A/L/TY

Reg. No: 24BHT0014

Final Assessment Test – November 2025

VIT Vellore Institute of Technology

Course: BHST209L - Principles of Bio-Medical Imaging and its Clinical Applications

Class NBR(s): 1034

Slot: F1+TF1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

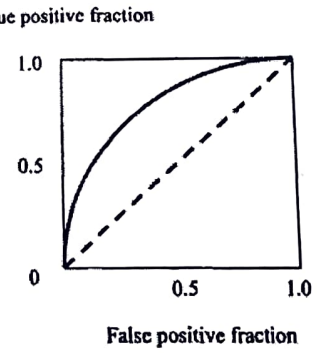
COs	CO Statements
CO1	Identify and describe the underlying science associated with the production of medical images, including the nature of the associated radiation and how it interacts with tissue.
CO2	Demonstrate an understanding of X-Rays and Computed Tomography (CT) for Magnetic Resonance Imaging (MRI) and Sonography
CO3	Demonstrate an understanding of Nuclear Imaging, Optical imaging, and other advance techniques.
CO4	Learn and apply the underlying principles of medical imaging modalities to identify, formulate and solve problems relating to imaging.
CO5	Describe the implementation of different image modalities for various diagnostic aspects their evaluation and assessment of disease states/ specific clinical applications.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. **CO1 BL4**

		Actual situation	
		Tumor present	*Tumor absent*
Diagnosis			
Tumor present		True positive	False positive
Tumor absent		False negative	True negative



a) The table above on your left shows the four possible outcomes of a tumor diagnosis. Please comment on the ROCs represented by the dashed line and the upper curve represented by a solid line. **[5]**

b) Evaluation of a novel serum biomarker for the rapid diagnosis of sepsis is performed in a sample of 100 patients with fever. The biomarker is compared with positive culture results as the gold standard and yields the following information: **[5]**

	Sepsis present (culture positive)	Sepsis absent (culture negative)
Biomarker positive	**30**	**10**
Biomarker negative	**30**	**30**
n	**60**	**40**

With reference to these results, give the values for the: Sensitivity, Specificity, Positive predictive value, Negative predictive value, and Accuracy.

2. Dual-modality PET/CT imaging, has invigorated nuclear medicine and attracted radiology's interest. Evaluating the information obtained and the resolution of the imaging modalities elaborate its role as a comprehensive clinical diagnostic tool in oncologic imaging. **CO5 BL5**

3. a) How is ultrasounds attenuation related to increase in distance and frequency? **[3] CO2 BL3**

   b) What are the factors that contribute to the loss of energy of an ultrasound beam? **[3]**

   c) A region of tissue consists of 3 cm fat, 2 cm muscle (ultra-sound propagated parallel to fibres), and 3 cm liver. What is the approximate total energy loss of ultrasound in the tissue? (Attenuation Coefficients α dB/cm for 1-MHz Ultrasound of Fat: 0.6, Muscle:1.2, Liver: 0.9) **[4]**

4. a) How is the Precessional frequency related to the Magnetic field strength and the Gyromagnetic ratio? **[2] CO2 BL1**

   b) Explain the principle of Magnetic Resonance Imaging? **[8]**

5. a) A brain tumor has a lower concentration of water than surrounding healthy tissue. The T1 value of the protons in the tumor is shorter than that of the protons in healthy tissue, but the T2 value of the tumor protons is longer. Which kind of weighting should be introduced into the imaging sequence in order to ensure that there is contrast between the tumor and healthy tissue? **[3] CO4 BL3**

   b) What are TR and TE and how does their duration affect image contrast? **[7]**

   a) Given the values of c = 1540 m s^{-1} and q = 1.05 g cm^{-3} for brain tissue, calculate the value of the characteristic acoustic impedance. **[3] CO2 BL1**

   b) What is medical ultrasound and how does it work? **[3+4]**

   a) Calculate the amount of scatter from a source at four feet if the intensity at six feet is 50mR/hour. **[5] CO4 BL3**

b) Calculate the CT number for liver, given: **[5]**

Attenuation coefficient of the measured pixel=10.

Attenuation coefficient of water=20.

8. a) An organ with a mass of 10 g receives a uniform dose of 10 cGy. How much energy is absorbed in each mass of tissue in the tumor, and how much energy is absorbed in the entire mass? **[5] CO2 BL3**

b) A narrow beam containing 2000 monoenergetic photons is reduced to 1000 photons by a slab of copper10^{-2}m thick. What is the total linear attenuation coefficient of the copper slab for these photons? **[5]**

9.a) Fine-needle aspiration cytology (FNAC) is a widely known and cost-effective diagnostic tool for detecting breast lesions. A needle is inserted into the breast lesion and aspirated and further the obtained specimens are stained and microscopically evaluated. It is simple to perform and carries a low complication rate. However, the effectiveness of FNAC depends on the skill and experience of the physician performing the aspiration. Still there is a high rate of inadequate specimen collection and sampling error for non-palpable and deep seated breast lesions. Please suggest and detail about an image guided method to guide the needle, ensuring precise sampling from breast lesions. **[2+8] CO5 BL4**

OR

9.b) Achieving intraoperative precision identification of tumor infiltration within surrounding brain parenchyma is always a challenge for the surgeon. Ability to identify tumorous tissue and blood vessels detection during brain tumor surgery will require in vivo and real-time high-resolution images of the tissue structure. Implement and describe a suitable modality which can be helpful in this situation. **[2+8] CO5 BL4**

10.a) What is fluorescence? How does a fluorescence microscope work? **[2+8] CO3 BL2**

OR

10.b) How does a confocal microscope work and what are the advantages of using it? **[8+2] CO3 BL2**

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