

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: MEDICAL IMAGING TECHNIQUES  
(COURSE CODE: 3350302)**

Diploma Programmes in which this course is offered	Semester in which offered
Biomedical Engineering	5 <sup>th</sup> Semester

**1. RATIONALE**

There has been tremendous development in imaging field during last few years. Few decades back we had only 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 student acquire skills to maintain these latest imaging systems for which this course is designed.

**2. LIST OF COMPETENCY (Programme outcomes according to NBA terminology)**

The course content should be taught and implemented with the aim to develop requires skills so that students are able to acquire following competency:

- **Maintain different types of medical imaging instruments.**

**3. COURSE OUTCOMES**

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Maintain X-ray equipment.
- Describe the layout of catheterization laboratory and the procedure of angiography.
- Maintain CT-scan and MRI machine.
- Identify the different types of ultrasound scan.

**4. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	06	70	30	20	30	<b>150</b>

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit ESE - End Semester Examination; PA - Progressive Assessment.

## 5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I</b> <b>X-ray</b> <b>Equipment</b>	1a. Describe electromagnetic radiation with its spectrum. 1b. Explain various interactions between X-rays and matter. 1c. Define Roentgen (R), Radiation absorbed dose (Rad). 1d. Explain factors that affect attenuation coefficient. 1e. Describe white and characteristic radiation. 1f. Explain Line focus principle of X-ray generators. 1g. Define various X-ray tube ratings. 1h. Compare stationary and rotating X-ray tubes. 1i. Explain construction and need of beam restrictors and grids. 1j. Explain construction of intensifying screens. 1k. Explain image intensifiers. 1l. Explain X-ray films. 1m. Explain construction of X-ray machine.	1.1 Electromagnetic radiation 1.2 Interactions between X-rays and matter: coherent scattering, photoelectric effect, Compton scattering, pair production and Photodisintegration. 1.3 Intensity of an X-ray Beam: Roentgen (R), Radiation absorbed dose (Rad). 1.4 Factors that affect attenuation coefficient 1.5 Generation and Detection of X-rays 1.5.1 X-ray Generation: White and characteristic radiation. 1.5.2 X-ray Generators: Line focus principle, X-ray Tube Ratings, Types of X-ray tubes. 1.5.3 Beam restrictors and grids 1.5.4 Intensifying screens, Image Intensifiers, X-ray films. 1.6 X-RAY machine: Technical specifications and block diagram.
<b>Unit– II</b> <b>X-ray</b> <b>Diagnostic methods</b>	2a. Explain conventional X-ray radiography with its basic components. 2b. Explain basic components of fluoroscopy. 2c. Describe angiography procedure. 2d. Explain mammography in detail. 2e. Describe the Biological effects of ionizing radiation.	1.1 Conventional X-ray Radiography 1.2 Fluoroscopy: Image, performance parameters, and operating system with feedback control, specifications image intensifier, television camera, image recording. 1.3 Angiography 1.4 Mammography 1.5 Biological effects of ionizing radiation.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit– III Catheterization Laboratory</b>	3.a. Explain the layout of Catheterization laboratory in brief. 3.b. Describe various pressure waveforms associated with Catheterization procedure.	3.1 Typical instrumentation layout in a Catheterization laboratory, 3.2 Pressure measurements and application.
<b>Unit – IV Advanced Imaging Techniques ( Computed Tomography and Magnetic Resonance Imaging)</b>	4a. Compare X-ray and Computed Tomography. 4b. Explain the Principle of CT-Scan. 4c. Explain the Generations of CT-Scan. 4d. Define CT number. 4e. Define Angular momentum, Magnetization, Larmor frequency and free induction decay. 4f. Explain the Principle of MRI Machine. 4.2.1 Explain types of magnets, NMR coils, transmitter and receiver. 4g. Describe the Biological Effect of magnetic fields.	4.1 Computed tomography: Basic Principle of CT, CT number, Generations of CT-Scanner. 4.2 Magnetic Resonance Imaging 4.2.1 Fundamentals of NMR: Angular momentum, Magnetic dipole moment, magnetization, Larmor frequency, free induction decay 4.2.2 Generation and detection of NMR signal: Introduction, types of magnets, NMR coils, transmitter and receiver. 4.2.3 Biological effects of magnetic fields and safety requirements For MRI Machine.
<b>Unit – V Ultrasound Imaging</b>	5a. Explain various properties of ultrasound. 5b. Understand the Ultrasound transducers. 5c. Draw and explain the basic block diagram of pulse-echo system 5d. Understand the different types of scan 5e. Describe the Biological effects of Ultrasound.	5.1 Introduction, properties of ultrasound & its limitations, Ultrasound transducer. 5.2 Pulse-echo technique 5.3 Ultrasound imaging: - A-scan, B-scan, Doppler method. 5.4 Biologic effects of Ultrasound.

