Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2017
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.
        ii) Figures in the right margin indicate full marks.

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

1. a) Describe a generalized medical instrumentation system.   (13)

    b) Draw and calculate the differential gain of an instrumentation amplifier.   (12)

    c) Why instrumentation amplifier is used instead of differential amplifier for biopotential   (05)
        acquisition?

    d) Mention some applications of biomedical instrumentation systems.   (05)

2. a) What are the requirements of a biopotential preamplifier? How these are achieved in an ECG (10)
        circuit?

    b) What are the noises associated with the ECG acquisition? Briefly describe them.   (10)

    c) The output of a biopotential preamplifier that measures the EOG is an undesired dc voltage (10)
        of $\pm 5V$ due to electrode half-cell potentials, with a desired signal of $\pm 1V$ superimposed.
        Design a circuit that will balance the DC voltage to zero and provide a gain of -10 for the
        desired signal without saturating the Op-amp.

    d) Draw 10-20 electrode system for EEG signal acquisition.   (05)

3. a) What are the differences between leads and electrodes? Briefly describe ECG leads.   (10)

    b) Briefly describe the working principle of a pacemaker. Mention different types of pacemaker (10)
        and compare them.

    c) How can you measure blood flow, velocity, pressure and volume? Mention at least two   (10)
        method of each.

    d) Calculate the cardiac output, given the following data: Spirometer O_2 consumption -   (05)
        250 ml/min; arterial O_2 content - 0.20 ml/ml; venous O_2 content - 0.15 ml/ml.

4. a) Describe instrumentation for electromagnetic blood flow meter.   (10)

    b) What are the major physiological effects of electrical current on human body?   (09)

    c) What is meant by applied parts of medical device? Explain type B, BF and CF applied parts. (08)

    d) Write short notes on: (08)
        (i)   Phonocardiography.
        (ii)   Plethysmography.

5. a) Define sensor and transducer. Mention the performance terminologies of sensors. (10)

    b) What is calibration? Why calibration is so important? (07)

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

    d) A sensor is designed for -30°C to +80°C to output 2.5V to 1.2V. Determine Range, Span and (06) Dynamic range.

6. a) Classify the electrochemical transducer according to detection approach. Describe working (12) principle of any one of them.

    b) Draw a schematic diagram of silicon microstrip detector. Describe the operating principle of (13) microstrip detector.

    c) Write short notes on (any two): (10)
        (i)   Physico-chemical transducer.
        (ii)   Ion selective electrode.
        (iii) Silicon detector radiation damage.

7. a) What do you mean by an optical transducer? Describe the operating principle of optical pulse (13) oximetry.

    b) What is thermocouple? Briefly describe the working principle of thermocouple. (10)

    c) What do you mean by piezoelectric sensor? Briefly describe the piezoelectric effect. (07)

    d) Mention the immobilization methods used in detection elements of biosensor. (05)

8. a) Describe the working principle of a glucose biosensor. (12)

    b) Sketch and briefly describe the working principle of P_{O_2} electrode. (11)

    c) Write short notes on: (12)
        (i)   Inhibition based electrode.
        (ii)   Bi-enzyme electrode.

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2017
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. a) What are the basic problems of an economic organization? Explain.   (10)

    b) Describe various economic systems to solve the basic problems.   (15)

    c) Explain production possibilities frontier on the basis of choices, scarcity and opportunity   (10)
        cost.

2. a) Explain the determinants of supply.   (15)

    b) Solve the problems: (20)

        There are 10,000 identical individuals in the market for commodity X, each with a demand
        function is given by $Q_{dx} = 12 - 2P_x$ and 1,000 identical producers of commodity X, each
        with a supply function is given by $Q_{sx} = 20P_x$.

        (i)   Obtain equilibrium price and quantity.

        Now, if the government decides to collect a sales tax of $2 per unit sold from each of the
        1,000 identical sellers-

        (ii)   What effect does this have on the equilibrium price and quantity?

        (iii)   Who actually pays the tax?

        (iv)   What is the amount of tax collected by the government?

3. a) What do you mean by production and production function?   (05)

    b) List and describe the main factors of production.   (15)

    c) What is project and project evaluation? What are the main methods of project evaluation?   (15)

4. a) Define price-elasticity of demand. Explain the types of price-elasticity of demand.   (15)

    b) The "Karim Brothers" is a publisher of romance novels. The corporation hired an economist (20)
        to determine the demand for its product. After months of hard work the economist informed
        the company that the demand for the firm's novel is given by the following equation:

        $$Q_X = 12,000 - 5,000P_x + 5I + 500P_c$$

        Where,
                Q_X is the demand from "Karim Brothers" novels.
                P_x is the price charged for the novels.
                I is the income per capita.
                P_c is the price of books from competing publishers.

