MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPT 102: INTRODUCTION TO TECHNOLOGY

DATE: 31/1/2022 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Constants

Acceleration due to gravity, $g = 9.81\ m/s^2$

$R = 8.3\ JK^{-1}mol^{-1}$,

$NA = 6.02 \times 10^{23}\ mol^{-1}$

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

a) Define the following terms

i. Commercial energy (2 marks)

ii. Fossil energy (2 marks)

b) i Explain how a solar water heater works. (2 marks)

ii. Explain how the hot water storage tank is protected against corrosion. (2 marks)

c) Discuss the advantages of solar water heaters over other methods. (5 marks)

d) Explain how a photovoltaic (PV) system works. (2 marks)

e) If a fibre loses 5% of its signal strength per km, how much of its strength would be left after 20 km? (4 marks)

f) State two ways in which energy is lost along the length of an optical fibre. (2 marks)

g) Compare the following technologies of medical imaging

i. Ultrasound technology. (3 marks)

ii. Magnetic Resonance Imaging (3 marks)

h) Explain why a gel is used between the patient and the transducer when an ultrasound scan is taken. (3 marks)

QUESTION TWO (20 MARKS)

a) Describe how solar cells convert sunlight into electricity, preferably using a cross section sketch of a solar cell. (4 marks)

b) i. Identify the two main types of passive solar hot water thermal systems and state the difference in their operation. (4 marks)

ii State two advantages of using solar energy as compared to nuclear energy. (2 marks)

c) Define the following categories of energy and state two examples each case

i. commercial energy and (3 marks)

ii. non-commercial energy (3 marks)

d) An ultrasound pulse is transmitted into the body of a patient. The pulse is partially reflected at a fat/muscle boundary and then at a muscle/bone boundary. The reflected pulses are received back at the transmitter and are displayed, after processing, on the screen of a cathode-ray oscilloscope (C.R.O).

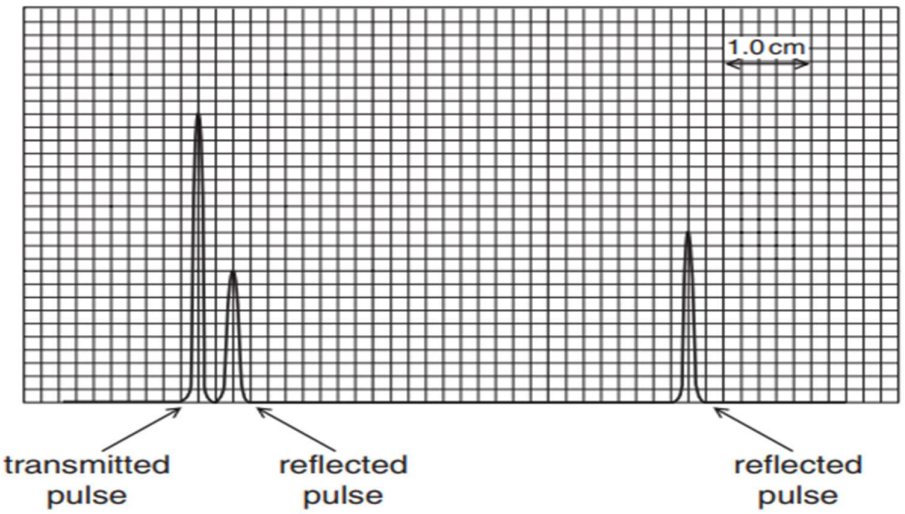

Figure 1

The trace is shown in Figure. 1.

The time-base of the c.r.o. is 10 μs cm^{-1}. Use Figure 1 to determine

i. The thickness of the layer of fat given that the speed of ultrasound in fat is 1450 m s^{-1} (2 marks)

ii. The muscle thickness given that the speed of ultrasound in muscle is 1590 m s^{-1}. (2 marks)

QUESTION THREE (20 MARKS)

a) Define the following terms as used in optical fibre technology

i. Step-index multimode (2 marks)

ii. Graded-index multimode (2 marks)

b) List three advantages of optical fibres over copper wire in communication systems. (3 marks)

c) Briefly describe how modern means of communication have contributed to industrial development in Kenya. (4 marks)

d) Explain how a cooling water circuit is used in a steam power plant. (5 marks)

e) The quality of an image produced using X-rays depends on sharpness and contrast. describe what is meant by

i. Sharpness (2 marks)

ii. Contrast. (2 marks)

QUESTION FOUR (20 MARKS)

a) Define the following terms

i. Frequency modulation (2 marks)

ii. Transducer (2 marks)

b) Discuss the function of the moderator in a nuclear reactor. (3 marks)

c) Describe two advantages of geothermal energy. (4 marks)

d) Discuss two factors that affect the efficiency of a solar water heating system. (4 marks)

e) Before the development of microwave links and optic fibres, co-axial cables were used widely for telephone communication.

i. Figure 2 shows one type of co-axial cable.

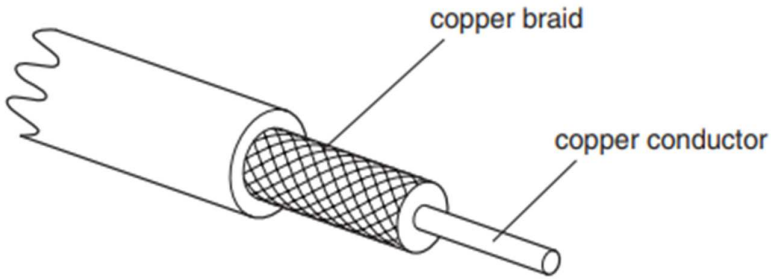

Figure 2

State the purpose of the copper braid and how this purpose is achieved. (2 marks)

ii. One advantage over co-axial cables of microwave links and of optic fibres is increased bandwidth. Explain why increased bandwidth has led to a reduction in the cost of telephone calls. (3 marks)

QUESTION FIVE (20 MARKS)

a) Describe two advantages of X-ray imaging compared to MRI. (6 marks)

b) How is a piezoelectric crystal used to generate waves of ultrasound? (4 marks)

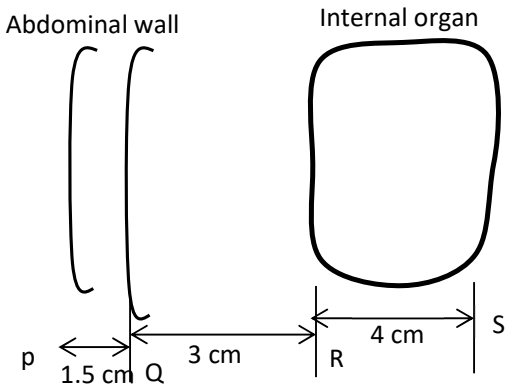

Figure 3

c) i) If the speed of ultrasound in the abdominal wall in Figure 3 is 1500 m/s find the time interval between a pulse being sent out and its echo being received from the inside surface at Q. (4 marks)

ii. The time between the pulses emitted from the transducer is 50 μ s. Find the frequency of emission of the pulses. (2 marks)

iii. The time taken for the ultrasound echo to return from the surface at S is 60 μ s.

I. What problems can this cause? (2 marks)

II. Give the solution to the problems you described in part (i) of this question. (2 marks)