GUJARAT TECHNOLOGICAL UNIVERSITY
BRANCH NAME: Biomedical Engineering (03)
SUBJECT NAME: MEDICAL IMAGING TECHNIQUES
SUBJECT CODE: 2170303
B.E.VII SEMESTER

Type of course: Core

Prerequisite: Fundamentals of Physics and Radiation, Fourier transform, Piezoelectric effect, fundamentals of Nuclear science.

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)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	2	0	6	70	20	10	30	0	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning.

Content:

Sr. No.	Content	Total Hrs	% Weigh tage
1	**X-Ray Imaging** Fundamentals of X-Ray: Electromagnetic Radiation, Interactions between X-rays and Matter: Coherent Scattering, Photoelectric Effect, Compton Scattering, Pair Production and Photodisintegration, Attenuation. X-Ray Generation & Detection: 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 Intensifies, X-ray Film, H & D Curve, Radiation Detectors, quality and exposure. X- Ray Image Characteristic**:** Spatial Resolution, Point Spread Function, Line Spread Function, Edge Spread Function, System Transfer Function, Image Noise, Image Contrast. X-ray Diagnostic Method: Conventional X- ray Radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Digital Subtraction Angiography. Biological Effects of Ionizing Radiation.	12	25

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, System noise, Image Artifacts.	7	15
3	**Ultrasound Imaging:** Fundamentals of Acoustical Propagation: Reflection and Refraction, Attenuation, Absorption and Scattering. 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.	12	25
4	**Magnetic Resonance Imaging** Principles of NMR imaging system, Image reconstruction techniques, Basic NMR components, Advantages and biological effect of NMR imaging system.	8	15
5	**Radionuclide Imaging** Radio-isotopes in Medical diagnosis, Interaction of Nuclear particles with Matter. Radionuclide generators, Nuclear Radiation Detectors, Rectilinear Scanner, Gamma camera, Longitudinal Section Tomography, Single Photon Emission Computed Tomography, Positron Emission Tomography, Internal Radiation Dosimetry and Biological Effect.	7	15
6	**Thermal imaging** Fundamentals of Medical Thermography, Infrared detectors, Thermographic equipment**.**	4	5
Total		50	

Books:

1. Principle of Medical imaging, K. Kir k Shung, Michael B. Smith, Benjami n M. W. Tsui, Pub: Academic Press.
2. Handbook of Biomedical Instrumentation, R.S.Khandpur.
3. Introduction to biomedical imaging, Andrew Webb.Pub: IEEE press series: Wiley Interscience
4. Fundamentals of medical imaging: Paul suetens. Pub: Cambridge university press.
5. The Physics of medical imaging, Steve Webb. Pub: Institute of Physics Publishing, Bristol and Philadelphia.
6. Medical Imaging, John G. Webster.
7. Radiologic science for Technologists, By: Stewart C. Bushong. Pub: Mosby: A Harcourt Health Sciences Company..

8. Quality Management: In the Imaging Sciences, By: Jeffery Papp. Pub: Mosby: A Harcourt Health Sciences Company

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	**U Level**	**A Level**	**N Level**	**E Level**
10%	**35%**	**30%**	**15%**	**10%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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.

Course Outcome:

After learning the course the students should be able to:

1. Understand fundamentals of imaging based on radiation.
2. Study the various imaging modalities.
3. Have knowledge of all the components of imaging modalities.
4. Learn the different techniques for image reconstruction.
5. Learn purpose of medical imaging and its biological effect for various imaging modalities.
6. Study about new Advancement in Medical imaging techniques and diagnostic methods.

List of Experiments: (Outlines)

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 Magnetic Resonance Imaging.
7. To study Radionuclide Imaging.
8. To study Single Photon Emission Computed Tomography.
9. To study Positron Emission Tomography
10. To study Infrared Imaging Technology.

Design based Problems (DP)/Open Ended Problem:

To Develop or implement algorithms for CT and MRI image reconstruction techniques or application for diagnosis.

Active Learning Assignments: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will assign topics from which students can grasp knowledge about current scenario of the biomedical image processing. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.