Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2020
Department of Biomedical Engineering

BME 2201
Human Physiology

Time: 1 Hour 30 Minutes **Full Marks: 120**

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

Section A

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

1.	a)	Define cell. Discuss about the composition of cell membrane.	(15)
	b)	What is Ion Channel? Discuss about different phases of action potential.	(10)
	c)	Mention about the function of cell membrane.	(05)
2.	a)	What is cell cycle? Discuss about Meiosis-I.	(15)
	b)	Define reflex arc. Briefly explain the synaptic transmission with proper diagram.	(10)
	c)	What is serum? Discuss about the composition of blood.	(05)
3.	a)	Define Neuron. Draw and level a neuron.	(08)
	b)	Define and classify immunity. Discuss about the structure of antibody.	(15)
	c)	Mention the differences between the sympathetic and parasympathetic nervous system.	(07)

Section B

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

4.	a)	Mention the special characteristics of cardiac muscle. Explain how the cardiomyocyte release calcium, with proper diagram.	(10)
	b)	List the pulmonary volume and capacity. Write down the spirometric indices.	(06)
	c)	Calculate the concentration of dissolved oxygen when the partial pressure of oxygen in the gas is 100 mmHg, (which is a normal alveolar value) by using pressure-solubility law. [where solubility coefficient is 0.0031 ml/mm of oxygen /dl of blood]	(08)
	d)	A patient comes with 65 mmHg of glomerular blood hydrostatic pressure, 25 mmHg of capsulari hydrostatic pressure and 35 mmHg of blood colloid osmotic pressure. Calculate the Net Filtration Pressure of this patient.	(06)

5. a) Write down the parameter of cardiac cycle along with proper diagram. (06)

b) A 55 years old man has 92 b/m heart rate and his End diastolic volume is 140 ml and End systolic volume is 60 ml. Calculate the cardiac output and Ejection fraction. Define cardiac output and ejection fraction. (10)

c) What are the digestive enzymes of small intestine? List the normal contents of gastric juice. (06)

d) What is hypoxia? Name the common lung function test. (08)

6. a) How blood pressure is regulated by kidney? Explain with diagram. (08)

b) Write down the role of haemoglobin in oxygen transport. Draw and level the oxygen-haemoglobin dissociation curve of a COVID patient when the temperature of the patient is 102°F, P_{50} and P_{CO2} is increased, 2,3 DPG increased but p^H is decreased. (10)

c) Draw, level and interpret a normal ECG. (06)

d) Write short notes on: (06)

i. Enthoven Triangle

ii. Heart Rate.

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BME 2211
Signals and Systems

Time: 1 Hour 30 Minutes **Full Marks: 120**

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

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

1. a) Define Signal. Briefly describe the procedure of analog to digital conversion of a signal with suitable example. (10)

b) A pair of sinusoidal signals with a common angular frequency is represented by (10)

$$x_1(n) = 3\sin(3\pi n) \text{ and}$$

$$x_2(n) = \sqrt{3}\sin(3\pi n)$$

Specify the period for which the period N of both $x_1(n)$ and $x_2(n)$ must satisfy them to be periodic.

c) Determine whether the following systems are time invariant or not. (10)

$$\text{(i) } y(t) = \frac{1}{c}\int_{-\infty}^{t} x(\tau)d\tau \qquad \text{(ii) } y(t) = \frac{x(t)}{R(t)}$$

2. a) Find $y(t) = x\left(\frac{3t-4}{9}\right)$ for the given signal shown in Fig. 2(a). (10)

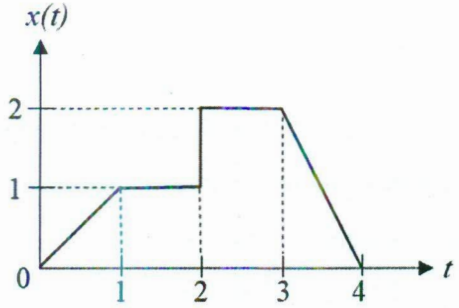

Fig. 2(a)

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

c) What is meant by convolution integral? Let input and impulse response of an LIT are like as $x(t) = e^{-at}u(t), a > 0$ and $h(t) = u(t)$ respectively. Find the output $y(t)$ of the LTI system. (12)

3. a) What is meant by transfer function? A system has the transfer function (10)

$$H(s) = \frac{4}{s+7} + \frac{3}{s-5}$$

Find the impulse response, assuming (i) the system is causal and (ii) the system is stable. Can this system be both causal and stable?

