1) • What is the equation for shielding calculation and explain the terms(C1) • What is the discharge limits prescribed by AERB	4

Content	Competencies	Number of Hours
	for I-131 effluent waste at discharge point to the public sewerage system(C1) • What is workload? (C1) • Explain and Draw the layout of delay tank for two bedded isolation ward(C1,C2) • Explain about the general procedures (rules) to be followed in a Nuclear Medicine lab to promote radiation safety(C2) • Explain and Draw the layout for category I, II, III and IV nuclear medicine laboratory(C1,C2)	
Unit 8:		
Radiation emergencies in Nuclear Medicine Laboratories	• Explain the emergency preparedness actions involved in nuclear medicine (C2) • List the 3 important steps involved in case of radioactive spill(C1) • What is radiation accidents? Give examples(C1) • What is misadministration in nuclear medicine? Explain the types, consequences, causes and preventive measures taken to avoid misadministration. (C1,C2) • What are the emergency situation likely to be occurred in NM department? Consider a spillage of radioactive material in a radio isotope lab. Explain in detail about the steps that are recommended in dealing with such an emergency situation. Provide an outline of decontamination procedures in such a situation and Explain what future actions, if any, may be necessary(C1,C2) • Explain in detail about the emergency situations likely to be occurred in nuclear medicine department and explain the handling procedures(C2) • Explain how to handle I-131 administered cadaver? (C2) • Explain about decontamination procedures. (C2) • What are the types of misadministration likely to be occurred in nuclear medicine department(C1) • Explain some of the emergency situations that may arise in Nuclear medicine department. (C1)	4
Unit 9:		
Transport of radioactive material	• Explain A1 and A2 values for transport (C2) • Explain detail about the regulations for safe transport of radioactive material (C2) • Define transport index? (C1) • Explain how the packages are classified for transport of radioactive materials? (C2) • Illustrate on different types of packages for transport of radioactive material. (C2) • Explain the procedures adopted to minimize the hazards during the transport of radioactive	4

Content	Competencies	Number of Hours
	material(C2) • Explain the categories of transport packages with diagram(C2) • What is TREMCARD? Explain in brief. (C1,C2)	
Unit 10:		
Legislation and Regulatory Requirements for Nuclear medicine Laboratories	• Explain (C2) ○ Atomic energy Act-1962 ○ Atomic Energy Radiation Protection Rules-2004 ○ Atomic energy Regulatory board, Competent Authority ○ Atomic Energy (Safe Disposal of Radioactive Waste) Rules 1987, AERB Safety Code, Licensing and Authorisation Procedures.	2

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	25	75
Revision	7	10
Assessment	7	10
Total	**39**	**95**

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

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x				
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1.Physics in Nuclear Medicine - by Drs. Simon R. Cherry, ***James*** A. ***Sorenson***, and Michael E
Additional References	2.Fundamentals of Nuclear Pharmacy, Fifth Edition- Gopal B. Saha, Ph.D. 3. Nuclear Medicine Therapy-Principles and Clinical Applications By Aktolun, Cumali, Goldsmith, Stanley J. (Eds.) 4. Nuclear Medicine Physics: The Basics 8th Edition by Ramesh Chandra and Arman Rahmim, Wolters Kluwer | Lippincott Williams and Wilkins

SEMESTER - V

COURSE CODE	:	COURSE TITLE
RTT3101	:	Principles and Practice of Radiotherapy Part I
RTT3102	:	Record Keeping
RTT3103	:	Radiation Protection, Standards and Regulations
RTT3111	:	Practical and Viva -I Radiotherapy Practice
RTT3131	:	Clinical practice- External Beam Radiotherapy
*** ****	:	Open Elective - II

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Principles and Practice of Radiotherapy Part1**
Course Code	**RTT3101**
Academic Year	Third year
Semester	V
Number of Credits	3
Course Prerequisite	Students should have knowledge in basics of Anatomy and Radiobiology.
Course Synopsis	• This course covers the basics of Oncology. • To provide fundamental knowledge of the preparation technique • To identify the fundamentals of physical effects of Radiotherapy.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Principles involved in multidisciplinary approach to cancer treatment (C2)
CO2	Explain Neoplasia. And its its sign and symptoms in the patient (C2)
CO3	Explain the importance of staging in cancer (C2)
CO4	Explain the steps involved in the radiotherapy planning for a patient with cancer (C2)
CO5	Explain common sign and symptoms of cancer, cancer related fatigue, Physical effect of surgery and radiotherapy (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		

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Basics of Oncology	• Explain the steps involved in radiotherapy planning (C2) • What is the rationale for combining multiple treatments in cancer? Explain the differences between the three main modalities of cancer therapy.(C1, C2) • What are the principle involved in multidisciplinary approach to cancer treatment ? Write note on neoadjuvant and adjuvant therapy.(C1, C2)	4

Content	Competencies	Number of Hours
	• Explain briefly on the different method by which cancer is known to spread.(C2) • What is multidisciplinary approach in cancer care? (C1)	
Unit 2:		
Neoplasia	• Explain on radio sensitivity and radio curability, and on factors affecting them.(C2) • What is meant by neoplasia? What are the steps in development of neoplasia Add a note on its sign and symptoms in the patient(C1,C2)) • Explain on Physical effects of neoplasia on the body(C2) • Explain on Simulation of patient and Reduplication of setup(C2) • Define Neoplasia and Oncology(C1)	4
Unit 3:		
Staging of cancer	• What is the importance of staging in cancer? Write in brief on the TNM staging system. (C1, C2) • What is the role of staging in caner management? (C2) • What are the common cancers that are associated with bone metastasis? Write the common complications of bone metastasis. Outline the management of bone metastasis.(C2) • Classify cancer. What are the difference between benign and malignant tumors(C2) • Explain the Common rules in TNM staging system(C2)	4
Unit 4:		
External beam therapy and brachytherapy	• How will you simulate a patient of cancer of the breast(C2) • Define Brachytherapy(C1) • Write about the properties and clincal use of Iridium 192 and Cobalt 60(C2) • Classify between teletheraphy and brachytherapy(C2) • What are the different methods of delivering radiotherapy treatment? What are their advantages and disadvantages?(C1, C2) • List the different steps of radiotherapy planning process. Write in detail on treatment simulation(C1, C2) • Explain the steps involved in the radiotherapy planning for a patient with cancer.(C2) • Explain few point to be considered in patient set up and immobilization for radiotherapy treatment (C2) • Explain bladder protocol in carcinoma of	6

Content	Competencies	Number of Hours
	cervix(C2) • What are the steps to be taken in CT acquisition of patient for radiotherapy planning (C2) • Explain Patient preparation, simulation and reduplication of treatment(C2) • Explain on External beam radiotherapy(C2) • Explain briefly about Linear Accelerator(C2) • Explain Brachytherapy :Rationale and Sources used(C2) • Explain about Split course radiotherapy(C2) • Explain about Bite block in head and neck cancer(C2) • Explain about the uses of Shoulder retractor(C2) • Explain the different type of brachytherapy(C2) • Classify Disadvantages of brachytherapy Different method of treatment in radiotherapy(C2)	
Unit 5:		
Time dose fractionation	• Explain Simulation procedure in cranio spinal irradiation (CSI)(C2) • Explain about altered fractionation schedules(C2) • What is the time dose fractionation (TDF) in radiotherapy(C1) • What are altered fractionation schedules? Write in brief on any two altered fractionation regimes(C2) • Explain the rationale for fractionation in radiotherapy (C2) • Explain in brief about altered fraction regimes.(C2) • Explain the concept of time dose fractionation in radiotherapy(C2) • Name any 2 altered fractionation(C1) • Define TD 5/5 and TD 50/5(C1)	7
Unit 6:		
Radiobiology	• Explain 4 Rs of radiobiology in detail(C2) • Explain the Repair of sub lethal damage(C2) • What is acute radiation syndrome? Explain the Acute radiation syndromes, and write in brief on anyone of them.(C1, C2) • What are the factors affecting early and late reactions? Explain on the late effects of radiation on spinal cord(C2) • Explain Acute and Late effects of Radiation therapy(C2) • Define Hyperfractionation(C1) • Explain about Late effect of radiotherapy(C2) • Explain Sub lethal and supra lethal dose(C2)	4

