NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED RADIOGRAPHY

MSc. IN MEDICAL ULTRASOUND PART I

ULTRASOUND PHYSICS AND INSTRUMENTATION

SRU 5101

First Semester Examination Paper

November 2024

This examination paper consists of 3 pages

Time Allowed : 4 hours

Total Marks : 125

Special Requirements: None

Examiner's Name : Dr. Davison Dzamatira

INSTRUCTIONS

ANSWER ALL QUESTIONS.

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**
Maximum possible mark	**125**

1. (a) To form a real-time ultrasound image a number of assumptions about how sound travels through and interacts with tissues are required. Describe any four of these assumptions, giving corresponding ultrasound artefacts examples that may emanate from flaws of these assumptions. [12]

(b) With the aid of a diagram, briefly explain the five main structural components of the ultrasound transducer and give the function of each. [10]

(c) What causes acoustic shadowing behind bone in an ultrasound image? [3]

2. (a) Describe and explain the measures that can be implemented to improve the frame rate during a colour doppler ultrasound examination. [10]

(b) Define the following types of resolution as they apply to ultrasound imaging:

i) Axial resolution. [4]

ii) Lateral resolution. [4]

(c) What is the approximate axial resolution in soft tissue of a pulsed ultrasound beam of 5MHz, assuming 4 cycles per pulse? [7]

3. (a) In real time USS imaging, the pulse repetition frequency (PRF) is a fundamental instrument factor in image formation.

i) Briefly explain the definition of PRF. [3]

ii) Explain why a lower PRF must be used to image to a depth of 10cm than when imaging to a maximum depth of 5cm. [7]

iii) How long from pulse generation does it take for an ultrasound echo to be received reflecting off a mass 6 cm below the surface of the skin. (assume a transducer frequency of 7 MHz and speed in soft tissue of 1540m/s) [5]

(b) Differentiate between continuous wave and pulsed wave doppler USS, giving use-cases, advantages and disadvantages for each. [10]

4. (a) i) Define acoustic impedance. [2]

ii) Explain the ways in which acoustic impedance contributes to ultrasound image production. [8]

(b) Explain how the following ultrasound artifacts are produced in ultrasound imaging, giving examples of how they contribute to or affect image interpretation.

i) Reverberation

ii) Posterior acoustic enhancement

iii) Twinkle

iv) Mirror image

v) Side lobe [15]

5. (a) Provide a brief explanation as to why tissue harmonics occur. [5]

List 4 advantages of ultrasound harmonic imaging. [5]

(b) With respect to ultrasound imaging, briefly explain the principles of time-gain compensation. [5]

Regarding ultrasound bioeffects, define the term Thermal index, and explain the factors that influence it. [10]

END OF EXAMINATION