TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MEDICAL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

ECL 4201: MEDICAL PHYSICS II

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2HOURS

DATE: Pick DateSep2018

Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **FOUR** questions.
Attemptany THREE questions.
Do not write on the question paper.

QUESTION ONE

a) What is the electroencephalogram? Why is it used? **(3 Marks)**
b) With the aid of a block diagram of the recording system, explain the steps involved in evoked potential recordings. **(14 Marks)**
c) What are the difficulties encountered and solutions employed, in the determination of the EEG from a Patient? **(8 Marks)**

QUESTION TWO

a) State two factors that determine the value of the acoustic impedance. **(2 Marks)**

b) An ultrasound investigation was used to identify a small volume of substance in a patient. It is suspected that this substance is either blood or muscle. During the ultrasound investigation, an ultrasound pulse of frequency of 3.5×10^6 Hz passed through soft tissue and then into the small volume of unidentified substance. A pulse of ultrasound reflected from the front surface of the volume was detected 26.5 μs later. The ratio of the reflected intensity to the incident intensity, for the ultrasound pulse reflected at this boundary was found to be 4.42×10^{-4}. The table below shows data for the acoustic impedances of various materials found in a human body.

medium	acoustic impedance Z/ kg m^{-2} s^{-1}
air	4.29×10^2
blood	1.59×10^6
water	1.50×10^6
brain tissue	1.58×10^6
soft tissue	1.63×10^6
bone	7.78×10^6
muscle	1.70×10^6

i). Use appropriate data from the table above to identify the unknown medium. You must show your reasoning. **(6 Marks)**

ii). Calculate the depth at which the ultrasound pulse was reflected if the speed of ultrasound in soft tissue is 1.54 km s^{-1}. **(3 Marks)**

iii). Calculate the wavelength of the ultrasound in the soft tissue. **(3 Marks)**

c) Describe the principles of the production of a short pulse of ultrasound using a piezoelectric transducer. **(11 Marks)**

QUESTION THREE

a) Figure question THREE shows the anatomy of the heart. Name the parts labelled A, B, C, D, E and F. **(3 Marks)**

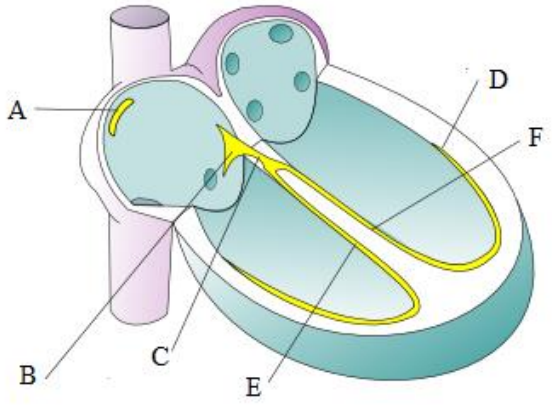

Figure question THREE

b) Use the diagram in (a) above to explain the typical ECG waveform with respect to the electrical activity that is occurring in the heart. **(12 Marks)**

c) Draw a typical lead II electrocardiogram and label all waves (P, QRS, T) and intervals. Explain what is happening electrically within the heart during each wave or interval **(10 Marks)**

QUESTION FOUR

a) Explain in your own words what is:
   i). Resting potential of the cell membrane
   ii). Action potential
   iii). Refractory period **(6 Marks)**

b) Explain why the opening of voltage-gated sodium channels proceeds in a positive feedback fashion during the generation of an action potential. Why isn't the opening of voltage-gated potassium channels mediated via a similar positive feedback loop? **(6 Marks)**

c) Show that the equilibrium potential for sodium (E_{Na}) = +58 mV if the concentration of Na on the outside of the cell is 10 times the concentration of Na on the inside of the cell. **(3 Marks)**

d) What happens to E_{Na} if the extracellular concentration of sodium ($[Na]_o$) in (b) above is increased by
   i). A factor of 10
   ii). A factor of 100?
   iii). Decreased by a factor of 10? **(4 Marks)**

e) Explain why E_{Na} changes in the above examples in terms of the balance between chemical and electrical forces across the cell's plasma membrane. **(6 Marks)**