Content	Competencies	Number of Hours
Unit 7:		
Physical effects of Radiotherapy	• Classify pain. How is a patient with cancer suffering from pain managed? (C2) • What are the common medication used for pain relief(C1) • What is meant by radio sensitivity and radio curability of tumor (C1) • What is the rationale of combining the multiple treatment option in cancer treatment? Explain in brief on neoadjuvant and adjuvant therapies. (C1,C2) • Explain Physical effects of radiotherapy, chemotherapy and surgery on the body(C2) • Explain Physical effects of Chemotherapy (C2) • List any 2 late effects due to cancer chemotherapy(C2) • Explain Complication associated cancer and its management(C2) • Explain Different type of cancer pain(C2) • Explain and define Tumor suppressor genes and oncogenes(C1, C2) • What are the Steps of pain management as per WHO ladder and explain?(C1) • Explain on Medical treatment options for cancer pain (C2)	5
UNIT 8		
Complications with cancer	• Explain common sign and symptoms of cancer? What is meant by cancer related fatigue(C1, C2) • Explain Physical effect of surgery and radiotherapy (C2) • Explain briefly on common causes of death in a patient with cancer,(C2) • Explain Complications associated with cancer and its treatment(C2) • Explain Causes of death due to cancer(C2) • Explain on Survival and Results in Cancer care(C2) • Explain on Clinical Signs of Cancer (C2) • Explain about Complications due to cancer treatment (C2) • List any 2 causes of death due to cancer(C1) • Explain on Clinical Symptoms of Cancer(C2) • Explain Survival and Results in Cancer (C2) • Explain Opioids in cancer pain(C2) • What are the common causes of death in a patient with cancer(C1) • Explain the different ways by which cancer spreads(C2) • Define Cancer cachexia syndrome(C1)	5

Learning Strategies, Contact Hours and Student Learning Time (SLT):							
Learning Strategies	**Contact Hours**			**Student Learning Time (SLT)**			
Lecture	29			100			
Revision	5			10			
Assessment	5			10			
Total	**39**			**120**			
Assessment Methods:							
Formative:	**Summative:**						
Unit Test	Mid Semester/Sessional Exam (Theory)						
Assignments/Presentations	End Semester Exam (Theory)						
Mapping of Assessment with COs:							
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**		
Mid Semester / Sessional Examination 1	x	x	x				
Assignments/presentations	x	x	x	x	x		
Unit test	x	x	x	x	x		
End Semester Exam (Theory)	x	x	x	x	x		
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	1. Radiotherapy: Principles and Practice, A Manual for quality in Treatment delivery, Sue E. Griffith, Churchill Living stone						
Additional References	1. Clinical Oncology for Medical Students and Physicians, Multidisciplinary Approach, Edition 1983 and other editions, Published by the American Cancer Society. 2. Clinical Oncology, Geoffrey R. Weiss, Associate Professor of Medicine, The University of Texas Health Science Center at San Antonio. 3. Cancer Facts, A concise Oncology Text, James F. Bishop, Harwood Academic Publishers. 4. Principles and Practice of Radiation Oncology, Carlos A Perez, 5. Radiation Oncology: Rational technique and results. 8th edition. James D & K.Khan Ang. 6. Clinical Oncology for Medical Students and Physicians. Philip Rubin. American Cancer Society.						

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Record Keeping**
Course Code	**RTT3102**
Academic Year	Third year
Semester	V
Number of Credits	2
Course Prerequisite	Students should have knowledge of patient records.
Course Synopsis	1. This course covers the basics knowledge in maintaining the record. 2. To understand how to improve patient safety by standardizing their health information. 3. To avoid the likelihood of mistakes and missing out the health information of individual patient. 4. To understand the Contents of Medical Records & Form Designing 5. To provide fundamental knowledge in maintaining the information of admission, treatment and discharge. 6. To understand the concept of Numbering and filing system of Medical Records.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain the goals and objectives of Medical Records along with the values of medical records to various users (C2)
CO2	Explain the various methods of numbering system in medical record management., filing system and their types, (C2)
CO3	Describe the format of output patient record and formats used to record the patient information (C2)
CO4	Explain medical record analysis (C2)
CO5	Explain fundamental rules of handling record in healthcare facilities on legibility and completeness in medical record management (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:		
Introduction to Medical Records	• Explain the values of medical record for research forms. (C1) • Explain Edwin smith papyrus. (C2) • Explain four important personalities in history of	9

Content	Competencies	Number of Hours
	medicine and their contributions. (C1) • Name the important text books in Ayurveda medicine their authors and its significance in history of medicine. (C1) • What are the values of medical records for patients? (C1) • Define medical record. (C1) • Explain the goals and objectives of Medical Records(C2) • What is the purpose of maintaining medical records? (C1) • Explain briefly about medical records found in primitive Egyptian medicine. (C2) • Explain the values of medical records for international health agencies. (C1) • Explain the goals and objectives of medical records. (C1) • Name the types of medical papyri and explain each briefly. (C1) • Name two main re-organizers of Ayurveda system of medicine and their contribution in history of medicine(C1) • What are the important personalities in the history of medicine and their contributions? (C1) • What are the purposes of Medical Records? (C1) • Explain the characteristics of good Medical Records(C2) • Explain values of Medical Records for various users(C2) • How medical records are useful for physicians in hospitals (C2)	
Unit 2:		
Numbering and filing system of Medical Records	• Explain serial numbering system(C2) • Define Numbering System What are the three types of numbering system used in Health Care facilities(C1) • Explain integrated Medical Record(C2) • Explain the unit serial II types of numbering system. (C2) • Explain various method of filing of medical record in medical record department. (C1) • List the merits and demerits of alphabetic filing system. (C2) • How many problem oriented medical records can help in improvement in Patient care. (C2) • Explain the various methods of numbering system in medical record management. (C2) • Explain numbering systems used in Health Care facilities(C2) • List merits and demerits of middle digit filing system.	7

Content	Competencies	Number of Hours
	(C2) • Explain middle digit filing system. (C2) • List the advantages of problem oriented medical record. (C2) • Explain source oriented Medical Records? (C2) • Explain Terminal Digit filing system(C2) • What are the three types of numbering system and also mention the advantages and disadvantages of each. (C1) • Expand and explain SOMR (Source Oriented Medical Records) (C2) • Explain about POMR (Problem Oriented Medical Records) with example(C2) • Explain sample sequence of middle digit filing system (C2) • Define filing system used in Medical Record(C1)	
Unit 3:		
Contents of Medical Records & Form Designing	• What do you mean by completeness of medical record? (C1) • Explain format of output patient record. (C2) • Explain a various rule involved in FORM designing. (C2) • Explain format of history and physical examination FORM. (C2) • Explain format for request for X-ray examination. (C2) • Explain format of admission and discharge form(C2) • Explain about few tips in developing new medical record forms (C2) • What are the formats used to record the patient information? (C1) • Define medical record form. (C1) • What are the contents of Medical Records? (C1)	9
Unit 4:		
Indexes and Registers	• Explain an importance of central cancer register(C2) • List the types of indexes and their use(C1) • What is an index. (C1) • List the types of index. (C1) • What is the purpose of those indexes? (C1) • Explain disease and operation index (C2) • Explain important registers maintained in all the hospitals (C2) • What are the important registers used in all the hospitals? (C2) • Explain indexes used in Medical Records (C2) • What are the indexes usually maintained in all the hospitals? (C2) • Define Medico Legal register(C1)	4

