UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	PRINCIPLE OF PHYSIOLOGICAL DEVICES
COURSE CODE	:	BEJ 45203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	1.	ANSWER **ALL** QUESTIONS
	2.	THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK.**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1   (a)   The membrane potential is a charge distribution across the cell membrane, measured in millivolts (mV).

       (i)   Illustrate the method for measuring membrane potential at the neuron using a voltmeter.

(3 marks)

       (ii)   Neurons conduct electrical impulses by using the action potential. Describe how an action potential is generated at a neuron. Include in your description the typical action potential waveform with labelling.

(9 marks)

       (iii)   The equilibrium potential (E_{Na}; Nernst potential) for Na^+ is +52 mV, and the resting membrane potential is -90 mV. Predict the direction of ion movement (Na^+) at the resting state. Justify your answer.

(4 marks)

   (b)   Bioelectrical signals are very low amplitude and low-frequency electrical signals that can be measured from biological beings, for example, humans. They can be measured through changes in electrical potential across a cell or an organ by using electrodes.

       (i)   Define the electrode and list its type.

(4 marks)

       (ii)   Name **TWO(2)** electrodes for recording electromyogram (EMG) and **TWO(2)** electrodes for recording electrocardiogram (ECG).

(4 marks)

   (c)   A differential amplifier has a positive input terminal, a negative input terminal, and a ground connection. Electrocardiogram (ECG) electrodes from a patient are connected to the positive and negative terminals, and a reference electrode is connected to ground. A disturbance signal develops on the patient's body. This will appear as a voltage from the positive terminal to ground and a similar voltage from the negative terminal to ground. Based on your evaluation,

       (i)   Recommend an idea to amplify the ECG signal while not essentially amplifying the noise signals.

(2 marks)

       (ii)   Choose the ECG electrodes connection technique that connects the patient to the amplifier. Show your diagram.

(3 marks)

Q2   (a)   **Figure Q2(a)** shows the ECG of a person at rest. The same person measured the blood pressure with a portable meter and found it to be 123/82 mmHg.

(i)   Use the graph to find the person's heart rate.

(3 marks)

(ii)   Estimate the person's pulse pressure and stroke volume.

(2 marks)

(iii)   Calculate the mean artrial pressure and cardiac output for this person.

(4 marks)

(b)   A physician is using the rapid-injection thermodilution method of finding a patient's cardiac output. Calculate the cardiac output from the following data:

(7 marks)

$V_i = 10$ ml, $\Delta T_i = -30$ K
$\rho_i = 1005$ kg/m^3, $c_i = 4170$ J/(kg·K)
$\rho_b = 1060$ kg/m^3, $c_b = 3640$ J/(kg·K)

$$\int_0^{t_1} \Delta T_b \, dt = -5.0 \; s \cdot K$$

(c)   (i)   Based on your survey, suggest the preferable portable device for indirectly measuring blood pressure that available in the market.

(3 marks)

(ii)   Decide any modification or improvement that you want to apply to the device. Justify your ideas and suggestions.

(4 marks)

(iii)   Sketch the prototype of your improvised blood pressure measurement device.

(4 marks)

Q3   (a)   A blood specimen has a hydrogen ion concentration of 40 nmol/liter and a partial pressure of carbon dioxide (P_{CO2}) of 60 mmHg. Calculate the hydrogen ion concentration. Predict the type of acid-base abnormality that the patient exhibits.

(5 marks)

(b)   There are **FOUR(4)** components in biosensor. Discuss the components and their function.

(8 marks)

(c)   (i)   Choose a commercially successful type of biosensor and justify its importance to the society.

(6 marks)

(ii)   Briefly outline your business plan for commercializing the selected biosensor.

(6 marks)

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Q4 (a) Define analog transducer and give **TWO(2)** examples of analog transducer.

                   (4 marks)

  (b) Determine the transducers used to measure the physical variables listed in **Table Q4(b)**.

                   (4 marks)

  (c) The temperature coefficient of a thermistor denotes the rate of change of thermistor resistance per 1°C and is commonly expressed in % / °C. Calculate the value of the thermistor temperature coefficient, α for T = 20°C and β = 4000 K.

                   (4 marks)

  (d) A 10 kΩ Negative Temperature Coefficient (NTC) thermistor has a material constant (β) value of 3455 K between the temperature range of 25°C to 100°C. Calculate its resistive value at 25°C and at 100°C.

                   (7 marks)

-END OF QUESTIONS –

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	PHYSIOLOGICAL DEVICES		
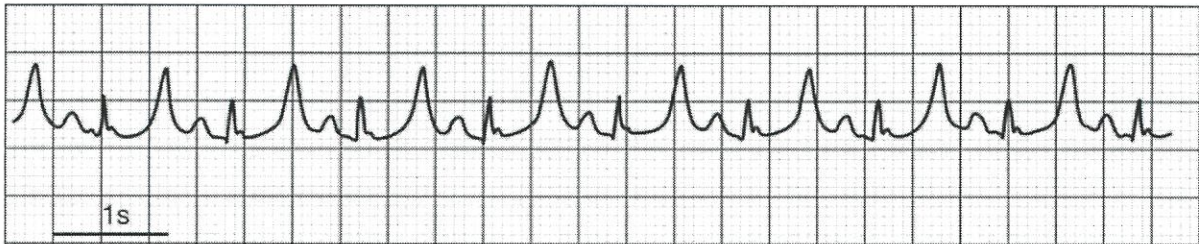
Figure Q2(a)

Table Q4(b)

Physical Variable	Type of Transducer
Light	
Temperature	
Pressure	
Velocity	

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