        Assume that the initial values of P_x, I and P_c are $5, $10,000 and $6 respectively.

        Using the above information, the company's manager wants to

        (i)   Determine what effect a price increase would have on total revenue.

        (ii)   Evaluate how sales of the novels would change during a period of rising income.

        (iii)   Assess the probable impact if competing publishers would raise their price.

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) Do you think the knowledge of sociology has impact on students of Biomedical Engineering? (15)
    Give reason in favor of your opinion with example.

6. a) What is cultural lag? Describe the impact of cultural lag in Bangladesh culture and society. (10)

    b) Define culture. Explain carriers of culture with example. (15)

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

7. a) "Functions of family is lost or modified"- What do you think? Explain in the light of post-modern society. (15)

    b) What is juvenile delinquency? Explain causes of juvenile delinquency in the light of rapid urbanization and industrialization. (20)

8. a) Explain the relationship between Industrialization and Urbanization. (10)

    b) How can you measure degree or level of urbanization? (10)

    c) What are the empirical consequences of urban living? (15)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2017
Department of Biomedical Engineering
Math 2215
Linear Algebra, Complex Variables 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)   What do you mean by homogeneous system of linear equation? How many types of solution   (06)
          are there exist for a homogeneous system of linear equation?

     b)   When a system of non-homogeneous linear equations is said to be consistent? Ascertain   (16)
          whether the following system is consistent; if it is, find all solutions

$$x_1 + x_2 - 2x_3 + x_4 = 1$$
$$2x_1 - x_2 + 2x_3 + 2x_4 = 2$$
$$3x_1 + 2x_2 - 4x_3 - 3x_4 = 3$$

     c)   Determine the polynomial $p(x) = a_0 + a_1 x + a_2 x^2$ whose graph passes through the points   (13)
          $(1, 4), (2, 0)$ and $(3, 12)$.

2.   a)   Is inverse exists for all matrices? Explain it. Reducing A to I find the inverse of the following   (17)
          matrix by using only row transformation

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

     b)   Is unit matrix idempotent? Show that   (08)

$$A = \begin{bmatrix} cos\theta & 0 & sin\theta \\ 0 & 1 & 0 \\ -sin\theta & 0 & cos\theta \end{bmatrix}$$

          is an orthogonal matrix.

     c)   When two matrices are conformable for multiplication? Find row rank of A, where   (10)

$$A = \begin{bmatrix} 0 & 1 & 3 & -2 & -1 \\ 0 & 2 & 6 & -4 & -2 \\ 0 & 1 & 3 & -2 & 1 \\ 0 & 2 & 6 & 1 & -1 \end{bmatrix}$$

3.   a)   Find basis and dimension of the subspace W of V spanned by the matrices   (12)

$$A = \begin{bmatrix} 1 & 2 \\ 1 & 2 \end{bmatrix}, \qquad B = \begin{bmatrix} 1 & 1 \\ 2 & 2 \end{bmatrix} \quad and \quad C = \begin{bmatrix} 2 & 3 \\ 3 & 4 \end{bmatrix}$$

          Where V be the vector space of 2×2 matrices over the real field $\Re$.

     b)   Define analytic function and write the sufficient condition for analyticity of a function.   (10)

     c)   Verify the continuity and differentiability of $f(z) = \bar{z}$ at origin.   (13)

4.   a)   Define orthonormal set of vectors. By using Gram Schmidt process orthonormalize the family   (17)
          of vectors

$$v_1 = (\frac{i}{\sqrt{3}}, \frac{i}{\sqrt{3}}, \frac{i}{\sqrt{3}}) \qquad v_2 = (0, i, 0) \qquad v_3 = (0, 0, -i)$$

     b)   Find the eigenvalues and eigenvectors of the matrix   (18)

$$A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{bmatrix}$$

          Also find the matrix P which diagonalize the matrix A. Determine $P^{-1}AP$.

Page 1 of 2

5. a) Show that $u = 3x^2y + 2x^2 - y^3 - 2y^2$ is harmonic. Find v such that $f(z) = u + iv$ is   (12)

    analytic. Hence express $f(z)$ in terms of z.

    b) Evaluate $\oint_C \dfrac{dz}{z(z^2+9)}$, where C is the square bounded by $x = \pm 2$ and $y = \pm 2$.   (10)

    c) Evaluate $\oint_C \dfrac{ze^{tz}}{(z+1)^3} dz$, where C is a simple closed curve enclosed the point $z = -1$.   (13)

6. a) Define with an example: (15)
      (i) Removable singular point.
      (ii) Pole.
      (iii) Essential singular point.

    b) Determine whether the following vectors are linearly independent   (08)
    $$\underline{A} = 2\underline{i} + \underline{j} - 3\underline{k}, \quad \underline{B} = \underline{i} - 4\underline{k}, \quad \underline{C} = 4\underline{i} + 3\underline{j} - \underline{k}$$

    c) Two rectangular xyz and $x'y'z'$ coordinates systems having the same origin are rotated with   (12)

    respect to each other. Derive the transformation equations between the coordinates of a point

    into the two systems.