Content	Competencies	Number of Hours
Unit 5:		
Analysis in Medical Records	• How medical record analysis can be carried out in medical record department. (C2) • Define medical record analysis. (C1) • Define TRACER CARD in medical record management(C1) • What do you mean by comprehensive or unit record system? (C1) • What are the reasons for analysis of Medical Records? (C1) • What are the types of Medical Record analysis? (C1) • Explain analysis of medical records and explain various types? (C1) • What is internal and external audit? Explain? (C1,C2) • What is qualitative analysis for Medical Records? (C1) • What is the importance of medical record analysis? (C1)	3
Unit 6:		
Medical record in Health care facility	• Explain fundamental rules of handling record in healthcare facilities. (C2) • What are the various physical facilities required for maintenance of medical record? (C1) • Explain the methods of IP and OP records in hospitals. (C2) • Explain confidentiality of medical records. (C2) • What is policy in retention of medical records such as OP records, IP records and records of medico-legal cases. (C1,C2) • Explain flow of In-Patient record through flow chart(C2) • Explain legibility and completeness in medical record management (C2) • Explain the steps in flow of op records? (C2) • Outline a flow chart of record and processing? (C2)	4
Unit 7:		
Computerization and Microfilming of Medical Records	• What is the process involve in computerization of medical record? (C1) • Explain the advantages and disadvantages of computerization of medical record. (C2) • List the need of computerization of medical record(C2) • Explain about the needs, advantages and disadvantages of microfilming of medical records (C2) • Explain Micro filing of Medical Records(C2) • Explain computerization of Medical Records (C2) • Explain Cost Saving (C2) • What are the advantages of Computerized Medical Records? (C2)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):							
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**					
Lecture	29	87					
Revision	5	10					
Assessment	5	10					
Total	**39**	**107**					
Assessment Methods:							
Formative:	**Summative:**						
Unit Test	Mid Semester/Sessional Exam (Theory)						
Assignments/Presentations	End Semester Exam (Theory)						
Mapping of Assessment with COs:							
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**		
Mid Semester / Sessional Examination 1	x	x	x				
Assignments/presentations	x	x	x	x	x		
Unit test	x	x	x	x	x		
End Semester Exam (Theory)	x	x	x	x	x		

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Medical Records, Bernard Benjamin, William Heinermann London
Additional References	2. Medical Record: Organization and Management, Mogli G D, Jaypee Brothers 3. Medical Records Manual: A guide for Developing countries, World Health Organisation.

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiation Protection, Standards and Regulations**
Course Code	**RTT3103**
Academic Year	Third year
Semester	V
Number of Credits	3
Course Prerequisite	Nil
Course Synopsis	1. Content is designed to provide the importance of radiation protection, its standards and regulations which should be followed. 2. Dose limits, Regulatory requirements, Radiation hazard evaluation, Radiation emergency preparedness and QA in Radiotherapy are emphasized.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	• Summarize on radioactive sources, simulators and teletherapy units used in radiotherapy, Define the different types of quantities and its units used in radiation physics (C2)
CO2	• Explain radiation protection, dose limits Summarize on responsibilities of RSO, Licensee, employer and role of technologist in Radiotherapy. (C2)
CO3	• Explain on radiation hazard and its control, Calculation of wall thickness for teletheraply and Brachytherpay facility. (C3)
CO4	• Explain radiation emergencies in teletherapy and brachytherapy facilities, Summarize on QA in LINAC, Brachytherapy units and in simulators. (C2)
CO5	• Explain about various personal monitoring devices and their advantages & disadvantages, explain the expression for relation between HVL and TVL, solving problems related to time, distance, shielding, TVL and HVL (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		X		
CO4			X			X		
CO5						X	X	

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Historical Developments in Radiotherapy	• List the specifications of Ir-192 brachytherapy source (C2) • Briefly explain the physical component of Linear accelerator. (C2) • Summarize on simulator(C2)	3

Content	Competencies	Number of Hours
Unit 2:		
Radiation Quantities and Units	• Explain Annual Limit of Intake(ALI) and Derived Air Concentration(C2) • Define equivalent and effective doses(C2) • Define Kerma and Kerma Rate(C2) • Define Radioactivity, FLUX. Exposure (C1) • Explain various categories of radiation quantities. (C1) • Define radiation weighting factor. (C2) • Define absorbed dose and Kerma. Explain the relationship between two with graph. (C2) • Summarize on natural background radiation. (C2)	3
Unit 3:		
Biological effects of radiation	• Explain chromosome aberration. (C2) • What is acute radiation sickness(C2) • Define LD50/30, LD50/60 (C1) • Explain somatic and hereditary effect. (C2) • Explain the stochastic and deterministic effects(C2) • Explain about the effect of radiation on cell. (C2) • What is the difference between chronic exposure and acute exposure?(C2)	3
Unit 4:		
Operational limits	• Explain the system of radiological protection. (C2) • Explain the recommended dose limits for both occupational workers and public. (C2) • Explain the three principles of Radiobiological protection(C2) • Briefly explain dose limits prescribed by ICRP(60). (C2)	3
Unit 5:		
Regulatory requirements	• Explain the responsibility of Radiation Safety Officer, Licensee, Employer (C2) • Explain the role of Technologist in radiotherapy. (C2)	3
Unit 6:		
Radiation Hazard evaluation and control	• Explain the factor to be taken into account for calculating the wall thickness for Teletherapy installation. (C2) • Define inverse square law, use factor . (C1) • Explain and derive equation for half-life and relationship between half-life and mean life. (C2) • Solve problems related to time, distance and shielding (C3) • Explain principles of radiation protection. (C2)	4

Content	Competencies	Number of Hours
	• Explain the expression for reduction factor.(C2) • Briefly explain the need of radiation protection. (C2) • Explain about radiation hazard and control of external hazard. (C2)	
Unit 7:		
Radiation Protection in Brachytherapy	• Explain emergency situations in brachytherapy. (C2)	3
Unit 8:		
Radiation Emergency Preparedness	• Briefly explain the radiation emergencies in radiotherapy facilities(C2)	5
Unit 9:		
QA in Radiotherapy	• Explain QA test performed in brachytherapy. (C2) • Explain the different daily quality assurance tests to be performed for LINAC(C2)	5
Unit 10:		
Personnel Monitoring	• Explain personal monitoring instruments. (C2) • Summarize on TLD. (C2) • Summarize the advantages and disadvantages of pocket dosimeter(C2) • What are the advantages of film dosimeter (C2)	4
Unit 11:		
	• Derive the expression for relation between HVL and TVL. (C2) • Define Half value layer. (C1) • Solve problems related to HVL(C3)	3

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	**65**
Revision	5	**10**
Assessment	5	**10**
Total	**39**	**85**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments	x	x	x	x	x	
Class test	x	x	x	x	x	
End Semester Examination	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Principles of Imaging Science and Protection, Michael A.Thompson, Janice D. Hall, Marian P. Hattaway, Steven B. Dowd 2. Fundamental Safety Principles, IAEA Safety Standards for protecting people and the environment.
Additional References	1. Physics of Radiation Protection, James E. Martin, A Wiley- Interscience Publication 2. AERB Safety Code “Teletherapy Installations” 3. AERB Safety Code “Brachytherapy Sources; Equipment and Installations” 4. AERB Safety Code “Medical Diagnostic X ray Equipment and Installations”

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Practical and Viva - I Radiotherapy Practice**
Course Code	**RTT3111**
Academic Year	Third year
Semester	V
Number of Credits	2
Course Prerequisite	Students should have knowledge in radiation safety and radiotherapy equipments
Course Synopsis	• This course covers the radiation safety in Radiotherapy Technology • It assists the students to learn the concepts of quality assurance and basic safety checks for the better knowledge • It provides fundamental knowledge that they are working with in their day today life, regarding the basic safety and quality assurance checks

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain and demonstrate different quality assurance procedures in linac to check the performance of the linac (C2, P4)
CO2	Explain and demonstrate different quality assurance procedures of HDR brachytherapy unit to check its performance (C2, P4)

