L-2/T-II/BME Date: 09/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-II B.Sc. Engineering Examination 2018-19 (January 2020 Term)

Sub: **BME 203** (Human Physiology)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks.

All the symbols have their usual meanings.

Assume reasonable values for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE.**

1. (a) Explain the cardiac cycle with a pressure-volume graph. (15)

   (b) How would an obstruction in the airway affect alveolar ventilation, arterial P_{CO_2}, and the body's pH? (15)

2. (a) A premature baby born is unable to produce adequate surfactant. In order to inhale an adequate amount of air, what do you think the intrapleural pressure has to be compared to a full-term baby? (15)

   (b) Calculate mean arterial pressure and pulse pressure for a person with a blood pressure of 115/73. (15)

3. (a) If the afferent arteriole of a nephron constricts, what happens to GFR in that nephron? If the efferent arteriole of a nephron constricts, what happens to GFR in that nephron? Assume that no autoregulation takes place. (15)

   (b) What are the factors that affect the cardiac output? Which of them are controlled by acetylcholine and norepinephrine? (15)

4 (a) Zayd is a tiny man, with a tidal volume of 400 mL and a respiratory rate of 12 breaths per minute at rest. What is his total pulmonary ventilation? Just before the physiology final examination, his ventilation increases to 18 breaths per minute from nervousness. Now what is his total pulmonary ventilation? (20)

Assuming his anatomic dead space is 120 mL, what is his alveolar ventilation in each case?

(b) Explain how the loop of Henle and vasa recta work together to create dilute renal filtrate. (10)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE.**

5. (a) Define homeostasis. "Negative feedback mechanism" is beneficial for regulating normal body function—explain with example. Why a positive feedback mechanism is called a vicious cycle? (3+7+5)

   (b) What do you mean by core & shell temperature? How is body temperature maintained in hot and cold climates? (5+ 10)

6. (a) What is erythropoiesis? Name the stages of erythropoiesis. Shortly discuss the factors that influence erythropoiesis. (3+4+8)

   (b) Name the descending tracts. Describe the origin, course and functions of the corticospinal tract. (3+8+4)

7. (a) Describe the general mechanism of muscle contraction and relaxation. Write a short note on actin filament of muscle. (9+ 6)

   (b) Name the hormones of anterior pituitary gland. Discuss briefly the role of different hormones in regulation of blood Ca^{++} level. (5+ 10)

8. (a) Name the steps of biosynthesis of thyroid hormone. Write down the effects of thyroid hormone on the cardiovascular system and central nervous system. Mention the features of cretinism. (5+6+4)

   (b) How do the refractory errors of the eyeball occur? What are the changes that occur during accommodation? Trace the pathway of accommodation. (6+3+6)

L-2/T-II/BME Date: 12/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-II B.Sc. Engineering Examination 2018-19 (January 2020 Term)

Sub: **BME 205** (Biofluid Mechanics and Heat Transfer)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks. All the symbols have their usual meanings.

Assume reasonable values for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE.**

1. (a) One method of measuring the cytoplasmic viscosity of cells is to aspirate a portion of the cell into a long micropipette of radius R_p, as shown in Fig. for Q no. 1(a). For such flows, Re<<1. The characteristic velocity is equal to the time rate of change of the cell length, $L' = \frac{dL}{dt}$, in the micropipette. This length of change depends upon the pressure drop ΔP across the cell, the micropipette radius R_p, the viscosity μ_c of the cell cytoplasm, and the radius R_c of the cell. Use the Buckingham Pi theorem to determine the dimensionless groups that are involved. **(15)**

