# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2012/2013

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| COURSE NAME | : | PRINCIPLE OF PHYSIOLOGICAL DEVICES |
| COURSE CODE | : | BEU 30202 |
| PROGRAMME | : | BEU |
| EXAMINATION DATE | : | JANUARY 2013 |
| DURATION | : | 2 1/2 HOURS |
| INSTRUCTION | : | ANSWER **FIVE (5)** QUESTIONS ONLY |

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

**Q1** (a) In medical measurements, if the standard or calibrator used in an assay is not traceable to an amount of pure substance then the value of the measurand cannot be accurately known. Explain the concept of traceability.

(3 marks)

(b) What are the differences between error and uncertainty?

(4 marks)

(c) Explain types of uncertainty of measurement.

(4 marks)

(d) The measurement of haemoglobin A1c (HbA1c) is an important marker for long term glycaemic control provided assay procedures and conditions are appropriate and strictly monitored. **Figure Q1 (d)** shows the uncertainty of measurement for different level of coefficient of variation (CV). Determine the range of uncertainty of measurement for an analytical CV of 3%. Consider the range should be fall within ± twice the CV.

(9 marks)

**Q2** (a) Nerve impulses carry information from one point of the body to another. It may be described as the progression along the neuron membrane membrane of an abrupt change in the resting potential.

(i) What is the specific name for the never impulses?

(2 marks)

(ii) Explain the nerve impulses conduction along a nerve fiber and relate your explanation to ionic exchange as shown in **Figure Q2(a)(ii)**.

(10 marks)

(b) What are the four main factors involved in the movement of ions across the cell membrane in the steady-state condition? Describe each of them.

(8 marks)

**Q3** (a) **Figure Q3(a)** shows the cross-section of a skin-gel-electrode interface. Draw the equivalent circuit for this interface.

(4 marks)

(b) Assuming that the initial impedance of the wet AgCl electrode is 100 kΩ and the initial impedance of the dry AgCl is five times larger than the wet AgCl electrode.

(i) Draw the graph to of impedance of the electrode versus frequency (0.01 - 100 kHz) for the electrode with and without the coupling of gel to the skin layer.

(4 marks)

(ii) Comment how these two conditions of electrodes would affect the measurement of the electrocardiography?

(6 marks)

(c) A set of biopotential electrodes made of silver is attached to the chest of a patient to detect the electrocardiogram. When current passes through the anode, it causes silver to be oxidized, producing silver ions in solution. There is a 20μA leakage current between these electrodes. Determine the number of silver ions per second entering the solution at the electrode-electrolyte interface.

(6 marks)

**Q4** You would like to measure small temperature changes using a thermistor. Thermistor is a resistor which changes its resistance in proportion to temperature.

(a) Suggest a suitable biomedical application of the thermistor.

(2 marks)

(b) Draw the block diagram for the temperature measurement circuit. Buffer circuit should be included in your design if the temperature change is very small.

(8 marks)

(c) Design and explain the temperature measurement circuit. Consider that the temperature change rate is small at 0.1 $^{o}$C/sec. Show all your calculations.

(10 marks)

**Q5** (a) Explain the principle of doppler effect and how it is used in detecting the blood flow.

(5 marks)

(b) A pulsed Doppler flowmeter has $f_o$ = 10M Hz, Speed of blood flow = 150 cm/s, speed of sound in blood = 1500 m/s and $\theta = 45^o$, calculate the Doppler shift for this Doppler flowmeter.

(5 marks)

(c) Draw an electromagnetic flow circuit block diagram and explain the detection of flow amplitude using the associated waveforms from the block diagrams.

(10 marks)

**Q6** The schematic circuit diagram for this question is attached to the exam paper as **Figure Q6**. The circuit diagram serves to monitor fetal's ECG. It is also used as a means for measuring respiration activity. As the lungs expand and contract, the geometrical configuration of the conducting path is modified by the positive and negative displacements of air. This alerts the conductivity between the electrodes and the resultant change is detected by the respiration circuits (T101, A101 and A103 in Area 3B and 4C, respectively).

