



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2022

Module Number: EE6209

Module Name: Introduction to Biomedical Engineering

[Three Hours]

[Answer all questions, each question carries 10 marks]

[Attach page 5 to the answer script]

- Q1 a) Biomedical Equipment can be categorized as equipment used in the clinical medical specialties.
- (i) State two examples of such a classification. If more than two are listed, only the first two will be considered.
  - (ii) State the advantage of classifying equipment as above.
- [2 Marks]
- b) A person coming into contact with electricity can be harmed in many ways.
- (i) Briefly explain the reaction of a human body be if it comes in to contact with an electric current of 1-4 A for 1 second?
  - (ii) State the reason why wet skin increases the severity of an electric shock?
- [2 Marks]
- c) List two properties of bioelectrodes and explain the importance of each. If more than two are listed, only the first two will be considered.
- [2 Marks]
- d) (i) Feedback and averaging are two methods to reduce noise in signals. Explain how each of them reduces the signal noise levels.
- (ii) Illustrate the anatomy of the middle ear using a diagram.
- (iii) Explain how speech is processed in a cochlear implant.
- [4 Marks]
- Q2 a) Answer the following questions regarding the nervous system.
- (i) State what constitutes the central nervous system (CNS)?
  - (ii) Briefly explain what is a "synapse" in the nervous system?
- [2 Marks]
- b) Write a short essay on motor neuroprosthetics.
- [2 Marks]
- c) (i) Briefly explain what is meant by motor imagery.
- (ii) Identify the channels of electroencephalogram (EEG) that is used to view motor imagery.
- [2 Marks]
- d) Answer the following questions regarding EEG.
- (i) How do you differentiate eye blinks from other artifacts in EEG?
  - (ii) How can you identify the mains noise in EEG processing?
  - (iii) State what epilepsy is and explain how you can diagnose epilepsy in using EEG?
- [4 Marks]

Q3 Attach page 5 your answer script :-

- a) Answer the following questions regarding about the musculoskeletal system.  
(i) Briefly explain the functionality of musculoskeletal system do?  
(ii) Write a brief summary of skeletal muscles. [2 Marks]
- b) Figure Q3b in page 5 illustrates the cross extensor reflex. Complete the motor neurons to the flexors and extensors in the diagram. Clearly mark the flexors and extensors. Stimulating interneurons are given as "+" and inhibitory interneurons are given as "-". [2 Marks]
- c) Compare and contrast a stroke and a heart attack. [2 Marks]
- d) (i) Figure Q3d-i shows the forearm of a person holding a book. The weight of the book is 4 kg and the weight of the arm is 2.5 kg where the centre of gravity is at 16 cm from the fulcrum. The biceps exert a force  $F_B$  and the triceps exert a force  $F_T$ . Evaluate the force exerted by the biceps in Newtons. Assume acceleration due to gravity is  $9.8 \text{ ms}^{-2}$ .

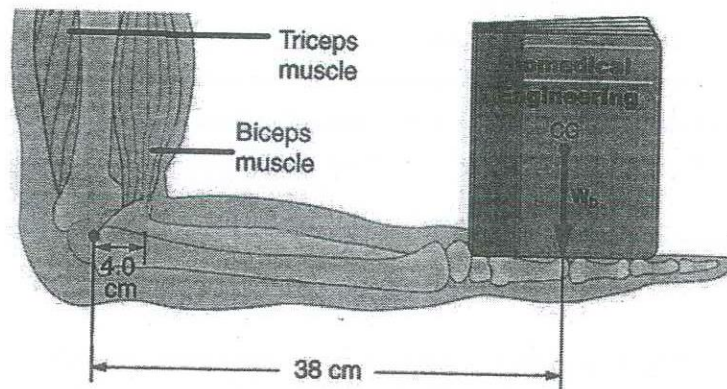


Figure Q3d-i

- (ii) Calculate the heart rate in the ECG in Figure Q3d-ii in page 5. Show your workings and circle the area you used for your answer.
- (iii) Identify the diagnosis in the ECG shown in Figure Q3d-iii in page 5. Show your workings and circle the area you used for your answer.

[4 Marks]

- Q4 a) Radiography is the use of ionizing electromagnetic radiation such as X-rays to view objects.  
(i) State the two types of X-ray radiation generated with an X-ray tube.  
(ii) Explain the difference between two types of X-ray radiation and draw the X-ray spectrum.

