

# GUJARAT TECHNOLOGICAL UNIVERSITY

## Biomedical Engineering

### B. E. SEMESTER: VII

Subject Name: **Medical Imaging Technology**

Subject Code: **170303**

| Teaching Scheme |          |           |       | Evaluation Scheme   |           |                           |                      |
|-----------------|----------|-----------|-------|---------------------|-----------|---------------------------|----------------------|
| Theory          | Tutorial | Practical | Total | University Exam (E) |           | Mid Sem Exam (Theory) (M) | Practical (Internal) |
|                 |          |           |       | Theory              | Practical |                           |                      |
| 3               | 0        | 2         | 5     | 70                  | 30        | 30                        | 20                   |

| Sr. No | Course Content                                                                                                                                                                                                                                                                                                                                                                                                                          | Total Hrs. |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1.     | <b>Fundamentals of Physics and Radiation:</b><br>Concepts of Radiation science; Radiographic definition and Mathematics review; Electromagnetic Radiation: Photons, Electromagnetic Spectrum, Wave Particle Duality; Interactions between Radiation and matters; Fundamentals of acoustic propagation; Interaction between sonic beams and matter; concepts of ultrasonic diagnostics.                                                  | 5          |
| 2.     | <b>Imaging with X-Rays:</b><br>X-ray tube: The generation: Electron-Target Interactions, X-ray emission spectrum: Characteristic x-ray spectrum, Bremsstrahlung x-ray spectrum, Factors affecting X-ray Emission Spectrum: Effect of mA, kVp, added filtration; X-ray unit: generators, filters and grids; Image intensifiers; X-ray detectors: Screen film detector, Image Intensifier; Radiographic techniques, quality and exposure. | 5          |
| 3.     | <b>X-ray Diagnostic Methods:</b><br>Fluoroscopy: Fluoroscopy and Visual Physiology, Image intensifier tube and Multifield intensification; Angiography: Arterial access, Catheters, Contrast media; Mammography: Soft tissue radiography, Equipments: Target composition, Filtration grids, Photo timers, Image receptors; Xeroradiography; Digital radiography; 3-D construction of images.                                            | 5          |
| 4.     | <b>Computed Tomography:</b><br>Operational modes: First generation scanners, Second, Third, Fourth, Fifth generation scanners; System components: Gantry, Collimation; High Voltage generators; Image characteristics: Image matrix, CT numbers; Image reconstruction; Image Quality: Spatial resolution, Contrast                                                                                                                      | 8          |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|     | resolution, System noise, Linearity, Spatial Uniformity.                                                                                                                                                                                                                                                                                                                                                                                                                          |   |
| 5.  | <b>Imaging with Ultrasonography:</b><br>Piezoelectric effect; Ultrasonic transducers: Mechanical and Electrical matching; The characteristics of transducer beam: Huygens principle, Beam profiles, Pulsed ultrasonic field, Visualization and mapping of the Ultrasonic field; Doppler effect-Doppler methods; Pulse echo systems[Amplitude mode, Brightness mode, Motion mode & Constant depth mode]; Tissue characterization: velocity, Attenuation or absorption, Scattering. | 8 |
| 6.  | <b>Developments in Ultrasound technique:</b><br>Color Doppler flow imaging: CW Doppler imaging device, Pulsed Doppler imaging system, clinical applications; Intracavity imaging: Design of the Phased array probe, Trans oesophageal, Transvaginal or Transrectal scanning; Ultrasound contrast media: Utilization of micro air bubbles, galactose microparticles and albumin encapsulated microairbubbles; 3-D image reconstruction; 2-D echo cardiography                      | 5 |
| 7.  | <b>Biological effects of Radiation and Ultrasound and its protection:</b><br>Modes of Biological effects: Composition of the body and Human response to Ionizing radiation; Physical and Biological factors affecting Radiosensitivity, Radiation Dose-response relationships; Time variance of radiation exposure; Thermal / Nonthermal effects due to cavitation in ultrasound fields; Designing of radiation protections and its procedures.                                   | 5 |
| 8.  | <b>Advances in Imaging:</b><br>Introduction to Magnetic Resonance Imaging, Radionuclide Imaging, Longitudinal section Tomography, Single Photon Emission Computed Tomography, Positron Emission Tomography.                                                                                                                                                                                                                                                                       | 5 |
| 9.  | <b>Nuclear medical imaging:</b><br>Radionuclides. Interaction of photons with matter. Data acquisition. Imaging: image quality, equipment. Clinical use. Biological effects and safety.                                                                                                                                                                                                                                                                                           | 5 |
| 10. | <b>Infrared imaging:</b><br>Infrared photography. Transillumination. Infrared imaging. Liquid crystal thermography. Microwave thermography.                                                                                                                                                                                                                                                                                                                                       | 5 |

**The Practical and Term work will be based on the topics covered in the syllabus.**

### **Text Book:**

1. Principles of Medical Imaging. By: K. Kirk Shung, Michael B. Smith, and Benjamin Tsui. Pub: Academic Press.
2. Introduction to biomedical imaging, Andrew Webb. Pub: IEEE press series: Wiley Interscience

### **Reference Books:**

1. Radiologic science for Technologists.  
By: Stewart C. Bushong. Pub: Mosby: A Harcourt Health Sciences Company..
2. Quality Management: In the Imaging Sciences.  
By: Jeffery Papp. Pub: Mosby: A Harcourt Health Sciences Company
3. Fundamentals of medical imaging:  
Paul suetens. Pub: Cambridge university press.
4. The Physics of medical imaging  
Steve Webb. Pub: Institute of Physics Publishing, Bristol and Philadelphia.
5. Fundamentals of digital image Processing  
Jain A K. Pub: Prentice Hall
6. Digital Image Processing 2<sup>nd</sup> edition 1987.  
Gonzalez R. C. Pub: Addison Wesley and P Wintz.