Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2023
Department of Biomedical Engineering

Ch 1115
Chemistry

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 thermo-setting polymer with some examples. Correlate the thermo-setting property with the structure of polymer. (08)

b) What are the three main steps of polymerization reaction? Describe them in brief with suitable examples. (08)

c) Write notes on the preparation, properties and uses of the following: (12)
(i) Urea formaldehyde resin
(ii) Low density polyethylene
(iii) Bakelite

d) What do you understand by co-polymer? Distinguish between homo polymer and co-polymer. (07)

2. a) Give a brief account of the structure of nucleus. How is stability of nucleus related with nuclear structure? (10)

b) What is radioactivity? State and explain the group displacement law in radioactivity. (08)

c) What is mass defect? How is it related to the binding energy and stability of the nucleus? (10)

d) Calculate the binding energy per nucleon (in MeV) in $^{4}_{2}He$ which has a mass of 4.00260 amu. (Mass of a neutron = 1.008655 amu and mass of one proton = 1.007825 amu). (07)

3. a) State the law of photochemical equivalence. Explain the significance of the terms involved in the equation. (08)

$$E = \frac{Nhc}{\lambda}$$

b) Explain the causes of high and low quantum efficiency of photochemical reactions. (10)

c) Write short notes on the following: (12)
(i) Primary and secondary photochemical reactions
(ii) Lambert and Beer's law
(iii) Chain reaction

d) The quantum yield for the reaction $2HI \rightarrow H_2 + I_2$ is 2. Calculate the number of photons absorbed in an experiment in which 0.01 moles of *HI* are decomposed. (05)

4. a) Define binding energy of a nucleus. Explain with the help of binding energy curve, the stability of a nuclei. (10)

b) What is meant by photosensitized reactions? Differentiate between Fluorescence and phosphorescence. (12)

c) What is conducting polymer? Write down the advantages of conducting polymer over conventional polymer. (13)

Section B

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

5. a) Define electrode & electrode potential. Illustrate with reaction mechanism the working principle of glucose sensor. (13)

b) What is EMF? Derive the relation between free energy and EMF. (10)

c) Find the pH of a solution placed in a hydroquinone half-cell which was coupled with standard calomel electrode. The emf of the combined cell was determined to be 0.123V at 25°C. (07)

$$E_{calomel} = 0.2415\ \text{V};\ E_Q^o = 0.6996\ \text{V}$$

d) Explain zeta potential. (05)

6. a) What is fuel cell? How proton exchange membrane fuel cell works? Explain. (10)

b) Mention the differences between battery & capacitor. (08)

c) Explain lithium-polymer battery with reaction mechanism. (10)

d) What current strength in amperes will be required to liberate 10 g of iodine from potassium iodide solution in one hour? (07)

7. a) What is unit cell? Write down the lattice parameters of seven primitive unit cells with one example each. (09)

b) Deduce Bragg's equation and explain its importance in crystallography. (10)

c) The unit cell of metallic gold is face-centered cubic. (07)

(i) How many atoms occupy the gold unit cell?

(ii) What is the mass of a gold unit cell?

d) Draw crystal planes with following Miller indices: $(3\bar{2}1)$, $(21\bar{4})$. (09)

8. a) What is Dropping Mercury Electrode (DME)? Explain the characteristics of DME. (10)

b) What is polarogram? Explain the different regions of the current-voltage curve in direct current polarography. (10)

c) Define AC polarography. Mention the advantages of AC polarography over DC polarography. (07)

d) Briefly explain diffusion, migration and convection current in electrochemistry. (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2023
Department of Biomedical Engineering

EEE 1115
Electrical Circuits

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 the following terms mathematically with their applications: voltage, current, electric power, and electric energy. (08)

b) State KVL and KCL with their circuit arrangement. State and explain Ohm's law. (10)

c) From the circuit shown in Fig. 1(c), find all currents. Given: $R_1 = 5\ \Omega$, $R_2 = 6\ \Omega$, $R_3 = 7\ \Omega$, $R_4 = 3\ \Omega$, $R_5 = 4\ \Omega$, $R_6 = 1\ \Omega$, $E = 10$ V. (12)

d) Calculate the energy stored in each capacitor in the circuit shown in Fig. 1(d). (05)

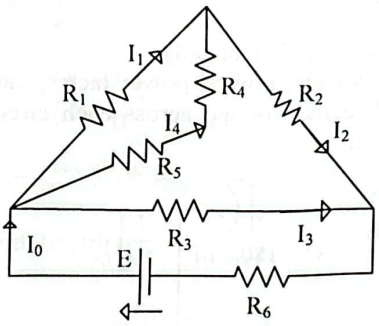

Fig. 1(c)

