Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2019
Department of Biomedical Engineering
BME 2201
Human physiology

Time: 3 hours   Full Marks: 210

N.B.   i) Answer ANY THREE questions from each section in separate scripts.
           ii) Figures in the right margin indicate full marks.

Section A
(Answer **ANY THREE** questions from this section in Script A)

1. a) What is cell and what are the principles of cell theory?   (05)

    b) How does nerve impulse cross synapse?   (10)

    c) Write short notes on: (10)
        i)   EPSP
        ii)   IPSP

    d) How lipid soluble and water soluble substance passing through a membrane? Explain with proper   (10)
        diagram.

2. a) Enumerate the importance of endoplasmic reticulum and mitochondria. Where and how the cellular   (10)
        respiration takes place?

    b) Discuss the pathway of taste sensation from tongue to cerebral cortex.   (10)

    c) What is meant by hearing loss? And hence name the types of hearing loss. Draw the pathway of air   (15)
        conduction and bone conduction.

3. a) Define Reflex Arc. Draw and label the Reflex Arc.   (10)

    b) Define neurotransmitter. Give the criteria of neurotransmitter.   (07)

    c) What is receptor? Write down the functional classification of receptor.   (10)

    d) What are the differences between Receptor potential and Action potential?   (08)

4. a) What is meant by Transplantation? Describe the different types of grafts.   (10)

    b) What are the differences between facilitated diffusion and simple diffusion?   (07)

    c) Discuss about the light reflex with proper diagram.   (10)

    d) What is Retina? Enumerate the 10 layer of Retina with net sketch.   (08)

5. a) What is cardiac cycle? State the various phases and parameters of cardiac cycle with proper (15) diagram.

    b) List the differences between cardiac action potential and skeletal muscle action potential. (10)

    c) Draw and label the different wave, interval and segment of ECG plot. (06)

    d) Write a short note on cardiac muscle? (04)

6. a) What is the largest organ of human body? List the layers of skin. What is Melanocyte? Where it is (07) located?

    b) Define peristalsis. Discuss about the phases of gastric secretion. (08)

    c) Write short notes on: (10)
        i)   Gastric parietal cell
        ii)   ECL cell

    d) List the special senses of human body. Enumerate the receptors for the special sense. What is (10) phototransduction?

7. a) Define blood pressure. Briefly discuss the various methods for blood pressure measurement. (09)

    b) What is pulmonary ventilation? State different volume and capacities found in spirogram. (12)

    c) What is Bohr effect? Write down the effect of CO_2 on Bohr effect? (08)

    d) Write down the working principle of pulse oximeter. (06)

8. a) What is central venous pressure and JVP? How can you measure the JVP? (09)

    b) How blood pressure can regulated by kidney? (10)

    c) Describe the different methods of heat loss from the body. (10)

    d) Write short notes on : (06)
        i) FEV_1
        ii)   Peak flow meter

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Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is signal? Find the even and odd components of the following signal: (10)
$$x(t) = 1 + t + 3t^2 + 5t^3 + 9t^4$$

    b) For each of the following signals, determine whether it is periodic, and if it is, find the fundamental   (08)
        period: i) $\cos^2(2\pi t)$;   ii) $e^{-2t}\cos(2\pi t)$.

    c) Briefly explain the working procedure of an analog to digital converter.   (09)

    d) A triangular pulse signal $x(t)$ is depicted in Fig. 1(d). Sketch the following signal derived from $x(t)$:   (08)
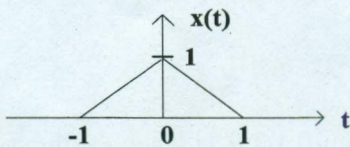 $x(3t) + x(3t + 2)$.
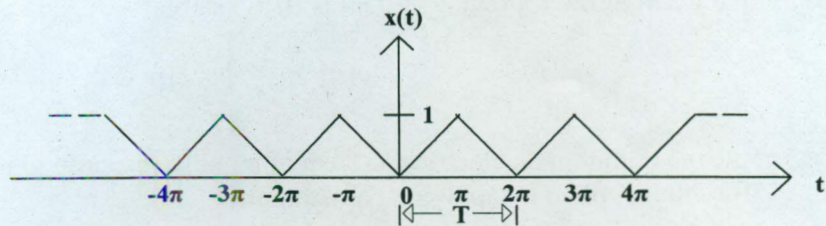

Fig. 1(d)

Fig. 2(c)

2. a) Define a Linear time-invariant (LTI) system with suitable examples.   (08)

    b) Define the following signals mathematically and represent graphically: (12)
        i) Impulse signal; ii) Step signal; iii) Ramp signal; iv) Exponentially damped sinusoidal signal.

    c) What is Fourier series? Determine the Fourier series coefficients (exponential representation) of the   (15)
        signal x(t) given in above Fig. 2(c).

