Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2021
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
ii) Figures in the right margin indicate full marks.

Section A

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

1. The values in Table 1 refer to the change in an individual's consumption of lemon and tea at home when the price of lemons rises (everything else including the price of tea, remaining the same): (35)

i) Define law of demand,
ii) Distinguish between shift in demand curve and movement along the demand curve,
iii) Draw the figure showing these changes, and
iv) Explain the figure drawn.

Table 1

	Before		After	
	Price (cents/unit)	Quantity (units/month)	Price (cents/cup)	Quantity (units/month)
Lemon	10	20	20	15
Tea	20	40	20	35

2. a) What is production possibilities frontier? Use a PPF to illustrate economic tradeoff between wheat and gun. (15)

b) Suppose, the demand function of a commodity x is $Q_{dx} = 50 - P_x$; and supply function of x is $Q_{sx} = 20 + 2P_x$. (10)
i) Obtain equilibrium price (P) and quantity (Q) of x.
ii) If the government imposes a sales tax of dollar 3 per unit sold to collect tax, what effect does this have on the equilibrium price (P) and quantity (Q)?

c) Technology and government policy do affect the supply of goods and services. How does it work, explain. (10)

3. a) Define opportunity cost and marginal cost with examples. (05)

b) Define market. For a given price, explain how the perfect competitive firm choose the best level of output that maximize profit. (20)

c) When do a perfect competitive firm decides not to run the firm in the short-run. Explain with necessary figure. (10)

4. a) What is GNP deflator and transfer payment? (05)

b) What is national income and personal income? What types of problem arises in calculating national income? (20)

c) How does government control inflation with monetary measures? (10)

Section B

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

5. a) Is sociology a science? Justify your answer with example from your own society. (10)

b) Explain the contributing factors behind origin and development of sociology. (10)

c) Explain the importance of studying sociology in BME. (15)

6. a) What is culture? Differentiate between culture and civilization. (10)

b) How does cultural lag creates social problems? (10)

c) Why is cultural relativism important? What are the ways of cultural diffusion? Discuss with example. (15)

7. a) What is development? How do you tell what country is more or less developed than the others? (10)

b) Define capitalism. How does capitalism work? (10)

c) Explain the forms of social change. What are the agencies of social change? Describe them with example. (15)

8. a) What do you understand by crime? Differentiate between white collar crime and victimless crime. (15)

b) Discuss the impact of urbanization on society. (10)

c) Explain the functions of family in modern industrial society. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2021
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
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Section A

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

1. a) Define cell, tissue, organ, and system. Write down the general characteristics of a cell. (10)
   b) Mention the name of the membranous and non-membranous cytoplasmic organelles. Write down the functions of smooth endoplasmic reticulum, lysosomes, golgi apparatus, and centrosome. (15)
   c) How lipid soluble and water soluble substances pass through a cell membrane? Explain with proper diagram. (10)

2. a) Mention the types of blood cells. Explain how does platelet act as a coagulant. (10)
   b) Discuss the classical pathway of blood coagulation with flow chart. (10)
   c) List the immunodeficiency disorders with their causes. Write down the types of immunity. (08)
   d) What are the types of graft? Why graft rejection occurs? (07)

3. a) Draw and label a neuron. Classify neurons with some examples and diagrams. (10)
   b) Define synapse. Write down the mechanism of synaptic transmission with proper diagram. (10)
   c) What is nerve impulse transmission? Why is it important for human? (10)
   d) Write short note on knee jerk. (05)

4. a) Define and classify receptor. Give the example of different types of exteroceptors. (15)
   b) Define neurotransmitters and neuromodulators. What are the differences between them? (10)
   c) Define reflex. Write down the name of different ascending and descending tracts of spinal cord. (10)

Section B

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

5. a) Write down the physiological properties of heart muscle. List the valve of human heart. (10)
   b) What are the differences between cardiac action potential and skeletal action potential with diagram? (12)
   c) What is ejection fraction? A 75 years old man has the high blood pressure 150/100 mm of Hg. His pulse rate is 98 b/m and his end diastolic volume is 145 ml. End systolic volume is 75 ml. Calculate his ejection fraction, stroke volume, and cardiac output. (13)