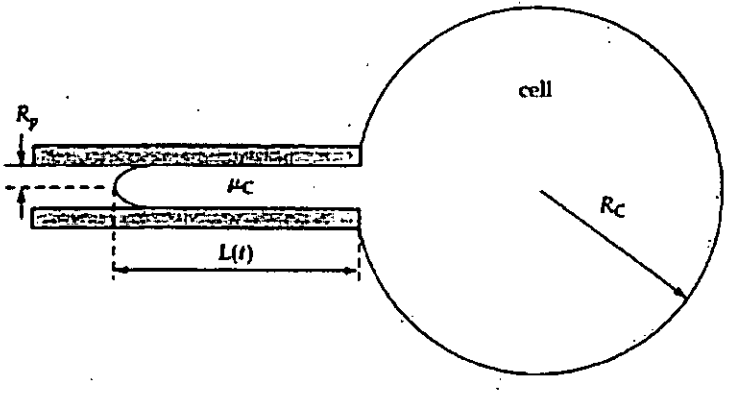

Fig. for Q. no. 1 (a)

(b) What is the hematocrit in each of the daughter branches for a simple one-parent-to-two daughter- branch network, if the inflow velocity is 50 mm/s (in a tube with a diameter of 60 μm) and the velocity in the first branch is 75 mm/s (in a **(15)**

tube with a diameter of 40 μm)? The diameter of the second branch is 30 μm. The feed hematocrit is 40% and the hematocrit in the second branch is 24%.

2. (a) Describe the stages of the development of an atherosclerotic plaque. What role does fluid mechanics play in atherosclerosis? **(15)**

(b) Calculate the flux and the rate of removal (for the total area, in g/hour) of urea from blood at steady state using a cellophane membrane dialyzer at 37°C. The membrane is 0.025 mm thick and has a total area of 2.0 m^2. The diffusivity of urea through the membrane is 1×10^{-10} m^2/s. The concentration of urea on the membrane surface in the blood side is 0.0264 g/100 cc and in the dialyzing fluid side is 0.0051 g/100 cc. **(15)**

3. (a) Simulations of thermal ablation can be performed using cylindrical coordinates. Derive the general heat conduction equation in cylindrical coordinate system. Modify the obtained general equation to incorporate heat transfer due to blood perfusion and metabolic heat generation. **(15)**

(b) Often the leg is cooled in a refrigerant prior to amputation surgery to reduce the blood flow and numb the nerve endings to make surgery and recovery easier for the patient. Find and sketch the leg's temperature profile in the radial direction after the cooling process has reached steady-state. Assume that the skin temperature is equal to the refrigerant temperature, which is unchanged by the cooling process. The leg can be approximated as a cylinder with constant thermal properties in the radial direction. The metabolic heat generation rate is slowed by the cooling, but is still present uniformly throughout the leg, at a value of 1.1 kW/m^3. The thermal conductivity of the leg muscle is 0.6 W/m.K, the radius of leg is 5.0 cm and the refrigerant temperature is 10°C. **(15)**

4 (a) To warm up some milk for a baby, a mother pours milk into a thin-walled cylindrical container whose diameter is 6 cm. The height of the milk in the container is 7 cm. She then places the container into a large pan filled with hot water at 70°C. The milk is stirred constantly, so that its temperature is uniform at all times. If the heat transfer coefficient between the water and the container is 120 $W/m^2\cdot K$, determine how long it will take for the milk to warm up from **(15)**

3°C to 38°C. Assume that the entire surface area of the cylindrical container (including the top and bottom) is in thermal contact with the hot water. Take the properties of the milk to be the same as those of water. Can the milk in this case be treated as a lumped system? Why?

(b) With necessary diagrams, describe volume-controlled constant flow ventilation in a mechanical ventilator. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE.**

5. (a) The specific gravity of human urine ranges from 1.001 - 1.035. What are the reasons for which specific gravity of urine can cross the lower or upper limit? What can be the possible biomedical application of shear thickening fluid? **(15)**

(b) Calculate the surface tension and the associated force for a red blood cell moving through blood. Assume that the radius of curvature for the red blood cell is 4 μm and the radius of curvature for the blood is 1 cm. The pressure difference across the cell and blood is 25 mmHg. Assume that a red blood cell is a perfect sphere when estimating contact area. **(15)**

6. (a) Calculate the time rate of change of air density during expiration. Assume that the lung has a total volume of 6000 mL, the diameter of the trachea is 20 mm, the air flow velocity out of the trachea is 22 cm/s, and the density of air is 1.3 kg/m^3. Also assume that lung volume is decreasing at a rate of 90 mL/s. **(16)**

