Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	BIOMEDICAL ENGINEERING & APPLICATIONS
COURSE CODE	:	BEU 41503
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	1. PLEASE **WRITE ALL ANSWERS** ON THIS QUESTIONS BOOKLET. 2. ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **FOURTEEN (14)** PAGES

Q1 (a) Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Elastic and viscous can be described using two attributes namely as mental models and stress-strain relationships. Distinguish the terms elastic and viscous by using these two attributes.

(6 marks)

(b) **Figure Q1(b)** shows an unstressed cube of rock. Illustrate the direction of force and the new shape of the rock when under the following conditions:

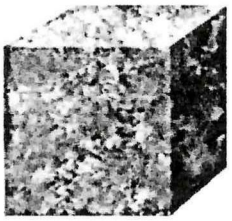

Figure Q1(b)

(i) Shear stress

(1.5 marks)

(ii) Compressional stress

(1.5 marks)

(c) Maxwell model and Voight-Kelvin model are the two constitutive models of viscoelasticity that have been developed to characterize materials.

(i) Illustrate these **TWO (2)** models of viscoelasticity using springs and dashpots. Label clearly the area of viscosity, η and elasticity, E.

(4 marks)

(ii) The Maxwell constitutive equation is given by:

$$\frac{d\varepsilon_{Total}}{dt} = \frac{\sigma}{\eta} + \frac{1}{E}\frac{d\sigma}{dt}$$

Under this model, analyse possible conditions that may appear if the material is put under two conditions: constant strain, ε and constant stress, σ.

(4 marks)

(iii) Identify each of the variables from the constitutive equation in **Q1(c)(ii)** if the models are equivalently represented as electrical circuits.

(4 marks)

(iv) **Figure Q1(c)(iv)** shows the graph of strain, ε against time, t for the Voigt-Kelvin model. Based on this graph, discuss the effect on the material when the force is applied across the material at t_1 and when the force is removed at t_2 (after the material has fully responded).

(4 marks)

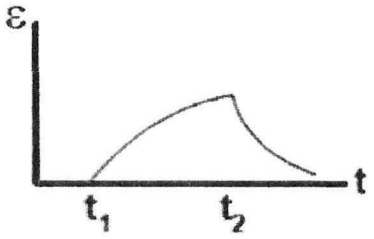

Figure Q1(c)(iv)

Q2 (a) Molecular biology is the study of molecular underpinnings of the processes of replication, transcription, translation, and cell function. All living organisms are dependent on three types of very large biological macromolecules.

(i) Name the **THREE (3)** types of biological macromolecules.

(3 marks)

(ii) Summarise the function of each macromolecules in **Q2(a)(i)**.

(6 marks)

(iii) Point out the relationship between the macromolecules in **Q2(a)(ii)**.

(2 marks)

(b) Sickle anemia (SCA) are painful medical condition and can be life threatening. Explain why SCA can be life threatening if compared to those with normal blood cells. Use appropriate diagram to aid with explanation.

(4 marks)

(c) An antibody (Ab) or also known as an immunoglobulin (Ig) is a large Y-shape protein produced by plasma cells that is used by the immune system to identify and neutralize foreign objects such as bacteria and viruses. Indicate **TWO (2)** physical forms that antibodies can occur.

(2 marks)

(d) Monoclonal antibodies (mAb or moAb) are monospecific antibodies that are produced by the same clone of plasma *B* cells. Autoimmune diseases arise from an abnormal immune response of the body against substances and tissues normally present in the body (autoimmunity). Briefly discuss how monoclonal antibodies can be used to treat the following tests/treatments.

(i) Immunofluorescence test.

(2 marks)

(ii) Immunohistochemistry test

(2 marks)

(ii) Therapeutic treatment.

(2 marks)

(iii) Cancer treatment.

(2 marks)

Q3 (a) **Figure Q3(a)** illustrates the example of information processing model of the human operator of assistive technology and if anything goes wrong in this information processing chain, it can lead to disabilities or various impairments.

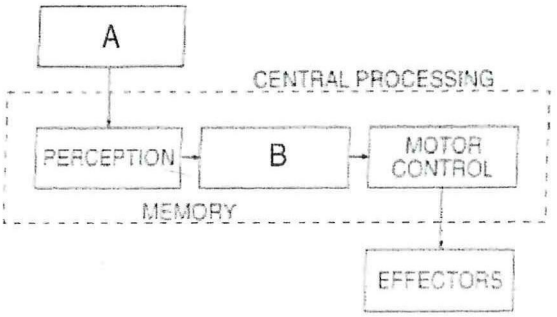

Figure Q3(a)

(i) Based on **Figure Q3(a)**, state the A and B components.

(2 marks)

(ii) Describe the effect of perception and B components during the information-processing event.

(3 marks)

(b) There has been a major growth in the application of technology to ameliorate the problems faced by people with disabilities since the late 1970s. The two most frequent used terms to describe this sphere of activity are assistive technology and rehabilitation engineering.

(i) Based on your understanding, differentiate the term between assistive technology and rehabilitation engineering.

(2 marks)

(ii) Discuss **TWO (2)** specific roles of rehabilitation engineer.

