Bachelor in Radiation Technology

Rules-Regulations & Curriculum (as per OBE)

(w.e.f. 2025-26)

REGISTRAR
Sai Tirupati University
Udaipur (Raj.)

PRINCIPAL
VENKATESHWAR INSTITUTE OF
PARAMEDICAL SCIENCES
UMARDA, UDAIPUR

Venkteshwar Institute of Paramedical Sciences

(A Constituent Unit of Sai Tirupati University, Udaipur)

Program Outcomes (POs)

PO 1 Aims to have a vast knowledge about the parts of human body, their function, their anatomical positions, structure and compositions.

PO 2 Aims to know the working principle of the radiological equipment give the knowledge about the use of radiological equipment in the diagnosis of the different diseases.

PO 3 Students gain the deep knowledge about protection of the patient and staff as well from the Harmful or unwanted radiations, to identify the risk, impact on health, dose limits for patient and staff.

PO 4 Students gain deep knowledge about the different radiological procedures and working of the body parts so that they can communicate with patient more effectively.

Program Educational Objectives (PEOs)

PEO1 Establish their careers in the field of medical imaging and related areas like clinical application designing, providing innovative and effective solutions to image the patient with high skilled techniques.

PEO2 To provide students with a solid foundation in human body parts, their functioning, use and production of radiation and different imaging techniques.

PEO3 To train students with good clinical practice skills and imaging protocols so as to develop newer imaging techniques for different type of diseases.

PEO4 To provide students with an environment with modern imaging modalities and high skilled health professionals so that they will be handle patient in emergency situation comfortably.

Program Specific Outcomes (PSOs)

PSO 1 Demonstrate practical aim of different instruments like ionization chambers, focal spot measurements, kvp measurement, radiation dosimeters, phantoms, cassettes, screens and lead shields etc. And handling of the radiological equipment.

PSO 2 Demonstrate knowledge on various radiological positioning and techniques for different type of examinations in different modalities like X-Ray, Computed Tomography, X-ray, fluoroscopy, MRI and other medical imaging techniques.

PSO 3 Describe modern imaging technologies for different type of the diseases and impact of the same on the healthcare system.

Program of Study & Scheme of Examination

1. TITLE OF THE PROGRAM - The title of the Program shall be "Bachelor in Radiation Technology".

2. DURATION OF PROGRAM /TRAINING - The Program shall be of three years duration 6 semester plus a one-year Internship from the date of commencement of the Program.

3. MEDIUM OF INSTRUCTION - English shall be the medium of instruction.

4. ELIGIBILITY FOR ADMISSION –

• For admission, a candidate must have passed the 10+2 (Senior Secondary) Examination or its equivalent Examination in the Science stream i.e. Physics, Chemistry, and Biology with 50% marks in the aggregate & pass in each subject individually for General Category and 45% for SC/ST/OBC/MBC candidates from a recognized Board or as per Govt. Guidelines.

• Candidate should have completed the minimum age of 17 years as of 31st December of the year of admission.

• Lateral Entry- Lateral entry Admission directly to Second year i.e third semester of a UG paramedical Program should be done from a candidate having diploma in Paramedical Subject of same specialty in addition to entry qualification.

5. CRITERIA FOR ADMISSION - Selection shall be done by an Admission Board of the University/Rajasthan Paramedical Council strictly on merit/written examination.

6. RESERVATION POLICY - Reservations in admissions shall be applicable as per the policy of the State Government.

7. ENROLMENT -

1. Every candidate who is admitted to the Program is required to get himself/herself enrolled with the admitted university after paying the prescribed eligibility and enrollment fees.
2. No student shall be allowed to appear in the university examination without enrollment in the university.

8. MIGRATION RULES -

• No student once admitted to the Program and enrolled by the university, will be permitted to migrate to any other university.

• No student will be admitted to the Program on migration from any other university.

9. ATTENDANCE –

A minimum of 75% attendance is required in each semester, both for theory and practical classes separately. Students with deficient attendance will not be permitted to appear in university examinations.

A student detained due to short attendance will have to repeat the semester.

10. WORKING DAYS - Each academic semester shall consist of minimum 120 working days, including examinations.

11. CONDUCTION OF THE UNIVERSITY EXAMINATION - A university semester examination shall be conducted twice in a year with the interval of six months. Even semester examination shall be conducted after six months of odd semester examinations.

12. ELIGIBILITY TO APPEAR FOR UNIVERSITY EXAMINATION - A student is required to have minimum 75 % attendance in theory and practical's separately of each semester to make him/her eligible to appear in the university semester examination.

Candidates failing in one or more subjects (theory/practical) of semester will require to appear in failing subjects in the next examination of same semester.

A candidate will have to clear all the subjects of first to fifth semester before appearing at sixth semester university examination otherwise he will not be allowed to appear in the Part-III sixth semester university examination.

13. APPOINTMENT OF EXAMINER & PAPER SETTER -

a. All the examiners, paper setters, theory examination answer book evaluators, external and internal examiners for practical examinations shall be appointed by the respective university.

b. Professor/ Assoc. Professor/ Assistant Professor/Lecturer/Paramedical Professional having PG qualification and 3 years professional/teaching experience after PG in respective fields is eligible to act as an internal or external examiner of theory/practical examination.

14. SCHEME OF EXAMINATION - The University examination for the Program shall be conducted semester wise at the end of every six months.

i. Theory –

(a) There shall be four Theory papers in each semester of study.

(b) Each Theory paper examination shall be of 3 hours duration and a maximum of 80 marks.

(c) Internal assessment (IA) shall be 20 marks for each Theory Paper.

(d) The Paper Setter shall set the questions within the prescribed Program of study of the concerned paper. There will be a set pattern of question papers duly approved by the Academic Council.

Proposed Pattern of question papers –

i. Every question paper shall contain Six questions out of which five need to be attempted.
ii. Question No. 1,3,4 shall be of long answer type. It shall carry 16 marks each.
iii. Question No. 2 shall have two parts carrying 8 marks each.
iv. Question No. 5 shall have four short notes each carrying 4 marks.
v. Question No. 6 shall have four short notes each carrying 4 marks.

(g) Passing Marks: A candidate will have to obtain at least 50% marks in each Theory paper including internal assessment to pass.

ii. Practical and Viva-Voce Examination -

(a) At the end of each semester there shall be the practical and viva-voce examination of 200 marks. It shall be conducted after the Theory examination is over. A candidate will have to obtain at least 50% marks in the practical and viva-voce examinations.

(b) The pattern of practical examination shall be as follows –

Semester	Practical & viva-voce	Internal Assessment	Total Marks	Min. Pass Marks	Practical Examiners
Ist Sem	150	50	200	100	One Internal & one External Examiner
IInd Sem	150	50	200	100	One Internal & one External Examiner
IIIrd Sem	150	50	200	100	One Internal & one External Examiner
IVth Sem	150	50	200	100	One Internal & one External Examiner
Vth Sem	150	50	200	100	One Internal & one External Examiner
VIth Sem	150	50	200	100	One Internal & one External Examiner

The university shall appoint the panel of examiners in such a manner that the complete syllabus of semester is taken care of by the internal/external practical examiner(s).

If the Practical examination consists of more than one subject/department, the Board of studies/ Committee of Program shall decide the distribution of marks of different parts of the practical examination ensuring that the maximum marks of all the parts of the practical examination do not exceed 200 Marks.

iii. Result

1. A candidate will have to obtain at least 50% marks separately in each Theory paper including internal assessment and a minimum of 50% marks in the practical examination for him to be declared pass.
2. A Candidate who has failed in theory paper(s)/ Practical examination will reappear in respective theory papers(s)/ Practical examination in next examination of same semester will held in next year of a subject.

iv. Supplementary/Remanded Examination -

(a) There shall be a supplementary examination of sixth semester only within Six months of the main examination of sixth semester.

(b) Internal assessment marks obtained in the main examination in the concerned failed paper(s)/practical shall be carried forward for working out the result of next Theory paper(s) and/or practical examination.

(c) If the candidate reappearing in the university examination due to failure in subjects then He/She shall be allowed to improve his/her internal assessment marks also or He/she can opt to carry forward his/her earlier obtained internal marks.

v. Promotion to next semester -

1. A candidate who has appeared in the University examination of a semester and has passed it OR failed in one or more subjects shall be promoted to next semester.
2. A candidate will be allowed to appear for the sixth semester examination only when the backlog of all subjects (theory and practical) of first semester to fifth semesters exams including elective papers (if any) is cleared.
3. A student detained due to short attendance will not be promoted to next semester in this case he/she have to repeat the whole semester.
4. The student is required to clear all the University examinations within 6 academic years from the joining of the Program otherwise he/she will have to leave the Program.

15. GRACE MARKS

1. A student who appears in all papers of the examination on the first attempt and obtains the required minimum pass marks in the total aggregate of an examination but fails to obtain the minimum pass marks in one subject (in theory or practical as the case may be) may be awarded the grace marks as per policy of the university up to a maximum of 06 marks, provided the candidate passes the examination by an award of such grace marks.
2. No grace marks will be awarded to a candidate who appears in part/ supplementary examination.
3. A candidate who passes the examination after the award of grace marks in a paper/practical or the aggregate will be shown in the marks sheet to have passed the examination by grace. Grace marks will not be added to the marks obtained by a candidate from the examination.
4. Non-appearance of a candidate in any part of the examination on account of any reason will make him ineligible for grace marks.
5. A candidate who is awarded grace marks in any subject to pass the examination will not be entitled to distinction in any subject.

16. REVALUATION / SCRUTINY - Revaluation of answer book(s) and scrutiny of the marks will be as per policy of the university.

17. TEACHING HOURS - Teaching hours shall be not less than 630 hours in every academic semester.

18. INTERNSHIP –

Every candidate after successful completion of the all-semester examination have to undergo a one-year compulsory rotating internship.

Candidates coming from other institutions with the permission of the Head of the concerned institution will be allowed for the internship program in the respective University after receipt of the fees prescribed by this University. Internships shall be rotating in the concerned department.

Internship Rules:

1. The intern will be eligible for 1-day casual leave each month and can carry over the leave to the next months, but he/she cannot avail of the next month's leave in advance.
2. The interns should conduct themselves in a manner befitting the profession.
3. The intern should dress appropriately in the clinical areas.
4. The intern must wear a white apron with a nametag when in the clinical area/wards.
5. The intern can avail of medical leave on producing a medical certificate but will have to compensate for the number of days of absence from the internship.

Authority for issue of Internship Completion Certificate - The Principal/Director of the college/ Institution shall issue a certificate of successful completion of a one-year internship to each candidate after satisfying that the candidate has completed the training program and has acquired the skills.

19. Award of Degree - The degree shall be awarded by the University only after receipt of the Internship completion certificate from the Principal/Director of the college/ Institution.

20. Log Book –

This predefined task performed by learners that contributes to the achievement, acquisition of the requisite knowledge, skills, attitude and/or competencies of stated objectives should be recorded in log book for the study period.

It includes selected assignments, self-assessment, feedback, work-based and in-training formative assessments, reflections and learnings from planned activity in the curriculum.

21. Skills Enhancement add on Programs/electives –

Students can select any one or more Discipline Specific Elective, Ability Enhancement Program, Generic Elective add-on Program at the beginning of a semester and the candidate will have to pass these add on Program before appearing at the sixth semester examination. The examination of these subjects shall be conducted at the Institute level.The Marks obtained by the candidates in these add-on Program shall be mentioned separately in the mark’s sheets of the respective university. These marks shall not be counted for preparing the merit list.

Program Scheme

L- Lecture, T-Tutorial, P-Practical, C- Credits

Core- Discipline Core Course

SEC- Skill Enhancement Course

AEC- Ability Enhancement Course

VAC- Value Added Course

SEMSETER-I										
Course Code	**Course Name**	**Course Category**					**Contact Hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207AN101	Human Anatomy - 1	Core	4	-	-	4	4	20	80	100
207PY102	Human Physiology - 1	Core	4	-	-	4	4	20	80	100
207RT103	Radiographic Techniques	Core	4	-	-	4	4	20	80	100
207RP104	Basic Radiation Physics & Principles of Radiotherapy - 1	Core	4	-	-	4	4	20	80	100
207PR105	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMSETER-II										
Course Code	**Course Name**	**Course Category**					**Contact hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207AN201	Human Anatomy - 2	Core	4	-	-	4	4	20	80	100
207PY202	Human Physiology -2	Core	4	-	-	4	4	20	80	100
207DR203	Dark Room Procedures	Core	4	-	-	4	4	20	80	100
207RP204	Basic Radiation Physics & Principles of Radiotherapy - 2	Core	4	-	-	4	4	20	80	100
207PR205	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMSETER-III									
Course Code	**Course Name**	**Course Category**				**Contact hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207MI301	Modern Imaging with Recent Advances - 1	Core	4	-	-	4	4	20	80	100
207QA302	Apparatus of Imaging, Radiotherapy &Quality Assurance-1	Core	4	-	-	4	4	20	80	100
207PH303	Physics of Radiotherapy -1	Core	4	-	-	4	4	20	80	100
207RM304	Radiation Protection & Monitoring-1	Core	4	-	-	4	4	20	80	100
207PR305	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMSETER-IV										
Course Code	**Course Name**	**Course Category**					**Contact hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207MI401	Modern Imaging with Recent Advances -2	Core	4	-	-	4	4	20	80	100
207QA402	Apparatus of Imaging, Radiotherapy &Quality Assurance-2	Core	4	-	-	4	4	20	80	100
207PH403	Physics of Radiotherapy-2	Core	4	-	-	4	4	20	80	100
207RM404	Radiation Protection & Monitoring-2	Core	4	-	-	4	4	20	80	100
207PR405	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMSETER-V									
Course Code	**Course Name**	**Course Category**				**Contact hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207SR501	Special Radiological Procedures & Contrast Media-1	Core	4	-	-	4	4	20	80	100
207RT502	Radiotherapy Planning & Techniques-1	Core	4	-	-	4	4	20	80	100
207RA503	Radiation Dosimetry Principles & Applications-1	Core	4	-	-	4	4	20	80	100
207HP504	Hospital Practice & Patient Care-1	Core	4	-	-	4	4	20	80	100
207PR505	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMSETER-VI									
Course Code	**Course Name**	**Course Category**				**Contact hour Per week**	**Evaluation**		
			L	**T**	**P**	**C**		**Internal**	**External**	**Total**
207SR601	Special Radiological Procedures & Contrast Media-2	Core	4	-	-	4	4	20	80	100
207RT602	Radiotherapy Planning & Techniques-2	Core	4	-	-	4	4	20	80	100
207RA603	Radiation Dosimetry Principles & Applications-2	Core	4	-	-	4	4	20	80	100
207HP604	Hospital Practice & Patient Care-2	Core	4	-	-	4	4	20	80	100
207PR605	Practical (All courses / Clinical Posting)	Practical	-	-	6	6	12	50	150	200
Total						22	28			

SEMESTER	CREDITS
I	22
II	22
III	22
IV	22
V	22
VI	22
Total Credits	**132**

INTERNSHIP – After completion of six semesters of Bachelor in Radiation technology the candidates will undergo one year Internship in a Government recognized hospital/Institution as partial fulfilment for the award of Bachelor in Radiation technology per government norms.

Detailed Syllabus

SEMESTER-I

Course Name: HUMAN ANATOMY-1 **L T P C**

Course Code: 207AN101 **4 0 0 4**

COURSE OBJECTIVE: The prime concern of this syllabus is to learn the terminology of the course and basic knowledge of cells & tissues and to understand anatomy of human body. This course will develop an understanding of the structure and function of organs and organ systems in normal human body.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe anatomical terms, basic structure of cells, tissues and glands.
CO2	Explain classification of bones and joints with histological features.
CO3	Apply knowledge of musculoskeletal system to identify anatomical parts.
CO4	Analyze structural and functional correlation of thoracic and limb bones.

UNIT 1

Introduction to Anatomy & Basic Terminology

- Definition and scope of human anatomy
- Levels of organization: Cell → Tissue → Organ → System → Organism
- Anatomical positions, planes and sections:
  - Median, sagittal, coronal, transverse planes
- Body cavities and their subdivisions:
  - Cranial, thoracic, abdominal, pelvic
- Anatomical directional terms:
  - Anterior/posterior, superior/inferior, medial/lateral, proximal/distal
- Histology of the cell:
  - Nucleus, cytoplasm, mitochondria, endoplasmic reticulum, Golgi body, ribosomes
- Epithelium:
  - Types: simple (squamous, cuboidal, columnar), stratified (keratinized/non-keratinized)
  - Location and functional correlation
- Connective tissue types:
  - Areolar tissue, adipose tissue, cartilage (hyaline, elastic, fibro cartilage), bone

UNIT 2

Skeletal System & Ossification

- Bone classification:
  - Long, short, flat, irregular, sesamoid
- Gross structure of bone:
  - Periosteum, endosteum, marrow cavity, compact vs spongy (cancellous) bone
- Microscopic anatomy:
  - Haversian system, osteons, lacunae, canaliculi
- Bone formation processes:
  - Intramembranous ossification (flat bones)
  - Endochondral ossification (long bones)
- Types of joints:
  - Fibrous (sutures), cartilaginous (symphysis), synovial (hinge, pivot, ball & socket, saddle)
- Synovial joint components:
  - Joint capsule, synovial membrane, synovial fluid, articular cartilage, ligaments

UNIT 3

Muscular System

- Types of muscle:
  - Skeletal (striated, voluntary)
  - Cardiac (striated, involuntary)
  - Smooth (non-striated, involuntary)
- Histological differences among muscle types
- Characteristics and functions:
  - Contractility, excitability, extensibility, elasticity
- Origin and insertion of muscles:
  - Definitions with examples (e.g., biceps brachii)
- Muscle physiology terms:
  - Tone, fatigue, hypertrophy, atrophy, tetanus

UNIT 4

Cardiovascular System

- Heart anatomy:
  - Chambers, valves (tricuspid, bicuspid, semilunar), septa, pericardial layers
- Major blood vessels:
  - Aorta, pulmonary arteries and veins, superior and inferior vena cava

- Coronary circulation:
    - Right and left coronary arteries, cardiac veins, venous drainage
- Systemic arteries and veins:
    - Upper limb (subclavian, brachial, radial), lower limb (femoral, popliteal)
    - Thoracic and abdominal arteries (aorta, renal artery, mesenteric artery)
- Pulse points and surface anatomy
- Lymphatic system overview:
    - Lymph vessels, thoracic duct
    - Major lymph nodes: cervical, axillary, inguinal
    - Spleen: structure and function in immunity

UNIT 5

Respiratory and Digestive Overview

- Respiratory system:
    - Nasal cavity, pharynx (nasopharynx, oropharynx, laryngopharynx)
    - Larynx, trachea, bronchi, lungs (lobes, bronchopulmonary segments)
    - Hilum of the lung and pleural membranes
    - Diaphragm and intercostal muscles: role in respiration
- Digestive system:
    - Alimentary canal: mouth, esophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine (colon, rectum)
    - Accessory organs:
        - Liver: surface anatomy, lobes, porta hepatis
        - Gall bladder: position and ducts
        - Pancreas: head, body, tail; relation to duodenum

Reference Books:

1. A.K. Jain, Textbook of Physiology (Volume I & II), 9th Edition, 2021.
2. Venkatesh, D. and Sudhakar, H.S., Basics of Medical Physiology, Wolters Kluwer Publication, 4th Edition, 2018.
3. Chaudhuri, Sujit K., Concise Medical Physiology, New Central Book Agency, 7th Edition, 2016.
4. Guyton and Hall, Textbook of Medical Physiology, Elsevier, 14th Edition, 2020.
5. Sembulingam, K. and Sembulingam, P., Essentials of Medical Physiology, Jaypee Brothers Medical Publishers, 8th Edition, 2019.

