GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Bio Medical Engineering

Course / Subject Code : ME01031031

Course /Subject Name : Medical Physics

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Medical Imaging Technology, Classical Physics and its application, Mathematics, Human Anatomy & Physiology.
Rationale:	The post graduate biomedical engineering students will be able to understand physiological basis, analytical methods and fundamental aspects of medical physics. The course also aims to develop an attitude of integrity, professionalism, critical-thinking and scientific rigor.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Describe the importance of physics in medicine
02	Understand application of classical physics to human body.
03	Understand the general principles of medical image reconstruction and registration
04	Compare and contrast the medical imaging techniques that are available in a hospital setting andexplain their relative merits
05	Explain the difference between imaging with ionising and non-ionising radiation in the context ofradiation dosimetry and risk.
06	Describe sensing and therapeutic applications of physics in medicine

**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 / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** Terminology, the Standard Human, and Scaling, Anatomical position and body plane terminology, Statics of the Body, Motion, Mechanical Properties of body, Muscles, Metabolism: Energy, Heat, Work & Power of the body, Fluid Pressure, Fluid Flow in the Body, and Motion in Fluids, Cardiovascular System, Lungs & Breathing, Sound, speech & Hearing, Light, eyes & Vision, Electric & Magnetic Properties.	10	25%
2.	**Radiation Physics** Brief review of quantum mechanics and modern physics, X-rays radiology – introduction, Passage of the radiation though matter; microscopic treatment, coherent and incoherent scattering on atoms, photoelectric effect, characteristic x-rays, Passage of x- rays through matter: macroscopic treatment, Filtering, X-rays instrumentation, Contrast and scattered radiation, X-rays detectors, Image intensifiers , Image screens , Digital detectors: computed radiography; the f-centers, direct radiography, indirect conversion methods, direct conversion methods, Other digital detectors, Dosimetry	8	20%
3.	**Medical Imaging Fundamentals** Mathematical Methods, Tomographic Reconstruction Techniques, Linear Systems, Acquisition, formation, processing and display of medical images, Perception, Evaluation of Image Quality	8	15%
4.	**Magnetic resonance imaging (MRI):** concept of spin and nuclear magnetic resonance, spin decay through interaction with tissues, use of different magnets in MRI systems, one or two simple imaging sequences, Sequence parameters, Image Artifacts, Contrast Mechanism.	9	15%

5.	**Ultrasound:** Production of ultrasound, Frequency, speed and Wavelength, Intensity and Power, Diffraction & Interference, Image spackle. Fourier components, Standing waves and Resonance, Reflection, Scattering, Refraction, Lenses and mirrors, Absorption and Attenuation, Non-Linear Propagation, Tissue characterization & Elastography, Doppler Effect, Resolution, Characteristics of sound waves, Relation between frequency and resolution. Wave equation-3D, Plane wave, Spherical Wave, Field pattern of transducer, Blood flow, Spectral Doppler Ultrasound, Color flow and Imaging, 3D and 4D ultrasound Physics.	10	25%
	Total	**45**	**100**

Reference Books:

1. Physics of the Human Body, Irving P. Herman, Springer, 2007.
2. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications, Nadine BarrieSmith and Andrew Webb (Cambridge University Press, 1st edition, 2011).
3. Medical Imaging Physics, William R. Hendee and E. Russell Ritenour (Wiley-Liss, 4th edition, 2002).
4. Principle of Medical imaging, K. Kir k Shung, Michael B. Smith, Benjami n M. W. Tsui, Pub:Academic Press.
5. Radiologic science for Technologists, By: Stewart C. Bushong. Pub: Mosby: A Harcourt HealthSciences Company.
6. Basic MRI Physics, Evert J Blinck (2004)
7. Diagnostic Ultrasound- Physics & Equipment, (Cambridge University Press, 2nd edition, 2010).
8. MRI Made easy, Author: Prof. Dr. Hans H. Schild, Schering AG.

List of Experiments:

1. Study of radiographic imaging quality factors.
2. Investigate the phenomenon of ionization of air exposed to air (X-ray Dosimetry).
3. To demonstrate X-Ray imaging equipment.
4. To study MRI imaging technique.
5. To study various image reconstruction techniques of Ultrasound.
6. To study image artifacts in Ultrasound imaging modality.
7. To study tissue characterization in ultrasonography imaging.

Note: Faculty can add more laboratory practical related to the contents in the syllabus.

Major Equipment:

Dosimeter

List of Open Source Software/learning website:

1. https://www.aapm.org/links/medphys/
2. https://versantphysics.com/software/
3. https://sourceforge.net/directory/science-engineering/medicalphysics/os:windows/
4. https://simaclinac.com/learning-resources/

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