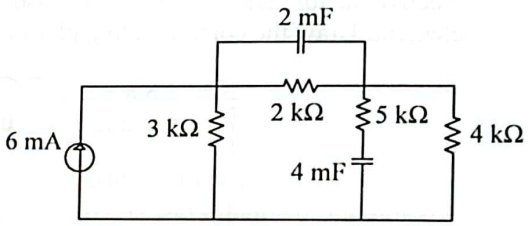

Fig. 1(d)

2. a) Explain Millman's theorem. (07)

b) Let's say you have a Y-network. It is required to convert it into Δ-network. Develop the necessary equations. (10)

c) Explain branch current method to analyze electrical networks. (08)

d) Find the Thevenin's and Norton's equivalent of the circuit shown in Fig. 2(d). (10)

3. a) Using superposition theorem, find v_o in the circuit in Fig. 3(a). (09)

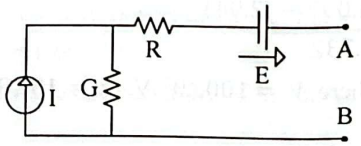

Fig. 2(d)

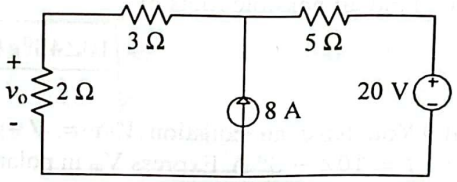

Fig. 3(a)

b) In the network shown in Fig. 3(b), $E_A = 30$ V, $E_B = 20$ V, $E_C = 5$ V, $E_D = 10$ V, $R_A = 20\ \Omega$, $R_B = 10\ \Omega$, $R_C = 30\ \Omega$, $R_D = 40\ \Omega$, $R_E = 50\ \Omega$, $R_F = 25\ \Omega$. Calculate mesh currents. (10)

c) Using Thevenin's theorem, find the equivalent circuit to the left of the terminals in the circuit shown in Fig. 3(c). Then find the current, *i*. (11)

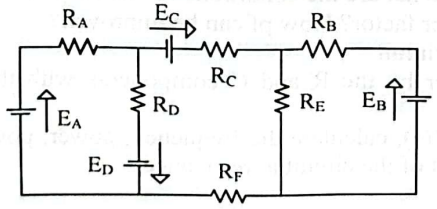

Fig. 3(b)

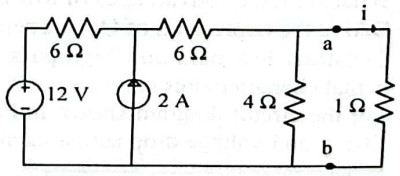

Fig. 3(c)

d) Derive Biot-Savart Law and write Ampere's Law for magnetic circuit. (05)

4. a) Define the following terms mathematically: magnetic field, electric field, flux, permeability, reluctance, and flux density. (12)

b) A magnetic circuit consists of a wrought-iron rod, 1.5 inch in diameter and 30 inch long, bent into a semicircle, and a cast-iron slab, 2 inch thick and 4 inch wide. How many ampere-turns will be required to establish a flux of 0.002 weber? Draw the magnetic circuit arrangement. (10)

c) Draw the magnetic core with parallel branches and hence write the equation of flux and mmf. The dimensions of the magnetic core that you have drawn are as follows- over-all: 28 inch by 16 inch; each window: 8 inch square; thickness of the core: 4 inch; material: sheet-steel laminations. Find the number of ATs on centre leg to establish a flux of 1600 kilolines. (13)

Section B

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

5. a) Define phase (lead and lag), impedance, admittance, reactance, and succeptance including their units. (10)

b) Find the angle of phase difference between $v = 100cos(\omega t - 30^0)$ and $i = -10sin(\omega t - 60^0)$. Which wave lags? (05)

c) Mention the name of essential electrical meters and their connection with circuit and applications. (09)

d) Let us suppose that you have a series R-L circuit and it is energized by a 50-cycle sinusoidal voltage having maximum value of 150 volts. Given R = 10 Ω and L = 0.05 h. Find the expression of impedance, instantaneous voltage and currents. What is the value of power factor of this circuit. (11)

6. a) Define RMS value and average value of a sinusoid mathematically. (05)

b) For the circuit shown in Fig. 6(b), determine current, power, power factor, vars, reactive factor, and voltamperes. Also calculate the voltage across each circuit element. Draw the corresponding phasor diagram. (16)