3. a) Write down the necessary conditions for representing a given signal by Fourier transform (FT)   (06)
        representation.

    b) What is meant by convolution integral? Let $x(t)$ be the input to an LTI system with unit impulse   (12)
        response $h(t)$, where $x(t) = e^{-at}u(t)$, $a > 0$ and $h(t) = u(t)$. Find the output y(t) of the LTI
        system.

    c) An anticausal signal is zero for $t > 0$. Determine the Laplace transform and ROC for the anticausal   (09)
        signal $x(t) = -e^{at}u(-t)$.

    d) What is meant by frequency response function? What are the characteristics of frequency response   (08)
        function of LTI system?

4. a) Determine the output of a LTI system represented by the following differential equation with a input   (12)
        and initial conditions:
$$\frac{d^2}{dt^2}y(t) + 5\frac{d}{dt}y(t) + 6y(t) = \frac{d}{dt}x(t) + 6x(t), x(t) = u(t), y(0^-) = 1 \text{ and } \frac{d}{dt}y(t)|_{t=0^-} = 2.$$

    b) A system has the transfer function   (08)
$$H(s) = \frac{3}{s+5} + \frac{2}{s-3}$$
Find the impulse response, assuming (i) the system is causal and (ii) the system is stable. Can this
system be both causal and stable?

c) Use the method of partial fraction to find the time signal for the following unilateral Laplace (10) transform:

$$X(s) = \frac{s+3}{s^2 + 3s + 2}$$

d) Find the differential-equation description of the system described by the following transfer function: (05)

$$H(s) = \frac{2s^2 + 2s - 2}{s^2 - 1}$$

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Illustrate the following properties of a system with suitable example: (10)
    (i) Linearity;   (ii) Shift Invariance

    b) Clarify the causality of a discrete time system. A system has input-output relationship given by the (08) following equation. Is this system causal?

    $$y[n] = \sum_{k=-\infty}^{\infty} (n-k)u[n-k]x[k]$$

    c) Determine whether the following system is BIBO stable. (05)

    $$y[n] = \frac{1}{M} \sum_{k=0}^{M-1} x[n-k]$$

    d) Determine the output of an electrical system of impulse response function [0,1,1,0,1] when the input (12) [0,2,5,0] (volts) applied by applying convolution.

6. a) What is sampling? State and explain Nyquist sampling theorem. (08)

    b) Illustrate sampling with a zero-order hold with reconstruction. (07)

    c) Calculate the DFT of a sequence {1,0,0,1} which has been sampled at 8 kHz and graphically represent (20) amplitude and phase spectrum.

7. a) Derive the computational complexity of DFT and FFT. (12)

    b) Draw the signal flow graph to obtain FFT using decimation in time approach with necessary equation (13) for $N = 8$.

    c) Define z-transform and inverse z-transform. What is the difference between z-transform and Laplace (10) transform? What is the relation between z-transform and DTFT?

8. a) Find the Z-transform of $x[n] = 7 \left(\frac{1}{3}\right)^n u[n] - 6 \left(\frac{1}{2}\right)^n u[n]$ and plot the ROC. (11)

    b) Determine the inverse Z-transform of $X(z) = \frac{2+z^{-1}}{1-\frac{1}{2}z^{-1}}$; ROC: $|z| > \frac{1}{2}$. (10)

    c) Mention two applications of z-transform in biosignal. (06)

    d) Find the transfer function of a discrete-time system whose input x[n] and output y[n] are related (08) through the following difference equation:

    $$y[n] - \frac{1}{2}y[n-1] = x[n] + \frac{1}{3}x[n-1]$$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2019
Department of Biomedical Engineering
BME 2231
Biomedical Instrumentation

**Time: 3 hours**   **Full Marks: 210**

N.B.   i) Answer **ANY THREE** questions from each section in separate scripts.