(4 marks)

(c) Various categories of assistive devices have been engineered through rehabilitation engineering. Suggest **TWO (2)** possible examples that you think relevant for each of these assistive device categories:

(i) For persons with severe visual impairments.

(2 marks)

(ii) For geriatric care.

(2 marks)

(d) Noah works as a rehabilitation engineer in Rehab Device Corporation. He is now in-charged in a new project to design an artificial prosthetic limb to be used by young and elderly patients.

(i) Plan the first **THREE (3)** important tasks that he needs to consider before starting the project based on the principles of assistive technology assessment.

(6 marks)

(ii) Ergonomic or human factor is another core part in designing rehabilitation and assistive technology device. Identify **TWO (2)** ergonomic principles with justification that you think relevant upon designing the prosthetic limb.

(4 marks)

1. Principle of _____.

   Justification:

2. Principle of _____.

   Justification:

Q4 (a) Biomagnetism is the phenomenon of magnetic fields produced by living organisms. List **TWO (2)** sources that can produce their own magnetic field.

(2 marks)

(b) Biomagnetic field is produced from the movements of electrically charged particles and natural electrical currents inside, outside and across cellular membranes. Meanwhile, biomagnetic measurement technique is the measurement of the magnetic field produced by the human body.

(i) Give **ONE (1)** advantage and **ONE (1)** disadvantage of biomagnetic measurement technique over conventional measurement by surface electrodes.

(4 marks)

(ii) **Figure Q4(b)(ii)** shows an overview of the magnetic induction of biomagnetic fields. If magnetomyogram is to be performed, suggest possible ambient magnetic field disturbances that can be picked up by the magnetometer.

(4 marks)

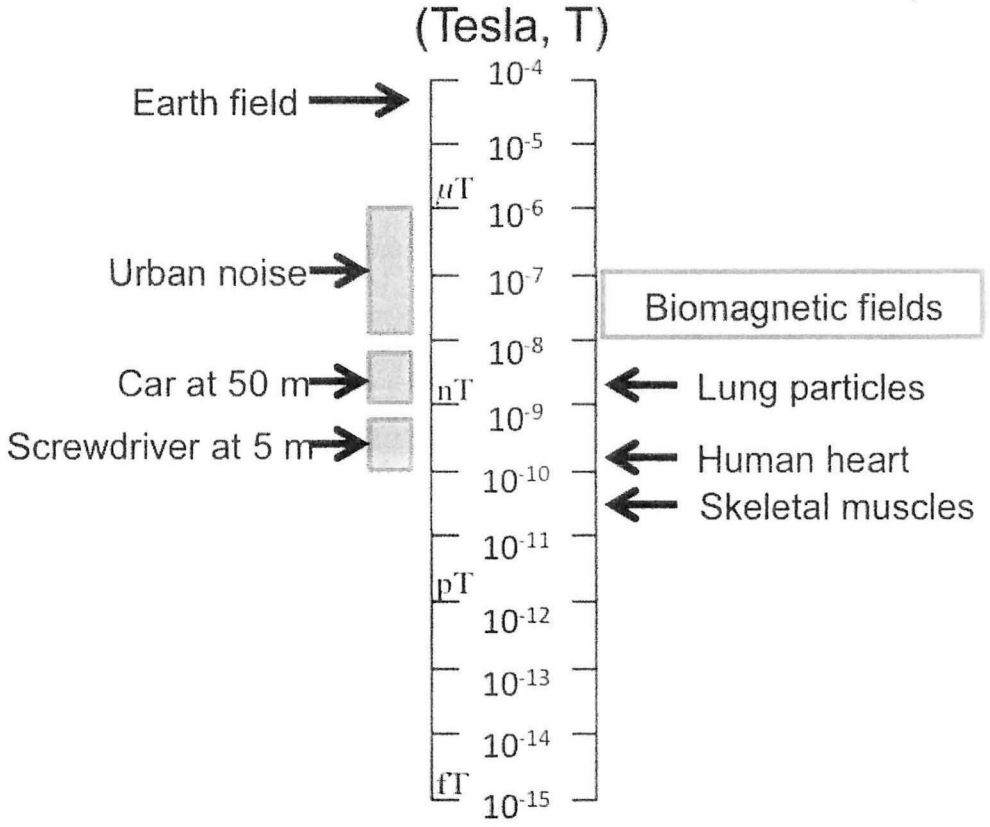

Figure Q4(b)(ii)

(c) Induction coil sensor is one of the well-known types of magnetic sensors. There are several special kinds of induction coil sensors such as Rogowski coil, H-coil sensor and gradiometer sensor. The gradiometer sensor has been used in Superconducting Quantum Interference Devices (SQUID) magnetometers for elimination of the influence of ambient field.

(i) With the aid of diagram, discuss the operating principle of gradiometer sensor.

(7.5 marks)

(ii) Sketch and label **THREE (3)** typical arrangements of gradiometer coils.

(4.5 marks)

(iii) Identify and briefly describe **THREE (3)** measurement systems that employ SQUID principle to detect signal from the human body.

(3 marks)

-END OF QUESTIONS-

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