(b) Draw schematic of stress relaxation of viscoelastic fluid. Name and explain a common mathematical model to solve problem associated with viscoelastic material. **(14)**

7. (a) What are the Fahraeus and Fahraeus-Lindqvist effects? Explain. **(15)**

(b) Calculate the volumetric flow rate within an arteriole with a length of 100 μm and a radius of 35 μm. The pressure difference across the arteriole is 10 mmHg. Also, calculate the change in diameter needed to reduce the volumetric flow rate by 5% and to increase the volumetric flow rate by 10%. **(15)**

8. (a) Imagine that you are making a model of blood flow through an artery; however, we could only use water as our fluid flowing through the model artery. Calculate the angular frequency of the pulsatile waveform and the initial inlet velocity if the characteristic length (diameter) of the blood vessel is 12 cm, the heartbeat is 72 beats/min (angular frequency is 5.24 rad/sec), and the inlet velocity is 40 cm/s. **(18)**

(b) What is the physical significance of Navier Stokes equation? Can this equation be applied to our real life problem? What are the limitations of Navier Stokes equation? **(12)**

L-2/T-II/BME Date: 19/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-II B. Sc. Engineering Examinations (January 2020 Semester)

Sub: **CSE 283** (Digital Techniques)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1(a) Design a 2-input NOR gate in **one** of the following two logics. [10]

i) DTL logic

ii) RTL logic.

Briefly explain its operation.

1(b) Draw the circuit diagram of the NAND-based SR latch in CMOS logic. [10]

1(c) Draw the circuit diagram of the following function in CMOS logic, where symbols carry the usual meaning. [10]

$f = (a + b) . (c + d)$

2(a) Design a 3-bit mod-6 synchronous down counter using D flip flops. Any invalid state must return to a valid state with the next CLK pulse. [20]

2(b) Draw the circuit diagram of a 3-bit universal shift register that performs the following operations. [10]

Control Bits S0 S1	Register Operation
0 0	Parallel Load
0 1	Shift Right
1 0	Shift Left
1 1	No change

3(a) Explain the difference between a level triggered device and an edge triggered device. [6]

3(b) Design a 3-bit binary ripple counter using T flip flops. Briefly explain its operation. [10 + 4]

3(c) Draw the circuit diagram of a 2-input TTL NAND gate. [10]

4(a) Explain the operation of a negative edge triggered master-slave D flip flop using a timing diagram. [12]

4(b) You are given a D flip flop. Design a JK flip flop using some basic gates and the D flip flop. Explain the operation of the designed JK flip flop. Also derive its characteristics equation and the excitation table. [6 + 6 + 6]

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 283** (Digital Techniques)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Show that NOR gate is a universal gate. Verify whether NOR and XOR operations follow the associative law or not? **(12)**

   (b) Reduce the following Boolean expression to four literals using Boolean algebra and necessary simplifications. **(12)**

   $$(P' + R)\,(P' + R')\,(P + Q + R'S)$$

   (c) Implement a 2-input XOR gate using 2-input NOR gates only. Keep the number of gates to a minimum. **(6)**

6. (a) Using a K-map (Karnaugh map), minimize $f(w,x,y,z) = \sum(1,2,4,7,9,10,12,14) + d(0,6,8,13)$. Find the prime implicants and the essential prime implicants. Write down the responsible min-term for each essential prime implicant. **(15)**

   (b) Show that the dual of exclusive-OR operation is also its complement. **(5)**

   (c) Derive the circuits for a three-bit parity generator and a four-bit parity checker using an odd parity bit. **(10)**

7. (a) Derive and design the circuit for the following problem using XOR gates, one 4 bit full adder and any other basic gates if necessary. You are not allowed to use ***inverters***. Here X and Y are 4 bit numbers which will be inputs to the circuit. Also, there is a two bit control input p, q to the circuit that controls the output of the circuit. Note that "+" means the addition operation and "-" means the subtraction operation. **(15)**

p	q	Output
0	0	X + Y + 1
0	1	X - Y - 1
1	0	X + Y
1	1	X – Y

   (b) Design a 4 bit binary to excess-3 converter using four 4×1 MUXs. You have to use the two most significant bits of the binary number as selectors in all the MUXs. **(15)**