Course Name: HUMAN PHYSIOLOGY- 1 **L T P C**
Course Code: 207PY102 **4 0 0 4**

COURSE OBJECTIVE: The prime concern of this syllabus is to integrate basic knowledge of cells, tissues, blood, physiological functions and diseases of system included in syllabus.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Recall structure & functions of blood cells, plasma proteins.
CO2	Understand homeostasis, blood coagulation and immunity concepts.
CO3	Apply physiological principles in BP, pulse, respiration measurement.
CO4	Analyze diseases like anemia, hypoxia using physiological data.

UNIT 1

Blood

- Composition of blood: plasma and formed elements
- Plasma proteins:
  - Albumin, globulin, fibrinogen – sources and functions
- Red blood cells (RBCs):
  - Structure, normal count, life span, erythropoiesis
- Hemoglobin (Hb):
  - Structure, types (HbA, HbF), synthesis and breakdown
  - Oxyhemoglobin, carboxyhemoglobin, methemoglobin
- White blood cells (WBCs):
  - Types: neutrophils, eosinophils, basophils, lymphocytes, monocytes – structure and immune function
- Platelets:
  - Structure and function
  - Clotting mechanism: intrinsic and extrinsic pathways, clotting factors
- Blood groups:
  - ABO system: antigens and antibodies
  - Rh system: inheritance, Rh incompatibility
- Blood disorders:
  - Anemia (types), polycythemia, leukemia (brief overview)

UNIT 2

Cardiovascular System

- Cardiac muscle physiology:
  - Autorhythmicity, pacemaker potential
  - Functional syncytium
- Conducting system of the heart:
  - SA node, AV node, Bundle of His, Purkinje fibers
- Cardiac cycle:
  - Events in atrial systole, ventricular systole, and diastole
  - Volume and pressure changes
- Heart sounds:
  - S1, S2 and murmurs (stenosis, regurgitation)
- Blood pressure (BP):
  - Systolic, diastolic, mean arterial pressure (MAP)
- Regulation of BP:
  - Neural (baroreceptor reflex), hormonal (RAAS, ADH)
- Electrocardiogram (ECG):
  - Waves (P, QRS, T), interpretation, clinical application

UNIT 3

Respiratory System

- Lung volumes and capacities:
  - Tidal volume, vital capacity, inspiratory/expiratory reserve
- Mechanism of breathing:
  - Inspiration and expiration: role of diaphragm and intercostals
- Gas exchange:
  - At alveolar-capillary membrane and tissue level
  - Diffusion principles, partial pressures
- Transport of gases:
  - Oxygen: bound to hemoglobin and dissolved
  - Carbon dioxide: bicarbonate, dissolved, carbamino compound
- Regulation of respiration:
  - Medullary (rhythmicity center), pontine centers (apneustic, pneumotaxic)
  - Chemoreceptor regulation (central and peripheral)
- Effects of altered environments:
  - High altitude (acclimatization), hypoxia, hypercapnia, cyanosis

UNIT 4

Digestive Physiology

- Salivary glands:
  - Parotid, submandibular, sublingual: secretion and composition
  - Function of saliva in digestion and protection
- Swallowing (deglutition):
  - Stages and neural control
- Gastric secretion:
  - Composition (HCl, pepsin, intrinsic factor), control (cephalic, gastric, intestinal phases)
- Bile:
  - Composition, synthesis, emulsification of fats
- Intestinal secretions and enzymes:
  - Pancreatic enzymes, brush border enzymes
  - Absorption of carbohydrates, proteins, fats, vitamins, water
- Defecation reflex:
  - Role of rectum, anal sphincters, voluntary control
- Digestive disorders:
  - Diarrhea, constipation: causes and effects

UNIT 5

Endocrine System

- Pituitary gland:
  - Anterior lobe hormones: GH, TSH, ACTH, FSH, LH, prolactin
  - Posterior lobe hormones: ADH and oxytocin
- Thyroid gland:
  - Thyroxine (T3, T4): metabolic roles, deficiency (hypothyroidism, cretinism)
  - Calcitonin: calcium regulation
- Adrenal glands:
  - Cortex: mineralocorticoids (aldosterone), glucocorticoids (cortisol)
  - Medulla: adrenaline, noradrenaline – fight or flight
- Pancreas:
  - Insulin: secretion, regulation, action on glucose metabolism
  - Glucagon: opposing effect
  - Diabetes mellitus: overview
- Feedback mechanisms:
  - Negative feedback (e.g., TSH regulation)
  - Positive feedback (e.g., oxytocin in labor)

Reference Books:

1. Human Anatomy Regional and Applied Vol. 1, Vol. 2 & Vol. 3 ,B.D. Chaurasia, C.B.S. Publishers, New Delhi ,9th Edition, 2022
2. Hand Book of General Anatomy ,B.D. Chaurasia, C.B.S. Publishers, New Delhi, 9th Edition, 2022
3. Text Book of Human Histology ,Inderbir Singh ,Jaypee Brothers, Medical Publishers, Delhi ,7th Edition ,2021
4. Gray's Anatomy ,Susan Standring ,Elsevier Churchill Livingstone, Edinburgh ,42nd Edition ,2021

Course Name: RADIOGRAPHIC TECHNIQUES **L T P C**
Course Code: 207RT103 **4 0 0 4**

COURSE OBJECTIVE: This course is designed to study about the anatomical positions, radiology and medical imaging, body position and movement, different body projections.

COURSE OUTCOMES: On completion of this course, the students will be able to:

CO1	Identify and explain standard radiographic positioning techniques for the entire skeletal system.
CO2	Apply correct patient positioning and exposure techniques for various body parts including skull, chest, abdomen, limbs, and spine.
CO3	Analyze and select appropriate special projections in challenging anatomical cases (e.g. TMJ, sinuses, spine deformities).
CO4	Demonstrate technical knowledge and aseptic precautions during mobile and OT radiography.

UNIT 1

Radiographic Techniques of Skull, Facial Bones & Neck

- Introduction to Skull Radiography
  - Anatomical landmarks and positioning lines (OML, IOML, AML, etc.)
  - General skull projections: AP, PA, Lateral, Towne's, Caldwell, SMV
- Specialized Skull & Facial Views
  - Petrous temporal bone, mastoid process
  - Mandible (AP axial, oblique, panoramic)
  - Nasal sinuses: Waters, Caldwell, lateral
  - TM Joint: open & closed mouth views
  - Optic foramina and sella turcica views
- Soft Tissue Neck Imaging
  - Larynx, nasopharynx, oropharynx radiographs
  - Foreign body localization techniques
- Dental Radiography (Basic Overview)
  - Intraoral: periapical, bitewing
  - Extraoral: occlusal, panoramic, lateral cephalogram

UNIT -2

Radiographic Techniques of Thorax and Abdomen

- Chest Radiography
  - PA, Lateral, AP (supine/erect), oblique chest views
  - Lordotic (Apicogram), decubitus, thoracic inlet views
  - Radiographic signs of pneumothorax, pleural effusion, consolidation
- Thorax Bones

- Sternum: RAO, lateral views
- Ribs: above and below diaphragm technique

- Abdomen Radiography
  - KUB (kidney-ureter-bladder) plain film
  - Erect and decubitus abdomen views
  - Radiographs for bowel obstruction, ascites
- Patient Preparation
  - Fasting, bladder evacuation, clothing/artifact removal
  - Breathing instructions during exposure

UNIT-3

Radiographic Techniques of Upper and Lower Limbs

- Upper Limb Radiography
  - Fingers, hand, wrist, forearm: AP, oblique, lateral
  - Elbow: AP, lateral, radial head view
  - Humerus: AP, lateral with shoulder visualization
  - Shoulder: AP, axial, scapular Y, Stryker notch view
  - AC and SC joints, clavicle, scapula radiography
  - Special view: carpal tunnel, scaphoid projection
- Lower Limb Radiography
  - Toes, foot, ankle: AP, oblique, lateral
  - Calcaneum: axial and lateral views
  - Knee: AP, lateral, sunrise, Rosenberg, intercondylar notch
  - Femur and tibia-fibula: AP and lateral

UNIT-4

Radiographic Techniques of Vertebral Column & Pelvis

- Cervical Spine
  - AP, lateral, oblique, open mouth (odontoid), swimmer's view
- Thoracic Spine
  - AP, lateral, oblique views
- Lumbar Spine
  - AP, lateral, oblique, spot L5-S1
- Sacrum and Coccyx
  - Separate and combined AP/lateral views
- Scoliosis Series
  - AP erect (whole spine), Cobb angle measurement
- Dynamic Views
  - Flexion and extension views for instability
- Pelvis & Hip Joints

- AP pelvis, frog-leg lateral
- Oblique views for SI joints
- Acetabular views

UNIT-5

Special Techniques: Mobile, OT & Miscellaneous Radiography

Topics Covered:

- **Ward Mobile Radiography**
  - Indications and precautions in ICU/wards
  - Handling portable X-ray units
  - Radiation safety in bedside radiography
- **Operation Theatre Radiography**
  - C-arm usage and positioning
  - Sterility, aseptic technique, lead protection
  - Fluoroscopy during ortho\padic or urology procedures
- **Dental Radiography**
  - Intraoral (IOPA, occlusal), panoramic (OPG) basics
- **Miscellaneous Techniques**
  - Localization of foreign body
  - Cine-radiography: contrast studies in motion
  - Macro and micro radiography
  - Mass miniature radiography (MMR) for tuberculosis
  - Use of battery-operated mobile units

Reference Books :

1. Radiographic and Imaging Techniques for Radiology Residents and Technologists, Rajesh Gothi, Springer Nature, Singapore, 1st Edition, 2025.
2. Textbook of Radiology for Residents and Technicians, Satish K. Bhargava & Sumeet Bhargava, Jaypee Brothers Medical Publishers, New Delhi, 1st Edition, 2022.
3. Clinical Radiography Techniques, A. P. Saxena, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2019.
4. Textbook of Radiography for Paramedical Students, Anil Kumar & Suresh Kumar, CBS Publishers & Distributors, New Delhi, 1st Edition, 2020.

Course Name: BASIC RADIATION PHYSICS & PRINCIPLES OF RADIOTHERAPY - 1 **L T P C**

Course Code: 207RP104 **4 0 0 4**

COURSE OBJECTIVE: This course is designed to fundamental physics principles, explain atomic and nuclear structures**,** differentiate types of radiation interaction with matter**,** understand the design, working principles, and safety features of X-ray tubes and related circuitry.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Apply principles of radiation interaction with matter and identify different types of radiation interactions.
CO2	Analyze the construction and working of X-ray tubes, transformers, and rectification circuits.
CO3	Evaluate X-ray production mechanisms (Bremsstrahlung and Characteristic radiation) and safety precautions.
CO4	Create exposure settings using concepts of voltage, tube current, intensity, and calculate radiological functions.

UNIT 1

Basic Physical Concepts & SI Units

- SI Units:
  - Base units (meter, kilogram, second, ampere, kelvin, candela, mole)
  - Derived units (joule, newton, pascal, watt, coulomb, gray, sievert)
- Scalar and vector quantities:
  - Definitions, examples, and vector addition
- Fundamental mechanical concepts:
  - Mass vs. weight, force (Newton's laws), momentum
- Work, energy & power:
  - Definitions, equations, units
  - Kinetic and potential energy with examples
- Density and pressure:
  - Concepts, applications in fluids and tissues
- Temperature and heat:
  - Units (Celsius, Fahrenheit, Kelvin), heat transfer (conduction, convection, radiation)
- Sound:
  - Frequency, wavelength, velocity, pitch, intensity, resonance
- Waves and oscillations:
  - Transverse vs longitudinal waves, amplitude, period, phase, harmonic motion

UNIT 2

Atomic Structure & Nuclear Physics

- Structure of the atom:
  - Proton, neutron, electron; orbital model
- Bohr's model of hydrogen atom
- Atomic number, mass number, isotopes
- Orbital electrons and energy levels:
  - Shells and subshells (K, L, M...), electron configuration
- Nuclear binding energy & mass defect
- Radiation types:
  - Alpha (α), Beta (β), Gamma (γ), X-rays, and electromagnetic spectrum
- Electricity & Magnetism:
  - Electric current, voltage, resistance (Ohm's law)
  - Magnetic fields and electromagnetic induction
- Electromagnetic (EM) spectrum:
  - Radio, microwave, IR, visible, UV, X-rays, Gamma rays
- Quantum theory basics:
  - Planck's constant, photoelectric effect, quantum energy = hν

UNIT 3

Radioactivity & Nuclear Reactions

- Radioactivity:
  - Definition, spontaneous emission, radioactive elements
- Laws of radioactive decay
  - Exponential decay law: $N = N_0 e^{(-\lambda t)}$
- Decay constant, half-life ($T_{1/2}$), mean life
- Modes of decay:
  - Alpha decay, beta decay (β^-, β^+), electron capture, internal conversion
- Radioactive equilibrium:
  - Transient vs. secular equilibrium
- Nuclear reactions:
  - (α,p), (α,n), proton and neutron bombardment
- Fission and fusion reactions
- Activation of nuclides:
  - Production of radionuclides
- Introduction to nuclear reactors:
  - Types used in medical isotope production (e.g., Mo-99 for Tc-99m)

UNIT 4

Interaction of Radiation with Matter

- Ionization and excitation:
  - Differences, biological significance
- Interactions of EM radiation:
  - Photoelectric effect: complete absorption, diagnostic imaging relevance
  - Compton scattering: partial energy loss, secondary electrons
  - Pair production: threshold energy, annihilation photons
- Interactions of particles:
  - Charged particles (protons, α) vs uncharged (neutrons)
- LET (Linear Energy Transfer):
  - High LET vs low LET radiation
- Attenuation and shielding:
  - Exponential attenuation, shielding materials (lead, concrete)
- Linear attenuation coefficient
- Half Value Layer (HVL):
  - Definition, calculation, practical significance in protection

UNIT 5

X-ray Production & Instrumentation

- X-ray tube structure:
  - Glass/metal housing, cathode (filament), anode (target), rotor-stator
- Radiation types:
  - Bremsstrahlung: slowing electrons
  - Characteristic: shell transitions (Kα, Kβ)
- Physics of X-ray production:
  - Energy conversion, efficiency, heat
- High voltage equipment:
  - Transformers (step-up, autotransformer), generators
- Voltage rectification:
  - Half-wave, full-wave, 3-phase, high-frequency systems
- Instrumentation:
  - kVp meter, mA meter, timers
- Thermionic emission:
  - Electron cloud, space charge effect
- Exposure parameters:
  - kVp, mA, exposure time, their effect on intensity and quality
- Inverse square law:
  - Intensity $\propto 1/d^2$
- Tube rating charts:
  - Heat units, anode cooling curves

- Electrical safety:
    - Earthing, leakage protection, emergency shut-off
- Mathematical tools:
    - Exponential functions in decay & attenuation
    - Trigonometric functions in wave calculations

Reference Books

1. Basic Radiological Physics, S. Thayalan, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2013.
2. The Physics of Radiology, H.E. Jones & J.R. Cunningham, Charles C. Thomas Publisher, Illinois, 4th Edition, 2000.
3. Medical Imaging Physics, William R. Hendee & E. Russell Ritenour, Wiley-Liss, New York, 4th Edition, 2002.
4. Introduction to Radiological Physics and Radiation Dosimetry, P.R. Moran, Wiley-Interscience, New York, 1st Edition, 1982.
5. Radiologic Science for Technologists: Physics, Biology, and Protection, S.C. Bushong, Mosby/Elsevier, St. Louis, 11th Edition, 2016.

Course Name:PRACTICAL FOR ALL COURSE / CLINICAL POSTING L T P C
Course Code:207PR105 0 0 6 6

List of Practical's Anatomy-1

1. Demonstration of Major organs through models and permanent slides.
2. Demonstration of parts of circulatory system from models.
3. Demonstration of parts of respiratory system from models.
4. Demonstration of digestive system from models.
5. Demonstration of excretory system from models.
6. Demonstration of nervous system from models.
7. Demonstration of various bones
8. Demonstration of various joints

List of Practicals Physiology-1:

1. To measure pulse rate
2. To measure blood pressure
3. To perform Hemoglobin by Sahli's Method
4. To perform Total RBC count.
5. To perform total leucocyte count.
6. To perform differential leucocyte count.
7. To perform PCV
8. To calculate Red cell indices.