**6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)**

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	X-ray Equipment	16	07	06	07	20
II	X-ray Diagnostic Methods	12	07	07	-	14
III	Catheterization laboratory	06	-	08	-	08
IV	Advanced imaging techniques (Computed Tomography and magnetic resonance imaging)	12	07	07	-	14
V	Ultrasound imaging	10	07	-	07	14
	<b>Total</b>	<b>56</b>	<b>28</b>	<b>28</b>	<b>14</b>	<b>70</b>

**Legends:** R = Remember; U = Understand; A = Apply and above levels (Bloom's Revised taxonomy)

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**7. SUGGESTED LIST OF EXERCISES/PRACTICALS**

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	Identify various front panel controls of X-ray machine.	02
2	I	Identify different PCB cards used in the X-ray machine.	02
3	III	Identify various areas of Cath lab in hospital.	02
4	III	Observe various procedures done in Cath lab (Angiography and Angioplasty)	02
5	IV	Identify different PCB cards used in the CT scan machine.	02
6	IV	Identify different PCB cards used in the MRI machine.	02
7	V	Identify different PCB cards used in the ultrasonic machine.	02
8	V	Compare performance of different ultrasonic probes (sector and electronic).	02
9		Obtain the effect of varying the MAS, and KVp values on	02

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
		display film in X ray	
10	I	Demonstrate operation of X-ray machine.	04
11	IV	Demonstrate various CT scanners at hospital.	02
12	IV	Demonstrate MRI in hospital diagnostic centre.	02
13	V	Demonstrate operation of ultrasonic machine.	02
14	V	Demonstrate operation of computer controlled ultrasonic scanner (Colour Doppler).	02
<b>Total</b> (Note: Practical requiring visit to Hospital/Diagnostic Centre may be excluded from external exam, only oral may be taken for such practical)			<b>28</b>

### 8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i. Student should visit the general hospital and diagnostic center.
- ii. Explore internet and visit websites of manufacturers of medical imaging instruments to collect specifications and details of their products and prepare a comparative report of instruments of different makes.

### 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Class Test
- ii. Assignment
- iii. Seminar/Symposium
- iv. Collection/Records
- v. Group discussion/Debate
- vi. Arranging hospital and reputed diagnostic centre visit.
- vii. Show video/animation films of working and maintenance of medical imaging instruments.

### 10. SUGGESTED LEARNING RESOURCES

#### A) List of Books

S.No.	Title of Book	Author	Publication
1.	Cheney's Equipment for Student Radiographer	Peter Carter, Audry Paterson, Mike Thornton, Andrew Hyatt	Blackwell Scientific Publications
2.		A. Kenny, R. Eugene Johnnton	CRC Press
3.	Medical Electronics	A.G. Patil	Excel Books
4.	Introduction to Physics of Diagnostic Radiology	Christen Sen's Thomas S. Curry Jamis E Dowdey Robert C.Murry	Lea and Febiger
5.	Medical Electrical Equipment	Robert E. Molleoy	B.I. publication
6.	Medical Instrumentation Application and Design	John G. Webster, Editor	A John Wiley and Sons, Inc., Publication
7.	Handbook of Biomedical	R.S. Khandpur	Tata McGraw Hill

S.No.	Title of Book	Author	Publication
	Instrumentation		
8.	Fundamentals of Medical Imaging	Paul Suetens	Cambridge University Press
9.	Introduction to Medical Imaging: Physics, Engineering and Clinical Applications	Andrew Webb, Nadine Barrie Smith	Cambridge University Press
10.	Fundamentals Physics of Radiology	Meredith and Messey	A John Wright and Sons Ltd

**B) List of Major Equipment/ Instruments with Broad Specifications**

- i. X-Ray Machine
- ii. MRI machine
- iii. CT-Scan
- iv. Ultrasoundography
- v. Cathlab
- vi. X-ray tube

**C) List of Software/Learning Websites**

- i. <http://www.gpamdavadbme.hpage.com>
- ii. <http://www.gpgbiomedical.hpage.com>

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**

**Faculty Members from Polytechnics**

- **Prof. S.S. Malkan**, Lecturer, Dept. of Biomedical Engineering, G.G.P.Ahmedabad
- **Prof. M.H. Dave**, Lecturer, Dept. of Biomedical Engineering, G.P.Gandhinagar
- **Prof. A.K. Bula**, Lecturer, Dept. of Instrumentation Engineering, G.P.Gandhinagar
- **Prof. N.D. Makwana**, Lecturer, Dept. of Biomedical Engineering, G.P.Gandhinagar

**Faculty Members from NITTTR**

- **Prof. (Ms.) Susan S. Mathew**, Associate Professor, Dept. of Electrical and Electronics Engineering,
- **Prof. Joshua. Earnest**, Professor, Dept. of Electrical and Electronics Engineering.