b) Consider a system H describe by the differential equation (09)

$$\frac{d}{dt}y(t) + 2y(t) = \frac{d^2}{dt^2}x(t) + 2\frac{d}{dt}x(t) - 3x(t)$$

Find the transfer function of the inverse system for H.

c) Use the method of partial fraction to find the time signal of the following unilateral Laplace transform (11)

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

Section B

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

4. a) Define BIBO stable system with appropriate conditions and examples. Determine if the systems described by the following input-output equations are linear or nonlinear. (12)

(i) $y(n) = x(n^2)$

(ii) $y(n) = x^2(n)$

b) Compute convolution $y(n) = x(n) * h(n)$ of the following signals (13)

$$x(n) = \{1, 1, \underset{\uparrow}{0}, 1, 2\}$$

$$h(n) = \{1, -2, -3, \underset{\uparrow}{4}\}$$

c) Consider the analog signal (05)

$$x_a(t) = 3cos2000\pi t + 5sin6000\pi t + 10cos1200\pi t$$

Assume that the signal is sampled using a sampling rate F_s = 5000 Hz. What is the discrete time signal obtained after sampling?

5. a) What is sampling? States and describe Shannon's sampling theorem with necessary diagram. (12)

b) Calculate the DFT of the data sequence $\{0, 1, 1, 0\}$ using the decimation-in-time (Cooley–Tukey) FFT algorithm and plot the amplitude and phase spectra. (18)

6. a) What is ROC? Determine the Z- transform of the signal (08

$$x(n) = \begin{cases} 13, & 0 \le n \le N-8 \\ 0, & elsewhere \end{cases}$$

b) Determine the causal signal $x(n)$ having the Z-transform (10)

$$X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$$

c) Determine the unit sample response of the system characterized by the difference equation (12)

$$y(n) = 2.5y(n-1) - y(n-2) + x(n) - 5x(n-1) + 6x(n-2)$$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2020
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BME 2231
Biomedical Instrumentation

Time: 1 Hour 30 Minutes **Full Marks: 120**

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

Section A

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

1. a) What is meant by Common Mode Rejection and briefly describe Common Mode Rejection Ratio (CMRR). (07)

b) You measure your ECG and found your ECG has a scalar magnitude of 0.53 mV on lead I and a scalar magnitude of 0.71 mV on lead II. Calculate the scalar magnitude on lead III. (05)

c) Briefly describe Wilson's central terminal. (08)

d) A student attempts to measure his own ECG on an oscilloscope having a differential input. For Figure 1(d) shown below, Z_{in} = 1 MΩ, Z_1 = 20 KΩ, Z_2 = 10 KΩ, Z_G = 30 KΩ and i_{db} = 1.5 μA. Calculate the power line interference the student observes. (10)

