Notre Dame University

Zouk Campus

Fall 2009

Biomedical Engineering-EEN426

Instructor: Nasser-Eddin M.,

Mid-term Exam (90 minutes)

Grade from 100

Student Name:

ID#:

1- Understanding the human body-10 pts

Select the correct answer

A group of cells having similar shape and function are:

organs

tissues

cells

The study of functions of the body is called:

biology

anatomy

physiology

The system that protects the body from harmful substances is:

the respiratory system

the lymphatic system

the cardiovascular system

In relation to the midline plane, lungs are:

bilateral

unilateral

medial

The outermost layer of the heart is the:

endocardium

myocardium

pericardium

A fast heart rate is referred to as:

bradycardia

tachycardia

flutter

Problem 2- True or false-20 pts

In the electrocardiogram at a heart rate of 80 per minute:

- F ➢ the PR interval should be less than 0.2 s and greater than 0.12 s
- T ➢ the QRS complex should last less than 0.02 s
- F ➢ the T wave is normally greater than 1 mV
- T ➢ there will be an interval of 0.75 s between the end of one complex and the beginning of the next
- T ➢ the T wave is ventricular repolarisation

In the normal cardiac cycle:

F a) the period of ventricular systole is equal to the Q-T interval
T b) the duration of the QRS complex depends on the heart rate
F c) the PR interval is less than 0.22 s
T d) ejection occurs throughout systole
T e) the R-R interval may vary

The oxygen carrying capacity of the blood is:

T a) the maximum quantity of oxygen that will combine with 100 ml of whole blood
F b) the ratio between oxygen uptake and oxygen usage
F c) independent of the haemoglobin concentration
T d) the oxygen physically dissolved in blood
F e) normally of the order of 15 ml per 100 ml whole blood

When measuring arterial blood pressure using a sphygmomanometer cuff:

T a) if the cuff is too small for the arm, the pressure will tend to read high
F b) accuracy is increased by leaving the cuff slightly inflated between readings
F c) the slower the deflation, the more accurate the reading
T d) a mercury column has a low frequency response
e) diastolic pressure agrees more accurately with direct measurement than will systolic pressure

Problem 3-Basic concepts-20 pts

1- How reliable is the sphygmomanometer? Does operator practice improve this? What do you think are the major sources of inaccuracy?

A Sphygmomanometer ~~is a d~~ or blood pressure meter is a device used to measure blood pressure, comprising an inflatable cuff to restrict blood flow, and a mercury or mechanical manometer to measure the pressure. It is always used in a conjuction with a means to determine at what pressure blood flow is just starting and at what pressure it is unimpeded. The major sources of inaccuracy are clerical errors, inconsistency in reporting over time, low precision of reporting estimates, inadequate estimation method

2- Why should the operator check that the position of measurements is at the same height above the ground as the heart?

The walls of the left ventricule should be stronger than at the rest of the heart

3- Why does the fact that blood flows in opposite directions in arteries and veins, not enable them to be distinguished through Doppler techniques?

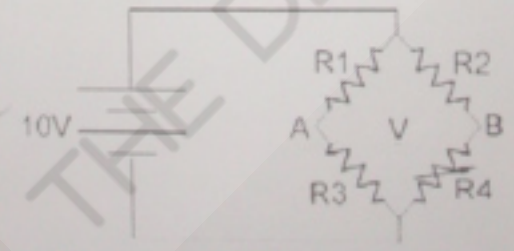
In fact, it is a technique for making a non-invasive velocity of blood pressure

4- Why would you expect the walls of the left ventricle to be much stronger that those of the rest of the heart?

Problem 4- Select the correct answer-20 pts

1- Strain gauges are small variable resistors that are glued onto an object where we wish to determine how much a material (e.g. steel) "stretches" due to applied loads. The more the material strains, the more the electrical resistance of the gauge changes. Practically, the variable resistor must be included in a circuit to allow the measurement to be made. In the drawing below, a "quarter bridge" is used for this purpose. It is made of 3 resistors of known resistance: R1 = R2 = R3 = 120 S and the strain gauge (R4) of an unknown resistance. If the voltmeter shows that the voltage at B is 0.030 V higher than at A, what is the resistance of the variable resistor?