List of PracticalsRadiographic Techniques:

1. Radiographic positioning for upper limbs: Hand, fingers, thumb, scaphoid, wrist, forearm, elbow& Humerus.
2. The shoulder- Calcified tendons, Acromio-clavicular joint, clavicle,sterno clavicular joint, scapula&coracoids process.
3. The Lower Limb: foot, toes, ankle joint, calcaneum& subtalar joint.
4. The hip, pelvis, and sacro-iliac joints: anatomy and image appearance, effect of rotation, hip joint, acetabulum, pelvis& Sacro-Iliac Joint.

List of Practical's Basic Radiation Physics & Principles of Radiotherapy 1:

1. Basic Concepts Of Electro - Magnetic Radiation: Structure of atom, Basic concepts of electricity, &magnetism current voltage & electro-magnetic induction radioactivity.
2. X–Ray: Discovery of x-rays, properties, Production, x-ray, Spectrum, bremsstrahlung and characteristic x-rays, Interaction, ionization, excitation, attenuation, Coolidge tube design, line focus principle.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learning's during the postings. Performance will be continuously evaluated by the faculty assigned to each section.

SEMSETER-II

Course Name: HUMAN ANATOMY-2 **L T P C**
Course Code: 207AN201 **4 0 0 4**

COURSE OBJECTIVE: The prime concern of this syllabus is to learn the terminology of the course and basic knowledge of cells & tissues and to understand anatomy of human body. This course will develop an understanding of the structure and function of organs and organ systems in normal human body.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Apply anatomical knowledge to analyze joint movements, dislocations, and abnormalities.
CO2	Explain human developmental stages including fertilization, germ layers, and organogenesis.
CO3	Analyze embryological development and its deviations leading to congenital malformations.
CO4	Evaluate the clinical and radiological significance of skeletal development and anomalies.

UNIT 1

Medico-Legal & Anthropological Aspects of Skeleton

Forensic Importance of Skeletal System

- Role of bones in post-mortem identification
- Forensic anthropology in crime investigation
- Skeletal preservation and examination techniques

Estimation of Age

- Ossification and epiphyseal union timing in long bones
- Age estimation using skull sutures (metopic, sagittal, coronal closure stages)
- Use of dental eruption in juveniles

Estimation of Sex

- Pelvic inlet, subpubic angle, greater sciatic notch (female vs male)
- Skull: prominence of brow ridge, mastoid process, mandible shape
- Discriminant function analysis for sex differentiation

Estimation of Stature (Height)

- Use of regression equations with femur, tibia, humerus
- Methods: anatomical vs mathematical reconstruction
- Application in disaster victim identification (DVI)

Estimation of Race

- Cranial index, nasal aperture, orbital shape, prognathism
- Differentiation between Caucasoid, Mongoloid, and Negroid features

Radiographic Role in Anthropology

- Long bone radiographs for epiphyseal analysis
- Skull and pelvis imaging in sex/race estimation
- Role of CT scan and 3D reconstruction

UNIT 2

Classification & Characters of Joints

Structural Classification

- Fibrous joints: sutures, syndesmoses, gomphoses
- Cartilaginous joints: primary (synchondrosis), secondary (symphysis)
- Synovial joints: types (plane, hinge, pivot, condyloid, saddle, ball & socket)

Functional Classification

- Immovable (synarthrosis), slightly movable (amphiarthrosis), freely movable (diarthrosis)
- Correlation with range of movement

Regional Classification

- Axial joints: intervertebral, craniovertebral
- Appendicular joints: limb joints — shoulder, elbow, wrist, hip, knee, ankle

Movements in Joints

- Uniaxial, biaxial, multiaxial movement
- Examples: flexion-extension (elbow), rotation (atlanto-axial), abduction-adduction (hip)
- Circumduction and gliding movements

Histology of Joint Structures

- Synovial membrane and fluid
- Articular cartilage (hyaline)
- Joint capsule and ligaments
- Blood supply and nerve innervation of joints

UNIT 3

Applied Anatomy of Joints & Dislocations

Common Joint Dislocations

- Shoulder: anterior dislocation, Bankart lesion
- Hip: posterior dislocation, congenital dislocation of hip (CDH)
- Elbow: nursemaid's elbow in children
- Patella: lateral dislocation in trauma
- TM Joint: dislocation during wide mouth opening

Anatomical Risk Factors for Dislocation

- Shallow sockets (glenoid cavity)
- Ligament laxity, muscle imbalance

- Congenital deformities

Healing and Complications
- Healing phases: inflammation, repair, remodeling
- Joint stiffness, instability, osteoarthritis
- Avascular necrosis risk in hip dislocation

Radiological Identification
- X-ray identification of dislocation direction
- CT/MRI for ligament involvement and complex injuries

UNIT 4

Embryology & Development

Gametogenesis
- Spermatogenesis: stages, hormonal regulation
- Oogenesis: oocyte maturation and meiosis arrest
- Chromosomal complement and sex determination

Fertilization & Early Development
- Acrosome reaction, zygote formation
- Cleavage: blastomere stages
- Morula and blastocyst development

Implantation
- Time and site of implantation
- Role of endometrial lining
- Ectopic pregnancy overview

Formation of Embryonic Disc & Germ Layers
- Bilaminar → trilaminar disc transition
- Ectoderm: skin, nervous system
- Mesoderm: muscle, bone, CVS
- Endoderm: gut, respiratory tract lining

Placenta
- Structure: chorionic villi, maternal-fetal interface
- Functions: respiration, nutrition, excretion
- Placental abnormalities: previa, accrete

UNIT 5

Congenital Malformations

Introduction to Congenital Anomalies

- Definition and classification (major vs minor, isolated vs syndromic)
- Prevalence and public health relevance

Causes of Malformations

- Genetic: chromosomal abnormalities (Down syndrome, Turner syndrome)
- Environmental: teratogens (drugs, alcohol), infections (TORCH), radiation
- Maternal factors: diabetes, nutritional deficiencies

Examples of Common Malformations

- Neural Tube Defects**:** spina bifida (occulta, cystica), anencephaly
- Facial Clefts**:** cleft lip, cleft palate – embryonic basis
- Limb Defects: polydactyly (extra digits), syndactyly (fused digits)
- Congenital Heart Defects: ASD, VSD, TOF (basics)

Diagnosis & Prevention

- Prenatal screening (ultrasound, alpha-fetoprotein)
- Genetic counseling
- Folic acid supplementation for NTD prevention

Reference Books:

1. Human Anatomy Regional and Applied Vol. 1, Vol. 2 & Vol. 3 ,B.D. Chaurasia, C.B.S. Publishers, New Delhi ,9th Edition, 2022
2. Hand Book of General Anatomy ,B.D. Chaurasia, C.B.S. Publishers, New Delhi, 9th Edition, 2022
3. Text Book of Human Histology ,Inderbir Singh ,Jaypee Brothers, Medical Publishers, Delhi ,7th Edition ,2021
4. Gray's Anatomy ,Susan Standring ,Elsevier Churchill Livingstone, Edinburgh ,42nd Edition ,2021

Course Code: HUMAN PHYSIOLOGY -2 **L T P C**
Course Code: 207PY202 **4 0 0 4**

COURSE OBJECTIVE: The prime concern of this syllabus is to learn the terminology of the course and basic knowledge of cells & tissues and to understand physiology of human body. This course will develop an understanding of function of organs and organ systems in normal human body.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Apply knowledge of sensory organs in understanding special senses like vision, hearing, smell, and taste.
CO2	Analyze the structure and function of central and peripheral nervous systems.
CO3	Evaluate physiological roles of the skin and immune system in maintaining homeostasis and defense.
CO4	Integrate pathological concepts such as oedema, thrombosis, and inflammation in clinical conditions.

UNIT 1

Digestive System

- Overview of the GI tract: oral cavity to anus
- Mouth & Pharynx:
  - Mastication and swallowing (deglutition reflex)
- Salivary Glands:
  - Types, secretion, enzyme amylase, regulation
- Esophagus& Stomach:
  - Mechanical digestion, peristalsis
  - Gastric secretions: HCl, pepsin, mucus, intrinsic factor
- Liver:
  - Bile production, metabolic functions (carbohydrate, protein, fat metabolism)
- Gall Bladder:
  - Storage and release of bile (via CCK hormone)
- Small Intestine:
  - Enzymatic digestion, absorption (villi and microvilli)
- Large Intestine:
  - Water and electrolyte absorption, formation of feces
  - Defecation reflex
- Nervous & Hormonal Control:
  - Enteric nervous system, role of gastrin, secretin, CCK

UNIT 2

Endocrine System

- Overview:
  - Classification of endocrine vs exocrine glands
- Pituitary Gland:
  - Anterior hormones: GH, TSH, ACTH, FSH, LH, PRL – functions and disorders
  - Posterior hormones: ADH, oxytocin
- Hypothalamus:
  - Neuroendocrine control and releasing hormones
- Thyroid Gland:
  - T3, T4 functions; calcitonin and calcium regulation
- Parathyroid Gland:
  - PTH and role in calcium/phosphate balance
- Adrenal Glands:
  - Cortex: cortisol (stress), aldosterone (electrolyte balance), androgens
  - Medulla: adrenaline, noradrenaline – sympathetic stimulation
- Pancreas:
  - Insulin and glucagon – glucose regulation, diabetes

UNIT 3

Sensory Organs and Special Senses

- Ear Anatomy & Physiology:
  - External ear (pinna, canal), middle ear (ossicles, tympanic membrane), inner ear (cochlea, vestibular apparatus)
  - Physiology of hearing and balance
  - Disorders: otitis media, deafness types (conductive, sensorineural)
- Eye Anatomy & Vision:
  - Layers: sclera, cornea, choroid, retina
  - Structures: lens, iris, aqueous/vitreous humor
  - Photoreceptors: rods and cones
  - Visual pathway and image formation
  - Disorders: cataract, glaucoma, myopia, hypermetropia
- Olfaction:
  - Olfactory epithelium, CN I
- Gustation (Taste):
  - Taste buds, cranial nerves (VII, IX), primary tastes

UNIT 4

Nervous System

- Neuron Types:
  - Unipolar, bipolar, multipolar; functions of excitability, conductivity
- Neuroglia:
  - Astrocytes, oligodendrocytes, Schwann cells, microglia
- Central Nervous System:
  - Brain:
    - Cerebrum (lobes, functions), cerebellum (coordination), brainstem (midbrain, pons, medulla)
  - Meninges and blood-brain barrier
  - Ventricular system and CSF flow
  - Spinal cord:
    - Structure, gray/white matter, reflex arcs
- Peripheral Nervous System:
  - Cranial nerves (origin and function of major nerves)
  - Spinal nerves (dorsal/ventral roots, dermatomes)
- Autonomic Nervous System:
  - Sympathetic vs parasympathetic
  - Neurotransmitters: acetylcholine, noradrenaline
  - Fight-or-flight response and homeostasis

UNIT 5

Skin, Immune System & Pathological Physiology

- Skin Anatomy:
  - Layers: epidermis (keratinized epithelium), dermis (connective tissue)
  - Appendages: sweat glands, sebaceous glands, hair, nails
  - Functions: barrier, thermoregulation, sensory reception
- Immune System:
  - Innate v/s adaptive immunity
  - Lymphocytes: T-cells, B-cells, NK cells
  - Antigen-antibody interaction
  - Autoimmune disorders (basics): lupus, RA
- Cell Injury:
  - Reversible v/s irreversible injury
- Inflammation:
  - Acute v/s chronic, cellular events, chemical mediators (histamine, cytokines)
- Oedema:
  - Transudates v/s exudates, causes
- Hemodynamic Disorders:
  - Hyperaemia, congestion, haemorrhage

    - Thrombosis, embolism, infarction: pathogenesis and consequences
- Sepsis v/s Asepsis
- Tissue Repair:
    - Wound healing phases (inflammation, proliferation, re-modeling)
    - Ulceration

Reference Books

1. A.K. Jain, Textbook of Physiology (Volume I & II), 9th Edition, 2021.
2. Venkatesh, D. and Sudhakar, H.S., Basics of Medical Physiology, Wolters Kluwer Publication, 4th Edition, 2018.
3. Chaudhuri, Sujit K., Concise Medical Physiology, New Central Book Agency, 7th Edition, 2016.
4. Guyton and Hall, Textbook of Medical Physiology, Elsevier, 14th Edition, 2020.
5. Sembulingam, K. and Sembulingam, P., Essentials of Medical Physiology, Jaypee Brothers Medical Publishers, 8th Edition, 2019.

Course Name: Dark Room Procedures **L T P C**
Course Code: 207DR203 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the fundamentals of manual processing, automatic processing, darkroom structure, fixer and its chemistry, care of intensifying screen.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Evaluate the photographic processes and factors affecting film quality.
CO2	Apply knowledge of film development and fixing using manual and automatic methods.
CO3	Understand the design, safety measures, and illumination techniques of a dark room.
CO4	Operate and maintain film processing equipment under controlled environmental conditions.

UNIT 1

The Photographic Process & Film Construction

- Introduction to Photographic Imaging
  - Concept of analog image formation using X-ray exposure
  - Importance of optical density, sharpness, and contrast
  - Principles of radiographic image capture and visibility
- Visible Light and Radiation-Induced Images
  - Electromagnetic spectrum: X-rays vs visible light
  - Image production due to interaction of radiation with film/screen
- Types of Images
  - Real vs mental (virtual) images
  - Reflected (e.g., mirrors), transmitted (e.g., X-rays), emitted light (e.g., scintillation)
- Light-sensitive Materials
  - Silver halide crystals (AgBr, AgCl)
  - Sensitivity specks, gelatin matrix, spectral sensitivity
  - Effect of temperature and humidity on photosensitivity
- Photographic Emulsion & Latent Image
  - Emulsion composition and role in image capture
  - Formation of latent image: activation centers, free electrons
  - Development of latent to visible image via reduction
- Positive Process
  - Making a positive from a negative image
  - Copying radiographs or duplicating films
- X-ray Film Construction
  - Film base (polyester), adhesive, emulsion, protective layer
  - Single vs double emulsion films

- Crossover Effect
    - Light crossing from one emulsion layer to another
    - Use of anti-crossover dyes and layers
    - Impact on sharpness and resolution

UNIT 2

Sensitometry & Image Characteristics

- Photographic Density
    - Optical density formula = $\log_{10}$ (Incident light / Transmitted light)
    - Density range for diagnostic films
- Characteristic Curve (H&D Curve)
    - Representation of exposure vs density
    - Toe: underexposure, Shoulder: overexposure
    - Straight line portion: diagnostic useful range
- Sensitometric Parameters
    - Gamma (slope) = contrast
    - Base + fog: minimum density
    - Speed point: film speed or sensitivity
- Sensitometer & Densitometer Use
    - Sensitometer: step wedge exposure
    - Densitometer: measuring optical density of developed film
- Film Storage & Handling
    - Temperature: ideal 10–21°C
    - Humidity: 40–60%
    - Protection from radiation, light leaks
- Radiograph Storage
    - Archival standards: 5–10 years
    - Filing, labelling, avoidance of folding or scratching

UNIT 3

Intensifying Screens, Cassettes & Luminescence

- Luminescence Concepts
- Fluorescence: instant light emission (ends when radiation ends)
- Phosphorescence: persistent glow after exposure ends
- Intensifying Screen Components
- Base (polyester), reflective layer, phosphor layer, protective coat
- Rare-earth phosphors: Gadolinium oxysulfide, Lanthanum oxybromide
- Advantage over calcium tungstate (more efficient, lower dose)
- Function in Radiography
- Converts X-rays to visible light to expose film
- Reduces patient radiation dose by 10–100 times

- Screen Characteristics
- Speed: fast, medium, slow
- Detail resolution vs patient dose trade-off
- Quantum mottle in fast screens
- Types of Cassettes
- Conventional (metal/plastic), flexible, curved for dental/orthopedic
- Rigid cassettes with foam for screen-film contact
- Digital cassettes: CR (Computed Radiography)
- Screen Mounting
- Uniform contact ensures sharp image
- Screen cleaning protocols to avoid artifacts

UNIT 4

Film Processing (Manual & Automatic)

- Development Process
- Converts latent image into black metallic silver
- Takes place in alkaline environment (pH ~10)
- Time-temp relationship: 5 min @ 20°C (manual)
- Developer Composition
- Reducing agents: Metol (gray tones), Hydroquinone (black tones)
- Preservatives: sodium sulfite (prevents oxidation)
- Restrainers: potassium bromide (prevents fog)
- Activators: sodium carbonate (swells emulsion)
- Hardener: gluteraldehyde in automatic developer
- Fixing Process
- Removes unexposed silver halide to prevent image fading
- Fixer pH: acidic (~4–5)
- Fixer Composition
- Fixing agent: ammonium thiosulfate
- Acidifier: acetic acid
- Preservative: sodium sulfite
- Hardener: aluminum salts
- Quality Control & Errors
- Inadequate fixing → milky films
- Improper temperature → reticulation, chemical fog
- Fixer exhaustion signs
- Laser & Dry Processing (Brightness-Based)
- Laser printers in digital radiography
- Dry processors using thermal heads or dye sublimation
- Artifacts in Films
- Static marks, water marks, chemical stains, pressure marks
- Causes and prevention strategies

UNIT 5

Processing Equipment & Dark Room Design

- Manual Processing Equipment
  - Stainless steel or plastic tanks for developer/fixer
  - Thermometer (range 0–50°C), stirrers, hangers (for suspending films)
- Automatic Processors
  - Motor-driven rollers, temperature-controlled tanks
  - Sections: developer, fixer, washer, dryer
  - Feed tray and exit rack
- Temperature Control
  - Immersion heaters: electric heaters in solution tanks
  - Thermostats: automatic regulation
  - Cooling methods: water jackets, external refrigeration
- Dark Room Design
  - Wet & dry areas: separated to prevent contamination
  - Entry: maze-type entrance, revolving door to block light
  - Ventilation: exhaust fans, air conditioning to maintain humidity
  - Anti-fogging construction: matte black walls, sealed fixtures
- Lighting
  - White light: for cleaning and maintenance only
  - Safe light: red or amber filter, max 15W, minimum 4 feet away
  - Compatibility of filter with film type
- Accessories
  - Loading bench with anti-static surface
  - Pass-box for film transfer
  - Chemical waste tanks with neutralization and disposal system

Reference Books

1. Fundamentals of Radiographic Techniques, Indrajit K. Saluja, Jaypee Brothers Medical Publishers, New Delhi, 1st Edition, 2010.
2. Essentials of Darkroom Procedures in Radiography, N.K. Mehra, Jaypee Brothers Medical Publishers, New Delhi, 1st Edition, 2008.
3. Clark's Positioning in Radiography, Whitley, Jefferson, Holmes, Sloane & Anderson, CRC Press, London, 13th Edition, 2015.
4. Merrill's Atlas of Radiographic Positioning and Procedures, Bruce W. Long, Jeannean Hall Rollins & Barbara J. Smith, Elsevier, St. Louis, 14th Edition, 2018.
5. Radiographic Imaging and Exposure, Terri L. Fauber, Elsevier, St. Louis, 6th Edition, 2020.