8. (a) Construct a 4-to-16-line decoder with five 2-to-4-line decoders with enable. Use block diagrams for the components. **(12)**

   (b) If the propagation delay is 1 ns for a NOT gate, and 2 ns for other basic gates, what is the propagation delay for a four bit carry look-ahead adder circuit to produce its final output? **(9)**

   (c) Construct a D-latch using four NAND gates only (You cannot use any other gates). Also, mention the function table and the excitation table. **(9)**

L-2/T-2/ BME

Date: 23/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B.Sc. Engineering Examination 2018-2019

Sub: **MME 297** (Structure and Properties of Biomaterials)

Full Marks: 180 Time: 2 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION-A

There are **FOUR** questions in this script. Answer any **THREE**.

1. (a) The purification of hydrogen gas is done by its selective diffusion through a palladium sheet. Compute the number of kilograms of hydrogen that pass per hour through a 5 mm thick sheet of palladium having an area of 0.20 m^2 at 500°C. Assume a diffusion coefficient of 1.0×10^{-8} m^2/s, that the concentrations at the high and low-pressure sides of the plate are 2.4 and 0.6 kg of hydrogen per cubic meter of palladium, and that steady-state conditions have been attained. **(10)**

   (b) Using suitable example, explain the effect of processing on microstructure and properties of material. **(15)**

   (c) 'Bricks are good insulating material whereas copper is a good conductor'-justify the statement. **(05)**

2. (a) Show that the atomic packing factor is 0.74 for FCC crystal. **(08)**

   (b) Why fewer carbon atoms enter the interstitial positions in BCC iron than in FCC iron. **(07)**

   (c) Calculate the activation energy for vacancy formation in aluminum, given that the equilibrium number of vacancies at 500 ° C (773 K) is 7.57×10^{23} m^{-3}. The atomic weight and density (at 500°C) for aluminum are, respectively, 26.98 g/mol and 2.62 g/cm^3. **(15)**

3. (a) 'Polycrystalline metals are generally stronger than single crystals'- justify the statement. **(10)**

   (b) Using suitable examples, explain the underlying mechanisms of material strengthening by strain hardening and precipitation hardening methods. **(20)**

4. (a) Estimate the theoretical fracture strength of a brittle material if it is known that fracture occurs by the propagation of an elliptically shaped surface crack of length 0.25 mm (0.01 in.) and having a tip radius of curvature of 1.2×10^{-3} mm (4.7×10^{-5} in.) when a stress of 1200 MPa (174,000 psi) is applied. **(15)**

(b) Suppose you have to design a steel-based structure which can be subjected to variable loading during service. List some measures that you may take to increase its resistance to fatigue failure. **(05)**

(c) Explain how DBTT influences materials selection process while designing materials for cryogenic applications. **(10)**

SECTION-B

There are **FOUR** questions in this script. Answer any **THREE**.

5. (a) Which one is preferable between socket prosthesis and osseointegrated prosthesis? Why? **(05)**

   (b) Explain whether or not a laboratory test is sufficient to evaluate a material for biomedical application. **(08)**

   (c) Discuss in detail about the types of hydrogel drug delivery system. **(17)**

6. (a) Explain reasons of using TEGDMA and BHT in preparation of dental filling composite. **(04)**

   (b) In a 27 vol% glass fiber reinforced nylon matrix composite, the fibers are aligned parallel to the loading direction. What proportion of the load and stress are carried by the fibers? The modulus of elasticity for glass is 72.4 GPa, for nylon is 2.8 GPa. **(12)**

   (c) How can the transformation temperature of nitinol be altered? Using schematic, explain the sensitivity of SME and PE to thermomechanical treatment. **(5+9)**

7. (a) Which SS is commonly used as implants? How can its structure, processing, and performance be interrelated? **(15)**

   (b) Among synthetic polymers, choose a suitable one for non-load bearing porous implant. Justify your choice with a specific example of application. **(07)**