6. a) What are the volume and capacities of human lungs? Mention the normal ranges of lung volume and capacities with diagram. (10)
   b) Write down the formula of Charle's law, Boyle's law, and Dalton's law. If the partial pressure of O_2 in the gas is 100 mm of Hg (which is a normal alveolar volume), then calculate the concentration of dissolved oxygen by using pressure-solubility law. [Where solubility coefficient is 0.0031 ml/mm of oxygen/dl of blood] (15)
   c) Define saliva. Write down the composition and function of saliva. (10)

7. a) Mention the name of different bile salts with its function. Discuss about liver function test. (10)
   b) Define renal threshold. Discuss about the mechanism of dilute urine formation. (15)
   c) How can you quantify glucose load in PCT when blood glucose level is 120 mg/dl and GFR is 125 ml/min? (05)
   d) Calculate the clearance value, when the plasma concentration of a substance is 20 mg/dl, urine concentration is 12 mg/dl, and urine volume is 1 ml/min. (05)

8. a) How does gastric parietal cells secret HCl? What are the contents of gastric juice? (10)
   b) Who invent the ECG? Explain the ECG lead with Einthoven triangle. (10)
   c) What is JVP? Explain the calculation of the JVP from Figure 8(c). (10)
   d) Write short note on 'oxygen-haemoglobin dissociation curve'. (05)

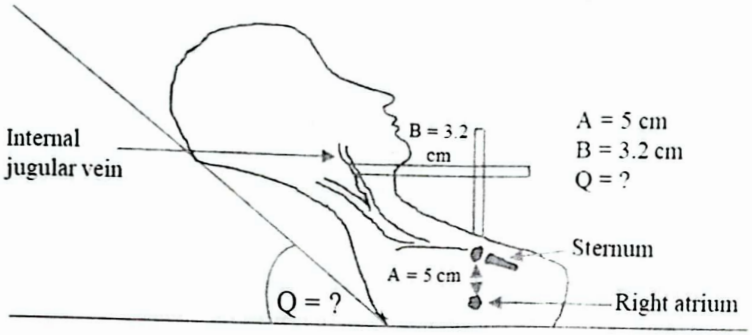

Figure 8(c)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2021
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) What is biomedical instrumentation? Describe generalized bioinstrumentation system with a suitable block diagram. (10)

   b) What is instrumentation amplifier? Why is it used instead of differential amplifier in an instrumentation circuit? Draw and calculate the differential gain of an instrumentation amplifier. (15)

   c) What is preamplifier? Why is it required in biomedical instrumentation? Discuss the requirements of a preamplifier. (10)

2. a) What is an ECG lead vector? Draw the vector diagram showing standard and augmented lead-vector directions in the frontal plane. (10)

   b) Draw electrode placement for EEG. (05)

   c) What is the origin of the EMG signal? Describe EMG acquisition system with block diagram. (12)

   d) A clinical staff member has attached a patient to an EEG machine for a sleep study that continuously displays the patient's EEG on a computer screen and stores it in memory. This staff member accidently used two different types of electrodes for the EEG lead and each electrode has a different source impedance. One had a relatively low impedance of 1500 Ω at EEG frequencies, while the other had a higher impedance of 4700 Ω. A ground electrode having an impedance of 2500 Ω was also used. The input impedance of each differential input of the EEG machine to ground was 10 MΩ and the instrument had a CMRR of 80 dB. The powerline displacement current to the patient was measured at 400 nA. The amplitude of the patient's EEG was 12 μV. (08)
   (i) How much common mode voltage will be seen on this patient and will it significantly interfere with the EEG signal?
   (ii) How much powerline interference will be seen on the patient's EEG?