[3 Marks]



- b) Answer the following questions are in reference to Figure Q4b.
- State two components of the X-ray imaging system marked as A and B.
  - State two different types of the component B used in clinical X-ray systems.

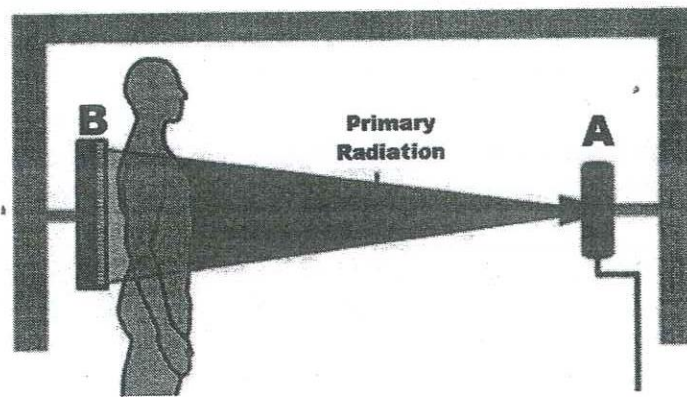


Figure Q4b

[2 Marks]

- c) A CT imaging system produces cross-sectional images of anatomy.
- Briefly explain the mechanism behind CT image formation.
  - Identify the CT image artifact shown in the Figure Q4c-ii and explain the reason for the artifact.
  - As a biomedical engineer, suggest a solution to fix the CT image artifact identified in Q4c-ii.

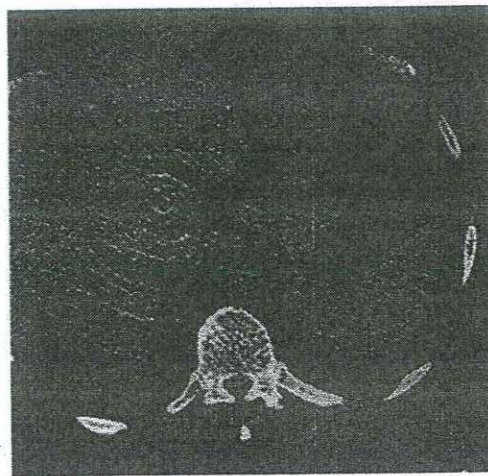


Figure Q4c-ii

[5 Marks]

- Q5 a) (i) Give an example and discuss how design choices or design failures leads to a breakdown of system performance in biomedical equipment or devices.
- (ii) Briefly explain why would you need risk management for medical devices? [3 Marks]
- b) State two examples of achievements in controlling communicable diseases in Sri Lanka along with their year of achievement. [2 Marks]

- c) (i) Explain what is a 'recall' in relation to biomedical devices?  
(ii) Suppose you are given to analyze the following recall as a Biomedical Engineer at FDA. Determine the cause of the recall.

**Recalling Firm/Manufacturer**

Siemens Medical Solutions USA, Inc

**Manufacturer Reason for Recall**

Siemens has become aware of three potential software issues with ARTIS pheno systems with software version VE10B. This may lead to a hazardous situation for patients if treatment cannot be continued on the system and treatment needs to be continued on an alternate system.

**Action**

On September 20, 2022, the firm notified affected customers via Urgent Medical Device Correction letters. This notification covered three issues.

1. System Error Management, in which the operator is unable to release X-Ray in "Bypass fluoroscopy" mode which remains permanently inhibited, and may result in a situation where it is necessary to cancel clinical treatment or to continue treatment on an alternative system. Customers should ensure that patient treatment can be continued in other ways if there is any possible danger for the safety of the patient.
  2. Head Holder Symbols, in which the user cannot tell whether a head holder has been selected in the system, may lead to a collision between the C-Arm and the head holder during system movement if the head holder is being used but not selected on the system. Customers should ensure that the configuration of the head holder is correct prior to system movements and double check configuration in the control room in case of uncertainty during the procedure.
  3. Stand Movement, in which rarely no stand movement is possible after a routine brake test, leading to a possible delay of procedure. Customers should carry out routine brake tests with sufficient time before starting any procedure. [3 Marks]
- d) Briefly explain the four underlying principles of good donation practice? [2 Marks]