   (c) Compare the strength and weakness of direct contact and agar diffusion assay method of toxicity test. **(08)**

8. (a) Choose a technique to characterize the molecular structure of organometallic compounds. Which signal does this technique utilize to analyze sample? **(08)**

   (b) What are the impacts of Ni, Mo, Cr and W on the performance of Co based alloy? Discuss effect of chain extender on the synthesis of polyurethane. **(4+6)**

(c) State the common methods of HA synthesis? Discuss the difference, strength, and weakness of these methods? Which one is industrially more feasible? **(12)**

L-2/T-2/BME Date: 16/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2018-2019

Sub: **MATH 215** (Linear Algebra)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION-A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Solve the following system of linear equations (if possible) by reducing augmented matrix into its reduced row echelon form: **(20)**

$$\begin{aligned} -x+2y-4z+\ w &= \ 1 \\ 3x- \qquad\quad 3w &= -3 \end{aligned}$$

(b) Prove that every square matrix can be expressed in one and only one way as the sum of a symmetric matrix and a skew symmetric matrix. **(10)**

2. (a) For the matrix $A=\begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$, find A^{-1} by using elementary row operations. **(15)**

(b) Express the matrix $A=\begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$ as a product of elementary matrices. **(15)**

3. (a) Find an LU factorization of $A=\begin{bmatrix} 1 & 1 & 0 \\ 4 & 6 & 1 \\ -2 & 2 & 0 \end{bmatrix}$. **(15)**

(b) Use Cayley-Hamilton theorem to find A^{-1}, **(15)**

where $A=\begin{pmatrix} 1 & -1 & 1 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{pmatrix}$.

4. (a) Find all eigenvalues and the corresponding eigenvectors for the matrix **(15)**.

$$A = \begin{pmatrix} 1 & 0 & 0 \\ 3 & -5 & 0 \\ 6 & -6 & 4 \end{pmatrix}.$$

(b) Determine rank, index and signature of the quadratic form **(15)**

$$x_1^2 + 2x_2^2 - 3x_3^2 + 8x_1x_2 - 16x_2x_3 + 10x_1x_3$$

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Find the standard matrix for the transformation T on $\mathbf{R}^3$, where T is the composition of a rotation of -45° about y-axis, followed by an orthogonal projection on xz-plane, followed by a dilation with factor $k = \sqrt{2}$. Hence find T(2, – 4, 5) by using the standard matrix. **(20)**

(b) Determine whether the set of all vectors of the form (a, b, c), where b = a - c is a subspace of $\mathbf{R}^3$. **(10)**

6. (a) Determine whether the following polynomials span P_2. **(15)**

$$\mathbf{p_1} = 1 - x - 2x^2,\ \mathbf{p_2} = 3 + x,\ \mathbf{p_3} = 5 - x + 4x^2,\ \mathbf{p_4} = -2 - 2x + 2x^2.$$

(b) Let S = { v_1 , v_2 , v_3 } is a basis for $P_2(x)$ where **(15)**

$$v_1 = 1 + 2x + x^2,\quad v_2 = 2 + 9x,\quad v_3 = 3 + 3x + 4x^2.$$

Find coordinate vector of $v = 1 + x + x^2$ with respect to S.

7. Let the linear transformation defined by

$$T(x,y,z) = (x-y-3z,\ 5x+6y-4z,\ 7x+4y+2z).$$

(30)

Find (i) a basis and the dimension of Range (T). (ii) a basis and the dimension of of Kernel (T). Then verify the dimension theorem.

8. Consider the vector space $\mathbf{R}^3$ with the Euclidean inner product. Apply *Gram-Schmidt* process to transform the basis vectors , $u_1 = (1, 1, 1)$, $u_2 = (0, 1, 1)$, and $u_3 = (0, 0, 1)$ into a orthogonal basis { v_1 , v_2 , v_3 } taking $v_1 = u_1$; then normalize the orthogonal basis vectors to obtain the orthonormal basis { q_1 , q_2 , q_3 }. Also find the QR-decomposition of the matrix $A = [u_1 | u_2 | u_3]$. **(30)**