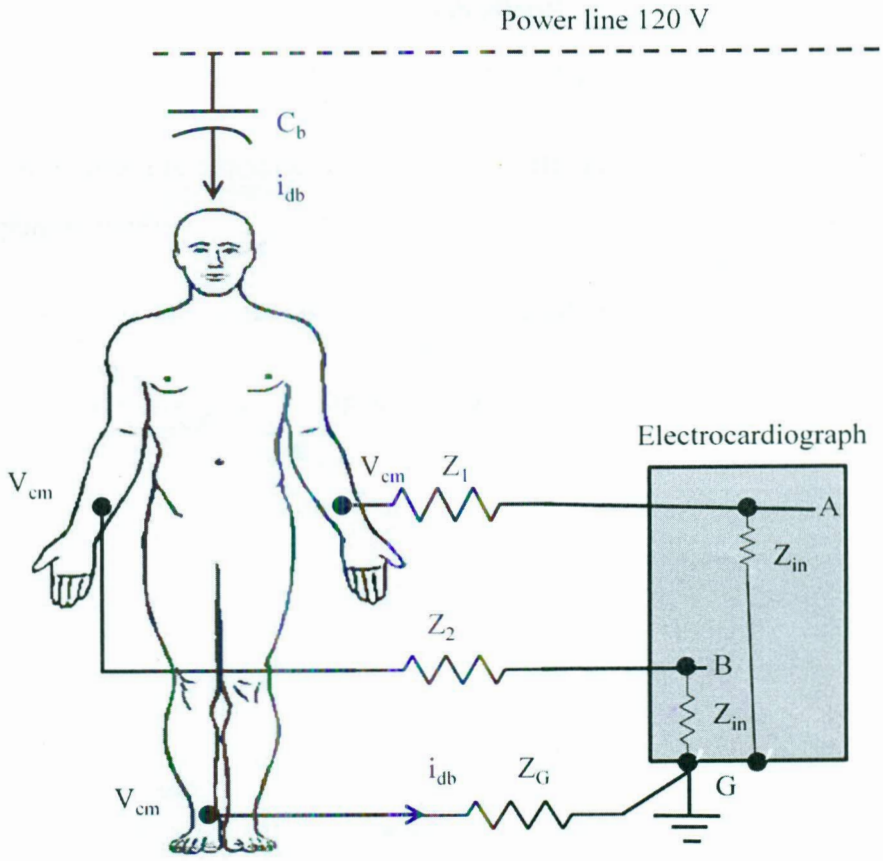

Figure 1(d)

2. a) Describe following Op-Amp circuits: (10)
   (i) Inverting/noninverting amplifier
   (ii) Voltage follower/buffer

   b) What is the principle of defibrillation? Describe a typical defibrillator circuit. (10)

   c) Explain the relationship of heart sounds to function of cardiovascular system. (10)

3. a) What is positive and negative pressure ventilator? (06)

   b) Define leakage current. Discuss different types of leakage currents. (12)

   c) What is meant by applied parts? Explain type B, BF, CF applied parts. (12)

Section B

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

4. a) What is sensor? Classify the biomedical sensors in term of the quantities that they measure. Briefly describe them. (08)

   b) What is meant by frequency response? Demonstrate typical frequency response of a transducer indicating bandwidth, flat frequency range, cutoff frequencies and resonant frequencies. (05)

   c) Why calibration is important in measurement system? (05)

   d) Describe the important points that should be considered to determine a transducer suitable for a specific measurement system. (12)

5. a) What is thermal transducer? Briefly describe the structure of RTD. (10)

   b) What is meant by fiber optic biosensor? Briefly describe the working principle and sensing details of a fiber optic biosensor. (12)

   c) What is Piezoelectric effect? Briefly describe the principle of Piezoelectric effect. (08)

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

   b) Briefly describe the immobilization methods used in detection element of different biosensors. (08)

   c) Sketch and briefly describe the working principle of a P_{CO2} electrode. (14)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2020
Department of Biomedical Engineering

Hum 2215
Economics and Sociology

Time: 1 Hour 30 Minutes **Full Marks: 120**

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

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

1. a) Define price elasticity of demand. Is the price elasticity of demand for white bread greater than the price elasticity for bread in general? Why? What general rule can we infer from this? (15)

b) From the specific supply equation $Q_s = 20P_x$ (P_x is given in \$). Derive (15)
(i) the producer's supply schedule and curve.
(ii) what things are kept constant in the given supply function?
(iii) what is the minimum price that this producer must be offered in order to induce him or her to start supplying commodity to the market?

2. a) What are some explicit and implicit costs incurred by an entrepreneur in running a firm? (05)

b) How does a firm in a perfectly competitive market, make sure that the firm is at risk position? Show it and explain necessary figure/figures. (15)

c) With reference to stage II of production, (10)
(i) why does the producer operate in stage II?
(ii) what factor combination within stage II will the producer actually use?

3. a) What are real and nominal GDP? Which is the better measure of economic well-being? Why? (15)

b) What are the best remedies for fighting inflation? (15)

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

4. a) Define culture. What are the basic elements of culture? (10)

b) Differentiate between culture and civilization. (20)

5. a) What is the relation between Industrialization and Urbanization? (15)

b) Explain what is social structure and its elements. (15)

6. a) What is family? (10)

b) Describe the function of family? (20)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year Backlog Examination, 2020
Department of Biomedical Engineering

Math 2215
Linear Algebra, Complex Variable and Vector Analysis

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) Define with examples the following matrices: (i) Elementary, (ii) Skew symmetric, and (iii) Hermitian. (10)

b) Define rank of a matrix. Compute the rank of the matrix $A = \begin{bmatrix} 1 & 2 & 1 & -1 \\ 9 & 5 & 2 & 2 \\ 7 & 1 & 0 & 4 \end{bmatrix}$ (12)

using minors. Also find the reduced row echelon form of A and verify your answer.