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Section A
(Answer **ANY THREE** questions from this section in Script A)

1.	a)	Describe basic concepts of biomedical instrumentation using an example.	(08)
	b)	Why instrumentation amplifier is used instead of differential amplifier for biopotential acquisition? Draw and calculate the differential gain of an instrument amplifier.	(12)
	c)	What is meant by preamplifier? What are the requirements of a biopotential preamplifier?	(07)
	d)	Briefly discuss about the driven-right-leg circuit.	(08)
2.	a)	Mention measurand, its amplitude, frequency range and electrode type for ECG, EEG and EMG signal acquisition system.	(05)
	b)	Describe EMG acquisition system with a block diagram.	(10)
	c)	Briefly discuss about Einthoven's Triangle & Cardiac vector.	(06)
	d)	What are the problems associated in ECG measurement?	(07)
	e)	What are the interference reduction techniques in ECG measurement?	(07)
3.	a)	Define cardiac output. Mention its importance.	(04)
	b)	Write short notes on: (i) Pacemaker; (ii) Medical ventilator; (iii) Incubator.	(12)
	c)	What are the differences between leads and electrodes? Briefly describes ECG leads.	(10)
	d)	Explain the working principle of haemodialyzer/haemodialysis machine.	(09)
4.	a)	What is meant by electric shock? Describe different types of electric shock.	(05)
	b)	What are the symptoms and applications of electric shock? Draw a diagram showing physiological effects of electric shocks with different current levels.	(12)
	c)	Explain leakage current. Briefly describe different types of leakage currents.	(10)
	d)	Consider the following situation: A nurse touches a defective monitor, having a leakage of 100µA. While at the same time touching a sink fixture tied to the ground. Is the nurse safe?	(08)

$R_1 = 0.01\ \Omega$
$R_2 = 10,000\ \Omega$
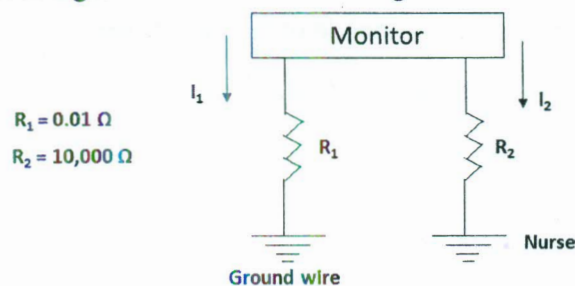
5. a) Define Sensor & Transducer. Classify the biomedical sensors in terms of the quantities that they measure. Briefly describe them. (08)

    b) Briefly describe the basic requirements of a transducer. (12)

    c) Why the selection of a transducer in a measurement system is so important? Discuss the steps for selection of a transducer. (05)

    d) Write short notes on: (10)
         (i)   Perfectly polarizable electrode and
         (ii) Perfectly non polarizable electrode.

6. a) Write short notes on: (16)
         i)   Thermocouple
         ii)   Resistance Temperature Detector (RTD)
         iii) IC Temperature Transducer
         iv)   Fluorescence

    b) Describe the operating principle of an optical pulse oximetry. (10)

    c) What is meant by Surface Plasmon Resonance (SPR)? Briefly describe the working principle of SPR optical biosensor. (09)

7. a) Define Piezoelectric effect. Briefly describe the principle of the Piezoelectric effect. (10)

    b) Classify the electrochemical transducer according to detection approaches. Briefly describe the working principle of an amperometric O_2 sensor. (10)

    c) Classify biosensors based on detection techniques. Briefly describe them. (10)

    d) Briefly describe the working steps of a biosensor. (05)

8. a) What is an enzyme electrode? Draw and describe the working principle of an enzyme electrode. (08)

    b) Write short notes on: (10)
         i)   Bi-enzyme electrode
         ii)   Inhibition based electrode

    c) Sketch and briefly describe the working principle of P_{CO2} electrode. (12)

    d) What are the critical care analytes of blood in clinical setting? (05)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2019
Department of Biomedical Engineering
HUM 2215
Economics and Sociology

Time: 3 hours   Full Marks: 210

N.B.   i) Answer **ANY THREE** questions from each section in separate scripts.
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Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Define demand schedule and law of demand with example.   (05)

    b) What are the main factors affect the supply of any goods and services?   (15)

    c) There are 10,000 identical individual of commodity X in the market, each with a demand equation   (15)
        is given by $Q_{dx} = 8 - P_x$ and 1000 identical products of X, each with a supply equation is given
        by $Q_{sx} = -40 + 20\,P_x$.
            (i)   Obtain equilibrium price and quantity.
        Now, if the government decides to collect a sales tax of $1 per unit sold from each of the 1000
        sellers,-
            (ii)   What effect does this have on the equilibrium price and quantity?
            (iii)   What is the total amount of tax collected by the government?