3. a) Describe a typical square pulse defibrillator circuit and calculate the energy delivered to the thorax by a square pulse defibrillator. (12)

   b) Why is a stethoscope used for? Draw the typical frequency curve for a stethoscope. (08)

   c) What is meant by phonocardiogram? Describe the correlation of the four heart sounds with electrical and mechanical events of the cardiac cycle. (10)

   d) A physician is using rapid-injection thermodilution method of finding a patient's cardiac output. Calculate the cardiac output from the following data: (05)

$$V_i = 10\ ml,\ \Delta T_i = -30\ K,\ \rho_i = 1005\ kg/m^3,\ C_i = 4170\ j/(kg.K),$$
$$\rho_b = 1060\ kg/m^3,\ C_b = 3640\ j/(kg.K),$$
$$\int_0^{t_1} \Delta T_b dt = -5.0\ s.K$$

4. a) Describe the generalized model and the three necessary conditions for an electrical accident. (10)

   b) What are the major physiological effects of electrical current on human tissue? How to prevent an electric accident in a hospital? (15)

   c) Briefly describe cardiac pacemaker with a block diagram. (10)

Section B

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

5. a) Describe the basic requirements of a transducer. (13)

b) What is meant by output impedance? What should we do to avoid loading effects for interfacing a sensor circuit with a transducer? (10)

c) A sensor is designed for: 30°C to +80°C to output 2.5V to 1.2V. Determine range, span, and dynamic range. (06)

d) What is calibration? Why is calibration so important? (06)

6. a) Define physiological variable. Explain how electrical physiology is measured. (10)

b) What is RTD? Why platinum is frequently used in RTD? Briefly describe different structures of RTD. (13)

c) What is optical transducer? Briefly describe the operating principle of an optical pulse oximetry. (12)

7. a) Briefly describe the working principle of photodiode. (08)

b) Describe the working principle of an amperometric O_2 sensor. (12)

c) What is biosensor? Briefly describe different types of transducers used in biosensor. (15)

8. a) What is an enzyme electrode? Draw and describe the working principle of an enzyme electrode. (10)

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

c) Sketch and describe the working principle of a P_{CO_2} electrode. (15)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2021
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BME 2211
Signals and Systems

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 signal with an example. Classify signals and sketch each category. (12)

b) Find the signal energy or power of $x(t) = tri\left(\frac{t-3}{10}\right)$. (12)

c) Write short notes on: (i) step function, (ii) impulse function, and (iii) ramp function with necessary equations and figures. (11)

2. a) What is A/D conversion? Briefly explain the steps of A/D conversion. (12)

b) What is meant by system? Give example. Classify systems with a brief explanation. (12)

c) What is LTI system? The input $x(t)$ and the impulse response $h(t)$ of a continuous-time LTI system are given below: (11)

$$x(t) = u(t), \qquad h(t) = e^{-at}u(t), a > 0$$

Compute the output $y(t)$ of this system.

3. a) Consider the *RC* circuit shown in Figure 3(a). Find the relationship between the input $x(t)$ and the output $y(t)$ if: (10)
(i) $x(t) = v_s(t)$ and $y(t) = v_c(t)$
(ii) $x(t) = v_s(t)$ and $y(t) = i(t)$

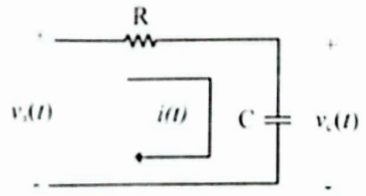

Figure 3(a)

b) Consider the RL circuit shown in Figure 3(b). Find a particular solution for this system with an input $x(t) = \cos(\omega_o t)\,V$. (13)

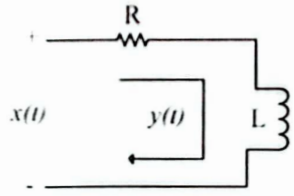

Figure 3(b)

c) Find the Laplace transform of $x(t) = e^{at}u(t)$ and depict the *ROC* and the locations of poles and zeros in *s*-plane. Assume that a is real and (i) positive and (ii) negative. (12)