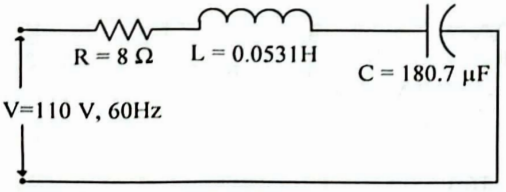

Fig. 6(b)

c) One branch of a parallel circuit consists of 6 Ω resistance, 48 Ω inductive reactance, and 40 Ω capacitive reactance, while the other branch consists of a resistance of 7 Ω and a capacitive reactance of 2 Ω. Find the total and branch currents when 100 volts are applied across the entire circuit. Calculate total power and power absorbed by branches. (14)

7. a) Find all possible roots of (10)

$$\sqrt[3]{\frac{10\angle 45^0 e^{j60}(-4.097 - j2.94)}{1 - j1.732}}$$

b) You have an equation $Vm = V - ZI$ where $V = 100\angle 0^o$ V, $Z = 15\angle 80^o$ Ω, $I = 10\angle -3^o$ A. Express V_m in polar form. (10)

c) Show that the circuit in Fig. 7(c) is in resonance for all frequencies when (15)

$$R_L = R_C = \sqrt{\frac{L}{C}}$$

What is the value of resistant impedance for the above case?

8. a) Explain series and parallel resonances. What are the conditions to ensure them? (05)

b) What are the disadvantages of low power factor? How pf can be improved? (07)

c) Derive the expression of Q for a series circuit. (05)

d) Construct low-pass and high-pass filter by the R and C components with their actual characteristics curve. (08)

e) For the circuit diagram shown in Fig. 8(e), calculate the frequency, power, power factor, and voltage drop across each part of the circuit at resonance. (10)

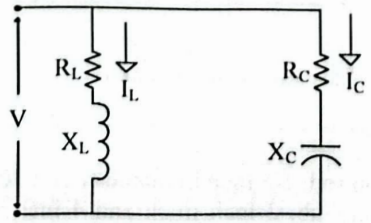

Fig. 7(c)

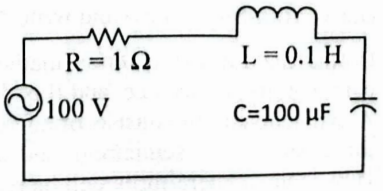

Fig. 8(e)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2023
Department of Biomedical Engineering

Math 1115
Differential and Integral Calculus

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 continuity of a function at a point. Discuss the continuity and differentiability at the point $x = 0$ of the function (16)

$$f(x) = \begin{cases} x^2 sin\left(\frac{1}{x}\right) & \text{when } x \neq 0 \\ 0 & \text{when } x = 0 \end{cases}$$

b) If $y = x^{cot^{-1}x} + (cos^{-1}x)^{tanx}$, find $\frac{dy}{dx}$. (10)

c) Evaluate $\lim_{x\to 0}\left[\frac{1}{x^2} - \frac{1}{sin^2 x}\right]$. (09)

2. a) Define maxima of a function at a point. Find the maxima and minima of the function $u(x,y) = x^3 + y^3 - 3axy$. (12)

b) State Euler's theorem on homogeneous function and verify it for the function $f(x,y) = \sqrt[3]{x^2 + y^2}$. (10)

c) Using Leibnitz's theorem, establish a relation between y_{n+2}, y_{n+1}, and y_n where $y = ln\left(x + \sqrt{1 + x^2}\right)$ and hence evaluate $(y_n)_0$. (13)

3. a) State Rolle's theorem and verify it for the function $f(x) = (x + 2).(x + 1).(x - 2)$ in $-1 \leq x \leq 2$. (12)

b) Expand $cos^2 x$ in power of $\left(x - \frac{\pi}{4}\right)$ in a finite Taylor's series with the remainder in Lagranger form. (13)

c) Find the radius of curvature of the curve $x = c(\theta + sin\theta), y = c(1 - cos\theta)$ at $\theta = 0$. (10)

4. a) Show that the two curves $x^3 - 3xy^2 + 2 = 0$ and $3x^2y - y^3 + 10 = 0$ cut orthogonally. (10)

b) Define asymptotes of a curve. Find all possible asymptotes for the curve $(x + 2)(y^2 - 3y - 2) - 3y^2 - 2x + 5y - 20 = 0$ (13)

c) If $y = \frac{2x + 3}{x^2 + 3x + 2} + cosx\, cos2x$, then find the n-th derivative of y. (12)

Section B

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

5. a) Integrate: $\int \left(\sqrt{tanx} + \sqrt{cotx}\right) dx$ (12)

b) Integrate: $\int \frac{dx}{a + b\,tanx}$ (12)

c) Integrate: $\int e^x \frac{x^2+1}{(x+1)^2} dx$ (11)