2. a) What is price-elasticity of demand? Is the price-elasticity of demand for "aluminum" greater than   (10)
        the "butter"? Why? What general rule infer from this? Explain.

    b) What are the two extreme cases for price-elasticity of demand? Explain with example.   (05)

    c) The "square" is a producer of medicine. The corporation hires an economist to determine the   (20)
        demand for its medicine. After months of hard work, the economist informs that the demand for the
        firm's medicine is given by the following equation:
            $Q_x = 12000 - 5000P_x + 5I + 500P_c$; where
                Q_x = Demand for square's medicine
                P_x = Price charged for square's medicine
                I = Income per capita
                P_c = price from competing producers
        Assume, the initial values of P_x, I and P_c are $5, $10,000 and $6, respectively. Using the above
        information, the manger wants to determine-
            i)   What effect a price increase would have on total revenue?
            ii)   How sale of the medicine would change during a period of rising incomes?
            iii)   Assess the probable impact if competing producers would raise their price.

3. a) Define GDP and GNP.   (05)

    b) Discuss major causes and consequences of inflation.   (15)

    c) How does government control inflation with monetary measures?   (15)

4. a) Define market. Write the types of market.   (05)

    b) Draw and explain the various cost curves. For a given price, explain how the competitive firm   (20)
        choose the level of output that maximize profit.

    c) Explain the shut-down position of a firm under perfect competition.   (10)

5. a) What is meant by sociology? Distinguish between social science and natural science. (10)

   b) What is social structure? Explain the elements of social structure. (10)

   c) What is society? What are the main characteristics of a society? (15)

6. a) Critically describe contribution of industrial revolution behind origin and development of sociology as a distinct science. (20)

   b) Discuss contribution of Karl Marx behind origin and development of sociology as a distinct discipline. (05)

   c) Differentiate between material and non-material culture. (10)

7. a) Discuss the anatomy of culture in the light of your own society. (10)

   b) What is civilization? Describe the relation between culture and civilization. (10)

   c) What is meant by community? Explain the key elements of community. (15)

8. a) Explain conflict perspective of sociology. (10)

   b) "Association is a means of pursuing ends"- do you agree with this statement? Explain your opinion with example. (15)

   c) What is urbanization? Critically explain the relationship between industrialization and urbanization. (10)

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Section A
(Answer **ANY THREE** questions from this section in Script A)

1. a) Describe and graph the locus represented by (09)
$$\left|\frac{z-12}{z-8i}\right| = \frac{5}{3}$$

    b) If $w = f(z)$ is continuous at $z = z_o$, then show that $\bar{w}$ is also continuous at $z = z_o$. (09)

    c) Define analytic function. What do we understand by harmonic function? Find the constants (17)
a, b, c such that the function $f(z) = -x^2 + 2xy + y^2 + i(ax^2 + bxy + cy^2)$ is analytic.
Also express $f(z)$ in terms of z.

2. a) Use suitable theorem to evaluate $\oint_c \frac{3z^2+5}{(z+1)(z^2+16)} dz$, where C is the circle $|z+i| = 4$ (13)
traversed in the positive sense.

    b) Evaluate $\oint_c \frac{e^z}{z^2(z-2i)^2} dz$, where C is a square having vertices at $\pm 1 + i, \pm 1 + 3i$, traversed (12)
in the positive sense.

    c) Define singularity of a function. Classify them with example. (10)

3. a) Is the matrix $A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ a & b & -1 & 0 \\ c & d & 0 & 1 \end{bmatrix}$ involutory? (06)

    b) Define symmetric and skew-symmetric matrices with examples. Find x and B, if (08)
$B = \begin{bmatrix} 4 & x+2 \\ 2x-3 & x+1 \end{bmatrix}$ is symmetric.

    c) Find the inverse of the matrix $A = \begin{bmatrix} -1 & 1 & 2 \\ 3 & -1 & 1 \\ -1 & 3 & 4 \end{bmatrix}$ by elementary row operations, if it exists. (14)

    d) What is meant by consistency of a system of linear equation? How many types of solution (07)
are there exist for a homogeneous system of linear equation? Explain.