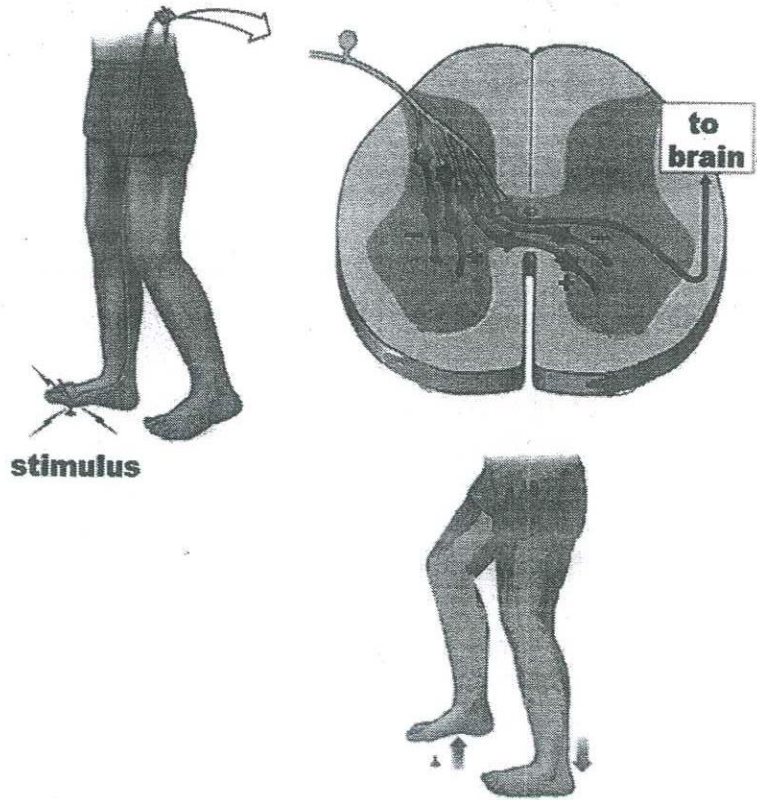


Figure Q3b

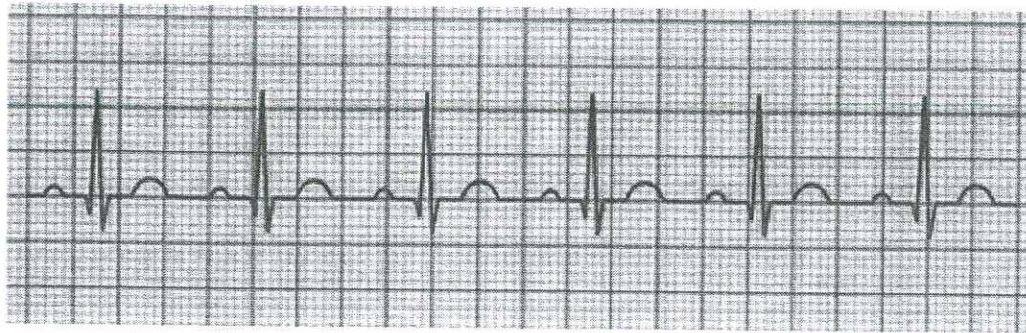


Figure Q3d-ii

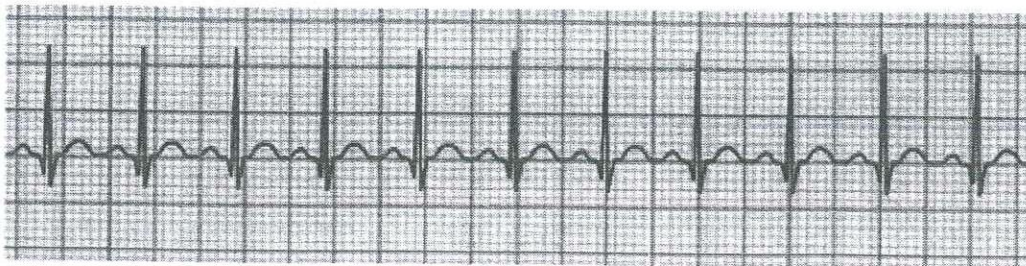


Figure Q3d-iii