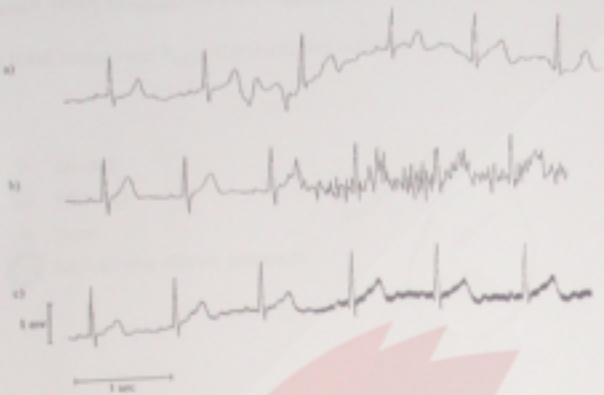
A. 114.8 Ω
B. 118.6 Ω
C. 120.0 Ω
D. 121.5 Ω
E. 125.4 Ω



$V_A = \frac{R_1}{R_1+R_1} \times 10 = 5\ V$ So $V_B = 5{,}030V$

$V_B = \frac{R_2}{R_2+R_4} V \Rightarrow R_4 = 118{,}6\ V$

2- The Figure below shows examples of electric interferences in Biopotential recordings:



Which one corresponds to an ECG with baseline changes and motion artifacts? Which one corresponds to signal with electromagnetic interference (60 Hz power line and RF)? Which one corresponds to ECG + muscle signal interference? Justify your choices.

3- In the model representing the connection between blood vessels we have:

$R_{arteries}$= 1mΩ, $R_{arterioles}$=70 mΩ, $R_{capillaries}$=20 mΩ, $R_{venules}$=8 mΩ, R_{veins}=1mΩ

the total resistance R_{total} of the model will be:

- 46 mΩ
- 100 mΩ
- Zero
- Non of the above answers

Problem 4-10 pts

A 10-MHz ultrasound probe detects a 1.4-kHz Doppler shift at a sonation angle estimated as 45 degrees. Find the estimated velocity of blood flow and the percent error in the estimate if the angle of sonation is incorrect by as much as 3 degrees:

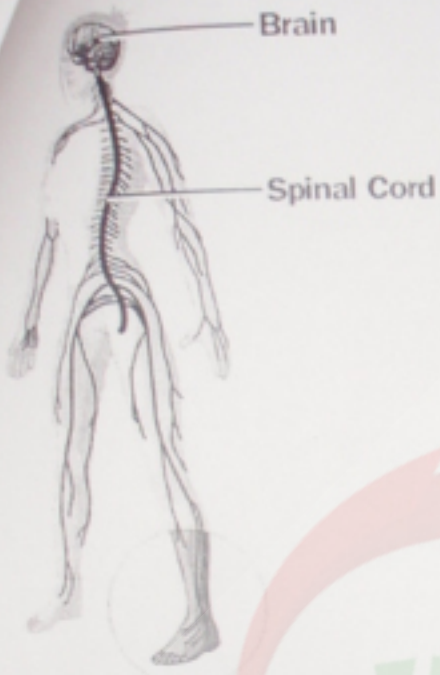
c=1.54 x 10^5cm/sec $\Delta f = 2 \times f_0 \times \frac{V}{C} \times \cos\theta \Rightarrow V = \frac{1,4\times10^3 \times 1,54\times10^3}{2\times10^7 \times \sqrt{2}} \times 2 = 0,158 m/s$

~~$V = 2\times10\times10^4$~~

$V = \frac{1,4\times10^3 \times 1,54\times10^3}{2\times10^7 \times 0,67} = 0,160 m/s$ $\% = \frac{0,158}{0,160}$

Problem 5.-Design-20 pts

The woman in the figure shown below cannot move her foot during walking due to a problem of transmission of the action potential from the brain to the foot level. Make a design through block-diagram for an electrical instrument that could help the foot of the woman to move.



GOOD LUCK