UNIVERSITY OF GHANA

SECOND SEMESTER EXAMINATIONS: 2014/ 2015

LEVEL 400: BACHELOR OF SCIENCE IN ENGINEERING

BMEN 407: Haemodynamics (2 Credits) **DURATION: 2 HOURS**

Answer All Questions

1. You are working on an independent project at the Red Cross blood bank laboratories. The chief phlebotomist has given you some blood samples from donors.

a. Sketch the shear stress as a function of shear rate for the blood sample given to you and explain your sketch. **(5 POINTS)**

b. Is the blood sample provided, a Newtonian or non-Newtonian fluid, explain your choice of answer? **(5 POINTS)**

c. Define and explain the Fahraeus Lindqvist effect. **(5 POINTS)**

d. What is red blood cell deformability? **(5 POINTS)**

e. List and describe the factors that determine the viscosity of the whole blood. **(6 POINTS)**

f. Explain in detail what is meant by apparent viscosity of blood? **(5 POINTS)**

g. Briefly describe Rouleaux and how low and high shear rates affect it. **(5 POINTS)**

2. The ventricles contract during a cardiac cycle and eject blood into an aorta of thickness 8 μm, radius of 10 mm and an elastic modulus of 1.0175 MPa. Assume blood density to be 1060 kg/m^3.

a. Calculate the speed of the pressure pulse experienced by the aorta as the blood moves through it. **(5 POINTS)**

b. Calculate the impedance and admittance of the pressure pulse of the aorta. **(5 POINTS)**

c. Assuming the blood moves from the aorta and branches into two arteries A and B, calculate the reflectance and transmission coefficients of the pressure pulse amplitude. **(6 POINTS)**

d. If the length of the aorta is 120 mm, calculate the resistance of the aorta wall. **(4 POINTS)**

 EXAMINER: Sophia Tetteh

3.

Using **Table 1**

a. Estimate how many arteries, arterioles, capillaries and veins **(A, B, C, D, E)** will open when the velocity of the blood in the aorta is 4.80×10^{-1} m/s and the velocity of blood in the capillary is 1.00×10^{-3} m/s. Note that there is only one aorta in humans. **(15 POINTS)**

b. Estimate the length of the entry region in the aorta, arteries, arterioles, capillaries and veins **(F, G, H, I, J)** of radius 20 μm. Assume viscosity to be 10^{-3} kg/ms and density of blood is 1060 kg/m^3. **(15 POINTS)**

c. Sketch and describe in detail the pressure – volume relationship of the cardiac cycle. **(14 POINTS)**

Table 1: Typical values of the major branches of the cardiovascular system, velocity and diameter

Location	Diameter [mm]	Average Velocity [m/s]	Number of Blood vessels Open	Length of entry region
aorta	20.00	4.80×10^{-1}	**A**	**F**
artery	4.00	4.50×10^{-1}	**B**	**G**
arteriole	0.05	5.00×10^{-2}	**C**	**H**
capillaries	0.008	1.00×10^{-3}	**D**	**I**
vein	5.00	1.00×10^{-2}	**E**	**J**

FORMULA BANK:

$$T = \frac{2a_0}{a_0+a_1+a_2} \quad R=\frac{8L\eta}{\pi r^4} \quad ; F \propto \frac{\Delta P}{R}; \; v = \frac{1}{4\mu}\frac{dP}{dx}[r^2 - R^2]; \; Q = \frac{-\pi R^4}{8\mu}\frac{dP}{dx};$$