UNIVERSITI SAINS MALAYSIA

Second Semester Examinations
1996/97 Academic Session

April 1997

ZCE 537/2 - Ultrasound and Magnetic Resonance Imaging

Time: [2 hours]

Please make sure that this examination paper consists of THREE printed pages before you commence the examination.

Answer FOUR questions. TWO from Section A and TWO from section B.

SECTION A

1. (a) Explain the differences between the following terms with reference to magnetic resonance imaging (MRI):

    (i)   T2 relaxation time   (20/100)
    (ii) T2* relaxation time   (20/100)

    (b) What are the factors that determine slice thickness during MR image acquisition? Discuss.

                                                                          (30/100)

    (c) Write short notes on the factors that affect MR image contrast. (30/100)

2. (a) How are field inhomogeneities corrected for in magnetic resonance imaging (MRI)? Describe the different processes.

                                                                          (30/100)

    (b) Discuss how the MR signal is produced following a 90-degree radiofrequency (RF) 'tipping' pulse.

                                                                          (30/100)

    (c) Describe the functions of the following gradients used in MR image formation:

    (i)   phase-encoding gradient   (20/100)
    (ii) frequency-encoding gradient   (20/100)

3. (a) What are the functions of the radiofrequency (RF) coils in a magnetic resonance imaging (MRI) system? Discuss briefly.

(30/100)

(b) Compare and contrast between the following pulse sequences used in MR image acquisition:

(i) spin echo sequence (20/100)
(ii) gradient echo sequence. (20/100)

(c) What is meant by a proton density-weighted image? Describe how it is obtained.

(30/100)

SECTION B

4. (a) Describe briefly why ultrasound methods are widely used within the battery of diagnostic techniques available?

(20/100)

(b) Describe two applications of the range of uses of ultrasound in medical diagnosis.

(40/100)

(c) Outline the range of physical effects which ultrasound can have on tissues and describe the types of measure taken in clinical practice to minimise the possibility of causing those effects by diagnostic ultrasound.

(40/100)

5. (a) Discuss the factors that affect speed of propagation and acoustic impedance of ultrasound waves.

(20/100)

(b) Describe briefly the main mechanisms of attenuation of ultrasound waves.

(25/100)

(c) (i) What is the relationship between attenuation and intensity of an ultrasound beam?
Write down the equation to show how the intensity I changes with distance z travelled by the wave and sketch a graph to show this changes.
What conclusions can be drawn from the graph?

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(ii)   From the above question 5c(i), obtain an equation showing how the Intensity Level (dB) changes with distance z and sketch a graph to show the changes.
What is the slope of the graph?
What conclusions can be drawn from the graph

(30/100)

(d)   The table below lists approximate values of μ at 1 MHz for some tissue media.

Tissue	Overall attenuation coefficient at 1 MHz, μ(dB/m)
Fat	60
Muscle	350
Bone	870

(i)   Find attenuation coefficients at 5 MHz and 10 MHz for those tissues.
(ii)   Sketch a graph to show how μ changes with frequency.
What conclusions can be made from the graph?

(25/100)

6.   (a)   Using appropriate diagrams, describe the M-Mode system and outline the differences when this system is compared to the A-Mode system.

(30/100)

(b)   Describe the Doppler effect as encountered in diagnostic ultrasound.

(20/100)

(c)   Schematically outline a pulsed Doppler instrument and discuss the functioning of each component block together with their interrelations.

(30/100)

(d)   Describe how such a pulsed Doppler instrument may be used to yield images of vessels in which blood flow is occuring.

(20/100)

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