7. a) If $\underline{\nabla}\Phi = 2xyz^3\underline{i} + x^2z^3\underline{j} + 3x^2yz^2\underline{k}$, find $\phi(x,y,z)$ when $\phi(1,-2,2) = 4$.   (10)

    b) Find directional derivative of $P = 4e^{2x-y+z}$ at the point $(1,1,-1)$ in a direction toward the   (12)
     point $(-3, 5, 6)$.

    c) Find the most general differential function $f(r)$ so that $f(r)\,\underline{r}$ is solenoidal.   (13)

8. a) State Stokes' theorem.   (05)

    b) Using Green's theorem evaluate $\oint_C (xy + y^2)dx + x^2 dy$, where C is the closed curve of the   (10)

    region bounded by $y = x$ and $y = x^2$.

    c) Verify the divergence theorem for $\underline{A} = 4x\underline{i} - 2y^2\underline{j} + z^2\underline{k}$ taken over the region bounded   (20)

     by $x^2 + y^2 = 4$, $z = 0$ and $z = 3$.

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 do you mean by fundamental period of continuous-time signal? Test whether the given (08)
signal is periodic or not: $x(t) = cost + sin\sqrt{2}t$.

   b) Define signal. Draw the even and odd signals of the signal shown in Fig. 1(b). _____ (09)

   c) Define the following signal mathematically and represent graphically (12)
      (i)   Exponential signal.   (iii) Impulse signal.
      (ii) Step signal.   (iv)   Ramp signal.

   d) The input-output relation is given by $y(t) = tx(t)$. Determine whether the system is time-variant (06)
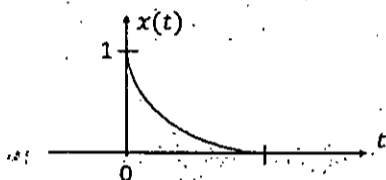or not.

Fig. 1(b)   Fig. 2(a)

2. a) Find $x(3t + 2)$ and $x(\frac{t}{3} + 2)$ for the given signal $x(t)$ shown in above Fig. 2(a). (10)

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

   c) What is Fourier transform? Determine the Fourier transform of the signal (13)
$$x(t) = e^{-at}sin\omega_0t\, u(t)$$

3. a) What do you mean by continuous-time Fourier series? Determine the Fourier series coefficients (16)
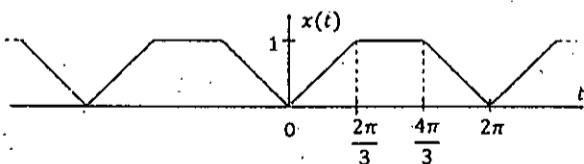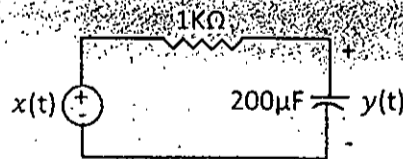(exponential representation) of the signal shown in Fig. 3(a).

Fig. 3(a)   Fig. 4(b): RC circuit with RC = 0.2 s

   b) Determine the Laplace transform of $x(t) = e^{at}u(t)$ and depict the ROC and the locations of (10)
poles and zeros in the s-plane. Assume that a is real.

   c) Find the inverse unilateral Laplace transform of (09)
$$X(s) = \frac{2s^3 - 9s^2 + 4s + 10}{s^2 - 3s - 4}$$

4. a) What do you mean by frequency response function? Determine the initial and final values of a (09)
signal $x(t)$ whose unilateral Laplace transform is
$$X(s) = \frac{7s + 10}{s(s + 2)}$$

   b) Use the Laplace transform to find the voltage across the capacitor $y(t)$, for the RC circuit (12)
depicted in above Fig. 4(b) in response to the applied voltage $x(t) = \frac{3}{5}e^{-2t}u(t)$ and the initial
condition $y(0^-) = -2$.

c) A system has the transfer function (08)

$$H(s) = \frac{2}{s+3} + \frac{1}{s-2}$$

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

d) Find a differential-equation description of the systems described by the following transfer functions: (06)

(i) $H(s) = \dfrac{s^2 - 2}{s^3 - 3s + 1}$ (ii) $H(s) = \dfrac{2(s+1)(s-1)}{s(s+2)(s+1)}$

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

5. a) An LTI system has impulse response $h[n] = \{0, 1, 5, 9, 3\}$. What will be the output of the system (10) when excitation $x[n] = \{1, 3, 0, 8\}$.

b) Check whether the following system is linear, time invariant and LSI? Also find its impulse (09) response: $y[n] = nx[n] + x[2-n]$

c) Determine whether the following LSI system has memory, causality and stability from its impulse (10) response $h[n] = (-1/2)^n u[n] + 2^n u[1-n]$.

d) Show that impulse response of a discrete time LTI system is the first difference of its step (06) response.

