GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170303
Semester – VII
Medical Imaging Techniques

Type of course: Professional Core Course

Prerequisite: Human Anatomy & Physiology, Basic Engineering Mathematics, Basic Physics.

Rationale: The purpose of this course is to learn the fundamentals and all the components of various Medical Imaging Modalities and also new developments in diagnostic methods for different imaging techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**X-Ray Imaging** <u>Fundamentals of X-Ray</u>: Electromagnetic Radiation, Interactions between X-rays and Matter: Coherent Scattering, Photoelectric Effect, Compton Scattering, Pair Production and Photodisintegration, Attenuation. <u>X-Ray Generation & Detection</u>: White Radiation, Characteristic Radiation, X-ray tube or Generators, Line Focus Principle, Factors affecting X-ray Emission Spectrum, Filters, Beam Restrictors and Grids, Intensifying Screens, Image Intensifiers, X-ray Film, H & D Curve, Radiation Detectors, quality and exposure. <u>X- Ray Image Characteristic</u>: Spatial Resolution, Point Spread Function, Line Spread Function, Edge Spread Function, System Transfer Function, Image Noise, Image Contrast. <u>X-ray Diagnostic Method</u>: Conventional X-ray Radiography, Fluoroscopy, Angiography, Mammography, Digital Subtraction Angiography. Biological Effects of Ionizing Radiation.	11
2	**Computed Tomography** Operational modes: First, Second, Third, Fourth, Fifth generation Scanners. System components: Gantry, Collimation. Image characteristics: Image matrix, CT numbers, Image reconstruction algorithms, Spatial resolution, Single-Slice CT, Multi-slice CT, System noise, Image Artifacts.	8
3	**Ultrasound Imaging**: <u>Fundamentals of Acoustical Propagation</u>: Reflection and Refraction, Attenuation, Absorption and Scattering.	9

	Generation and Detection of Ultrasound: Piezoelectric Effect, Ultrasonic Transducers, Mechanical and Electrical Matching, Transducer Beam Characteristic, Huygens principle, Doppler effect, Beam profiles, Pulsed ultrasonic filed, Visualization and mapping of the Ultrasonic field, Axial and Lateral Resolution, Focusing, Transducer Arrays. Ultrasonic Diagnostic Methods: Pulse-Echo Systems [A or Amplitude mode, B or Brightness mode, M or Motion mode & C or Constant depth mode], Doppler Methods, Duplex Imaging, Tissue Characterization [velocity, Attenuation or absorption, Scattering]. Developments in Ultrasound technique: Color Doppler Flow Imaging [CW Doppler imaging device, Pulsed Doppler imaging system, clinical applications], Ultrasound Contrast Media, Intracavity Imaging, 2-D echo cardiography. Biological Effects of Ultrasound.	
4	**Magnetic Resonance Imaging** Basic Principles, Radio Frequency Pulse, Spin-Spin and Spin-Lattice relaxation (T1, T2 and T2*), TR, TE and Tissue Contrast, Slice Selection and Spatial Encoding, Field of View, Artifacts in MRI. MRI Equipment and basic components, Advantages and biological effect of MR imaging system and safety.	10
5	**Radionuclide Imaging** Radio-isotopes in Medical diagnosis, Interaction of Nuclear particles with Matter. Gamma camera, Single Photon Emission Computed Tomography, Positron Emission Tomography, Internal Radiation Dosimetry and Biological Effect.	5
		43

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30%	**30%**	**15%**	**15%**	**10%**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

Reference Books:

1) Principle of Medical imaging, K. Kirk Shung, Michael B. Smith, Benjamin M. W. Tsui, Pub: Academic Press.

2) MRI: The Basics, 4th Edition Hashemi, Ray Hashman; Bradley, William G.; Lisanti, Christopher J., Pub: Lippincott Williams & Wilkins
3) Fundamentals of medical imaging: Paul Suetens. Pub: Cambridge university press.
4) Introduction to biomedical imaging, Andrew Webb. Pub: IEEE press series: Wiley Interscience
5) The Physics of medical imaging, Steve Webb. Pub: Institute of Physics Publishing, Bristol and Philadelphia.
6) Medical Imaging, John G. Webster.
7) Handbook of Biomedical Instrumentation, R. S. Khandpur.
8) Radiologic science for Technologists, By: Stewart C. Bushong. Pub: Mosby: A Harcourt Health Sciences Company.
9) Quality Management: In the Imaging Sciences, By: Jeffery Papp. Pub: Mosby: A Harcourt Health Sciences Company

Course Outcomes:
After learning this subject, students will be able to:

Sr. No.	CO Statement	Marks % weightage
CO-1	Understand fundamental components of x-ray machine and imaging techniques.	25
CO-2	Understand fundamental of CT-scan imaging techniques.	18
CO-3	Understand fundamentals of ultrasound imaging techniques and probe structure.	22
CO-4	Understand fundamental components of MRI machine and imaging techniques.	25
CO-5	Understand radionuclide imaging methods.	10

List of Practical:

Sr.No.	Title
1.	To study X-ray imaging with Diagnostic methods.
2.	To study Computed Tomography with image characteristics.
3.	To study Image Reconstruction algorithms for CT scan.
4.	To study Ultrasonography with different Modes.
5.	To study Color Doppler Flow Imaging and 2-D echo cardiography.
6.	To study fundamentals of Magnetic Resonance Imaging.
7.	To study Magnetic Resonance Imaging - Device.
8.	To study Radio Nuclide Imaging devices.