Course Name: Basic Radiation Physics & Principles of Radiotherapy - 2 **L T P C**

Course Code: 207RP204 **4 0 0 4**

COURSE OBJECTIVE: This course is designed to fundamental physics principles,explain atomic and nuclear structures**,** differentiate types of radiation interaction with matter**,** understand the design, working principles, and safety features of X-ray tubes and related circuitry.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Apply principles of radiation interaction with matter and identify different types of radiation interactions.
CO2	Analyze the construction and working of X-ray tubes, transformers, and rectification circuits.
CO3	Evaluate X-ray production mechanisms (Bremsstrahlung and Characteristic radiation) and safety precautions.
CO4	Create exposure settings using concepts of voltage, tube current, intensity, and calculate radiological functions.

UNIT 1

Introduction to Tumors, Radiotherapy & Radiation Concepts

1. Tumor Classification:
    - Benign tumors: localized, slow-growing, encapsulated (e.g., lipoma)
    - Malignant tumors: invasive, fast-growing, metastasizing (e.g., carcinoma, sarcoma)
2. Common Radiotherapy-Responsive Malignancies:
    - Cervix, breast, oral cavity, brain, head & neck, esophagus, prostate, lung
3. Radioactivity and Ionizing Radiation in Treatment:
    - Ionizing radiation: electromagnetic (X-rays, γ-rays) and particulate (α, β)
    - Role of radiation in DNA damage → tumor cell death
4. Radioactive Sources Used in Therapy:
    - Cobalt-60: γ-ray emitter (5.27 years half-life)
    - Iridium-192, Cesium-137: temporary implants or afterloaders
5. Radiation Techniques:
    - External Beam Radiotherapy (EBRT): Teletherapy
    - Brachytherapy: Interstitial/intracavitary
    - Systemic Therapy: Iodine-131, Strontium-89 for metastases
6. Key Radiobiological Concepts:
    - Tissue Tolerance Dose (TD5/5, TD50/5)

- Tumor Lethal Dose
- Therapeutic Ratio = Normal Tissue Tolerance / Tumor Dose
- Radiosensitivity: High (lymphoma), Moderate (squamous cell), Low (melanoma)

7. Units of Measurement:
   - Exposure: Roentgen (R)
   - Absorbed dose: Gray (Gy) = 1 J/kg
   - Biological dose: Sievert (Sv) = Gy × weighting factor
8. Radiation Prescription:
   - Example: 60 Gy in 30 fractions, 2 Gy/day
   - Importance of fractionation and total dose control
9. Radiation Reactions:
   - Acute: mucositis, dermatitis, diarrhea
   - Chronic: fibrosis, organ dysfunction, necrosis, secondary malignancy

UNIT 2

Teletherapy Techniques and Equipment

1. Teletherapy Techniques:
   - Superficial, Orthovoltage, Megavoltage
   - 2D conventional vs 3D conformal vs IMRT vs IGRT
2. Orthovoltage Machines:
   - 200–400 kVp range
   - Shallow penetration, used historically for skin lesions
3. Megavoltage Machines:
   - Cobalt-60 Machine:
     - γ-ray source, fixed beam
     - Components: source head, beam collimators, SSD indicators, shutter mechanisms
   - Linear Accelerator (LINAC):
     - Produces high-energy X-rays or electrons
     - Parts: electron gun, RF generator, waveguide, bending magnet, collimator (MLC)
4. Beam Direction Techniques:
   - Anterior-Posterior (AP/PA), lateral, tangential, arc therapy
   - Isocentric technique (100 cm SAD)
5. Beam Modification Devices:
   - Wedges: change dose distribution angle
   - Bolus: tissue equivalent material to build up dose on surface
   - Compensators: for tissue inhomogeneity
   - Shields: customized blocks, MLCs
6. Patient Immobilization & Mould Room Techniques:
   - Thermoplastic masks: head/neck cancer
   - Plaster or fiberglass casts: pediatric/limb immobilization
   - Bite blocks and shoulder retractors
7. Clinical Applications:
   - 2D: basic planning with X-ray
   - 3D-CRT: CT-based contouring

- IMRT: multiple intensity beams
- IGRT: daily image-guide

UNIT 3

Principles of Basic Radiobiology

- Cell Cycle: G1, S, G2, M phases
- Radiation effects on different cell phases
- Cell Survival Curve: shoulder region, D_0, Dq values
- LET (Linear Energy Transfer): high vs low LET radiation
- RBE (Relative Biological Effectiveness): effect per unit dose
- OER (Oxygen Enhancement Ratio): radiosensitivity in oxygenated vs hypoxic tissue
- Time-Dose-Fractionation Concepts**:**
  - Single vs multiple fractions
  - Hyperfractionation, hypofractionation
  - BED (Biologically Effective Dose)
- Acute and Chronic Radiation Effects:
  - Acute: mucositis, desquamation, nausea
  - Chronic: fibrosis, secondary malignancies

UNIT 4

Brachytherapy Principles & Applications

- Definition and Advantages of Brachytherapy
- Radium and substitutes: Cesium-137, Iridium-192, Iodine-125
- Types of brachytherapy:
  - Interstitial: seeds or wires in tissues (e.g., prostate, tongue)
  - Intracavitary: vaginal, cervical applications
  - Intraluminal: esophagus, bronchus
  - Surface moulds: custom applicators for skin tumors
- Dose rate classification:
  - LDR (Low Dose Rate), MDR (Medium), HDR (High)
- Modern remote afterloading systems: Microselectron-HDR, Selectron-HDR

UNIT 5

Demonstrations and Radiation Safety

Demonstration Topics:

1. Beam modification devices (wedges, bolus, compensators)
2. Lead bench and radium-safe for handling radioactive materials
3. Mould room techniques and cast making
4. Cobalt-60 machine: external structure and operational parts
5. Linear accelerator: functioning of gantry, collimator, control console

6. Beam direction devices: lasers, fiducials, skin marks
7. Interstitial Microselectron HDR demonstration
8. Intracavitary application using HDR/MDR Selectron
9. Surface mould application for skin lesions
10. Radiation safety devices: lead aprons, TLD badges, warning signage

Reference Books

1. Basic Radiotherapy Physics and Dosimetry, K. Thayalan, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2022.
2. Essentials of Radiation Oncology, K.S. Gopi, Jaypee Brothers Medical Publishers, New Delhi, 1st Edition, 2020.
3. Radiation Therapy Physics, William R. Hendee & E. Russell Ritenour, Wiley-Liss, New York, 4th Edition, 2004.
4. Introduction to Radiobiology, Eric J. Hall & Amato J. Giaccia, CRC Press (Taylor & Francis Group), Boca Raton, 5th Edition, 2023.

Course Code: PRACTICAL FOR ALL COURSES / CLINICAL POSTING L T P C

Course Code: 207PR205 0 0 6 6

List of Practicals Anatomy-2

1. Demonstration of various parts of reproductive system (Male and female from models and charts)
2. To study circulatory system from charts and transverse section (TS) of artery and vein from permanent slides.
3. To study digestive system from charts and TS of liver, spleen and pancreas from permanent slides.
4. Study of Urinary system (charts)
5. Study of Genital system (male & female) from charts and TS of testis and ovary from permanent slides.
6. To study nervous system (From models / charts)
7. To study various body fluids.

Note: Demonstrations can be done with the help of models, charts and histological slides

List of Practicals Physiology-2:

1. To perform bleeding time.
2. To perform clotting time.
3. To study about CSF examination.
4. To study about intrauterine contraceptive devices.
5. To demonstrate microscopic structure of bones with permanent slides.
6. To demonstrate microscopic structure of muscles with permanent slides.

List of Practicals Dark RoomTechniques:

1. Dark Room: Definition. Construction of darkroom. Equipment presents in darkroom.
2. X-Ray Cassettes: Definition, Construction, Uses, Types & Care of cassette.
3. Intensifying Screens: Definition, Constructions, Different layers, Uses & Types.
4. Radiographic Film: Definition, Different layers, Different types of Radiographic film & Handling and storage of Radiographic film.

List of Practicals Basic Radiation Physics & Principles Of Radiotherapy 2:

1. Basic Concepts Of Electro - Magnetic Radiation: Structure of atom, Basic concepts of electricity, &magnetism current voltage & electro-magnetic induction radioactivity.
2. X–Ray: Discovery of x-rays, properties, Production, x-ray, Spectrum, bremsstrahlung and characteristic x-rays, Interaction, ionization, excitation, attenuation, Coolidge tube design, line focus principle.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learnings during the postings. Performance will be continuously evaluated by the faculty assigned to each section.

SEMSETER-III

Course Name: MODERN IMAGING WITH RECENT ADVANCES-1 **L T P C**
Course Code: 207MI301 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the principles, components, and functions of advanced medical imaging modalities including Ultrasound, Doppler, CT, MRI, CR, DR, and DSA.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the principles, components, and functions of advanced medical imaging modalities including Ultrasound, Doppler, CT, MRI, CR, DR, and DSA.
CO2	Explain the working mechanisms, advantages, and limitations of various imaging techniques.
CO3	Apply anatomical knowledge to interpret cross-sectional imaging.
CO4	Analyze imaging technologies based on clinical indications and patient suitability.

UNIT 1

Ultrasound & Colour Doppler

- Principle of Ultrasonography:
  - Sound wave interaction with tissues; acoustic impedance
  - Echo patterns, reflection, scattering, and refraction
- Types of Transducers:
  - Linear array, convex array, phased array, sector scanners
- Colour Doppler:
  - Doppler shift, aliasing, direction of flow, velocity measurements
  - Resistance Index (RI), Pulsatility Index (PI)
- Clinical Applications:
  - Obstetrics &gynecology: fetal biometry, anomaly scan
  - Abdominal: liver, kidney, spleen, gall bladder
  - Vascular: carotid Doppler, deep vein thrombosis (DVT)
  - MSK: tendon/ligament imaging, joint effusion
- Cross-sectional Anatomy:
  - Visualization of liver, kidney, uterus, bladder, thyroid in USG

UNIT 2

Computed Tomography (CT)

- Historical Overview:
  - Godfrey Hounsfield's contribution; evolution of scanner generations
- Basic Principles:
  - X-ray attenuation, linear attenuation coefficient, Hounsfield units (HU)
  - Role of detectors, gantry, slip ring technology
- Types of CT Systems:
  - Conventional (axial), spiral/helical CT, multislice CT
- Scanner Generations:
  - 1st to 6th generation: tube/detector geometry and advancements
- Technical Terms:
  - Pitch, slice thickness, voxel size, reconstruction algorithms
- Cross-sectional Anatomy:
  - Brain (ventricles, sulci), thorax (lungs, heart), abdomen (liver, pancreas), pelvis (bladder, uterus)
- Clinical Applications:
  - Trauma imaging, oncology (tumor staging), angiography
- Radiation Dose Considerations:
  - ALARA principle, CTDI, DLP monitoring

UNIT 3

Magnetic Resonance Imaging (MRI)

- Basic MRI Physics:
  - Proton alignment in magnetic field
  - T1 and T2 relaxation, precession, resonance, flip angle
- MRI Sequences:
  - T1-weighted, T2-weighted, FLAIR, DWI, GRE
  - Sequence selection based on pathology
- Comparison with CT & USG:
  - Advantages and limitations of MRI (soft tissue detail, radiation-free)
- Contrast Media:
  - Gadolinium-based agents: uses, precautions
- Cross-sectional Imaging:
  - CNS: brain/spinal cord
  - Joints: knee, shoulder
  - Abdomen: liver, adrenals, pancreas
- Advanced Applications:
  - Functional MRI (fMRI), MR angiography (MRA)
  - Limitations: motion artifacts, cost, contraindications (pacemakers, metal)

UNIT 4

Spectroscopy & Digital Imaging Techniques

- Magnetic Resonance Spectroscopy (MRS):
  - Chemical shift principle, metabolites (NAA, choline, creatine)
  - Application in brain tumors, metabolic disorders
- Computerized Radiography (CR):
  - Imaging plate (IP), scanning by laser, latent image erasure
- Digital Radiography (DR):
  - Flat-panel detectors: direct vs indirect
  - Image acquisition and post-processing (windowing, annotation)
- Digital Subtraction Angiography (DSA):
  - Mask and contrast image subtraction
  - Real-time vascular imaging for interventional procedures
- Scanned Projection Radiography:
  - Used in whole-body bone scan and DR entry-level systems
- Analog vs Digital Comparison:
  - Advantages: no film, easy storage, image manipulation
  - Limitations: equipment cost, software dependency

UNIT 5

Clinical Applications and Protocols

- Diagnostic and Interventional Use:
  - CT-guided biopsies, USG-guided aspirations
  - MRI for stroke protocol, tumor characterization
- Modality Selection:
  - Trauma: CT
  - Soft tissues/CNS: MRI
  - Gallstones/pregnancy: USG
- Protocol Designing:
  - Brain: CT non-contrast, MRI with contrast (FLAIR, DWI)
  - Chest: HRCT lung, CT Pulmonary Angiogram (CTPA)
  - Abdomen: Triphasic liver CT, abdominal USG
  - MSK: MRI for ACL tear, shoulder cuff injuries
- Patient Preparation:
  - Fasting, bladder filling, metal screening (MRI)
  - Contrast allergy check, renal function tests (CT/MRI)
- Role in Diagnosis & Planning:
  - Early detection, staging, treatment monitoring
  - Pre-operative and post-operative imaging

Reference Books

1. Medical Imaging Technology, K.N. Ananda Rao, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 1st Edition, 2014.
2. Essentials of Medical Imaging, S.K. Bhargava, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2nd Edition, 2019.
3. Computed Tomography: Physical Principles, Clinical Applications, and Quality Control, Euclid Seeram, Elsevier Health Sciences, St. Louis, 4th Edition, 2016.
4. MRI in Practice, Catherine Westbrook & Carolyn Kaut Roth, Wiley-Blackwell, Oxford, 5th Edition, 2018.
5. Diagnostic Imaging Series (Volume-wise: Brain, Chest, Abdomen, etc.), Anne G. Osborn, Karen L. Salzman & Jeffrey S. Ross, Elsevier Health Sciences, Philadelphia, Updated Edition, 2024.

CourseName: APPARATUS OF IMAGING, RADIOTHERAPY & QUALITY ASSURANCE-1 **L T P C**

Course Code :207QA302 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the knowledge of radiation protection and exposure control mechanisms such as grids, timers, and beam limitation.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Understand the fundamentals of electrical systems, electricity generation, and distribution in radiology.
CO2	Explain the working of high-tension generators and rectification techniques used in radiographic equipment.
CO3	Analyze the design, functioning, and clinical application of various X-ray tubes and control circuits.
CO4	Apply knowledge of radiation protection and exposure control mechanisms such as grids, timers, and beam limitation.

UNIT 1

Basic Electrical System and Power Supply in Radiology

- Basic Electrical Concepts: Voltage, current, resistance, Ohm's Law, and power
- Electricity Generation: Sources – thermal, hydro, solar, nuclear
- Power Distribution in Hospitals: Three-phase distribution, isolation transformers
- AC vs DC Current: Characteristics and medical application relevance
- Transformers:
  - Step-up and step-down transformers
  - Autotransformers in X-ray control panels
- Power Conditioning Devices:
  - Voltage stabilizers, line voltage compensators
- Earthing: Necessity in radiological equipment for safety and function
- Circuit Protection: Fuses, MCBs, relays, overload circuit breakers
- UPS & Emergency Power:
  - Battery backup, online and offline UPS
  - Generator sets for emergency use
- Voltage Fluctuations:
  - Effects on X-ray tube performance and image artefacts

UNIT 2

High Tension Generators and Rectification Circuits

- Importance of High Voltage: Role in X-ray generation (30–150 kVp)
- Generator Types:
  - Single-phase (full/half-wave), three-phase (six- and twelve-pulse), high-frequency

- Rectification Methods:
    - Self-rectification
    - Half-wave and full-wave (two diode, four diode)
    - Three-phase rectification circuits
- Valves vs Solid State Rectifiers
- Ripple Factor:
    - Effect on beam quality and image contrast
- Constant Potential Generators
- Programmed Generators:
    - Used in digital radiography, modular generator systems
- Voltage Waveform Diagrams:
    - Before and after rectification (graphical representation)

UNIT 3

The X-ray Tube and Exposure Circuit Components

- X-ray Tube History and Evolution
- X-ray Tube Construction:
    - Glass vs metal envelope, rotating vs stationary anode
    - Line focus principle, anode angle, focal spot
- Tube Rating Charts:
    - Heat units (HU), loading limits, anode cooling curves
- Heat Dissipation:
    - Oil bath, fan-cooled, rotating anode mechanisms
- Tube Supports:
    - Floor ceiling suspensions, overhead cranes
- Mammography Tube Design
- Exposure Circuit:
    - Control panel: kVp, mA, exposure time
    - Filament circuit: thermionic emission, mA selector
    - Kilovoltage selector, compensation circuit
- Exposure Switches:
    - Dead-man type, two-stage switch
- Exposure Timers:
    - Mechanical, synchronous, electronic, AEC
- Mains Compensation: Adjusting for fluctuations during exposure

UNIT 4

Beam Limiting Devices and Scatter Radiation Control

- Scatter Radiation:
    - Origin, impact on image contrast and patient dose
- Beam Limiting Devices:
    - Aperture diaphragms, cones, light beam collimators (LBD)
- Centering Devices:

    - Laser lights, radiographic markers, cassette grids
- Grids:
    - Components (lead strips and radiolucent spacers)
    - Types: linear, focused, cross-hatched, stationary, moving (Potter-Bucky)
    - Grid ratio, frequency, grid cut-off
- Air-Gap Technique
- Additional Scatter Control:
    - Breast compression, tight collimation, proper positioning

UNIT 5

Specialized Radiographic Equipment, Maintenance, and Telegamma Units

A. Specialized Equipment

- Portable and Mobile X-ray Units: Battery-powered, capacitor discharge types
- Fluoroscopy Equipment: Image intensifier, spot film device, fluoroscopic table
- Image Intensifier Systems (LLTV): Principle and components
- Contrast Injectors: Use in CT, DSA
- Dental Radiography: Intraoral, panoramic, cephalometric machines
- Mammography:
    - Dedicated units, target/filter, breast compression, magnification
- Skull Tables and Positioning Aids

B. Equipment Maintenance & Testing

- Routine Care & Cleaning
- Preventive Maintenance
- Quality Assurance (QA) Tests:
    - Timer accuracy, mA linearity, kVp reproducibility
    - Focal spot size, light beam alignment
    - Safety checks of cables, locks, mechanical parts

C. Telegamma Units

- Cobalt-60 Radiotherapy Machines:
    - Source production, shielding, and housing
- Fixed vs Isocentric Units
- Collimation and Penumbra Control
- Leakage Radiation Monitoring
- QA in Radiotherapy:
    - Mechanical alignment, beam output, safety interlock

Reference Books

1. Basic Radiological Physics, R.S. Dhingra, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 3rd Edition, 2022.
2. Fundamentals of Radiological Equipment, Indrajit Khandekar, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2021.