6. a) State Nyquist-Shanon Sampling theorem. Give a detail mathematical analysis for the theorem. (15)

b) Is it possible to reconstruct a continuous time signal from its samples taken at uniform time (13) interval? Briefly explain reconstruction process and the difficulties associated with it.

c) What is aliasing effect? What is meant by discrete-time processing of continuous-time signals? (07)

7. a) The following facts about a sequence $x[n]$ are given : (10)
   (i) $x[n]$ is periodic with period $N = 8$.
   (ii) $\sum_{n=0}^{7} x[n] = 3$;
   (iii) $\sum_{n=3}^{10} (-1)^n x[n] = 1$; and
   (iv) $x[n]$ has the minimum power per period.

   Determine the sequence $x[n]$.

b) An LTI system with impulse response $h[n] = (0.8)^n u[n]$; what will be the output of the system (12) when excitation $x[n] = \cos(\frac{2\pi n}{N})$? [Use Fourier analysis techniques]

c) How can you use an existing low pass filter as a high pass filter? Justify it using multiplication (13) property of Fourier transform.

8. a) Briefly explain the advantages of using z-transform instead of DT Fourier transform. (05)

b) An LTI system is characterized by system function (12)

$$H(z) = \frac{3 - 4z^{-1}}{1 - 3.5z^{-1} + 1.5z^{-2}}$$

Specify the ROC of the $H(z)$ and determine $h[n]$ for the following conditions:
(i) Stable system, (ii) Causal system and (iii) Anticausal system

c) Determine the system function for the causal LTI system with difference equation, (13)

$$y[n] - \frac{1}{2}y[n-1] + \frac{1}{4}y[n-2] = x[n]$$

Also using z-transforms, determine $y[n]$ if $x[n] = \left(\frac{1}{2}\right)^n u[n]$.

d) Determine first three terms of $x[n]$ from the transfer function: (05)

$$X(z) = \frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}} \; ; Roc: |z| > 1$$

Using power series expansion method.

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2017
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) Enumerate the physiological importance of endoplasmic reticulum, ribosome and (15)
      mitochondria.

    b) Describe briefly about diffusion.   (10)

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

2. a) Suppose, you are working on a lab that deals with the origin of life. Suddenly, you receive a (10)
      bacterial cell. How could you differentiate the bacterial cell from human cell?

    b) Define reflex arc. Draw and label the reflex arc.   (10)

    c) What is haemophillia? Why it is rare in female, explain it.   (10)

    d) Write a short note on Na^+ K^+ pump.   (05)

3. a) Draw and label a typical cell membrane. Explain the functions of the cell membrane in details. (10)

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

    c) What is blood? Give the composition of blood. Enumerate the functions of blood.   (10)

    d) Write short notes on: (05)
        (i)   Neutrophil.
        (ii)   Basophil.

4. a) What is membrane potential? Enumerate the importance of membrane potential.   (10)

    b) Show the pathway of direct and indirect Light reflex.   (10)

    c) Write down the pathway of smell.   (10)

    d) Explain how lipid soluble and water soluble substances passing through a membrane.   (05)

5. a) Define cardiac cycle. What are the parameters of cardiac cycle? Draw and label the various (15) parameters of cardiac cycle and mention the phases of cardiac cycle.

    b) What is conductive system of heart? Write down the pathway of conduction system of heart (10) using a flowchart.

    c) State the properties of cardiac muscle (05)

    d) Write a short note on QRS axis (05)

6. a) What are the contents of gastric juice? Describe the regulation of HCl secretion by gastric (15) parietal cell with net sketch.

    b) What are the major organ and accessory gland of GI tract? List the digestive enzyme with (10) their functions.

    c) How carbohydrate is digested in GI tract? What is the end product of carbohydrate digestion? (05)

    d) Write short notes on: (05)
        (i) Gastric parietal cell
        (ii) ECL cell

7. a) Write down the four systems used for Elimination in human body. Describe the mechanism (15) of Urine formation with net sketch.

    b) Discuss the Renal Regulation of blood pressure. (10)

    c) Draw and label the different parts of a nephron. (05)

    d) Write short notes on net filtration pressure and GFR. (05)

8. a) Describe the lungs volume and capacity with proper diagram. (10)

    b) What is the physical principal of Gas Exchanges? Describe the partial pressure with the (10) equation.

    c) Write short notes on:
        (i) Henry's Law.
        (ii) Dalton's Law.
        (iii) Frank-Starling Law of the heart.