4. a) Determine the forced response, natural response, and output of a system described by the differential equation (15)

$$\frac{d}{dt}y(t) + 3y(t) = 4x(t)$$

in response to the input $x(t) = \cos(2t)u(t)$ and the initial condition $y(0^+) = -2$.

b) Define system function. Check the stability of the system with characteristic equation: (12)

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$

c) Sketch pole-zero plot and the magnitude response of the system having the transfer function: (08)

$$H(s) = \frac{(s-0.5)}{(s+0.1-5j)(s+0.1+5j)}$$

Section B

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

5. a) Explain the relationship between z-plane and s-plane. (10)

b) Using DFT-IDFT method, find the circular convolution of given data sequences: (15)

$$x_1(n) = \{1, 3, -5, 7\};\ x_2(n) = \{2, 4, 6, -8\}$$

c) What is BIBO stable system? Determine whether the given systems are stable or not: (10)

(i) $h(n) = a^n u(n)$

(ii) $h(n) = 2^n u(n-3)$

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

b) Determine the unit step response of the system whose linear constant coefficient difference equation is (12)

$$y(n) + 3y(n-1) + 2y(n-2) = x(n) - 2x(n-1)$$

when the initial conditions are $y(-1) = 1;\ y(-2) = 0$.

c) Consider a causal and stable LTI system whose input $x(n)$ and output $y(n)$ are related through the third order difference equation: (11)

$$y(n) + \frac{5}{12}y(n-1) + \frac{1}{8}y(n-2) - \frac{1}{24}y(n-3) = x(n)$$

Determine:

(i) The frequency response of the system

(ii) The impulse response of the system.

7. a) Determine the IDTFT of (10)

$$X(e^{j\omega}) = 2cos2\omega;\ -\pi < \omega < \pi$$

b) Calculate the DFT of the sequence {0, 1, 1, 0} using the decimation-in-time (Cooley-Tukey) FFT algorithm. (15)

c) Using residue method, find the inverse z-transform of (10)

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

8. a) The impulse response $h(n)$ and input $x(n)$ of a LTI system are respectively: (14)

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

Determine the response of the system using graphical convolution.

b) Using partial fraction method, determine the inverse z-transform of (10)

$$X(z) = \frac{1 + z^{-1}}{1 - z^{-1} + 0.5z^{-2}}$$

c) Find the constant coefficient difference equation, if the input $x(n)$ and output $y(n)$ of the system are given below respectively: (11)

$$x(n) = \left(\frac{1}{2}\right)^n u(n);\qquad y(n) = \left(\frac{1}{2}\right)^n u(n) + 2\left(\frac{1}{3}\right)^n u(n).$$

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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
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Section A

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

1. a) Discuss four cases with example about the arithmetic operations and rules in matrices which are different significantly from the arithmetic operations and rules in real numbers. (13)

b) Partition the following matrices A and B in such a way that null entries are separated efficiently. Using partitionery rule, find the product of the following two matrices A and B such that they are conformate for multiplication. Express product matrix in notation form and find only the elements at the position (2, 1) and (2, 2). (14)

$$A = \begin{bmatrix} 1 & 2 & 3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 2 & 2 & 2 \end{bmatrix}, B = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

c) Define with example and point out three important properties of: (08)
(i) Symmetric matrix,
(ii) Singular matrix.

2. a) If $Kx + y = 2$; $2x + 3y = K$, then what value of K the system of linear equation has (i) no solution; (ii) unique solution; and (iii) many solutions. If exist, find the unique solution and many solutions corresponding to each suitable numerical value of K. (15)

b) Reduce the following matrix to its echelon form, canonical form, and finally normal form. (20)

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

Hence find its rank.
If each row of matrix A be the vectors X, Y, and Z respectively. Are the vectors linearly independent, why? If possible, express the vectors as a linear combination.