4. a) Find the rank of the matrix (15)
$$A = \begin{bmatrix} 1 & 2 & -2 & 3 & 1 \\ 1 & 3 & -2 & 3 & 0 \\ 2 & 4 & -3 & 6 & 4 \\ 1 & 1 & -1 & 4 & 6 \end{bmatrix}$$
By reducing it to row canonical form. What will be its normal form?

b) The network given below shows the traffic flow (in car per hour) over several one way (15)
streets in a town during a typical early afternoon. If 40 cars are permitted to pass through
the root x_4, what will be the volume of traffic in other roots?
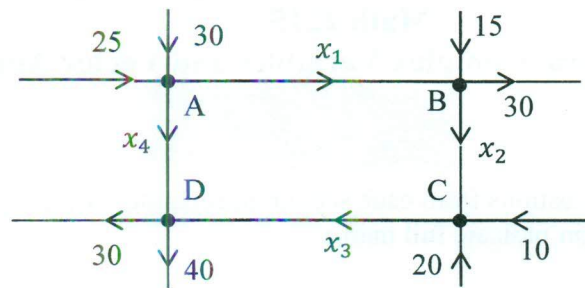
c) Determine the values of h so that the matrix $\begin{bmatrix} 1 & h & 4 \\ 3 & 6 & 8 \end{bmatrix}$ is the augmented matrix of a (05)
consistent system.

Section B
(Answer **ANY THREE** questions from this section in Script B)

5. a) A practical moves along the curve $x = 2t^2$, $y = t^2 - 4t$, $z = 3t - 5$, where t is time. Find (11)
the components of its velocity and acceleration at time $t = 1$ in the direction $\hat{\imath} - 3\hat{\jmath} + 2\hat{k}$.

    b) Find curvature k and torsion τ for the space curve $x = 3cost$, $y = 3sint$, $z = 4t$. (15)

    c) If $\bar{a}$ is a constant vector and $\bar{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$, show that $curl(\bar{a} \times \bar{r}) = 2a$. (09)

6. a) Find the directional derivative of $\Phi = x^2yz + 4xz^2$ at (1, -2, -1) in the direction $2\hat{\imath} - \hat{\jmath} -$ (10)
$2\hat{k}$.

    b) Verify Green's theorem in the plane for $\oint_c \{(xy + y^2)dx + x^2dy\}$, where C is the closed (13)
curve of the region bounded by $y = x$ and $y = x^2$.

    c) By use of divergence theorem evaluate $\iint_s (\bar{A}.\bar{n})ds$ where $\bar{A} = x^2y\hat{\imath} + y\hat{\jmath} - xz^2\hat{k}$ and S is (12)
the boundary of the region bounded by the paraboloid $z = x^2 + y^2$ and the plane $z = 4y$.

7. a) Define vector space. (09)

    b) Let w be the subspace of $\mathbb{R}^5$ spanned by the vectors (1, -2, 0, 0, 3), (2, -5, -3, -2, 6), (12)
(0, 5, 15, 10, 0) and (2, 6, 18, 8, 6). Find a basis and dimension of w.

    c) Define row space and column space. Let (14)

$$A = \begin{bmatrix} 1 & 1 & 4 & 1 & 2 \\ 0 & 1 & 2 & 1 & 1 \\ 0 & 0 & 0 & 1 & 2 \\ 1 & -1 & 0 & 0 & 2 \\ 2 & 1 & 6 & 0 & 1 \end{bmatrix}$$

Find a basis for the row space and column space of A.

8. a) Find all eigenvalues and corresponding eigenvectors of the matrix $A = \begin{bmatrix} 3 & -4 \\ 2 & -6 \end{bmatrix}$. (14)
Also find the non-singular matrix P and diagonal matrix D such that $D = P^{-1}AP$

    b) State Cauchy-Schwarz inequality. Verify that the following is an inner product in $\mathbb{R}^2$, (12)
$< u, v > = x_1y_1 - x_1y_2 - x_2y_1 + 3x_2y_2$, where $u = (x_1, x_2)$, $v = (y_1, y_2)$.

    c) Define orthonormal set of vectors. Find the norm of $v = (1 - 2i, 3 + i, 2 - 5i)$. (09)