(a) Based on the circuit diagram in **Figure Q6**, state the purpose of the following components:-

(i) DS101 to DS104 (Area 1A)

(ii) A110 ¼ LM246N and its output connection (Area F1)

(iii) T101

(9 marks)

(b) Calculate the gain for the modulated respiration signal pre-amplifier formed by the two IC A103 (Area 3C and 4C) and A102 (Area 3E and 4E).

(6 marks)

(b) Calculate the resonant frequency and the bandwidth for the narrow bandpass filter formed by the IC A101 (Area 2A).

(5 marks)

**-END OF QUESTION-**

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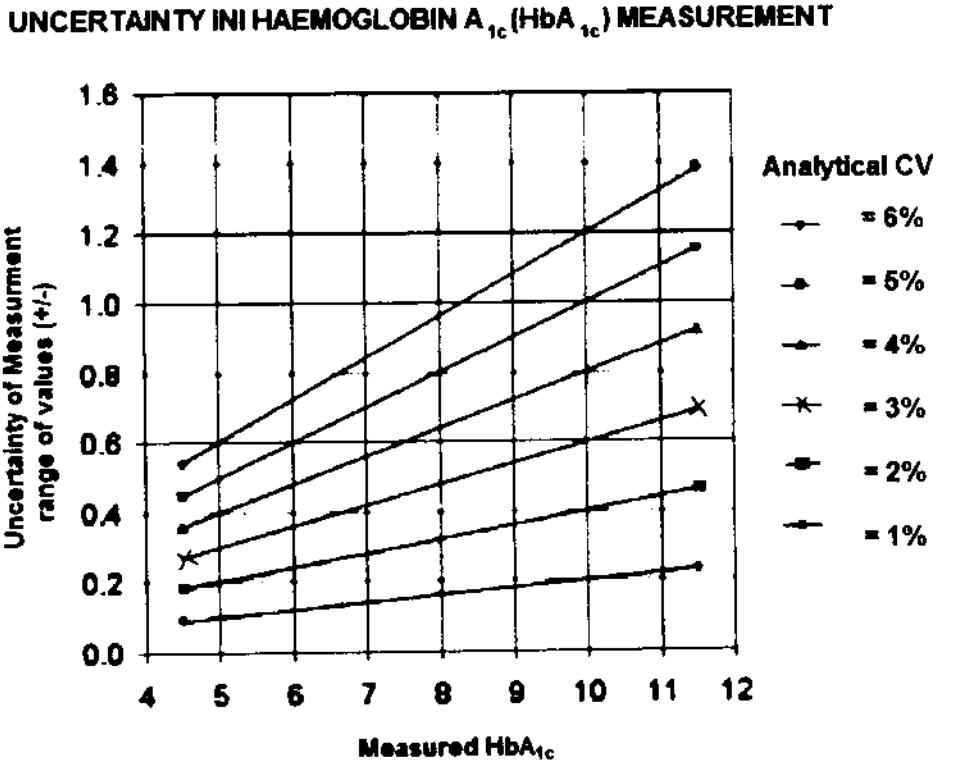