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

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

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
UNIT 1		
Beam quality measurement in Linac	• What is beam quality index?(C1) • Define TPR 20/10(C1) • Explain the procedures for TRP 20/10 (C2,P4)	6
UNIT 2		
congruence of radiation field and light field	• What is radiation field? How can you check the radiation field in Linac? (C1) • What type of films can be used to check the congruence of radiation field and light field? (C1) • Explain the procedure for optical and Radiation field congruence check in linear accelerator (C2, P4)	6
UNIT 3		
Measurement of Transmission factors	• Define and Explain the procedures for Tray transmission factor(C1, C2)	5

	• What is Block transmission factor? Why it is used? Explain in detail how to perform QA for the same(C1, C2) • What is wedge transmission factor? Explain the procedure for performing wedge transmission factor (C1, C2,P4)	
UNIT 4		
Inverse Square law demonstration	• Define inverse square law(C1) • Explain the procedure for Verification of Inverse square law for Photons(C2)	4
UNIT 5		
Brachytherapy QA-source strength measurement	• What is brachytherapy? (C1) • What are the different techniques used in the brachytherapy? (C1) • Explain the procedure for Source strength measurement. (C1, C2)	4
UNIT 6		
Preparation of Mould for head & neck cancers	• What are the different immobilizing devices used in radiotherapy department? (C1) • Why immobilization is done for the patients before delivering radiotherapy? (C1) • Explain the steps for preparation of thermoplastic mould for Head and neck cancers. (C2, P4)	5
UNIT 7		
Preparation of Mould for Pelvis case.	• what are the type of cancers where pelvic moulds are prepared? (C1) • Explain the steps for preparation of thermoplastic mould for cancers. (C2, P4)	6
UNIT 8		
Preparation of Mould for breast cancer.	• What are the important thing to be considered while making pelvic mould? (C1) • Explain the steps for preparation of thermoplastic mould for Breast and cancers. (C2, P4)	6
UNIT 9		
Preparation of Mould for brain cancers	• What are the important thing to be considered while making pelvic mould? (C1) • Explain the steps for preparation of thermoplastic mould for Head and neck, Pelvic, brain, Breast and Esophagus cancers. (C2, P4)	10

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)		20

Problem Based Learning (PBL)							
Case Based Learning (CBL)							
Clinic							
Practical		40					
Revision		10					
Assessment		2					
Total		**52**				**20**	
Formative:		**Summative:**					
Viva		Viva					
Clinical assessment		Log Book					
Clinical Log Book							
Mapping of Assessment with COs:							
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester Examination							
Quiz / Viva		x	x	x	x	x	
Clinical/Practical Log Book/ Record Book		x	x	x	x	x	
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	1 The Physics of Radiation Therapy- Faiz M Khan						
Additional References	1 Quality and Safety in Radiotherapy (Imaging in Medical Diagnosis and Therapy) by Todd Pawlicki, Peter Dunscombe, Arno J. Mundt , Pierre Scalliet 2 Handbook of Radiotherapy Physics: Theory and Practice, Second Edition by Philip Mayles 3 Textbook of Radiotherapy, Radiation Physics, Therapy and Oncology. 6th Edition. C.K. Bomford. Churchill Livingstone.						

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Clinical practice- External beam Radiotherapy**
Course Code	**RTT3131**
Academic Year	Third Year
Semester	V
Number of Credits	7
Course Prerequisite	Students should have basic knowledge of basic science subjects, Radiotherapy Equipment's, Physics of radiotherapy and radiation safety aspects.
Course Synopsis	This course will help the students to know about radiotherapy delivery equipments such as linear accelerator, and brachytherapy units and improves the knowledge on production and clinical applications of the radiation beams.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Prepare the shielding devices (C3, P3)
CO2	Understand the basic requirements of immobilizing devices, its usage in Radiotherapy practice and to accurately position and immobilize all patients as per instructions (C3, P3)
CO3	Understand different imaging protocols for Radiotherapy imaging (C3, P3)
CO4	Understand the simulation and mark-up procedure for all standard treatment techniques, and to deliver radiotherapy using various techniques (C3, P3)
CO5	Learn the importance of effective communication, team work, ethical values and professionalism, Be able to demonstrate a sensitive and caring attitude to patients (C3, P3)

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:		
Patient identification for the radiation therapy	• To identify the right patient for the treatment with name, hospital number and appropriate radiotherapy chart (C3, P3) • To explain procedures to patient and to practice as per regulatory guidelines (C2, P3)	68

Content	Competencies	Number of Hours
Unit 2:		
Patient positioning and Immobilization for the treatment	• To position the patient on the treatment couch using patient specific immobilization devices that was used during the simulation process (C3, P3) • To set the patient for the treatment position (C3, P3)	68
Unit 3:		
Imaging and treatment verification	• To acquire patient images using various imaging devices (C3, P3) • To observe the images and make necessary changes in the patient position (C3, P3) • To verify the patient for the accurate treatment position • To assess patient comfort during before the radiation delivery and to monitor the patient in the whole process(C2, P3)	68
Unit 4:		
Radiation therapy delivery	• To consider all the safety measures prior to the radiation delivery (C2) • To deliver the treatment for the patient based on the specific plan given by the Medical physicist(C3, P3) • To monitor the patient during radiation therapy, and to communicate with the Physicists regarding any troubleshooting (C2, P3) • To prepare the shielding blocks for the electron beam therapy (C3, P3)	69

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)		60
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic	190	
Practical		
Revision	15	
Assessment	8	
Total	**213**	**60**
Formative:	Summative:	
Viva	Viva	
Clinical assessment	Log Book	
Clinical Log Book		

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	CO5	
Mid Semester Examination						
Quiz / Viva	x	x	x	x	x	
Clinical/Practical Log Book/ Record Book	x	x	x	x	x	
Feedback Process:	Mid-Semester Feedback					
	End-Semester Feedback					
Main Reference:	1. Walter and Millers, Text Book of Radiotherapy, Radiation Therapy Physics, Therapy and Oncology. C.K. Bomford, 6th Edition, Churchill Livingstone. 2. Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby.					
Additional References	1. The Physics of Radiation Therapy- Faiz M Khan 2. Radiation Therapy Physics- William Hendee, Mosby 3. Radiation detection and measurement-G F Knoll					

SEMESTER - VI

COURSE CODE		COURSE TITLE
BST3201	:	Biostatistics & Research Methodology
RTT3201	:	Principles and Practice of Radiotherapy Part II
RTT3211	:	Practical and Viva II Radiotherapy Practice
RTT3231	:	Clinical Practice- Advances in Radiation Beam Therapy
RTT ****	:	Program Elective - II

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy 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
Variables	• Distinguish between qualitative & quantitative with appropriate examples (C2) • Distinguish between continuous & discrete variables	4

Content	Competencies	Number of Hours
	with appropriate examples (C2) • Distinguish between nominal & ordinal variables with appropriate examples (C2)	
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 (C3)	2
Graphical presentation of data	• Explain the concepts of Histogram, Frequency Polygon, Frequency Curve (C2) • Construct Histogram, Frequency Polygon, Frequency Curve for statistical data (C3)	2
Diagrammatic presentation of data	• Explain the concepts of Bar diagram and Pie diagram (C2) • Construct Bar diagram and Pie diagram for statistical data (C3)	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 distribution curve (C3)	2
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

Content	Competencies	Number of Hours
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. (C3)	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 Exam (Theory)
End Semester Exam (Theory)	

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Semester / Sessional Examination 1	x	x				
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/lecture_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	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Principle and Practice of Radiotherapy Part II**
Course Code	**RTT3201**
Academic Year	Third year
Semester	VI
Number of Credits	3
Course Prerequisite	Students should have basic knowledge in Oncology
Course Synopsis	• This course covers the basics the etiology and epidemiology of cancer • This subject helps to the students in diagnosis and general management of different sites and acquire practical skills in Treatment preparation and verification. • To understand signs and symptoms of cancer

