GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
Level: Diploma
Branch: Biomedical Engineering
Subject Code: DI04003031
Subject Name: Medical Imaging Techniques

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	PCC

Prerequisite:	Basic knowledge of Human Anatomy & Physiology, Fundamentals of Physics (optics, waves), and introductory concepts of Biomedical Instrumentation.
Rationale:	There has been tremendous development in imaging field during last few years. Few decades back we only had an X-ray machine to image human body. Today, we have highly sophisticated equipment like CT scan, Ultrasound Scanner, MRI, Endoscope, etc. that have completely changed the scenario of medical imaging. Hence it is essential that the students acquire skills to maintain these latest imaging systems for which this course is designed.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
1	Interpret the working of various elements of X-Ray equipment and their specification.	Understand
2	Select relevant X-Ray imaging modality for specific applications	Apply
3	Differentiate between various generations of CT scan machines.	Analyze
4	Identify different types of ultrasound scans.	Remember
5	Interpret the functioning of MRI machine.	Understand

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	X-ray technique	10	
	1. Introduction to X-rays: Definition, Properties, Measurement units 2. Generations of X-rays: White and Characteristics radiation 3. X-ray Generators: Types of X-ray tubes. Stationary and Rotating 4. X-RAY machine: Technical specifications and block diagram 5. X-ray tube ratings, 1.6 Beam restrictors and collimators.		25%
2	Digital radiographic techniques	9	
	1. Digital Vs. Conventional X-ray Radiography 2. Catheterization laboratory: a. Layout of Cath lab 3. Fluoroscopy: Performance parameters and image reproduction 4. Angioplasty and Angiography: Step by step procedure 5. Mammography: basic technique.		20%
3	Computed Tomography technique	9	
	1. Computed tomography: Basic Principle of CT 2. CT number 3. Generations of CT-Scanner 4. X-ray Vs CT Scan		20%
4	Ultrasound Imaging technique	9	
	1. Introduction, properties of ultrasound & its limitations 2. Ultrasound transducer. 3. Pulse-echo technique		20%

	4. Ultrasound imaging: - b. A-Mode, c. B-Mode, d. M-Mode 5. Biologic effects of Ultrasound.		
5	Advanced Imaging Techniques and Radiation Safety	08	
	1. Magnetic Resonance Imaging (MRI): Basic working principle of MRI, Block diagram, Parts of NMR machine. 2. Magnets and Coils of MRI machine 3. Biological effect of Ionizing radiation on human health. 4. Prevention of Radiation hazards and safe practices. 5. Methods of Radioactive waste disposal		15%
	Total	**45 Hrs.**	**100 %**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25 %	**40 %**	**25 %**	**10%**	--	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. **Handbook of Biomedical Instrumentation** by *R. S. Khandpur*, Tata McGraw-Hill, New Delhi
2. **Medical Electronics** by *A. G. Patil*, Excel Books
3. **Introduction to Physics of Diagnostic Radiology** by *Thomas S. Curry, James E. Dowdey, Robert C. Murry*, Lea and Febiger
4. **Medical Electrical Equipment** by *Robert E. Molleoy*, B.I. Publications
5. **Medical Instrumentation: Application and Design** by *John G. Webster (Editor)*, John Wiley and Sons, Inc.
6. **Fundamentals of Medical Imaging** by *Paul Suetens*, Cambridge University Press
7. **Introduction to Medical Imaging: Physics, Engineering and Clinical Applications** by *Andrew Webb, Nadine Barrie Smith*, Cambridge University Press
8. **Fundamentals of Radiology Physics** by *Meredith and Massey*, John Wright and Sons Ltd

(b) Open-source software and website:

1. X-Ray Imaging : https://www.ncbi.nlm.nih.gov/books/NBK564423/ https://www.aerb.gov.in/images/PDF/TrainingModule/3-MEDICAL-IMAGINGTECHNIQUES.pdf
2. CT Scan: https://www.aerb.gov.in/images/PDF/TrainingModule/3-MEDICAL-IMAGINGTECHNIQUES.pdf https://www.nibib.nih.gov/science-education/science-topics/computed-tomography-ct
3. Ultrasound Imaging: https://www.nibib.nih.gov/science-education/science-topics/ultrasound https://www.uscultrasound.com/what-is-ultrasound-and-how-does-it-work/
4. MRI: https://www.nibib.nih.gov/science-education/science-topics/magnetic-resonance-imagingmri https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/magneticresonance-imaging-mri

Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. hours required.
1	To Observe X-ray machine components and controls.	1	4
2	To adjust exposure factors (kvp, mas) based on body part and patient size.	1	2
3	To Study of the radiation dose and safety aspects of X- ray.	1	2
4	To adjust collimators to restrict the X-ray beam to the area of interest.	2	2
5	To Observe CT scanner components and user interface.	3	4
6	To Demonstrate the administration of contrast agents for contrast-enhanced CT.	3	2
7	To Understand about biological affect and safety aspects of computed tomography.	3	2
8	To Analyze CT scans in group discussions, interpreting findings.	3	2
9	To Observe fluoroscopy system components and controls.	2	2
10	To adjust the image intensifier and understanding its role for image enhancement.	2	2
11	To Study about the Principle of Magnetic Resonance Imaging.	5	4
12	To Study about the different types of magnets used MRI machine.	5	2
13	To Study about different types of coil arrangement in MRI.	5	2
14	To Understand the transducer, console, and imaging setting in Ultrasound	4	2
15	To Demonstrate different modes and probes of ultrasound imaging.	4	2

16	To Demonstrate the performance of different ultrasonic probes (sector and electronic).	4	2
17	To Practice Scanning techniques for different anatomical regions.	4	2
18	To Observe angiography machine components, controls, and safety features.	2	4
19	To Observe mammography machine components, controls, and compression systems.	2	4
20	To Analyze X-ray, CT, MRI, and ultrasound images (To Observe images of X-ray, CT, MRI, and ultrasound scan)	All	2
21	To Understand the environmental impact of imaging equipment and practices.	All	2
22	To Develop eco-friendly practices and waste reduction during usage of medical imaging techniques/instrumentation/equipment.	All	4

List of Laboratory/Learning Resources Required:

The major equipment/instruments and software required to develop PrOs are given below, with broad specifications to facilitate their procurement by the administrators/management of the institutes. This will ensure the conduction of practical skills in all institutions across the state properly so that the desired skills are developed in students.

a) X-Ray Machine
b) Ultrasound Machine
c) CT Scan Machine (External Facility)
d) MRI Machine (External Facility)
e) Cathode Ray Oscilloscope

Suggested Project List:

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, in the fifth and sixth semesters, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about 14-16 (fourteen to sixteen) student engagement hours during the course. The students ought to submit micro-project by the end of the semester to develop

the industry oriented COs. A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Design a circuit for generating required current and voltage ratings for an X-Ray Machine.
2. Prepare model to demonstrate various types of X-Ray modalities.
3. Prepare model to demonstrate various generations of CT-Scan machine.
4. Prepare model to demonstrate various modes of transmission in Ultrasound
5. Prepare model to demonstrate various modes of display in Ultrasound
6. Prepare a chart depicting various advanced imaging modalities like MRI, PET and Nuclear Medicine.
7. Prepare a Report of Detailed Analysis of any one real Image of any (X-Ray, CT, MRI, Ultrasound) Imaging Technique.

Suggested Activities for Students: If any

Other than the classroom and laboratory learning, following are the suggested student-related co- curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Visit to a nearby Imaging Centre.
b) Visit nearby Hospital where Medical Imaging facilities are available.
c) Prepare a chart of components currently used for Medical Imaging Equipment.
d) Prepare mini/micro project related to any one Imaging Modality.
e) Participate in a seminar/workshop for learning new trends and technology in Medical Imaging Techniques.
f) Prepare a poster for safety guidelines to be followed while operating/handling imaging equipment.

Followings are some sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (MOOCs) may be used to teach various topics/ subtopics.
b) Guide student(s) in undertaking micro-projects.
c) Arrange to visit nearer Hospital/Imaging Centre.
d) Video films/animation films on working of different types of Medical Imaging Equipment.
e) Perform practical virtually on the various online website/software
f) Arrange expert lectures on advanced topics related to Medical Imaging.

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