3. Principles and Practice of X-ray Equipment, C.S. Pentlow& J.M.T. Howarth, Charles C. Thomas Publisher Ltd., Illinois, 1st Edition, 2010.
4. Practical Radiographic Imaging, Jennie M. Rowe, Elsevier Health Sciences, St. Louis, 7th Edition, 2018.
5. Principles of Radiographic Imaging: An Art and a Science, Richard R. Carlton & Arlene M. Adler, Cengage Learning, Boston, 5th Edition, 2020.

Course Name: PHYSICS OF RADIOTHERAPY - 1 **L T P C**
Course Code :207PH303 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the fundamentals of manual processing, automatic processing, darkroom structure, fixer and its chemistry, care of intensifying screen.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Understand the relationships between absorbed dose, exposure, and KERMA, and calculate absorbed dose for different media.
CO2	Apply Bragg-Gray theory and stopping power principles in dosimetric calculations.
CO3	Analyze dose distribution and scattering patterns using different phantom materials and assess dose build-up and depth dose distribution.
CO4	Evaluate dosimetric parameters and determine dose in irregular or asymmetric fields using methods like Clarkson's technique.

UNIT 1

Radiation Units &Dosimetric Concepts

- Radiation Measurement Units:
  - Activity: Becquerel (Bq)
  - Exposure: Roentgen (R)
  - Absorbed Dose: rad, Gray (Gy); 1 Gy = 100 rad
  - Dose Equivalent: rem, Sievert (Sv); Sv = Gy × Quality Factor
  - KERMA: Kinetic Energy Released per unit MAss
- Relationships and Calculations:
  - Conversions between exposure, absorbed dose, and KERMA
  - Calculation of absorbed dose in air and tissues
  - Concepts of absorbed dose in soft tissues, water, and other media

UNIT 2

Bragg-Gray Theory & Stopping Power

- Bragg-Gray Cavity Theory:
  - Assumptions: cavity must not disturb field, energy absorbed via charged particles
  - Applications in ion chamber calibration
- Stopping Power:
  - Collisional and radiative stopping power
  - Total mass stopping power and its relevance to electrons and photons
- Dose Transfer Concepts:
  - Transfer of dose between dissimilar media
  - Use of conversion factors in tissue equivalent media
- Exposure from Radioactive Sources:
  - Inverse square law application

- Exposure rate constant (Γ) and clinical calculations

UNIT 3

Dose Distribution and Scattering in Media

- Phantom Materials:
  - Water, PMMA, polystyrene, solid water – equivalence and applications
- Depth Dose Distribution:
  - Central axis depth dose curve
  - Build-up effect and surface dose
- Percentage Depth Dose (PDD):
  - Definition, influencing factors (SSD, field size, energy, depth)
- Scatter Factors:
  - Tissue-Air Ratio (TAR): used in isocentric setup
  - Scatter-Air Ratio (SAR): component of scatter at depth
  - Mathematical relationships between PDD, TAR, SAR

UNIT 4

Dose Calculation Techniques

- Clarkson's Method:
  - Calculation of dose for irregular fields using sector integration
  - Sector summation method for blocked and cut-out fields
- Field Shaping Concepts:
  - Asymmetric fields, wedge fields, blocked fields
- Back Scatter Factor (BSF):
  - Definition, influence of field size, energy, and depth
  - Use in surface dose correction
- Correction Techniques:
  - Effective field size correction
  - Heterogeneity corrections (tissue density adjustments)

UNIT 5

Advanced Dosimetric Parameters and Calculations

- Dosimetric Factors:
  - Collimator Scatter Factor (Sc): scatter from treatment head
  - Phantom Scatter Factor (Sp): scatter from phantom/patient
  - Tissue Phantom Ratio (TPR): dose at depth/reference dose
  - Tissue Maximum Ratio (TMR): ratio of dose at depth to maximum dose
  - Scatter Maximum Ratio (SMR): scatter contribution at max depth
- Inter-relationships:
  - Formulas connecting PDD, TMR, TPR, and SMR
  - Influence of energy, depth, field size

- Clinical Dose Calculations:
    - For Linear Accelerators: SSD & SAD-based methods
    - For Cobalt-60 Units: use of BSF, PDD, TAR
    - Applications in single-field and multiple-field techniques

Reference Books

1. Introduction to Radiation Dosimetry, Ravinder Nath, Jaypee Brothers Medical Publishers, New Delhi, 1st Edition, 2021.

2. Fundamentals of Radiation Physics and Dosimetry, K.N. Udupa, Himalaya Publishing House, Mumbai, 1st Edition, 2019.

3. The Physics of Radiation Therapy, F.M. Khan, Wolters Kluwer Health, Philadelphia, 5th Edition, 2020.

4. The Physics of Radiology, H.E. Johns & J.R. Cunningham, Charles C. Thomas Publisher Ltd., Illinois, 4th Edition, 2000.

5. Introduction to Health Physics, Herman Cember & Thomas E. Johnson, McGraw Hill Education, New York, 5th Edition, 2021.

Course Name: **RADIATION PROTECTION & MONITORING -1** **L T P C**

Course Code :207RM304 **4 0 0 4**

COURSE OBJECTIVE: This course is to design basic radiation protection strategies for both patients and personnel in clinical settings.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Recall the definitions and applications of radiation protection quantities and units.
CO2	Explain various natural and artificial sources of radiation and exposure standards.
CO3	Apply radiation detection and measurement techniques using dosimeters and survey instruments.
CO4	Analyze the biological effects of radiation on different tissues and populations.

UNIT 1

Radiation Protection Quantities and Units

- Quantities:
  - Exposure (Roentgen – R)
  - Absorbed Dose (Gray – Gy; old unit: rad)
  - Kerma / Air Kerma
  - Integral Dose (total energy deposited)
  - Equivalent Dose (H) = Absorbed Dose × Radiation Weighting Factor
  - Effective Dose (HE) = ∑(H × Tissue Weighting Factor)
- Units:
  - Gray (Gy), Sievert (Sv), Becquerel (Bq)
  - Conversion of old to SI units: 1 Gy = 100 rad, 1 Sv = 100 rem, 1 Bq = 1 disintegration/sec
- ICRP Dose Limits:
  - Occupational: 20 mSv/year averaged over 5 years
  - Public: 1 mSv/year (excluding medical)

UNIT 2

Sources of Radiation Exposure

1. Natural Radiation

- Cosmic Radiation:
  - Origin from outer space
  - Higher exposure at higher altitudes
- Terrestrial Radiation:
  - Uranium, thorium, potassium-40 in soil and rock

- Internal Radiation:
    - Naturally present radionuclides (C-14, K-40, Radon-222)
- Radon Gas:
    - Inhaled gas from uranium decay in basements

2. Human-Made (Artificial) Sources

- Medical Exposures:
    - Diagnostic imaging, nuclear medicine, radiation therapy
- Occupational Exposure:
    - Radiology staff, nuclear plant workers
- Nuclear Industry:
    - Reactor operations, mining, fuel processing
- Fallout from Accidents:
    - Chernobyl, Fukushima incidents

3. Comparison Table of Annual Dose

Source	Typical Annual Dose (mSv)
Cosmic Radiation	0.3–1.0
Terrestrial Radiation	0.2–0.8
Medical Exposure	Variable (up to 10+)
Radon Inhalation	1.0–3.0
Total Natural Dose	~2.4 mSv/year

4. Occupational vs Public Exposure Limits

- Occupational: 20 mSv/year (5-year average), max 50 mSv/year
- Public: 1 mSv/year

UNIT 3

Radiation Biology and Effects

- Mechanisms of Radiation Action:
    - Direct action: damage to DNA/molecules
    - Indirect action: free radicals from water radiolysis
- Cell Cycle Sensitivity:
    - Most radiosensitive: M and G2 phases
- Somatic Effects:
    - Acute Radiation Syndrome (ARS): hematopoietic, GI, CNS
    - Skin erythema, burns, tissue damage
- Genetic Effects:
    - Heritable mutations, DNA alterations
- Stochastic vs Deterministic Effects:

    - Stochastic: no threshold (cancer, genetic effects)
    - Deterministic: threshold dose (skin burn, cataract)
- Radiation Effects on Embryo/Fetus:
    - Growth retardation, malformations, prenatal death
    - Increased cancer risk in later life
- Late Effects:
    - Cancer induction, cataracts, infertility

UNIT 4

Personal Monitoring & Survey Instruments

1. Personal Monitoring Devices

- Film Badge:
    - Photographic film, monthly replacement
- TLD (Thermoluminescent Dosimeter):
    - Lithium fluoride crystals, reusable, light emission on heating
- Pocket Dosimeter:
    - Real-time reading, immediate feedback

2. Field Survey Instruments

- Geiger-Müller Counter:
    - Audible and visual alert for β and γ rays
- Ionization Chamber:
    - Accurate dose rate measurement
- Scintillation Detector:
    - Sodium iodide crystal, used in nuclear medicine

3. Counting Statistics

- Radiation counts follow Poisson distribution
    - Mean (N), SD = √N, SE = SD / √n

4. Importance of Personal Monitoring

- Ensures occupational dose limits
- Legal requirement
- Implements ALARA principle

UNIT 5

Radiation Protection Principles and Regulatory Framework

1. Radiation Protection Principles

- Time: reduce time of exposure
- Distance: inverse square law
- Shielding: lead aprons, walls, barriers

2. Radiation Protection for:

- Patients:
  - Beam limitation, shielding gonads, exposure justification
- Personnel:
  - TLD badges, barriers, lead glass, protocols

3. Regulatory and Advisory Bodies

- ICRP – International Commission on Radiological Protection
- NCRP – National Council on Radiation Protection (USA)
- UNSCEAR – UN Scientific Committee on Atomic Radiation
- AERB (India) – Atomic Energy Regulatory Board

4. ALARA Principle

- Dose to be kept As Low As Reasonably Achievable

5. Radiation Protection in Pregnancy

- Risks to embryo/fetus
- Shielding, justification, postponement when possible
- Counseling female radiation workers

Reference Books

1. Basics of Radiation Physics and Protection, A.K. Gaur, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2020.
2. Radiation Safety in Medical Practice, R. Ravichandran, BI Publications Pvt. Ltd., New Delhi, 1st Edition, 2019.
3. Radiobiology for the Radiologist, Eric J. Hall & Amato J. Giaccia, Lippincott Williams & Wilkins, Philadelphia, 8th Edition, 2019.
4. An Introduction to Radiation Protection, Alan Martin & Samuel A. Harbison, CRC Press (Taylor & Francis Group), Boca Raton, 7th Edition, 2018.
5. Radiation Protection and Dosimetry: An Introduction to Health Physics, Michael G. Stabin, Springer, New York, 1st Edition, 2007.

Course Name: PRACTICAL FOR ALL COURSE/ CLINICAL POSTING L T P C

Course Code :207PR305 0 0 6 6

RT-301: Modern Imaging with Recent Advances – 1

1. Ultrasound Machine Demonstration- Identification of transducers (linear, convex, phased array)&Perform mock scans on a phantom to identify liver, kidney, and uterus.

2. Doppler Ultrasound Demonstration -Measurement of flow velocity and direction using color Doppler& observe resistance and pulsatility index in carotid or renal arteries.

3. CT Scan Protocol Setting & Reconstruction-Set up scanning parameters for head CT (slice thickness, pitch, kVp)& Reconstruct axial images and identify cross-sectional brain anatomy.

4. MRI Sequences and Interpretation- Compare T1, T2, FLAIR, and DWI sequence& Identify key anatomical structures on MRI brain/knee.

5. Digital Radiography (DR) Post-processing- Perform windowing, annotation, magnification, and cropping & Compare analog vs digital images for contrast and sharpness.

6. DSA Procedure Observation-Watch and document a digital subtraction angiography procedure& Identify mask and contrast-enhanced image subtraction

RT-302: Apparatus of Imaging, Radiotherapy & QA – 1

1. X-Ray Tube Component Identification -Disassemble model/demo of an X-ray tube&Identify anode, cathode, rotor, envelope, and explain functions.

2. Generator Types and Waveform Observation-Compare ripple factors of single-phase vs three-phase vs HF generator&Study rectification circuits using diagrams.

3. Grid Performance Evaluation- Demonstrate types of grids and measure grid ratio& Show impact of grid use on scatter reduction in an image.

4. Beam Collimation & Alignment Test-Use LBD (Light Beam Diaphragm) for field collimation & Perform alignment and centering check using test tools.

5. Preventive Maintenance Checklist- Perform basic maintenance of DR unit (cleaning, calibration logs)&Identify early signs of malfunction (e.g., artifacts, exposure issues).

RT-303: Physics of Radiotherapy – 1

1. Phantom Setup and Depth Dose Measurement- Use water-equivalent phantom& Measure central axis depth dose and plot PDD curve.

2.Clarkson's Method Demonstration- Calculate dose in an irregular field using the sector summation method&Apply correction for blocked field in phantom.

3. Calculation of Absorbed Dose and KERMA-Use formulas to calculate dose from exposure& differentiate dose to air, soft tissue, and water using conversion factors.

4. Radiation Field Mapping and Isodose Curves- Draw isodose distribution using given beam data& compare 6 MV vs Co-60 dose distribution.

RT-304: Radiation Protection & Monitoring – 1

1. Personal Monitoring Demonstration- Handling and reading TLD and film badges& recording dose readings and plotting trends.

2.Radiation Survey with GM Counter- Measure ambient radiation in control and patient areas& Identify potential hotspots or scatter zones.

3.Shielding Efficiency Experiment- Compare lead sheets of different thicknesses in blocking radiation& Plot reduction in counts using GM counter.

4. Dose Limit Awareness Drill-Simulate radiation protection breach and plan response& discuss ICRP dose limits for workers vs the public.

5. Radiation Safety Protocol Simulation- Perform mock patient screening before MRI&Discuss pregnancy precautions and shielding for female workers.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learnings during the postings. Performance will be continuously evaluated by the faculty assigned to each section.

SEMSETER-IV

Course Name: MODERN IMAGING WITH RECENT ADVANCES - 2 **L T P C**

Course Code :207MI401 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the fundamentals of PACS, PET, OPG, DEXA, and various cameras.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Define and explain the principles and applications of PACS, PET, OPG, DEXA, and various cameras.
CO2	Describe the physics, quality control, and clinical relevance of mammography and isotopic imaging.
CO3	Apply knowledge to demonstrate the image acquisition, transfer, and storage via PACS and digital systems.
CO4	Analyze the strengths, limitations, and comparative advantages of imaging modalities like PET, OPG, and mammography.

