Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2022
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 terms (i) Voltage, (ii) Current, (iii) Power, and (iv) Energy. (08)

b) State KVL. Also, find out the currents and voltages in the circuit shown in Fig. 1(b). (13)

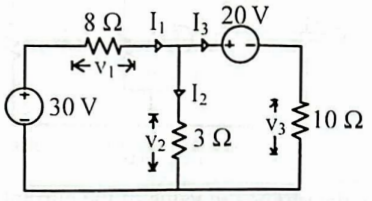

Fig. 1(b)

c) For the network shown in Fig. 1(c), determine the voltage V_1 and current I. (14)

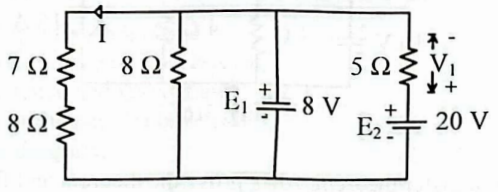

Fig. 1(c)

2. a) Why Y-Δ transformation is necessary? Determine R_{eq} and V of the circuit as shown in Fig. 2(a). (09)

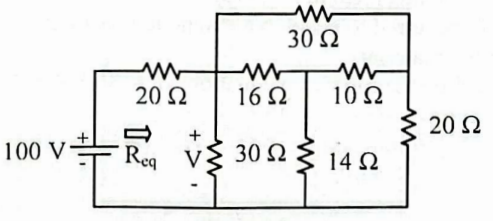

Fig. 2(a)

b) Using super mesh approach, find the current through each element of the network of Fig. 2(b). (13)

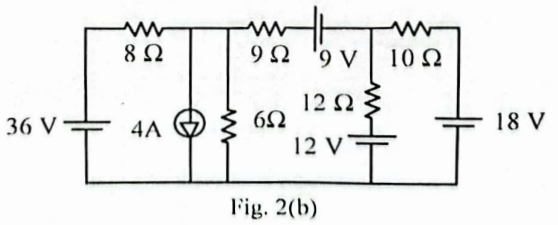

Fig. 2(b)

c) Use mesh analysis to find out the current I_o and I_1 in the circuit of Fig. 2(c)

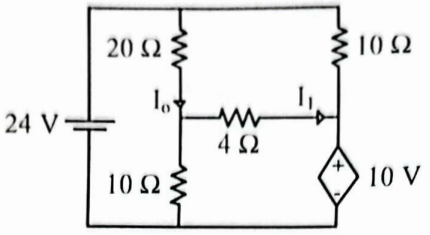

Fig. 2(c)

3. a) State and explain (i) Reciprocity theorem and (ii) Thevenin's theorem. (10)

b) Determine the Thevenin's equivalent circuit of Fig. 3(b) with respect to the terminal *a-b*. (14)

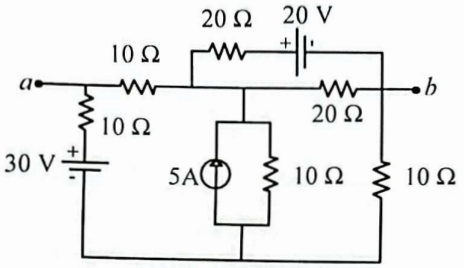

Fig. 3(b)

c) Apply superposition theorem, determine the value of the current I from Fig. 3(c) (11)

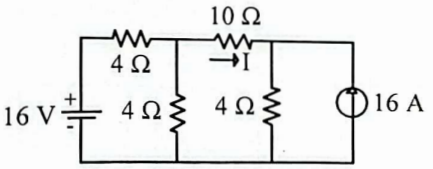

Fig. 3(c)

4. a) State maximum power transfer theorem. Also, prove the theorem and find out the maximum power at load. (11)

b) Define and explain the terms in case of magnetic circuits (i) flux, (ii) hysteresis, and (iii) Ampere's circuital law. (09)

c) For the series magnetic circuit shown in Fig. 4(c) (15)

(i) Find the value of I required to develop a magnetic flux of $\varphi = 4 \times 10^{-4}$ wb.

(ii) Determine μ for the material.

Here, B and H are related by the following equation: $H = 300 \times B + 20$ At/m.

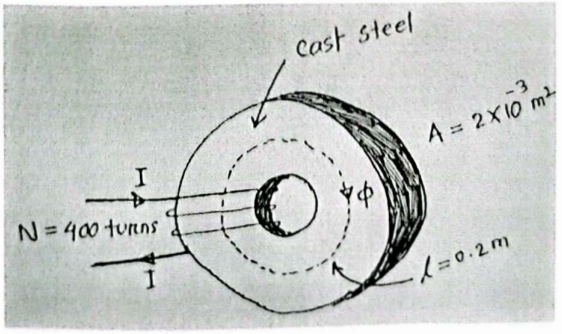

Fig. 4(c)