c) Using elementary row transformation, find the inverse of the matrix (13)

$$A = \begin{bmatrix} 3 & -2 & -1 \\ -4 & 1 & -1 \\ 2 & 0 & 1 \end{bmatrix}$$

2. a) Discuss the consistency of the following system of equations, and if found consistent, solve the system using the inverse of the coefficient matrix: (13)

$$2x + 3y + 4z = 11$$
$$x + 5y + 7z = 15$$
$$3x + 11y + 13z = 25$$

b) Examine whether or not the vectors $v_1 = [1, 2, 1, 4]$, $v_2 = [0, 1, 1, 1]$, and $v_3 = [2, 0, 1, 7]$ are linearly dependent and find a relationship for the vectors, if exists. (10)

c) Use Cayley-Hamilton theorem to find A^{-2} where $A = \begin{bmatrix} 2 & 3 & 4 \\ -3 & 1 & 2 \\ 3 & 4 & 5 \end{bmatrix}$ if possible. (12)

3. a) Is the function $u(x, y) = 2x - y^3 - 3x^2y$ harmonic? If so, find its conjugate harmonic function $v(x, y)$ and the corresponding analytic function $f(z)$. (13)

b) Identify different types of singularities of (11)

$$f(z) = \frac{z^5}{(z-2)^2(z+2i)} + \frac{z\sqrt{z-3}\, e^{\left(\frac{1}{z-2}\right)}}{sinz}$$

c) Evaluate $\oint_C \frac{f(z)}{z-3i} dz$ where C is the curve (i) $|z - i| = 1$, (ii) $|z - 1| + |z + 1|$ (11)

$= 13$, and (iii) $f(z) = e^{i\pi z}$.

4 a) Using the Cauchy-Riemann equations, show that the function $f(z) = \frac{1}{z}, z \neq 0$ (10)

is analytic at all point in the deleted neighborhood of $z = 0$.

b) Define simple closed curve and simply connected region. Evaluate $\int_C R_e(z^2)dz$ (12)

from $z = 0$ to $z = 2 + 4i$ along the (i) x-axis from 0 to 2 and then vertically to $2 + 4i$, and (ii) parabola $y = x^2$.

c) Evaluate $\oint_C \frac{e^{3z}}{(z - \pi i)^2} dz$ (13)

where C is the circle $|z - 1| = 4$ oriented in the positive sense.

Section B

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

5. a) A particle moves along the curve $x = 2t^2, y = t^2 - 4t, z = 3t - 5$, where t is time. Find the components of its velocity and acceleration at time $t = 1$ in the direction $\hat{\imath} - 3\hat{\jmath} + 2\hat{k}$. (10)

b) Find the curvature k and torsion τ for the space curve $x = t, y = t^2, z = (2/3)t^3$. (15)

c) Find the equation for the tangent plane and the normal line to the surface $4z = x^2 - y^2$ at the point (3, 1, 2). (10)

6 a) What is meant by directional derivative? Find the directional derivative of $x^2yz + z^2 + x$ at (1, -1, 2) for the direction $3\hat{\imath} - 4\hat{\jmath} + 5\hat{k}$. (10)

b) Use divergence theorem to evaluate $\iint_S (\bar{V}.\bar{n})\, dA$ (13)

where $\bar{V} = x^2z\hat{\imath} + y\hat{\jmath} - xz^2\hat{k}$ and S is the boundary of the region bounded by the paraboloid $z = x^2 + y^2$ and the plane $z = 4y$.

c) Evaluate $\iint_R (x^2 + y)\, dxdy$ (12)

where R is the region in the xy plane bounded by $x^2 + y^2 = 4$.

7 a) Determine whether or not the following vectors form a basis for the vector space R^3: (i) (1, 1, 1), (1, 2, 3), and (2, -1, 1) and (ii) (1, 1, 2), (1, 2, 5), and (5, 3, 4). (10)

b) Define inner product space and orthogonality of a vector space V. Prove that $|< u, v >| \leq \|u\|\|v\|$. (12)

c) Find the orthonormal basis of the subspace W of C^3 spanned by $v_1 = (1, i, 0)$ and $v_2 = (1, 2, 1, -i)$. (13)

8 a) Find all eigenvalues and corresponding eigenvectors of the matrix $A = \begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$. (16)

Also find the non-singular matrix P and a diagonal matrix D such that $D = P^{-1}AP$

b) Write down the condition of Inner product space. 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) Find the norm of $v = (1 - 2i, 1 + 2i)$. (07)