UNIT 1

Digital Imaging Systems and PACS

- Introduction to Digital Imaging:
  - Shift from analog to digital
  - CR (Computed Radiography), DR (Digital Radiography), Flat-panel detectors (direct & indirect)
- PACS (Picture Archiving and Communication System):
  - Definition and purpose
  - Core components:
    - Image acquisition: from modality
    - Storage: server/database
    - Retrieval & distribution: viewing workstations, mobile access
  - DICOM Standards:
    - Digital Imaging and Communications in Medicine
    - DICOM headers, image tags
- Workflow:
  - Integration with RIS (Radiology Information System)
  - HIS (Hospital Information System) interface
  - Teleradiology: remote reporting and interpretation
- Advantages over Film-Based Imaging:
  - Speed, storage, remote access, efficiency, environmental safety

UNIT 2

Mammography and Orthopantomogram (OPG)

Mammography

- Low kV (25–30 kVp) and high mAs technique
- Breast Compression:
  - Reduces motion, improves image quality, reduces dose
- Grids and Filters:
  - Used to enhance contrast and reduce scatter
- Clinical uses:
  - Breast cancer screening, mass evaluation, microcalcification detection
- Limitations:
  - Dense breasts, false positives/negatives
- Quality Assurance (QA) and Quality Control (QC):
  - Regular equipment checks, phantom studies

Orthopantomogram (OPG)

- Panoramic X-ray:
  - Covers jaw, teeth, and TMJ
- Rotational Technique:
  - Simultaneous movement of X-ray source and film
- Positioning:
  - Bite block, chin rest, Frankfurt plane alignment
- Applications:
  - Dental implant planning, impacted teeth, jaw fractures

UNIT 3

Nuclear Imaging and PET

- Radioisotopes in Imaging:
  - Technetium-99m: versatile use
  - Iodine-131: thyroid imaging and therapy
  - Gallium-67: infection, tumor detection
- Radioactivity Principles:
  - Half-life, decay modes, radiation emission
- Gamma Camera:
  - Parts: collimator, NaI(Tl) crystal, photomultiplier tubes
  - Image acquisition: static vs dynamic scans
- Rectilinear Scanner:
  - Historical importance, limitations
- PET (Positron Emission Tomography):

- Principle:
  - Positron emission, annihilation → 511 keV photons detected in coincidence
- Radiotracers: FDG (Fluorodeoxyglucose)
- PET-CT Fusion Imaging:
  - Combines structural and functional imaging
- Clinical Uses:
  - Oncology (staging), neurology (epilepsy, dementia), cardiology (myocardial viability)
- Radiation Safety:
  - ALARA, shielding, patient isolation if needed

UNIT 4

DEXA and Imaging Cameras

DEXA (Dual-Energy X-ray Absorptiometry)

- Principle:
  - Two X-ray energies differentiate bone and soft tissue
- Components:
  - X-ray source, detector array, scanning arms
- Applications:
  - Bone Mineral Density (BMD), osteoporosis detection, body fat distribution
- T-Score and Z-Score Interpretation:
  - T-score < -2.5 → osteoporosis
  - Z-score compares with age-matched controls
- Calibration and QA:
  - Phantom scanning, daily system checks

Imaging Cameras

- Types:
  - Laser printers (dry and wet)
  - Photographic cameras
  - CCD (Charge-Coupled Device), CMOS (Complementary Metal-Oxide Semiconductor)
- Operation:
  - Image capture, digitization, enhancement, hardcopy printing
- Maintenance:
  - Dust protection, software calibration, printer heads cleaning

UNIT 5

Computers in Radiology and Image Transmission

- Use of Computers in Imaging:
  - CT: slice reconstruction
  - MRI: multi-sequence analysis

    - USG: real-time display with Doppler
    - Workstations for manipulation: MPR (multiplanar), 3D reconstructions
- Image Formats:
    - DICOM (standard), JPEG (compressed), TIFF (high quality)
- Structured Reporting:
    - Templates for diagnosis
    - Integrated measurements (e.g., lesion size, HU)
- Artificial Intelligence (AI):
    - CAD (Computer-Aided Detection), deep learning in diagnostics
- Networking in Radiology:
    - LAN (Local Area Network): within hospital
    - WAN (Wide Area Network): across cities (teleradiology)
- Image Compression:
    - Lossy: reduces size but may affect quality
    - Lossless: no data loss, larger size
- Cloud Storage:
    - Remote server storage of images
- Data Security:
    - Encryption, firewall
    - Confidentiality: HIPAA (Health Insurance Portability and Accountability Act)

Reference Books

1. Radiologic Science for Technologists: Physics, Biology, and Protection, Stewart C. Bushong, Elsevier Health Sciences, St. Louis, 12th Edition, 2025.
2. Textbook of Radiographic Positioning and Related Anatomy, Kenneth L. Bontrager & John Lampignano, Elsevier Health Sciences, St. Louis, 10th Edition, 2024.
3. Essentials of Nuclear Medicine Imaging, Fred A. Mettler Jr. & Milton J. Guiberteau, Elsevier Health Sciences, Philadelphia, 7th Edition, 2019.
4. Diagnostic Imaging: Principles and Practice, David Sutton, Churchill Livingstone (Elsevier), London, 7th Edition, 2013.
5. Computed Body Tomography with MRI Correlation, Joseph K.T. Lee, Elsevier Health Sciences, Philadelphia, 5th Edition, 2006.

Course Name:APPARATUS OF IMAGING, RADIOTHERAPY & QUALITY ASSURANCE – 2 **L T P C**

Course Code :207QA402 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the components and working principles of linear accelerators, simulators, and heavy particle units

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Explain the QA procedures for LINACs, simulators, brachytherapy, and diagnostic systems
CO2	Apply knowledge of imaging equipment selection, installation, and acceptance testing
CO3	Analyze routine QA checks for radiological devices (CT, MRI, TPS, Gamma Knife, etc.)
CO4	Evaluate equipment performance and documentation for regulatory compliance and patient safety

UNIT 1

Linear Accelerator (LINAC) & Heavy Charged Particle Generators

A. Linear Accelerator (LINAC) Design & Function

- Block diagram of LINAC – explanation of signal flow and function
- Power Supply Unit: HV generator, RF source, and control circuits
- Modulator:
  - Thyratron-based or solid-state modulator
  - Pulse forming network (PFN)
- Electron Gun: Thermionic emission, beam characteristics
- Magnetron/Klystron: Microwave generation for particle acceleration
- Wave Guide System:
  - Function of circulators and attenuators
  - RF transmission and vacuum considerations
- Accelerator Tubes:
  - Traveling Wave Type – design and working principle
  - Standing Wave Type – cavity structures and mode of operation
- Beam-Shaping Devices:
  - Flattening filters for photon beam
  - Scattering foils for electron beam

B. LINAC Quality Assurance

- Daily, weekly, monthly, and annual QA protocols
- Beam flatness and symmetry
- Output constancy, mechanical isocenter checks
- Multi-leaf collimator (MLC) QA

- Dosimetric calibration

C. Heavy Charged Particle Generators

- Cyclotron: Design, operation, and application in PET/therapy
- Synchrotron: Acceleration mechanism, use in proton/heavy ion therapy
- D-T Generator: Deuterium-tritium reaction for neutron generation
- Proton Generators: Beam optics, range modulators, Bragg peak
- Pion Therapy Units: Historical perspective, beam production and targeting

UNIT 2

Simulator in Radiotherapy

A. Design and Types of Simulators

- Conventional Simulator vs. CT Simulator
- Design layout and mechanical structure:
    - Gantry, collimators, light field projection
    - Couch movement and immobilization devices
    - Control console

B. Function and Applications

- Treatment field localization
- Radiographic and fluoroscopic imaging
- Use in 3D conformal radiotherapy (3D-CRT) planning

C. Quality Assurance for Simulators

- Laser alignment and isocenter verification
- Field size accuracy
- Reproducibility of table movements
- Image quality checks (contrast, resolution)

UNIT 3

Quality Assurance in Imaging Systems

A. Aim and Scope of QA in Imaging

- Importance of QA in radiodiagnosis and therapy
- Regulatory mandates (AERB, NABH, etc.)

B. Routine QA for Imaging Modalities

- CT Scanner:

    - HU accuracy, uniformity, slice thickness, contrast resolution
- MRI:
    - Image uniformity, geometric distortion, RF noise, SNR
- X-ray Systems:
    - kVp accuracy, mA linearity, exposure time
    - Focal spot size, HVL, beam alignment
    - Collimator and Bucky tray alignment
    - Central ray and distance indicator accuracy
- Fluoroscopy Systems:
    - Contrast and brightness check
    - AEC performance

C. QA of Processing Systems

- Film processing QA
- Sensitometric and densitometric tests
- Digital system calibration (CR/DR)

UNIT 4

QA in Brachytherapy, TPS, Gamma Knife, and X-Knife

A. Manual Brachytherapy QA

- Source activity check
- Source positioning verification
- Applicator geometry and integrity
- Radiation safety procedures

B. HDR & PDR Units

- Source loading/unloading tests
- Dwell time accuracy and positional verification
- Emergency response protocols

C. Treatment Planning System (TPS) QA

- Algorithm validation
- Input/output consistency
- Dose calculation accuracy
- CT-Number-to-density curve validation

D. Gamma Knife & X-Knife QA

- Mechanical and isocenter alignment
- Beam profiling and dosimetric validation
- Stereotactic accuracy
- Treatment verification with phantoms

UNIT 5

Equipment Management, Regulations, and Performance Monitoring

A. Regulation and Accreditation
- NABH and AERB regulations for imaging and therapy equipment
- Radiation Safety Officer (RSO) roles
- Equipment audit and compliance documentation

B. Purchasing & Installation
- Identification of clinical imaging/radiotherapy requirements
- Development of equipment specifications
- Tendering process and vendor selection
- Acceptance testing post-installation

C. Continuing Education & Monitoring
- Training programs for technologists and physicists
- Continuous monitoring of equipment performance
- Maintenance logs and incident documentation

D. Routine Performance Checks
- Equipment-wise checklist creation (CT, MRI, LINAC, Simulator, etc.)
- External beam evaluation
- Preventive maintenance strategies

Reference Books

1. Essentials of Medical Physics, R. Ravichandran, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2010.
2. Radiation Protection and Safety in Radiological Procedures: A Manual for Technicians, Indrajit Khandekar, Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, New Delhi, 1st Edition, 2016.
3. The Physics of Radiation Therapy, Faiz M. Khan, Lippincott Williams & Wilkins, Philadelphia, 5th Edition, 2014.
4. Radiobiology for the Radiologist, Eric J. Hall & Amato J. Giaccia, Wolters Kluwer Health, Philadelphia, 8th Edition, 2019.
5. Medical Imaging Physics, William R. Hendee & E. Russell Ritenour, Wiley-Liss, New York, 4th Edition, 2002.

Course Name: **PHYSICS OF RADIOTHERAPY-2** **L T P C**
Course Code :207PH403 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the physical principles behind phantom beam studies, wedge filters, bolus, and compensators.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the parameters influencing isodose distribution and the construction of isodose charts.
CO2	Explain the physical principles behind phantom beam studies, wedge filters, bolus, and compensators.
CO3	Apply knowledge of beam geometry and modifiers like wedges and bolus in clinical planning.
CO4	Analyze the factors affecting dose distribution such as source size, SSD, SDD, and penumbra.

UNIT 1

Isodose Distribution and Beam Parameters

- Definition and significance of isodose curves.
- Measurement and plotting of isodose curves.
- Isodose charts and beam profiles.
- Parameters affecting isodose distribution:
  - Beam energy
  - Source-to-skin distance (SSD)
  - Source-to-detector distance (SDD)
  - Field size
  - Penumbra and source size
- Collimation systems and flattening filters.
- Wedge filters:
  - Types (physical and dynamic)
  - Wedge angle
  - Wedge transmission factor
  - Wedge systems and their applications
  - Impact on dose distribution

UNIT 2

Compensators and Beam Modifiers

- Use of bolus materials:
  - Types
  - Placement techniques
  - Impact on surface dose
- Tissue compensators:
  - Design and fabrication
  - Clinical uses
- Shielding blocks and field shaping devices:
  - Construction materials (Cerrobend, lead)
  - Design considerations
  - Skin sparing and underdosing effects

UNIT 3

Electron Beam Therapy – Fundamentals

- Basic interaction of electrons with matter.
- Collisional losses (ionization and excitation).
- Radiation losses (Bremsstrahlung production).
- Polarization and electron scattering.
- Definitions:
  - Most probable energy
  - Mean energy
  - Energy at depth
- Absorbed dose concepts in electron beam therapy.

UNIT 4

Electron Beam Dosimetry and Calibration

- Measurement of absorbed dose in phantom.
- Output calibration protocols.
- Reference depth and field size selection.
- Central axis depth dose curves.
- Isodose distribution for various electron energies.
- Electron applicators and collimators.
- Field flatness and beam symmetry in electron therapy.

UNIT 5

Dose Calculation and X-ray Contamination

- Electron beam dose calculation methods.
- Depth dose characteristics in clinical setups.
- Field size dependence and output correction factors.
- Methods to minimize x-ray contamination in electron beams.
- Comparison of dose profiles between photon and electron fields.

Reference Books

1. The Physics of Radiology, H.E. Johns & J.R. Cunningham, Charles C. Thomas Publisher Ltd., Illinois, 4th Edition, 1983.
2. The Physics of Radiation Therapy, Faiz M. Khan, Lippincott Williams & Wilkins, Philadelphia, 5th Edition, 2014.
3. Handbook of Nuclear Medicine and Molecular Imaging, C.S. Levin, E.J. Hoffman & D.W. Townsend, Academic Press (Elsevier), London, 1st Edition, 2021.
4. Textbook of Radiation Physics, S.B. Bhatt, Himalaya Publishing House, Mumbai, 2nd Edition, 2016.
5. Basic Radiation Physics and Radiotherapy, P.N. Tandon, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 3rd Edition, 2022.

Course Name: RADIATION PROTECTION & MONITORING-2 **L T P C**
Course Code: 207RM404 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the fundamental concepts of radiation, units, and types of exposure involved in radiological protection.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Explain radiation detection, measurement, and procedures to minimize exposure to ionizing radiation.
CO2	Apply radiation safety principles in clinical and laboratory environments to protect patients and staff.
CO3	Analyze radiation protection guidelines, recommendations from advisory bodies, and their clinical relevance.
CO4	Evaluate radiation shielding designs and exposure standards, including ALARA and pregnancy safety norms.

UNIT 1

Basics of Radiation Protection

- Nature and types of ionizing radiation
- Sources: natural vs artificial
- Interaction of radiation with matter
- Principles of time, distance, and shielding
- ALARA principle (As Low As Reasonably Achievable)
- Introduction to stochastic and deterministic effects

UNIT 2

Quantities and Units in Radiological Protection

- Exposure
- Absorbed dose
- Kerma and Air Kerma
- Equivalent dose, Effective dose
- Integral dose
- Radiation weighting factor (WR), Tissue weighting factor (WT)
- SI Units vs Conventional Units

UNIT 3

Detection and Measurement of Ionizing Radiation

- Types of radiation detectors:
  - Ionization chamber
  - GM counter
  - Scintillation detector
- Field survey instruments
- Personal monitoring devices:
  - Film badge
  - Thermoluminescent dosimeter (TLD)
  - Pocket dosimeter
  - Pulsed optically stimulated luminescence (OSL)
- Principles of calibration and response

UNIT 4

Regulatory Framework and Advisory Bodies

- International Commission on Radiological Protection (ICRP)
- National Council on Radiation Protection (NCRP)
- United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR)
- Atomic Energy Regulatory Board (AERB - India)
- Dose limits:
  - Occupational worker
  - General public
  - Pregnant radiation workers
- Justification, Optimization, and Dose Limitation

UNIT 5

Radiation Protection for Personnel and Patients

- Time-distance-shielding principles
- Protective barriers: lead aprons, thyroid shields, mobile shields
- Protection during fluoroscopy, CT, mobile radiography
- Room design and protective structures
- Beam limitation, technique selection, general shielding
- Use of grids and filters
- ALARA and pregnancy:
  - Effects of radiation on fetus
  - Pregnancy declaration policies
  - Shielding considerations in obstetric imaging

Reference Books

1. Radiation Protection in Medical Radiography, Mary Alice Statkiewicz Sherer, Paula J. Visconti & E. Russell Ritenour, Elsevier Health Sciences, St. Louis, 8th Edition, 2021.
2. Introduction to Health Physics, Herman Cember & Thomas E. Johnson, McGraw Hill Education, New York, 5th Edition, 2019.
3. Radiologic Science for Technologists: Physics, Biology, and Protection, Stewart C. Bushong, Elsevier Health Sciences, St. Louis, 11th Edition, 2021.
4. Fundamentals of Radiation Protection for Occupational and Public Health, G.S. Pant & B.K. Sapra, Jaypee Brothers Medical Publishers, New Delhi, 2nd Edition, 2020.
5. Principles of Radiation Protection: A Textbook for Undergraduates and Interns, M. Madan, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 1st Edition, 2018.

RT-401: Modern Imaging with Recent Advances – 2

1. Demonstration of PACS workflow – image acquisition, storage, and retrieval.
2. Identification and analysis of DICOM headers and image tags.
3. Observation of mammography unit components, breast compression, and QA procedures.
4. Demonstration of OPG machine – patient positioning and panoramic imaging technique.
5. Demonstration of PET-CT fusion imaging and discussion of radiotracers (FDG).

RT-402: Apparatus of Imaging, Radiotherapy & QA – 2

1. Demonstration of Linear Accelerator (LINAC) components and signal flow.
2. Observation of simulator setup for radiotherapy localization.
3. Demonstration of QA procedures for CT and MRI systems.
4. Study of brachytherapy QA protocols – source strength verification and dwell time check.
5. Demonstration of NABH/AERB compliance checklist for radiological equipment.

RT-403: Physics of Radiotherapy – 2

1. Plotting of isodose curves using phantom data.
2. Demonstration of wedge filter usage and determination of wedge angle.
3. Preparation of compensator design for irregular tissue contours.
4. Measurement of electron beam depth dose distribution in water phantom.
5. Comparison of photon and electron beam profiles for different energies.

RT-404: Radiation Protection & Monitoring – 2

1. Demonstration of radiation survey using GM counter and ionization chamber.
2. Measurement of personal dose using TLD badge and interpretation of readings.
3. Study of radiation shielding barriers and room design requirements.
4. Demonstration of ALARA implementation during fluoroscopy and mobile radiography.
5. Observation of pregnancy protection protocols in diagnostic imaging.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learning's during the postings. Performance will be continuously evaluated by the faculty assigned to each section.

SEMSETER-V

Course Name: SPECIAL RADIOLOGICAL PROCEDURES & CONTRAST MEDIA-1 **L T P C**

Course Code: 207SR501 **4 0 0 4**

COURSE OBJECTIVE: This course deals with equipment setup, patient preparation, and procedural techniques in radiological practices.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Perform or assist in contrast procedures such as IVP, Barium studies, and angiography.
CO2	Analyze procedural images and evaluate appropriate contrast techniques used per organ system.
CO3	Assess patient safety, adverse reactions, and aftercare in special procedures.
CO4	Design a trolley setup, procedural workflow, and emergency management in contrast procedures.

UNIT 1

Basics of Contrast Procedures & Contrast Media

- Introduction to special radiological procedures.
- Contrast Media:
  - Classification (Positive, Negative, Dual contrast).
  - Indications and Contraindications.
  - Chemical nature (Iodinated, Non-iodinated, Barium sulfate).
  - Routes of administration.
  - Adverse Reactions – Types, emergency drugs & management protocols.
  - Preparation of emergency trolley and anaphylaxis kit.

UNIT 2

Gastrointestinal and Hepatobiliary Studies

- Gastrointestinal System:
  - Barium Swallow
  - Water-soluble contrast swallow
  - Barium Meal (Single and Double contrast)
  - Barium Meal Follow Through
  - Small Bowel Enema (Enteroclysis)
  - Barium Enema
- Hepatobiliary System:
  - Intravenous Cholangiography
  - T-tube Cholangiography
  - Peroperative Cholangiography
- Patient preparation, filming, positioning, aftercare.