3. a) Test whether the following matrix is invertible or not. If possible, find the inverse of the following matrix using elementary transformation: (13)

$$A = \begin{bmatrix} 1 & 20 & 2 \\ 2 & -1 & 3 \\ 4 & 1 & 8 \end{bmatrix}$$

b) Given $2x - y + 3z = 0$; $3x + 2y + z = 0$; $x - 4y + 5z = 0$. If $BX = 0$, where 'B' is the coefficient matrix and $X = [x, y, z]^t$ of the above system of linear equations, then find nullity and the basis of the null space. Also sketch the solution space. (11)

c) Find all the eigen values and the eigen vectors corresponding to the largest eigen value of the matrix: (11)

$$\begin{bmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 2 & 3 \end{bmatrix}$$

4. a) Given a vector $A(1, 1, 1)$, using matrix 4×4 operator, shift it uniformly 3 units in positive direction. Then, using rotational 3×3 matrix operator, rotate it 180^o in anti-clockwise about x axis and finally scale unequally with 2, 3, and 4 along x, y, and z axes respectively. Draw original and modified (image) vector after each operation (transformation). If the order of matrix operators are being interchanged. Are the modified points (final stage) have same position (for both cases), why? (14)

b) A particle moves along the path $x = 12t^2 + 2$; $y = 6t$; and $z = 2$. Find velocity, acceleration, tangential vector, normal vector, and radius of curvature at $t = 0$. (15)

c) Define (i) vector point function and (ii) vector space. (06)

Section B

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

5. a) Find the roots of $(3\sqrt{2} - 3i)^{\frac{1}{2}}$ and locate them graphically. (12)

b) Represent graphically the set of values of z for which $\left|\frac{z-3}{z+3}\right| < 5$ (09)

c) Evaluate each of the following: (14)

(i) $\lim_{z \to 2e^{\frac{\pi i}{3}}} \frac{z^3 + 8}{z^4 + 4z^2 + 16}$

(ii) $\lim_{z \to 0} \frac{1 - cosz}{sinz^2}$

6. a) Write down the criterion for analyticity of a complex function. Construct the analytic function $f(z)$ for which the real part is $e^{2x}(xcos2y - ysin2y)$ by using Milne-Thompson method. (15)

b) Define derivative of a complex function. Prove that $f(z) = z^2\bar{z}$ is not differentiable anywhere in the complex plane. (12)

c) Prove that $\psi = ln[(x-1)^2 + (y-2)^2]$ is harmonic in every region which does not include the point (1, 2). (08)

7. a) Define branch point with example. Locate and classify all the singular points in the finite z plane of the following functions: (15)

(i) $f(z) = \frac{\ln(z + 3i)}{(z^2 - 2z + 5)^2}$

(ii) $h(z) = cosec\left(\frac{1}{z^2}\right)$

b) Evaluate $\int_i^{2-i} (3xy + iy^2)dz$ along the curve $x = 2t - 2, y = 1 + t - t^2$. (10)

c) Using Cauchy's integral formula, evaluate $\oint_C \frac{e^{z^2}}{(z-1)^3} dz$, where C is the circle $|z - i| = 1$. (10)

8. a) Find the values of constants λ and μ so that the surfaces $\lambda x^2 - \mu yz = (\lambda + 2)x$ and $4x^2y + z^3 = 4$ intersect orthogonally at the point (1, -1, 2). (14)

b) Evaluate $\iint_S \vec{F}.\vec{n}\, dS$ where $\vec{F} = 2xy\hat{\imath} + yz^2\hat{\jmath} + xz\hat{k}$ and S is the surface of the region bounded by $x = 0$; $y = 0$; y= 3; $z = 0$; and $x + 2z = 6$. (12)

c) Evaluate $\oint_C \bar{F}.d\bar{r}$ where $\bar{F} = (x - 3y)\hat{\imath} + (y - 2x)\hat{\jmath}$ and C is the closed curve in the xy plane: $x = 2cost$; $y = 3sint$ from $t = 0$ to $t = 2\pi$. (09)