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain curative, radical and palliative intent of treatment (C2)
CO2	Explain in detail about the etiology and epidemiology, signs and symptoms, diagnosis and general management and prevention of different cancer? (C2)
CO3	Explain briefly about early signs and symptoms of cancer Prevention of cancer (C2)
CO4	Explain different target volumes shown in radiotherapy for treatment planning (C2)
CO5	Briefly explain the various Patient positioning techniques in radiotherapy (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							
CO5	x			x				

Course Content and Outcomes:

Content	**Competencies**	**Number of Hours**
Unit 1:		
Treatment intent	• What are the Curative and palliative intent of treatment? (C1) • Classify radical vs Palliative intent of treatment(C2) • What are the four cardinal principles of palliative care(C1) • Explain about the care given in hospital for palliative care(C2) • Explain about treatment programme to cure	6

Content	Competencies	Number of Hours
	cancer(C2) • Explain about the practice given for palliative care (C2)	
Unit 2:		
Etiology and Epidemiology	• Explain detail about the etiology and epidemiology, signs and symptoms, diagnosis and general management and prevention of breast cancer, head and neck cancer and GIT cancer, lung cancer prostate cancer, CNS cancer prevention of Lymphomas, bladder cancer, oral cavity cancer, (C1, C2) • Explain on hodgkins lymphomas and its risk factors, diagnosis and treatment(C2) • What are the different treatment modalities for breast cancer(C1) • Explain about the anatomy of the oral cavity, head and neck with neat labelled diagram(C1,C2) • Explain about the risk factors of GIT cancer (C2)	6
Unit 3:		
genetics and early detection of cancer	• Explain and define Tumor suppressor genes and oncogenes(C2) • Explain in brief for genetic basis for development of cancer. How can cancer be prevented, name all different cancer genes (C1,C2) • Explain about application of genetics (C2) • Define carcinogenesis(C1) • Explain briefly about early signs and symptoms of cancer(C2) • Explain in detail on public awareness about early sign and symptoms of cancer(C2) • Define carcinogenesis and explain about its types(C1) • Explain about the common cause of cancer(C2)	5
Unit 4:		
Treatment planning	• What are different target volumes shown in radiotherapy for treatment planning and explain all? (C1, C2) • Define OR and PRV, GTV and CTV, ITV and PTV IV(C1) • Define maximum, minimum, and median Target volume? (C1) • Define different types of fractionation? (C1)	5
Unit 5:		
Patient positioning technique	• Briefly explains the various Patient positioning techniques in radiotherapy? (C2) • What are different types immobilization device used for head and neck cancers? (C1) • What are different types immobilization device used for chest and pelvic cancers? (C1)	9

Content	Competencies	Number of Hours
	• Briefly describes the different immobilization devices in radiotherapy? (C2) • List all the immobilization devices and positioning techniques? (C1) • Explain Documentation of the various data entermet or recorded in patient's chart(C2)	
Unit 6:		
Image Processing and archiving	• Explain in detail about Image processing and archiving(C2) • Define PACS and write note on its workflow(C1) • Explain on different types of imaging protocols(C2) • Explain treatment verification(C2) • Explain about different On-line / off-line corrections(C2) • Explain about image registration and draw its flow chart(C2) • Define geometric errors and describe about different types of geometric errors(C1, C2) • Define adaptive radiotherapy(C1)	8

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	100
Revision	5	10
Assessment	5	10
Total	**39**	**120**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Clinical Oncology for Medical Students and Physicians, Multidisciplinary Approach, Edition 1983 and other editions, Published by the American Cancer Society.
Additional References	1. Clinical Oncology, Geoffrey R. Weiss, Associate Professor of Medicine, The University of Texas Health Science Center at

	San Antonio. 2. Cancer Facts, A concise Oncology Text, James F. Bishop, Harwood Academic Publishers. 3. Principles and Practice of Radiation Oncology, Carlos A Perez, 4. Radiation Oncology: Rational technique and results. 8th edition. James D & K.Khan Ang. 5. Clinical Oncology for Medical Students and Physicians. Philip Rubin. American Cancer Society. 6. Practical Radiation technical manual. Mould room techniques for Teletherapy, published by International Atomic Energy Agency. 7. Textbook of Radiotherapy, Radiation Physics, Therapy and Oncology. 6th Edition. C.K. Bomford. Churchill Livingstone.

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	B.Sc. Radiotherapy Technology
Course Title	**Practical and Viva - II Radiotherapy Practice**
Course Code	**RTT3211**
Academic Year	Third year
Semester	VI
Number of Credits	2
Course Prerequisite	Students should have knowledge in radiotherapy equipments
Course Synopsis	• This course covers the radiation safety in Radiotherapy Technology • It assists the students to learn the concepts of quality assurance and basic safety checks for the better knowledge • It provides fundamental knowledge that they are working with in their day today life, regarding the basic safety and quality assurance checks

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain and demonstrate different quality assurance procedures in linac to check the performance of the linac (C2, P4)
CO2	Explain and demonstrate different quality assurance procedures of HDR brachytherapy unit to check its performance (C2, P4)

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

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

Course Content and Outcomes:

Content	Competencies	Number of Hours
UNIT 1		
Output measurement of Linear Accelerator	• What is output of linac machine?(C1) • Explain how to perform Photon and Electron Output - TRS 398 protocol(C2,P4)	6
UNIT 2		
Autoradiography	• What is autoradiography?(C1) • List the specification of Ir-192 source(C1) • Explain how positional accuracy of brachytherapy source will be checked using autoradiography QA. (C1, C2, P4)	6
UNIT 3		
Daily QA of Linear accelerator	• What is X-ray and electron output constancy,Laser localization, and Distance indicator (ODI)?. Explain the quality assurance procedure for all. (C1, C2)	5

Content	Competencies	Number of Hours
	• Why Collimator size indicator, Door interlock and Door closing safety will be checked? Explain the procedure for the same. (C1, C2) • Explain how to check the working of Audiovisual monitor and Beam on indicator (C1, C2,P4)	
UNIT 4		
Making cerrobend blocks (Cut out preparation)	• What is cerrobend block? Why it is used(C1) • What are the components of cerrobend(C1) • Explain the procedure of making cerrobend block for electron beam irradiation(C2, P4)	7
UNIT 5		
HVL measurement	• What is HVL? Why it is used? (C1) • Explain the procedure for the Measurement of half value layer(C1, C2, P4)	6
UNIT 6		
Preparation of patient set-up and verification in SAD technique for head and neck cancers	• What is isocenter?(C1) • Explain the procedure for the patient verification for head and neck cancers (C2, P4)	5
UNIT 7		
Preparation of patient set-up and verification in SAD technique for carcinoma brain	• Why portal imaging is done before radiotherapy? (C1) • Explain the procedure for the patient verification for brain cancers (C2, P4)	5
UNIT 8		
Preparation of patient set-up and verification in SAD technique for carcinoma breast	• What are the different portal imaging devices used for patient verification? (C1) • Explain the procedure for the patient verification for breast cancers (C2, P4)	6
UNIT 9		
Preparation of patient set-up and verification in SAD technique for pelvic cancers	• What are the advantages and disadvantages of different imaging devices used for patient verification? (C1) • Explain the procedure for the patient verification for pelvic cancers (C2, P4)	6

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)		20
Problem Based Learning (PBL)		
Case Based Learning (CBL)		

Clinic		
Practical	40	
Revision	10	
Assessment	2	
Total	**52**	**20**
Formative:	**Summative:**	
Viva	Viva	
Clinical assessment	Log Book	
Clinical Log Book	End Semester Exam	

Mapping of Assessment with COs:

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

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Clinical practice- Advances in Radiation Beam therapy**
Course Code	**RTT3231**
Academic Year	Third year
Semester	V
Number of Credits	9
Course Prerequisite	Students should have basic knowledge of basic science subjects, functioning of different Radiotherapy Equipment's, Physics of radiotherapy, patient immobilization, biological aspects of radiotherapy, radiation safety aspects and advanced techniques in radiotherapy,
Course Synopsis	This course will help the students to know about various imaging and radiotherapy delivery techniques and improves the knowledge on various aspects, advantages and disadvantages of different treatment delivery techniques machines.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Understand advanced delivery techniques and verification process and daily organization of the treatment unit (C3, P3)
CO2	Understand the Usage of different immobilizing devices for different techniques (C3, P3)
CO3	Understand different imaging devices, their uses, advantages and disadvantages (C3, P3)
CO4	Understand the importance of various radiotherapy techniques for the various types of cancers and to differentiate between each treatment techniques have complete treatment documentation (C3, P3)
CO5	Demonstrate professional behavior, Learn the importance of effective communication, team work, ethical values and professionalism, Be able to demonstrate a sensitive and caring attitude to patients (C3, P3)

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:		
Patient Immobilization for	1. To Identify the patient for the treatment delivery using name, hospital number and appropriate	88

Content	Competencies	Number of Hours
radiotherapy	radiotherapy chart (C1, P3) 2. To use suitable and patient specific immobilizing devices for the patients (C3, P3) 3. To Position the patient on the treatment couch after explain the procedures to be done (C3, P3)	
Unit 2:		
Imaging and treatment verification	1. To learn various imaging techniques such as Cone Beam Computed Tomography, Electronic Portal Imaging Device based images etc and to acquire patient images using suitable imaging devices (C2,C3, P3) 2. To make necessary changes based on the images and to position the patient accurately for the treatment (C3, P3) 3. To monitor the patient throughout the radiotherapy (C2, P3)	87
Unit 3:		
Radiation therapy delivery	1. To communicate with the Physicists regarding any troubleshooting (C3, P3) 2. To consider all the safety measures before the radiation delivery(C1,C2) 3. To deliver the treatment for the patient based on the specific treatment plan given by the Medical physicist(C3, P3)	88
Unit 4:		
Advances in Radiotherapy	1. To learn various treatment delivery techniques such as Image Guided Radiotherapy, Stereotactic Radiotherapy, Stereotactic Radiosurgery and Stereotactic Body Radiation Therapy 2. To learn techniques such as Three Dimensional Conformal Radiotherapy, Intensity Modulated Radiotherapy, Volume Modulated Radiation Therapy, Electron Beam Radiation Therapy and also Two Dimensional Treatment Delivery	88

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)		80
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic	248	
Practical		
Revision	15	
Assessment	8	
Total	**271**	**80**

Formative:	**Summative:**
Viva	Viva
Clinical assessment	Log Book
Clinical Log Book	

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

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. Walter and Millers, Text Book of Radiotherapy, Radiation Therapy Physics, Therapy and Oncology. C.K. Bomford, 6th Edition, Churchill Livingstone. 2. Principles and Practice of Radiation Therapy, Introduction to Radiation Therapy, Charles M. Washington & Dennis T. Leaver, Mosby.
Additional References	1. The Physics of Radiation Therapy- Faiz M Khan 2. Radiation Therapy Physics- William Hendee, Mosby 3. Radiation detection and measurement-G F Knoll

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Recent Advances in Radiotherapy Technology**
Course Code	**RTT3241**
Academic Year	Third year
Semester	VI
Number of Credits	3
Course Prerequisite	Students should have knowledge in existing different radiotherapy machines and their working principle.
Course Synopsis	• This course covers the recent Advances in Radiotherapy Technology • It assists the students to learn the concepts of advanced machines and treatment techniques for the better knowledge and also for the treatment of cancer • This subject helps to compare different treatment techniques and machines and adopt for the advanced treatment technique • This subject will bridge the gap between the knowledge obtained in the physics of radiotherapy and radiotherapy equipments • It provides fundamental knowledge that they are working with in their day today life, regarding the principle, working and the applications of different machines and also different imaging techniques used before the radiation treatment

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain and Define types simulations and various portal imaging devices (C2)
CO2	Explain Multileaf collimator, different radiotherapy delivery techniques, and their QA (C2)
CO3	Explain Image Guided Radiotherapy, importance of Respiratory gating and other advanced radiotherapy techniques (C2)
CO4	Explain advanced treatment techniques in Brachytherapy and procedures total body and skin irradiation/ Integrated Brachytherapy. (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	

Course Content and Outcomes:

Content	**Competencies**	Number of Hours
Unit 1:		
Advanced techniques 1:	• What is CT simulator? Explain (C1,C2) • Classify CT simulator and conventional CT(C1,C2)	6

Content	Competencies	Number of Hours
	• Name the immobilization accessories used in CT simulator(C1) • What is Digitally Reconstructed Radiograph? (C1) • List the advantages of CT simulator(C1) • Name the types of CBCT(C1) • What are the advantages of KVCBCT and MVCBCT (C1) • Explain the advantages of KVCBCT and MVCBCT (C1,C2) • Explain cone beam CT (C2) • What is virtual simulator? Explain (C1,C2)	
Unit 2:		
Advanced techniques 2:	• Explain in detail about Dose Volume Histogram(DVH) (C1,C2) • What is leaf transmission in MLC? Define different leaf transmissions. (C1) • Explain tongue and groove arrangement in MLC(C1,C2) • List the various MLC QA(C1) • Explain the Advantages and disadvantages of CT and MRI(C2) • Explain XYZ method of isocenter setup(C1,C2) • Explain various parameters in Plan optimization and evaluation in 3DCRT(C1,C2) • Name and explain the various techniques of IMRT(C1,C2) • What are the disadvantages of 2 dimensional treatment planning? (C1) • What is BEV (Beams Eye View)? (C1) • List the various steps involved in 3DCRT treatment. Briefly explain(C1,C2) • What is image registration and image segmentation in 3DCRT? (C1,C2) • Explain in detail about multileaf collimator(MLC) as an Intensity modulator(C2) • What is Tomotherapy? Explain in detail (C1,C2) • Explain Talon in tomotherapy(C1,C2) • Explain advantages and disadvantages of step and shoot and dynamic IMRT delivery. (C1,C2) • Name and summarize 2 different types of online portal imaging systems(C1,C2) • Illustrate on mechanical testing of DMLC (C2) • Explain in detail Electronic portal Imaging Device(EPID) (C2) • What are the limitations of portal radiographs? (C1) • What is the material used to make MLC? Write the reason. Define the width of MLC(C1) • Explain isodose curve and isodose surfaces(C1,C2) • Explain Image Segmentation in 3DCRT? (C1,C2) • Explain the concept of Multi leaf collimator(C2)	13

Content	Competencies	Number of Hours
Unit 3:		
Advanced techniques 3:	• Explain Linac based SRS technique(C2) • What is Tomotherapy? Explain in detail(C1,C2) • Explain MiMIC(C1,C2) • Explain stereotactic frames used for radiosurgery(C1,C2) • Explain in detail Cyberknife(C1,C2) • What is cyber knife? Why and when it is used? (C1) • Explain Exactrac /Novalis Body system(C1,C2) • Explain in brief about ultrasound as image guiding tool in radiotherapy(C1,C2) • Explain 4 dimensional computed tomography(C2) • Explain real time tumor tracking in IGRT(C2) • Explain in room CT scanner(C1,C2) • Explain helical tomotherapy(C1,C2) • Explain x-ray knife and gamma knife for Stereotactic Radiosurgery(SRS) (C1,C2) • What is the difference between SRS and SRT? (C1) • What is x-ray knife and gamma knife? What are the differences between the both? Where and why are they used? (C1) • What is Image Guided Radiation Therapy(IGRT)? Why and when it is used? (C1) • Explain the various technologies and methods in IGRT(C2) • Explain peacock system. (C1,C2) • Explain Crane in tomotherapy(C1,C2) • Explain on stereotactic frame in SRS(C2) • Explain beam collimation in SRS(C2)	9
Unit 4:		
Advanced techniques 4:	• What is Adaptive Radiotherapy(C1) • Name the types of Adaptive Radiation Therapy(C1) • What is the difference between Adaptive Radiotherapy and Image guided Radiotherapy(C1) • Name the different respiratory tracking system in Radiotherapy(C1) • Briefly explain different respiratory tracking system in Radiotherapy(C2) • What is the need of Adaptive Radiation Therapy(C1) • List the differences between ART and IGRT(C1)	4
Unit 5:		
Advanced techniques 5:	• What is Integrated Brachytherapy? (C1) • Explain Image guided Brachytherapy(C1,C2) • What is Image guided Brachytherapy? Why it is used? (C1) • List the imaging modalities used in IGBT(C1) • What are the goals of image guidance in brachytherapy?(C1) • What are the advantages and disadvantages of	3