UNIT 3

Genito-Urinary and Reproductive Procedures

- Renal and Urinary System:
  - IVP / IVU
  - Antegrade / Retrograde Pyelography
  - MCU (Micturating Cystourethrogram)
  - Nephrostogram
  - Infusion Pyelography
- Reproductive System:
  - Hysterosalpingography (HSG)
- Equipments, contrast media, filming techniques, and aftercare.

UNIT 4

Joint, CNS and Ductal Procedures

- Musculoskeletal System:
  - Arthrography (Knee, Shoulder, Hip)
- CNS Procedures:
  - Myelography (Lumbar Puncture-based)
- Glandular & Ductal Systems:
  - Sialography
  - Dacryocystography (Lacrimal duct)
  - Bronchography
- Trolley setup, patient positioning, filming techniques, adverse reaction management.

UNIT 5

Angiography & Interventional Radiology

- Angiographic Studies:
  - Cerebral Angiography
  - Cardiac Angiography
  - Abdominal Aortogram
  - Renal and Selective Arteriography
  - Peripheral Arterial and Venous Studies
- Interventional Procedures:
  - PTC (Percutaneous Transhepatic Cholangiography)
  - ERCP (Endoscopic Retrograde Cholangiopancreatography)
  - DSA (Digital Subtraction Angiography)
  - FNAC under US/CT guidance
  - Percutaneous Nephrostomy

- Cardiac Catheterization Techniques:
    - Embolization
    - Angioplasty
    - Stenting
    - Drainage procedures
- Image-Guided Biopsies:
    - MRI-guided
    - CT-guided
    - US-guided
- Protocols, safety measures, aftercare, and image interpretation.

Reference Books

1. Whitley, A. S. (2020),Clark's positioning in radiography (13th ed.). CRC Press.
2. Bontrager, K. L. (2021). Textbook of radiographic positioning and related anatomy (10th ed.). Elsevier.
3. Sutton, D. (2012). Textbook of radiology and imaging(Vol. 1 & 2, 7th ed.). Elsevier.
4. Fosbinder, R. A. (2011). Essentials of radiologic science(2nd ed.). Lippincott Williams & Wilkins.
5. Arora, S. S. (2020). Manual of contrast media procedures (1st ed.). CBS Publishers & Distributors Pvt. Ltd.

Course Name: RADIOTHERAPY PLANNING & TECHNIQUES-1 **L T P C**
Course Code: 207RT502 **4 0 0 4**

COURSE OBJECTIVE: This course deals with knowledge of multi-field and isocentric techniques in radiation therapy treatment planning.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the principles of isodose curves and charts, their influencing parameters, and clinical significance.
CO2	Explain beam modification devices like wedge filters and compensators used in treatment planning.
CO3	Apply knowledge of multi-field and isocentric techniques in radiation therapy treatment planning.
CO4	Analyze patient data acquisition and tissue inhomogeneity corrections in 2D and 3D planning systems.

UNIT 1

Isodose Concepts and Beam Parameters

- Isodose Distributions:
  - Definition and significance of isodose curves and charts in treatment planning
  - Clinical relevance in defining treatment areas and avoiding healthy tissue
- Measurement of Isodose Curves:
  - Water phantom dosimetry
  - Ionization chambers and diode/film dosimetry
  - Plotting isodose charts manually and via TPS (treatment planning systems)
- Influencing Parameters:
  - Beam energy/quality (orthovoltage, megavoltage)
  - Source size and geometric sharpness
  - Source to Surface Distance (SSD) vs. Source to Detector Distance (SDD)
  - Penumbra: definition, factors, and implications
  - Collimation, flattening filter types, and their effect on dose distribution
  - Field size and depth dose behavior

UNIT 2

Beam Modification and Field Combination Techniques

- Wedge Filters:
  - Definition, wedge angle and wedge factor
  - Physical vs. dynamic wedges
  - Effect on beam quality and depth dose
  - Design considerations and practical use in dose compensation
- Field Combination Techniques:

    - Parallel opposed fields: pros/cons, patient thickness vs. dose uniformity
    - Edge effects and lateral tissue damage
    - Integral dose: definition and clinical relevance
- Multiple Fields:
    - Three-field technique
    - Four-field box and cross-fire techniques
- Isocentric and Rotational Techniques:
    - Stationary beams with isocentric setup
    - Arc/rotation therapy
    - Wedge field combination strategies

UNIT 3

Target Volume Definitions and Imaging Techniques

- Target Volumes – ICRU-50 Standards:
    - GTV: Gross Tumor Volume
    - CTV: Clinical Target Volume
    - PTV: Planning Target Volume
    - Irradiated volume, cold spots and hot spots – significance in treatment optimization
- Patient Data Acquisition:
    - Body contour mapping techniques
    - Use of Radiographs, CT, MRI, Ultrasound for internal structure delineation
    - Use of DICOM images in planning systems
- Treatment Simulation:
    - Conventional simulator-based planning
    - CT simulators and simulator CT systems
    - Virtual simulation systems and their advantages
- Treatment Verification:
    - Use of port films for daily treatment confirmation
    - Use of EPID (Electronic Portal Imaging Device) in IMRT/IGRT

UNIT 4

Corrections for Tissue Irregularities and Dose Distribution Techniques

- Surface Irregularity Correction Methods:
    - Effective SSD technique
    - TAR/TMR correction
    - Isodose shift technique
- Internal Tissue Inhomogeneity Corrections:
    - Attenuation and scattering effects in different tissues
    - Power law TAR method, equivalent TAR method
    - Impact on dose when treating bone, bone-tissue interface, lungs, and air cavities
- Compensating Devices and Patient Setup:
    - Bolus material use: types, thickness, clinical implications

- Tissue compensators: design and use
- Importance of accurate patient positioning and immobilization devices in planning

UNIT 5

Field Shaping, Shielding, Skin Dose Management, and Site-Specific Planning

- Field Shaping and Shielding:
  - Shielding blocks: materials, thickness calculation, and divergence angle
  - Custom lead blocks vs. MLC (multileaf collimators)
  - Independent jaws and collimator angles
- Skin Dose Considerations:
  - Electron contamination from photon beams
  - Build-up region and skin sparing effect
  - Effect of field size, oblique incidence, and absorber-skin distance
- Field Matching and Separation:
  - Orthogonal field junction techniques
  - Cranio-spinal irradiation planning
  - General guidelines for adjacent field separation
- Site-Specific Treatment Planning:
  - Head & Neck: Use of opposed fields, small beam therapy, wedge usage
  - CNS: Brain, pituitary, and medulloblastoma techniques
  - ENT: Oral cavity, larynx, naso-/oropharynx, thyroid, tonsils, lip, maxillary antrum
  - Breast: Tangential field planning, field-in-field modulation
  - Pelvis: Cervix, esophagus, bladder, and gynecologic malignancies
  - Others: Lungs, bones, lymphoma (mantle field), prostate, ophthalmic tumors
  - Whole/Hemi-body Irradiation: Photon and electron-based strategies

Reference Books

1. Halperin, E. C., Perez, C. A., & Brady, L. W. (2013). Radiation therapy planning (5th ed.). Lippincott Williams & Wilkins.
2. Attix, F. H. (1986). Introduction to radiological physics and radiation dosimetry. Wiley.
3. Khan, F. M. (2014). The physics of radiation therapy (5th ed.). Lippincott Williams & Wilkins.
4. Washington, C. M., & Leaver, D. T. (2013). Principles and practice of radiation therapy. Elsevier.
5. Sahani, A. (2018). Radiation therapy techniques. CBS Publishers & Distributors.

Course Name: RADIATION DOSIMETRY PRINCIPLES & APPLICATIONS-1 **L T P C 4 0 0 4**

Course Code: 207RA503

COURSE OBJECTIVE: This course deals with knowledge of standard procedures for radiation monitoring and instrumentation under various environmental conditions.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the principles and characteristic curves of gas-filled detectors and various radiation detectors.
CO2	Explain the construction and working of GM counters, scintillation counters, and semiconductor detectors.
CO3	Apply knowledge to analyze the working regions of gas detectors and evaluate detector performance.
CO4	Analyze detector characteristics like resolving time, true count rate, and calibration factors.

UNIT 1

Principles of Gas-Filled Detectors

- Basic principle and construction of gas-filled detectors.
- Characteristic curve: regions – Ionization, Proportional, GM.
- Working mechanism of:
  - Ionization chamber
  - Proportional counter
  - Geiger-Muller (GM) counter
- Detector dead time, recovery time, resolving time.
- Factors affecting detector efficiency.
- True vs observed count rate.
- Applications in radiological monitoring.

UNIT 2

Other Radiation Detectors

- Scintillation Counters:
  - Principle, types of scintillators (organic/inorganic), PMT usage.
  - Applications in gamma spectroscopy and low-level counting.
- Semiconductor Detectors:
  - Working principle of silicon and germanium detectors.
  - Advantages, resolution, and cooling requirements.
- Alpha, Gamma, X-ray & Neutron Monitoring Devices:
  - Alpha probes and proportional counters.
  - Gamma survey meters and ion chambers.

- Neutron monitors: BF_3 and He-3 detectors.
- Field instrumentation and personnel monitoring relevance.

UNIT 3

Measurement of Ionizing Radiation

- Concepts of exposure, dose, and units: roentgen, gray, sievert.
- Free air ionization chamber:
  - Principle, structure, limitations.
- Thimble chambers and chamber walls:
  - Material selection, effective Z, calibration needs.
- Ion collection mechanisms:
  - Recombination, saturation, charge collection efficiency.
- Polarity effect in ionization chambers.

UNIT 4

Calibration of Radiation Detectors

- Chamber calibration techniques.
- Use and working of condenser chambers.
- Farmer-type chambers:
  - Construction, sensitivity, stem effect.
- Electrometers:
  - String electrometer and modern digital types.
  - Current-to-voltage conversion, leakage correction.
- Specialized ionization chambers:
  - Extrapolation chamber
  - Parallel plate chamber
- Calibration protocols: traceability and QA.

UNIT 5

Environmental Factors & Measurement Accuracy

- Influence of environmental conditions:
  - Temperature, pressure, and humidity corrections.
- Use of barometers and thermometers in dosimetry.
- Background radiation and shielding.
- Practical considerations for accurate exposure measurements.
- Ion chamber polarity reversal tests and corrections.

Reference Books

1. Attix, F. H. (1986). *Introduction to radiological physics and radiation dosimetry*. Wiley.
2. Knoll, G. F. (2010). *Radiation detection and measurement* (4th ed.). John Wiley & Sons.
3. Khan, F. M. (2014). *The physics of radiation therapy*. Lippincott Williams & Wilkins.
4. Agrawal, J. P. (2015). *Fundamentals of radiation physics*. Pragati Prakashan.
5. Thayalan, K. (2018). *Basic radiological physics*. Jaypee Brothers Medical Publishers.

COURSE OBJECTIVE: This course deals with knowledge of strategies for patient safety, comfort, and vital monitoring during radiological procedures.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the structure, roles, and administrative functions in a hospital and radiology department.
CO2	Explain the methods of communication and interaction with patients, attendants, and hospital staff.
CO3	Apply techniques of patient handling during radiographic procedures in complex scenarios (e.g., trauma).
CO4	Analyze patient needs, dignity, and ethical issues in various medical settings.

UNIT 1

Hospital Administration and Staffing

- Organization of hospitals and radiology departments.
- Roles and responsibilities of radiographers, radiologists, technicians, nurses, and administrative staff.
- Cooperation and coordination between departments (e.g., radiology with surgery, emergency, ICU).
- Professional ethics in radiography.
- Maintenance of medical records: Radiology request forms, reporting formats, archiving, and confidentiality protocols.

UNIT 2

Patient Handling in Radiographic Practice

- Guidelines for handling patients during radiographic procedures:
  - Seriously ill and unconscious patients.
  - Trauma patients (e.g., with fractures, bleeding, spinal injury).
  - Patients on wheelchairs, stretchers, or with limited mobility.
- Radiographic management of:
  - Visually impaired
  - Hearing/speech impaired
  - Mentally challenged
  - Non-English speaking patients
  - Drug/alcohol-dependent patients
  - Patients on oxygen support
- Moving patients with care: Body mechanics, use of aids, team techniques.

UNIT 3

Communication and Patient Interaction

- Principles of therapeutic and professional communication.
- Verbal and non-verbal communication.
- Effective listening skills, empathy, and cultural sensitivity.
- Patient interaction protocols before, during, and after the examination.
- Communication with patient's relatives and visitors.
- Importance of professional appearance and behavior.

UNIT 4

Hygiene and Preliminary Patient Care

- Personal and departmental hygiene standards.
- Handwashing, glove use, infection control, and waste disposal.
- Handling of receptacles: urinals, bedpans, vomit bowls—cleaning and disposal.
- Preparation of examination room.
- General preliminaries to examination: checking identity, consent, explanation of procedure.
- Comfort measures: Pillows, blankets, privacy, patient reassurance.

UNIT 5

Vital Signs, Homeostasis, and Patient Monitoring

- Introduction to vital signs and homeostasis in imaging:
    - Body temperature
    - Pulse
    - Respiratory rate
    - Blood pressure
- Monitoring techniques and normal ranges.
- Oxygen therapy in radiology:
    - Oxygen delivery devices (nasal cannula, masks)
    - Chest tubes and central lines – precautions during imaging.
- Understanding patient distress: dyspnea, syncope, and pain.
- Emergency preparedness in radiology.

Reference Books

1. Essentials of Patient Care in Imaging Technology,R. K. Sharma, P. Kumar, Jaypee Brothers Medical ,3rd Edition, 2020
2. Textbook of Radiographic Positioning and Related Anatomy, Kenneth L. Bontrager, John Lampignano, Elsevier, 10th Edition, 2020

3. Radiography in the Digital Age: Physics - Exposure - Radiation Biology, Carroll, Quinn B.,Charles C Thomas ,3rd Edition, 2018
4. Introduction to Radiologic and Imaging Sciences and Patient Care, Arlene M. Adler, Richard R. Carlton, Elsevier, 7th Edition, 2022
5. Manual of Radiographic Technique and Patient Care, David M. Malet, Little, Brown and Company, 4th Edition, Year: 2019

Course Name: PRACTICAL FOR ALL COURSE/ CLINICAL POSTING **L T P C 0 0 6 6**

Course Code: 207PR505

RT-501: Special Radiological Procedures & Contrast Media – 1

1. To study and prepare contrast media types used in radiographic procedures.
2. To perform and assist in Barium Meal Follow Through examination.
3. To set up the trolley for Intravenous Pyelography (IVP) and demonstrate patient preparation.
4. To assist in Hysterosalpingography (HSG) and record post-procedure aftercare.
5. To observe and note the steps in Digital Subtraction Angiography (DSA) procedure.

RT-502: Radiotherapy Planning & Techniques – 1

1. To plot isodose curves using manual data and study influencing parameters.
2. To demonstrate the use of wedge filters and analyze their effect on beam modification.
3. To perform mock planning for parallel opposed and four-field box techniques.
4. To demonstrate patient data acquisition using CT simulator and contouring on TPS.
5. To verify treatment setup using Electronic Portal Imaging Device (EPID).

RT-503: Radiation Dosimetry – Principles & Applications – 1

1. To study the characteristic curve and working regions of a GM counter.
2. To calibrate an ionization chamber and determine exposure rate.
3. To demonstrate the working principle of a scintillation counter.
4. To perform environmental correction for temperature and pressure in dosimetry readings.
5. To study the polarity effect and recombination losses in ionization chambers.

RT-504: Hospital Practice & Patient Care – 1

1. To study hospital organization structure and roles of radiology staff.
2. To demonstrate safe handling and transfer of trauma or unconscious patients.
3. To practice effective communication and consent-taking before a radiographic procedure.
4. To record and interpret patient vital signs: temperature, pulse, respiration, and blood pressure.
5. To prepare an emergency trolley for radiology and demonstrate infection control procedures.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learning's during the postings. Performance will be continuously evaluated by the faculty assigned to each section.

SEMSETER-VI

Course Name: SPECIAL RADIOLOGICAL PROCEDURES & CONTRAST MEDIA-2 **L T P C 4 0 0 4**

Course Code:207SR601

COURSE OBJECTIVE: This course deals with knowledge radiological workflow protocols for contrast and interventional studies including MRI/CT/US guidance.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe various radiological investigations for GIT, angiography, and interventions.
CO2	Explain procedural techniques, contrast media, and patient preparation for GI and angiographic studies.
CO3	Apply knowledge to identify and evaluate radiological images of GIT and vascular systems.
CO4	Analyze different interventional procedures, their indications, and post-procedural care.

UNIT 1

Radiological Investigations for Gastrointestinal Tract (GIT)

- Barium Swallow: Indications, patient preparation, procedure, normal & pathological findings.
- Water Soluble Contrast Swallow: Indications (e.g., suspected perforation), contrast agents, advantages, precautions.
- Barium Meal (Single & Double Contrast): Techniques, positioning, spot films, interpretation of ulcers, tumors, and motility disorders.
- Barium Meal Follow Through: Technique, indications (Crohn's disease, malabsorption), radiographic appearances.
- Small Bowel Enema (Enteroclysis): Method, indications, catheter placement, contrast media, image interpretation.
- Barium Enema: Patient prep (enema protocol), single vs. double contrast, demonstration of polyps, carcinoma, diverticulosis.

UNIT 2

Angiographic Techniques and Procedures

- Cerebral Angiography: Indications (aneurysm, AVM), catheterization, contrast injection, digital subtraction technique.
- Cardiac Angiography: Coronary angiogram steps, interpretation of coronary artery disease.
- Abdominal Aortogram: Techniques, normal anatomy vs aneurysms, arterial disease.
- Renal & Selective Arteriography: Technique, use in renal artery stenosis, tumors.
- Splenoportovenography: Indications (portal hypertension), technique using splenic puncture or catheter.

- Peripheral Angiography: Arterial/venous catheterization, imaging of limbs for PVD, thrombus, varicose veins.

