Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	MEDICAL IMAGING
COURSE CODE	:	BEU 40403
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN THIS BOOKLET

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

Q1 (a) State the condition that causes scattering of an ultrasound beam.

(3 marks)

(b) The most common piezoelectric cystal used for ultrasound transducers signal transduction between an electrical voltage and mechanical vibration is lead zirconate titanate (PZT). Determine the resonant frequency of the crystal where the speed of sound in crystal is roughly $4000ms^{-1}$, and the thickness of the crystal is 1.3mm.
(Hint: The most common oscillation occurs at the thickness of the crystal is half of the sound wavelength)

(3 marks)

(c) Predict the type of ultrasound scanning mode that is most suitable in opthomology and justify your answer.

(3 marks)

(d) (i) Attenuation of the ultrasound beam is characterized by an exponential decrease in both the pressure P and the intensity I of the ultrasound beam as a function of its propagation distance z cm:

$$I(z) = I(z=0)\exp(-\mu z) \qquad (eq.1)$$

$$P(z) = P(z=0)\exp(-\alpha z) \qquad (eq.2)$$

$$\mu = 2\alpha \qquad (eq.3)$$

μ is the intensity attenuation coefficient and α is the pressure attenuation coefficient with units of cm^{-1}. According to (***eq.*1**) until (***eq.*3**), derive the formulation of $\mu = \alpha$ with units of $dBcm^{-1}$.

(3 marks)

(ii) The intensity of a 1000 kHz ultrasound beam entering tissue is 10 mW/cm^2. Determine the intensity at a depth of 10 cm. (Hint: the attenuation coefficient for soft tissue is 1 dB cm^{-1} MHz^{-1})

(6 marks)

(e) Analyse the principles for blood velocity estimation in the ultrasound imaging between Doppler shifts and Time-Domain signal Correlation (TDC) techniques.

(7 marks)

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Q2 (a) Image reconstruction in Computed Tomography (CT) is performed using filtered backprojection technique where it is preceded by a series of corrections. One of the corrections is made for the effects of beam hardening.

(i) Describe the phenomenon of beam hardening and its effect to the image.

(3 marks)

(ii) Considering the effects of beam hardening, illustrate the final image that would be formed from the filtered backprojection of a series of acquired projections in **Figure Q2 (a)**.

(4 marks)

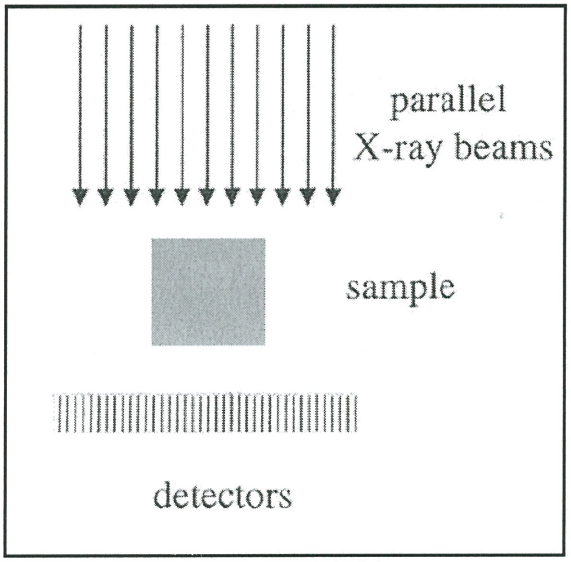

FIGURE Q2 (a)

(b) Discover how the helical scanning mode can improve the time performance in Computed Tomography (CT) operation compared to axial scanning mode.

(4 marks)

(c) Explain the purpose of implementing a set of 'synthetic projections' in fan beam reconstruction.

(2 marks)

(d) Using examples, discuss the concepts of dual-source and dual-energy of the CT scan techniques.

(8 marks)

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(e) A CT image is a map of tissue CT numbers. The value of the CT number is expressed in Hounsfield units (HU) and it is varying in value from +3000 to -1000 based on the type of tissue or medium in which the X-ray propagation where the CT number of water is zero. Using a related equation, justify why the CT number of water is zero.

(4 marks)

– END OF QUESTION –