Content	Competencies	Number of Hours
	IGBT(C1,C2) • Explain the steps involved in image guided brachytherapy(C1,C2) • Explain different imaging techniques used in image guided brachytherapy(C1,C2) • What are the advantages of IGBT(C1)	
Unit 6:		
Advanced techniques 6:	• What is Total Skin Irradiation technique? Why and when it is used? (C1) • Name and explain the different techniques of total skin irradiation therapy. (C1,C2) • Explain the guidelines used for total skin electron irradiation(C2) • Name and Explain the techniques and equipments used in TBI(C1,C2) • Explain on patient support/positioning devices in TBI(C1,C2) • Explain compensator designing in TBI(C1,C2) • Explain on beam energy selection in Total Body Irradiation(TBI) (C2) • Mention the different techniques in total skin irradiation(C1)	4

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	87
Revision	5	10
Assessment	5	10
Total	**39**	**107**

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

Mapping of Assessment with COs:						
Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1	x	x	x			
Assignments/presentations	x	x	x	x	x	
Unit test	x	x	x	x	x	
End Semester Exam (Theory)	x	x	x	x	x	

Feedback Process:	Mid-Semester Feedback
	End-Semester Feedback
Main Reference:	1. The Physics of Radiation Therapy- Faiz M Khan
Additional References	1. Radiation Therapy Physics William Hendee, Mosby 2. Principles and Practice of Radiation Therapy, G.K.Rath & B.K.Mohanthi. ILBS 3. Textbook of Radiotherapy, Radiation Physics, Therapy and Oncology. 6th Edition. C.K. Bomford. Churchill Livingstone.

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	Bachelor of Science in Radiotherapy Technology
Course Title	**Radiation Dosimetry and Quality Assurance**
Course Code	**RTT3242**
Academic Year	Third year
Semester	VI
Number of Credits	3
Course Prerequisite	Students should have knowledge in radiation safety and radiotherapy equipments
Course Synopsis	• This course covers the radiation safety in Radiotherapy Technology • It assists the students to learn the concepts of quality assurance and basic safety checks for the better knowledge • It provides fundamental knowledge that they are working with in their day today life, regarding the basic safety and quality assurance checks

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Explain beam quality and its measurement – TRS 398 (C2,P4)
CO2	Define and Explain the methods to measure transmission factors (C2,P4)
CO3	List and Explain daily QA of LINAC (C2,P4)
CO4	Explain the procedure to check Optical and Radiation field congruence, Verification of Inverse square law for Photons and measurement of half value layer (C2,P4)
CO5	Explain brachytherapy QA and procedure for different mould preparation and CT acquisition (C2.P4)

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:		
Beam quality and output measurement of Linear Accelerator	• Explain the procedures for TRP 20/10 (C2) • Explain how to perform Photon and Electron Output – TRS 398 protocol(C2,P4)	6
Unit 2:		
Measurement of transmission factors	• Define and Explain the procedures for Tray transmission factor(C1, C2)	6

Content	Competencies	Number of Hours
in Linear Accelerator	• What is Block transmission factor? Why it is used? Explain in detail how to perform QA for the same(C1, C2) • What is wedge transmission factor? Explain the procedure for performing wedge transmission factor (C1, C2,P4)	
Unit 3:		
Daily QA of Linear accelerator	• What is X-ray and electron output constancy, Laser localization, and Distance indicator (ODI)?. Explain the quality assurance procedure for all. (C1, C2) • Why Collimator size indicator, Door interlock and Door closing safety will be checked? Explain the procedure for the same. (C1, C2) • Explain how to check the working of Audiovisual monitor and Beam on indicator (C1, C2,P4)	9
Unit 4:		
LINAC QA : 1	• Explain the procedure for optical and Radiation field congruence check in linear accelerator (C2)	4
LINAC QA : 2	• Explain the procedure for Verification of Inverse square law for Photons(C2) • What is HVL? Explain the procedure for the Measurement of half value layer(C1, C2, P4)	5
Brachytherapy QA	• What is brachytherapy? What are the different techniques used in the brachytherapy? Explain the procedure for Source strength measurement. (C1, C2) • Explain how positional accuracy of brachytherapy source will be checked using autoradiography QA. (C1, C2, P4)	4
Procedure for mould preparation and CT acquisition	• What are the different immobilizing devices used n radiotherapy department? (C1) • Why immobilization is done for the patients before delivering radiotherapy? (C1) • Explain the steps for preparation of thermoplastic mould for Head and neck, Pelvic, brain, Breast and Oesophagus cancers. (C2, P4)	5

Learning Strategies, Contact Hours and Student Learning Time (SLT):		
Learning Strategies	**Contact Hours**	**Student Learning Time (SLT)**
Lecture	29	87
Revision	5	10
Assessment	5	10
Total	**39**	**107**
Assessment Methods:		
Formative:	**Summative:**	
Unit Test	Mid Semester/Sessional Exam (Theory)	
Assignments/Presentations	End Semester Exam (Theory)	

Mapping of Assessment with COs:							
Nature of Assessment		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	
Mid Semester / Sessional Examination 1		x	x	x			
Assignments/presentations		x	x	x	x	x	
Unit test		x	x	x	x	x	
End Semester Exam (Theory)		x	x	x	x	x	
Feedback Process:	Mid-Semester Feedback						
	End-Semester Feedback						
Main Reference:	1. The Physics of Radiation Therapy- Faiz M Khan						
Additional References	1. Quality and Safety in Radiotherapy (Imaging in Medical Diagnosis and Therapy) by Todd Pawlicki, Peter Dunscombe, Arno J. Mundt , Pierre Scalliet 2. Handbook of Radiotherapy Physics: Theory and Practice, Second Edition by Philip Mayles 3. Textbook of Radiotherapy, Radiation Physics, Therapy and Oncology. 6th Edition. C.K. Bomford. Churchill Livingstone.						

SEMESTER - VII & VIII

INTERNSHIP

Manipal College of Health Professions	
Name of the Department	Department of Radiotherapy and Oncology
Name of the Program	**Bachelor of Science in Radiotherapy Technology**
Course Title	**Internship**
Academic Year	Fourth Year
Semester	VII and VIII Semesters
Duration	1 year (48 hours / weeks; 8 hours / day; 6 days a week)
Course Prerequisite	Students should have knowledge of basic science subjects, Different Radiotherapy Techniques, Patient immobilising procedures, Medical Ethics, Radiotherapy sources, Radiation Safety measures including personnel monitoring , Maintaining patient records, hospital practice and patient care.
Course Synopsis	This course will give training and confidence for the trainees to immobilize patient using different immobilizing devices, perform patient verification , deliver radiation therapy using different techniques and different modalities, perform various daily quality control procedures and record keeping.