UNIT 3

Interventional Radiological Procedures

- PTC (Percutaneous Transhepatic Cholangiography): Technique, indications, bile duct obstruction.
- ERCP (Endoscopic Retrograde Cholangiopancreatography): Diagnostic & therapeutic roles, contrast use.
- DSA (Digital Subtraction Angiography): Equipment, contrast agents, image subtraction principles.
- FNAC (Fine Needle Aspiration Cytology): US/CT-guided technique, cytological evaluation.
- Percutaneous Nephrostomy: Indications, procedure, catheter placement under fluoroscopic/US guidance.

UNIT 4

Cardiac Catheterization & Vascular Interventions

- Embolization: Indications (bleeding, tumors, AVMs), materials (coils, PVA), procedure under fluoroscopy.
- Angioplasty: Balloon dilatation techniques, stent deployment.
- Drainage Procedures: Abscess drainage under CT/US guidance, needle selection, catheterization.
- Stenting: Self-expanding vs balloon-expandable stents, applications in vascular/urogenital obstructions.
- Complications & Management: Contrast reactions, bleeding, vascular injury.

UNIT 5

Image-Guided Procedures (MRI, CT, US)

- Ultrasound-Guided Procedures: Biopsy, aspiration, catheter placements.
- CT-Guided Procedures: Lung/liver/kidney biopsy, tumor localization.
- MRI-Guided Interventions: Use in neuro and pelvic regions.
- Radiation Safety & Contrast Reactions: Preventive strategies, anaphylaxis management.
- Pre- and Post-Procedural Protocols: Consent, coagulation profile, sedation, observation.

Reference Books

1. Radiographic Imaging and Techniques – K. M. Natarajan, Jaypee Brothers, 4th Edition, 2020
2. Essentials of Radiologic Science – Sushil Kumar, CBS ,s, 3rd Edition, 2021
3. Merrill's Atlas of Radiographic Positions & Radiologic Procedures – Frank H. M., Elsevier, 14th Edition, 2022
4. Interventional Radiology: A Survival Guide – Kieran Murphy, Andreas Adam, Elsevier, 4th Edition, 2020
5. Grainger & Allison's Diagnostic Radiology – Andy Adam, Adrian Dixon, Elsevier, 7th Edition, 2021

Course Name: RADIOTHERAPY PLANNING & TECHNIQUES-2 **L T P C**
Course Code:207RT602 **4 0 0 4**

COURSE OBJECTIVE: This course deals with knowledge of treatment planning using TG-43, 2D/3D planning, and conformal techniques with QA protocols.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe basic terminology, decay processes, source calibration and concepts of brachytherapy.
CO2	Explain construction, dosimetry, and implant systems used in surface mould, interstitial, and intracavitary brachytherapy.
CO3	Apply dose distribution principles, optimization rules, and planning systems for different implant techniques.
CO4	Analyze the physics and application of Gamma Knife, X-Knife, CyberKnife, and tomotherapy systems.

UNIT 1

Fundamentals of Brachytherapy

- Introduction to brachytherapy: basic definitions and concepts
- Brachytherapy sources: Ra-226, Cs-137, Co-60, Ir-192 – construction and applications
- Ideal properties of brachytherapy sources
- Radioactive decay processes: physical, biological and effective half-life
- Source calibration:
  - mgRa equivalent, Apparent Activity
  - Air Kerma Strength, Reference Air-Kerma Rate (RAKR)
  - Exposure rate calibration and milligram-hours
- Dosimetric quantities and units used in brachytherapy

UNIT 2

Brachytherapy Techniques and Dosimetry Systems

- Techniques:
  - Surface moulds (circular, square, rectangular, concave, convex, sandwich)
  - Interstitial implants
- Dosimetry Systems:
  - Manchester System: rules, dose specification, optimization
  - Quimby System: dose distribution and implant rules
  - Paris System: implant geometry and dose calculation
  - Definitions: implant plane, basal dose point, reference dose, implant dimensions

    - Stepping source dosimetry system
- Use of PP tables for planar/volume implants
- Safety margins in single/double-plane implants

UNIT 3

Intracavitary Applications and Dosimetry

- Intracavitary brachytherapy (Cervix Cancer):
    - Stockholm system: source placement, applicators, dose prescription
    - Paris system: applicators and dose rules
    - Manchester system: Point A, B, MIR, Z; tandem & ovoid loadings
- ICRU-38 Guidelines:
    - Reference volume and height, bladder and rectum points
    - Concept of 60 Gy dose
- Applicators:
    - Fletcher suit, Henschke, ring, vaginal
    - Preloaded vs afterloading systems
- Tools and accessories: catheters, packing materials

UNIT 4

Dose Calculations and Planning Systems

- Exposure rate constant and inverse square law
- Exposure calculation using Sievert integral
- TG-43 dose formalism
- Dose calculations for:
    - Surface moulds
    - Interstitial implants
    - Intracavitary implants
- Orthogonal radiograph-based planning
- CT-based 2D/3D treatment planning
- Planning for LDR and HDR brachytherapy

UNIT 5

Advanced Radiotherapy Technologies

- Gamma Knife: Construction, design, QA, dose prescription, applications
- X-Knife: Modified LINAC, energy selection, circular cone planning, QA
- CyberKnife: Working principle and clinical use

- Tomotherapy: Principle, image guidance, applications
- Asymmetric Jaws: Function and clinical applications
- MLC & MMLC: Construction, use in CRT, IMRT, stereotactic RT, QA
- Intraoperative Radiotherapy (IORT): Principle, procedure, advantages
- PDR (Pulsed Dose Rate) brachytherapy: Principle, radiobiological advantages/disadvantages, QA

Reference Books

1. Johns, H. E., & Cunningham, J. R. (1983). *The physics of radiology* (4th ed.). Charles C. Thomas.
2. Khan, F. M. (2021). *The physics of radiation therapy* (5th ed.). Wolters Kluwer.
3. Bentel, G. C. (2006). *Treatment planning in external beam radiotherapy* (2nd ed.). Springer.
4. Nityanand, C. C., & Anand, A. (n.d.). *Textbook of radiotherapy: Radiation physics, therapy and oncology*. Jaypee Brothers Medical Publishers.
5. Padmanabhan, H. K. (n.d.). *Essentials of medical physics*. Jaypee Brothers Medical Publishers.

Course Name: RADIATION DOSIMETRY PRINCIPLES & APPLICATIONS-2 **L T P C 4 0 0 4**

Course Code: 207RA603

COURSE OBJECTIVE: This course deals with the principles of Bragg-Gray theory and stopping power in radiation dosimetry.

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Describe the principles of Bragg-Gray theory and stopping power in radiation dosimetry.
CO2	Understand the construction, working, and use of plane-parallel and cylindrical ionization chambers in beam calibration.
CO3	Apply calibration protocols for megavoltage photon and electron beams using chamber-specific factors.
CO4	Analyze different methods of measuring absorbed dose: calorimetry, chemical, and solid-state dosimetry.

UNIT 1

Fundamentals of Bragg-Gray Theory

Bragg-Gray Cavity Theory:

- Concept: A small gas-filled cavity embedded in a medium is used to infer absorbed dose in the medium.
- Assumptions:
  - The cavity does not perturb the charged particle field.
  - No energy is deposited by photon interactions directly in the cavity.
  - Secondary charged particles crossing the cavity originate in the surrounding medium.
- Limitations:
  - Valid only when cavity is sufficiently small.
  - Fails for very high LET radiations or non-uniform fields.
  - Assumes charged particle equilibrium (CPE) exists.

Stopping Power:

- Mass Stopping Power (S/ρ): Energy loss per unit mass.
- Collision Stopping Power: Energy loss due to ionization and excitation.
- Radiative Stopping Power: Energy loss due to bremsstrahlung.
- Importance in energy deposition calculations in media like water, air, muscle.

Application in Dose Measurement:

- Converts ionization measured in gas cavity to dose in surrounding medium.
- Used in calculating absorbed dose using chamber readings.

Bragg-Gray Relations:

Effective Point of Measurement (EPOM):

- Concept of shifting chamber location for dose measurement accuracy.
- Depends on chamber geometry: e.g., 0.6 × radius shift for cylindrical chambers.

UNIT 2

Ionization Chambers

Plane-Parallel Chambers:

- Construction: Flat electrodes, small cavity depth, precise spacing.
- Materials: High-Z or low-Z wall materials (e.g., PMMA, graphite).
- Use Cases: Low energy electron beams (<10 MeV), superficial X-ray beams.
- Calibration: Must be calibrated against primary standards for electron beams.

Cylindrical Chambers (Farmer Type):

- Design: Central electrode, guard ring, outer wall; air cavity.
- Use Cases: MV photon beams in teletherapy (e.g., Co-60, LINAC).
- Chamber Sensitivity: Defined by volume and wall material.

Effective Measurement Point and Perturbation Corrections:

- EPOM: Accounted for in treatment planning and dose calculations.
- Perturbation Factors:
    - Pwall, Pcel, Pgr, Pfl: Correct for changes in particle fluence due to chamber presence.

Chamber Volume and Sensitivity:

- Larger volume: better signal but lower spatial resolution.
- Requires stable gas volume and temperature correction (Ptp factor).

UNIT 3

Calibration Protocols for Megavoltage Beams

Protocols Overview:

- AAPM TG-51: USA standard based on absorbed dose to water.
- IAEA TRS-398: Global standard, similar principles with flexibility in reference conditions.

Absorbed Dose to Water vs Air Kerma:

- Absorbed Dose to Water (D_w): Preferred due to clinical relevance.
- Air Kerma (K_air): Older protocol, now rarely used.

Cavity Gas Calibration Factor (Ngas):

- Converts ionization current to dose:
  D=M·NgasD = M \cdotNgasD=M·Ngas
- Ngas: Includes factors for pressure, temperature, and electrometer calibration.

Calibration Coefficient (ND,w):

- Supplied by standards lab (e.g., BARC, NPL)
- Specific to beam quality and chamber type.

Use of Bragg-Gray in Calibration:

- Ngas or ND,w is derived from Bragg-Gray or stopping power ratios.

Calibration for Photon and Electron Beams:

- Photon (X-rays): Reference depth at 10 cm, field size 10x10 cm^2, SSD 100 cm.
- Electron: Depth depends on energy (dref), use of plane-parallel chambers.

UNIT 4

Dose Transfer and Conversion

Dose Transfer Parameters:

- Converting dose between media
- E.g., from air to water, or water to bone.

Stopping Power Ratios:

- Depends on energy and composition of media.
- Must be used in high-precision dose calculations (e.g., Monte Carlo methods).

Perturbation Corrections:

- Needed for high accuracy dosimetry.
- Corrects for:
    - Wall effects
    - Electrode effects
    - Chamber orientation

Clinical Examples:

- Dose measurements near interfaces (lung-bone, air-water).
- Inhomogeneity corrections in treatment planning systems (TPS).

Build-up Caps and Phantoms:

- Build-up Caps: Ensure CPE for measurements in air.
- Water Phantoms: Gold standard for dose measurement due to tissue equivalence.

UNIT 5

Advanced Dosimetry Techniques

Calorimetry:

- Principles: Measures temperature rise due to radiation.
- Types:

    - Adiabatic Calorimeter: Insulated; measures direct temperature rise.
    - Isothermal Calorimeter: Maintains constant temp using feedback control.
- Primary Standard: Used for absolute dose measurements.

Chemical Dosimetry:

- Fricke Dosimeter:
    - Based on oxidation of ferrous to ferric ions.
    - Read via spectrophotometry at 304 nm.
    - Calibration with known radiation dose.
- Advantages: High accuracy, but sensitive to impurities and temperature.

Solid-State Dosimetry:

Thermoluminescent Dosimeters (TLD):

- Materials: LiF (TLD-100), $CaSO_4$:Dy.
- Principle: Radiation traps electrons → heating → light emission proportional to dose.
- Used in: Patient dosimetry, in vivo measurements, QA of beams.

Film Dosimetry:

- Radiographic Film:
    - High spatial resolution.
    - Requires densitometer, nonlinear response.
- Radiochromic Film:
    - Self-developing, dose-dependent color change.
    - Used for IMRT QA, brachytherapy, proton therapy.

Reference Books

1. Khan's The Physics of Radiation Therapy, Faiz M. Khan, 5th Edition, 2014, Lippincott Williams & Wilkins
2. Introduction to Radiological Physics and Radiation Dosimetry, Frank H. Attix, 1st Edition, 1986
3. Radiation Dosimetry: Physical and Biological Aspects, M. Ravikumar, 1st Edition, 2015, Jaypee Brothers
4. Clinical Dosimetry Measurements in Radiotherapy, David W. O. Rogers, James E. Cygler, AAPM Monograph Series, 2009, Medical Physics Publishing
5. Basic Radiation Physics and Dosimetry, G. S. Pant. 2nd Edition, 2019, CBS

Course Name: HOSPITAL PRACTICE & PATIENT CARE-2 **L T P C**
Course Code: 207HP604 **4 0 0 4**

COURSE OBJECTIVE: This course deals with the principles of procedures for infection control and handling infected patients in diagnostic settings

COURSE OUTCOMES: On completion of this course, the students will be able to :

CO1	Recall principles of first aid including management of shock, burns, fractures, and unconsciousness.
CO2	Explain emergency procedures, artificial respiration, and aseptic techniques.
CO3	Apply patient preparation steps for general and special radiological exams.
CO4	Analyze procedures for infection control and handling infected patients in diagnostic settings.

UNIT 1

Basic First Aid and Emergency Care

- Definition and principles of first aid.
- First aid for:
  - Shock and electric shock
  - Hemorrhage (internal and external)
  - Burns (thermal, electrical, chemical)
  - Asphyxia
  - Fractures
  - Loss of consciousness and fainting
- Cardiopulmonary resuscitation (CPR)
- Artificial respiration (mouth-to-mouth, bag-mask ventilation)
- Emergency care for collapsed patients
- Transport of injured or unconscious patients

UNIT 2

Patient Preparation for Radiological Procedures

- Importance of patient preparation
- Preparation for:
  - General radiography (chest, abdomen, extremities)
  - Special procedures (IVP, Barium studies, HSG, MCU, etc.)
- Consent forms and patient information
- Dietary preparation (e.g., fasting, laxatives)
- Bladder and bowel preparation
- Post-procedure patient instructions

UNIT 3

Contrast Media and Drug Administration

- Types of contrast media: ionic, non-ionic, barium-based, iodinated
- Indications and contraindications
- Techniques of administration: oral, rectal, intravenous, intra-arterial
- Emergency drugs for contrast reactions
- Adverse reactions and management
- Legal aspects and documentation
- Regulation of narcotics and dangerous drugs in radiology

UNIT 4

Aseptic Techniques and Infection Control

- Definitions: asepsis, antisepsis, sterilization, disinfection
- Personal protective equipment (PPE)
- Hand hygiene protocols
- Sterile field setup and handling of sterile items
- Infection control policies in diagnostic settings
- Handling infectious patients (in radiology dept. and wards)
- Safe disposal of biomedical waste

UNIT 5

Radiation Hazards and Protective Measures

- Definition and types of radiation hazards (somatic and genetic effects)
- Sources of radiation exposure (primary, scatter, leakage)
- ALARA principle
- Shielding (lead apron, barriers)
- Time-distance-shielding principles
- Use of dosimeters
- Trolley setup for special X-ray procedures
- Safety signage and protocols in radiology department

Reference Books

1. Essentials of Patient Care in Imaging Technology, R. K. Sharma, P. Kumar, Jaypee Brothers Medical ,3rd Edition, 2020
2. Textbook of Radiographic Positioning and Related Anatomy, Kenneth L. Bontrager, John Lampignano, Elsevier, 10th Edition, 2020
3. Radiography in the Digital Age: Physics - Exposure - Radiation Biology, Carroll, Quinn B., Charles C Thomas ,3rd Edition, 2018

4. Introduction to Radiologic and Imaging Sciences and Patient Care, Arlene M. Adler, Richard R. Carlton, Elsevier, 7th Edition, 2022
5. Manual of Radiographic Technique and Patient Care, David M. Malet, Little, Brown and Company, 4th Edition, Year: 2019

RT-601: Special Radiological Procedures & Contrast Media – 2

1. Perform Barium Swallow and Barium Meal examination procedures with patient preparation.
2. Demonstrate cerebral and renal angiography setup and explain catheterization technique.
3. Perform ERCP and PTC procedure demonstration using available models or simulators.
4. Perform DSA image acquisition and subtraction technique using software demo.
5. Demonstrate ultrasound and CT-guided biopsy procedures on phantom models.

RT-602: Radiotherapy Planning & Techniques – 2

1. Demonstrate brachytherapy source loading and applicator placement (using dummy sources).
2. Perform dose calculation using TG-43 formalism for a simple implant geometry.
3. Demonstrate planning for surface mould and interstitial implants using treatment planning system (TPS).
4. Perform QA checks for Gamma Knife or CyberKnife system (demonstration).
5. Demonstrate 2D and 3D CT-based brachytherapy planning using planning software.

RT-603: Radiation Dosimetry – Principles & Applications – 2

1. Calibrate a Farmer-type ionization chamber using reference radiation beam.
2. Measure absorbed dose using a plane-parallel chamber for electron beam.
3. Perform calibration using TG-51 or IAEA TRS-398 protocol demonstration.
4. Demonstrate Fricke dosimetry and analyze results using spectrophotometer data.
5. Use TLD and film dosimetry for dose measurement and comparison.

RT-604: Hospital Practice & Patient Care – 2

1. Demonstrate CPR and artificial respiration using manikin.
2. Demonstrate aseptic techniques and PPE usage in radiology department.
3. Prepare patient for special radiological procedures such as IVP and Barium Enema.
4. Demonstrate contrast administration techniques and management of contrast reactions.
5. Demonstrate radiation protection measures and use of dosimeters.

Clinical Posting:

BRIT students will be posted to various sections of the Radiology Department for practical training, where they will learn patient handling and identification using CR numbers and Lab IDs. They will observe and assist in performing various radiographic procedures across different imaging departments. Each student must maintain a logbook detailing their activities and learning's during the postings. Performance will be continuously evaluated by the faculty assigned to each section.