6. a) Evaluate: $\int_0^1 \frac{dx}{(x+1)\sqrt{2-x-x^2}}$ (12)

b) Evaluate: $\int_0^{\frac{\pi}{2}} \ln(sinx)\, dx$ (11)

c) Prove that $2^{2m-1}\lceil(m)\left\lceil\left(m+\frac{1}{2}\right)\right. = \lceil(2m)\sqrt{\pi}$. (12)

7. a) Form a reduction formula for $\int sin^p x\, cos^q x\, dx$ and hence evaluate $\int sin^4 x\, cos^2 x\, dx$. (12)

b) Establish the relation between Gamma and Beta function. (11)

c) Use the rule of differentiation under integral sign to prove that (12)

$$\int_0^{\infty} \frac{ln(1+a^2x^2)}{1+b^2x^2} dx = \frac{\pi}{b} ln \frac{a+b}{b}.$$

8. a) Evaluate $\lim_{n\to\infty}\left[\frac{n+2}{n+1} + \frac{n+4}{n^2+4} + \frac{n+6}{n^2+9} + \cdots\ldots\ldots\ldots\ldots\ldots\ldots + \frac{3}{2n}\right]$ (10)

b) Find the value of the double integral $\iint_R xy\, dA$, where R is the first quadrant of circle $x^2 + y^2 = a^2$. (12)

c) Find the volume of the region common to the intersecting cylinders $x^2 + y^2 = a^2$ and $x^2 + z^2 = a^2$. (13)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2023
Department of Biomedical Engineering

BME 1101
Basic Biomedical Engineering

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 biomedical engineering. Mention the application areas of biomedical engineers. (05)

b) Draw a cell membrane structure and classify ion channels. Explain the generation of AP with neat sketch. (15)

c) State basis biophysics laws and relationships and derive the expression of resting potential of a membrane permeable to one ion. (15)

2. a) Approximate intracellular and extracellular concentrations of the important ions across a frog skeletal muscle are given below. At room temperature, find E_K, E_{Na}, and E_{Cl}. (13)

Ions	Cytoplasm (mM)	Extracellular fluid (mM)
K^+	140	2
Na^+	13	110
Cl^-	3	90

b) Define biomaterial. What are the conditions to be satisfied for a material to be biomaterial? (10)

c) What is biosignal processing? Briefly describe the applications of biosignal processing. (12)

3. a) What are the physiological origins of biosignals? Give two practical applications of EMG and EEG. (08)

b) Sketch ECG waveform. How does the heart generate each part of the ECG pattern? Explain in brief. (13)

c) Write down the EEG frequency spectrum. (07)

d) How does wound healing response occur after biomaterial implantation? (07)

4. a) How can you determine the performance of biomaterials? (07)

b) Explain the procedure of biomedical signal processing with a block diagram. (13)

c) What is meant by Na^+-K^+ pump? Briefly explain the pumping mechanism of Na^+-K^+ pump. (15)

Section B

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

5. a) Discuss the constructional details of Galileo's telescope and prove that the angular magnification (15)

$$M = \frac{F}{f}\left(1 - \frac{f}{D}\right)$$

where the symbols have their usual meanings.

b) Discuss the details of a spectrometer. (10)

c) A telescope with an objective of focal length 50 cm is used to bring into view an object 150 cm distant. When the eye piece is adjusted to form the image at infinity, the magnifying power is 5. i) Calculate the focal length of the eye piece and ii) magnifying power of the telescope, if the eye piece is adjusted to view objects at infinity. (10)

6. a) What are the coherent sources? Explain the importance of such sources in interference phenomenon. (10)

b) Discuss the determination of wavelength of a monochromatic light using Newton's rings. (15)

c) The diameter of the 9^{th} dark ring in a Newton's rings system viewed normally by reflected light of wavelength 5800 $\dot{A}$. Calculate the radius of curvature of the planoconvex lens and the thickness of the air film. (10)

7. a) Discuss the drawbacks of classical physics in explaining photoelectric effect. (10)

b) What is Compton effect? Prove that the Compton red shift depends only on the angle of scattering. (15)

c) The photoelectric threshold frequency of silver is 1.086×10^{15} Hz. Calculate i) the maximum kinetic energy of ejected electrons and ii) the stopping potentials in volts for the electrons, when the surface is illuminated with ultra-violet light of frequency 1.5×10^{15} Hz. (10)

8 a) What is meant by nuclear binding energy? Draw a binding energy curve. Hence explain the nuclear fission and fusion reactions from the curve. (12)

b) Explain the construction and working principle of a nuclear reactor. (13)

c) The half life of $^{238}_{92}U$ is 4.5×10^9 years. In how many years will 1.1 gram of pure $^{238}_{92}U$ i) lose one centigram and ii) be reduced to one centigram. (10)