Course Outcomes (COs): **At the end of the course student shall be able to:**	
CO1	Identify and Immobilize the patient using different immobilizing devices such as Vac-Lok, Thermoplastic moulds, head and neck rests, Breast board, belly board, bite block, shoulder retractor etc.(C2, P5)
CO2	Perform imaging using different imaging techniques. (C2, P4)
CO3	Perform various daily quality control checks of teletherapy machines. (C2, P4)
CO4	Perform various treatment verification procedures using image guidance. (C2,P4)
CO5	Deliver radiation therapy using different techniques and different modalities. (C2, P4)
CO6	Maintain patient record and verification system. Learn the importance of effective communication, team work, ethical values and professionalism (C2, 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**
Area 1: Mould Room, Electron cut-out preparation and Imaging	
1. Mould preparation: Different types of Mould preparations for different types of cancers. (C2,P4) 2. Cut out preparation: Preparation of electron cut-outs for different areas of treatment. (C2,P4) 3. Imaging: Taking patient image in CT scanner and Simulator (C2,P5)	
Area 2: LINAC	
1. To verify patient setup using different imaging modalities. (C2,P4) 2. To set patient for treatment(C2,P5) 3. To work with control console, Record and Verify system(C2,P4) 4. To deal with basic LINAC daily quality assurance procedures. (C2,P4) 5. To adhere with the principles of Radiation Safety. (C2,P4)	
Area 3: Simulator	
1. To set imaging room for daily activities (C2,P4) 2. To practice and evaluate daily QA of imaging and other accessory devices (C2,P4) 3. To express procedures to patient and to practice as per regulatory guidelines (C2,P5) 4. To perform scans for various brachytherapy procedures (C2,P4) 5. Documentation and record keeping (C2,P4)	
Area 4: Brachytherapy and Treatment planning system room	
1. To perform daily QA of Brachytherapy unit (C2; P4) 2. To observe treatment planning techniques (C2;P4)	
Learning Strategies: Small group discussion (SGD), Case Based Learning (CBL), Clinics, Seminars.	
Formative Assessment: Viva, Clinical assessment (OSCE, OSPE, WBPA), Clinical Log Book Interns will be evaluated periodically i.e. Twice in a year and aggregate marks of both assessments will be used to issue internship completion certificate. Internship completion certificate will be issued from Dean's office, only after o successfully clearing both assessments and o obtaining satisfactory completion certificate from the head/ In-charge of the department at the end of internship.	

7. Program Outcomes (POs) and Course Outcomes (COs) Mapping

Sem.	Course Code	Course Title	Credits	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
I	ANA1103	Anatomy	3	CO1 CO2							
I	PHY1101	Physiology - I	2	CO1 CO2 CO3 CO4							
I	CSK1001	Communication Skills	2		CO3	CO4		CO1 CO2		CO1 CO2 CO3 CO4	
I	EIC1001	Environmental Science	1	CO1 CO2 CO3		CO4 CO5	CO2		CO1 CO3 CO5	CO4	
		Indian Constitution	1	CO1		CO3	CO2 CO5	CO2	CO4	CO1 CO3 CO5	CO4
I	RTT1101	Basic Physics	3	CO1 CO2 CO3 CO4 CO5	CO3 CO4 CO5	CO1 CO4 CO2 CO3 CO5	CO2				
I	RTT1102	Basic and Applied Mathematics	4	CO1 CO2 CO3 CO4							
I	RTT1121	Fundamentals of Computers and Computer Applications	4	CO1 CO2 CO3 CO4	CO3 CO4						
II	PHY1201	Physiology - II	2	CO1 CO2 CO3 CO4							
II	GPY2204	General Psychology	2	CO1					CO2 CO3	CO1 CO2 CO3	
II	RTT1201	Radiation Physics	4	CO1 CO2 CO3 CO4						CO3 CO4	
II	RTT1202	Radiation Quantities and Detection	3	CO1 CO2 CO3 CO4 CO5						CO2 CO4 CO5	
II	RTT1203	Radiobiology	4	CO1						CO1	

Sem.	Course Code	Course Title	Credits	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
				CO2 CO3 CO4 CO5						CO2 CO4 CO5	
II	RTT1204	Bioethics	3	CO2			CO1 CO3 CO4	CO5	CO1 CO3 CO4 CO5	CO2	
II	RTT1205	Hospital Practice and Patient Care	2				CO1 CO2 CO3 CO5	CO1 CO3 CO4	CO2 CO4 CO5		
III	PAT2102	Pathology	2	CO1 CO2 CO3 CO4	CO3 CO4						
III	RTT2101	Radiotherapy Equipments	4	CO1 CO2 CO3 CO4						CO2 CO3	
III	RTT2102	Principles and Practice of Radiology Part I	3	CO1 CO2 CO3 CO4 CO5				CO6		CO6	
III	RTT2103	Patient Positioning and Immobilization/ Mould Room Techniques	2	CO1 CO3 CO4		CO2	CO2			CO1 CO3 CO4	
III	RTT2131	Clinical practice-Radiotherapy Equipments	6		CO1 CO2 CO3 CO4 CO5 CO6		CO6	CO2 CO6	CO1 CO3 CO4 CO5		
III	*** ****	Open Elective I	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	RTT2201	Physics of External Beam Radiotherapy	3	CO1 CO2 CO3 CO4					CO3	CO2 CO4	
IV	RTT2202	Principles and Practice of Radiology Part II	3	CO1 CO2 CO3 CO4 CO5 CO6						CO3 CO4 CO5	

Sem.	Course Code	Course Title	Credits	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
IV	RTT2231	Clinical Practice-Radiation Beam therapy	11		CO1 CO2 CO3 CO4 CO5		CO5 CO4 CO6	CO1	CO2 CO3	CO6	
IV	RTT2241	Physics of Brachytherapy	3	CO1 CO2 CO3 CO4 CO5							
IV	RTT2242	Basics of Nuclear Medicine and safety	3	CO1 CO2 CO3 CO4			CO2 CO4		CO1 CO3		
V	RTT3101	Principles and Practice of Radiotherapy Part I	3	CO2 CO3 CO5			CO1 CO4		CO1 CO4 CO5		
V	RTT3102	Record Keeping	2	CO1 CO2 CO5			CO3 CO4		CO2 CO3 CO4 CO5		
V	RTT3103	Radiation protection, standards and Regulations	3	CO1 CO2		CO4	CO3		CO3 CO4 CO5	CO5	
V	RTT3111	Practical and Viva -I Radiotherapy Practice	2		CO1 CO2	CO2			CO1		
V	RTT3131	Clinical Practice-Eternal beam Radiotherapy	7	CO3	CO1 CO2 CO3 CO4 CO5		CO2	CO5	CO1 CO4		
V	*** ****	Open Elective-II	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	Biostatistics and Research Methodology	3	CO1 CO2 CO3 CO5 CO6	CO4						
VI	RTT3201	Principles and Practice of Radiotherapy Part II	3	CO1 CO2 CO3 CO4 CO5			CO5			CO3 CO2	

Sem.	Course Code	Course Title	Credits	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
VI	RTT3211	Practical and Viva -II Radiotherapy Practice	2		CO1 CO2	CO2			CO1		
VI	RTT3231	Clinical Practice-Advances in Radiation Beam therapy	9		CO1 CO2 CO3 CO4 CO5		CO4 CO5		CO1 CO2 CO3		
VI	RTT3241	Recent Advances in Radiotherapy Technology	3	CO1		CO2	CO3 CO4		CO3	CO2 CO4	
VI	RTT3242	Radiation Dosimetry and Quality Assurance	3		CO1 CO2 CO3 CO4 CO5	CO1 CO2 CO3 CO4 CO5					
VII & VIII	-	Internship	(Duration: 1 year)		CO1 CO2 CO3 CO5 CO6		CO6		CO5	CO2 CO4	CO1 CO3 CO4

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.
2.4 The maximum credits for theory course is 4; theory and practical combined is 5.
2.5 Internship is not credited.
2.6 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 and supplementary) will be conducted in November-December. All the ESE for the even semesters (regular and supplementary) 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 or as specified in the curriculum, 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, $\mathbf{1st\ Year\ CGPA} = \frac{(8.35 \text{ x } 20) \ + \ (7 \text{ x } 25)}{20 \ + \ 25} = 7.6$

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 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.

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

Head of the Department **Dean**

Deputy Registrar - Academics **Registrar**