**FIGURE Q1(d)**

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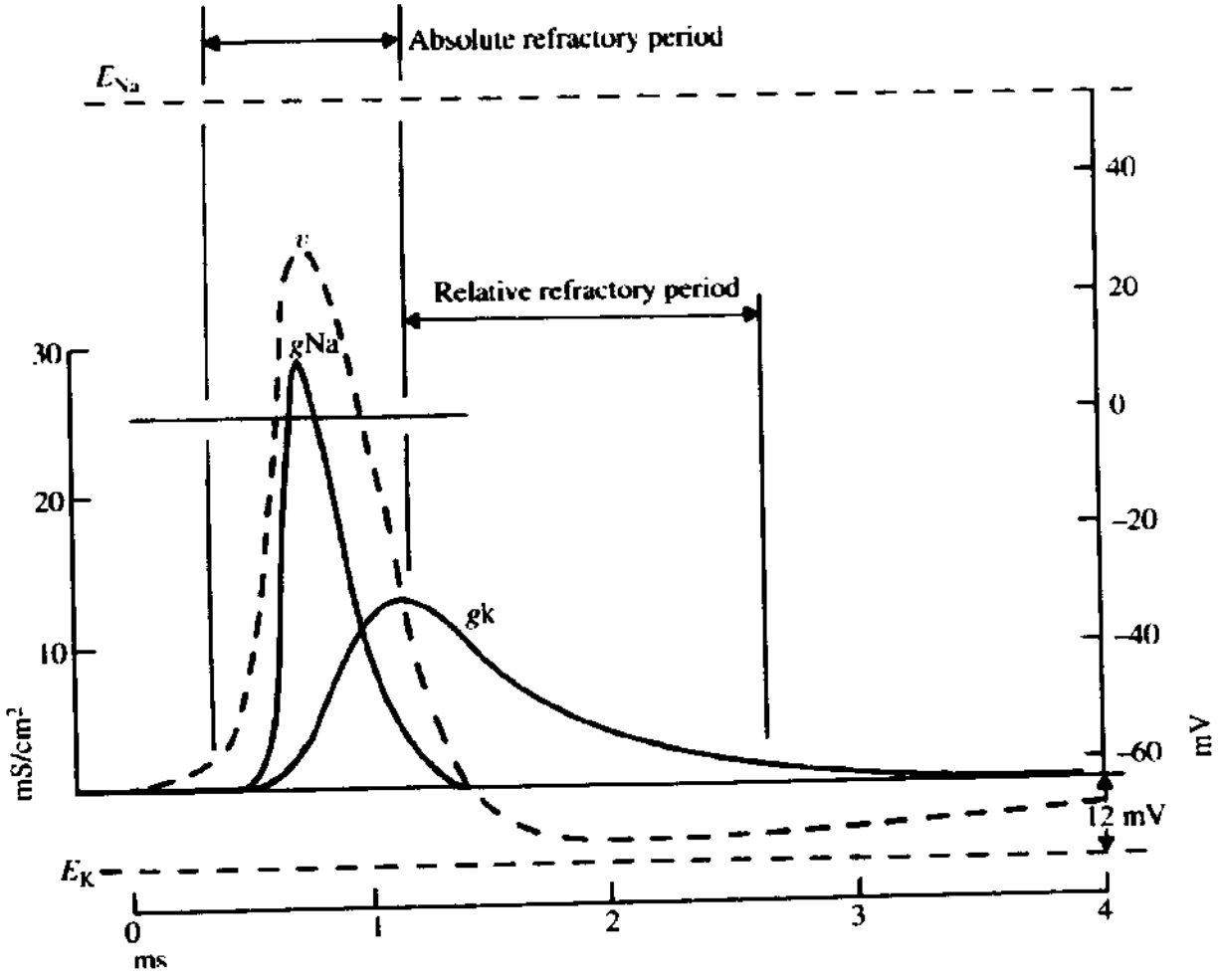


**FIGURE Q2(a)(ii)**

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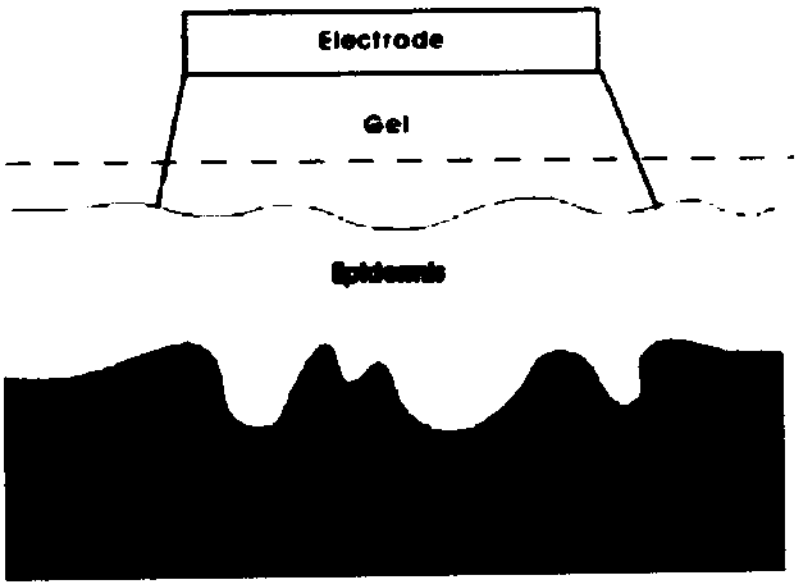


**FIGURE Q3(a)**