Section B

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

5. a) How can you represent a voltage or current? Assume that the current $i = I_m sin\omega t$ flows through a given RC branch. Show that the voltage across the branch is (10)

$$v = I_m Z sin(\omega t + \theta) = V_m sin(\omega t + \theta)$$

where, $Z = \frac{V_m}{I_m} = \sqrt{R^2 + \left(-\frac{1}{\omega C}\right)^2}$, $\theta = tan^{-1}\frac{-1}{\omega RC}$

b) One hundred and ten volts are applied to a series circuit consisting a 8 Ω resistance, 0.0531 henry inductance, and 189.7 μf capacitance. When the frequency is 60 cycles, calculate current, power, power factor, vars, reactive power, and volt-amperes. Also, calculate the voltage drop across each circuit element. Draw the necessary vector diagram. (15)

c) Determine the rms and average value of the periodic waveform of Fig. 5(c). (10)

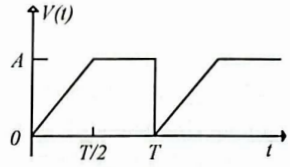

Fig. 5(c)

5. a) An equation which is useful in filter circuit analysis is (13)

$$\alpha + j\beta = 2ln\left(\sqrt{1 + \frac{z_1}{4z_2}}\right) + \sqrt{\frac{z_1}{4z_2}}$$

If $z_1 = 25.14\angle -90^o\ \Omega$ and $4z_2 = 795\angle +90^o\ \Omega$, evaluate α and β.

b) For the circuit shown in Fig. 6(b), determine: (15)
(i) Conductance and susceptance of each branch
(ii) The resulting conductance and susceptance
(iii) Resonant frequency of the parallel branches
(iv) The vector or phasor diagram.

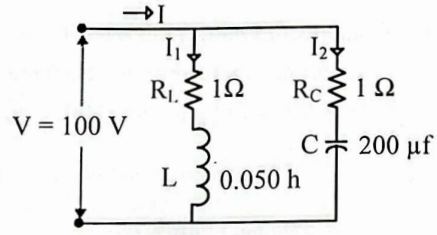

Fig. 6(b)

c) Given $V = 173.2 + j100$ volts and $I = 5.0 + j8.66$ amps. Find the real power and reactive volt-amperes by the method of conjugates. (07)

7. a) Define an electric filter. Mention the types of filter. What are the applications of filters? (10)

b) Explain series and parallel resonances. Also, write down the characteristics and applications of series resonance. (10)

c) For the circuit shown in Fig. 7(c), find I_1, I_2, and total power consumed. (15)

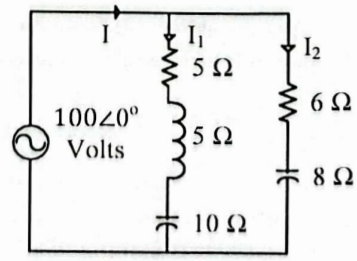

Fig. 7(c)

8. a) Define power factor. Draw the power triangle, impedance triangle, and admittance triangle. What are the disadvantages and causes of low power factor? How power factor can be improved? Draw necessary circuit diagram and vector diagram along with mathematical illustration. (15)

b) Write down the names and applications of the meters used in circuit lab. Also, explain how the range of an ammeter can be increased? (12)

c) Find the angle of phase difference between $v = 100cos(\omega t - 30^o)$ and $i = -10sin(\omega t - 60^o)$. Which wave leads? What is the reading of a wattmeter in this case? (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2022
Department of Biomedical Engineering

Ph 1115
Physics

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 Lissajous figures? Draw Lissajous figure using following equations: $x = asin\omega t$ and $y = 2asin2\omega t$. (12)

b) Show that in the case of a stationary wave no energy is transferred. (13)

c) A room dimensions $5 \times 6 \times 4$ meters. Calculate: (i) the mean free path of the sound wave in the room, (ii) the number of reflections made per second by the sound wave with the walls of the room. Velocity of sound in air is 350 m/s. (10)

2. a) What is meant by acoustic intensity level and acoustic pressure level? (10)

b) Discuss analytically the formation of stationary waves due to reflection (i) at a rigid boundary and (ii) at a free boundary. (15)

c) Deduce the frequency and quality factor for a circuit with L = 3 mH, C = 5 μF, and R = 0.2 Ω. (10)

3. a) What is meant by forced vibration? Explain the oscillatory behavior of SHM. (12)

b) Discuss the conditions under which the discharge of the capacitor is periodic, critically damped, and oscillatory in the case of LCR circuit. (13)

c) Calculate the velocity at which a source of frequency 980 Hz should approach the observer at rest in order to produce Doppler's shift of 380 Hz. Velocity of sound is 350 m/s. (10)

4. a) What is meant by resonance? Discuss the factors influencing loudness. (10)

b) Derive an expression for reverberation time of a dead room. (13)

c) A sound wave of frequency 840 Hz and amplitude 1.2×10^{-4} cm is travelling through the air at N.T.P. (12)
(i) Obtain the value of its velocity and wavelength.
(ii) Write down the equation of the wave.
(iii) Obtain the maximum values of the particle velocity and amplitude of pressure vibration.
(Density of air at N.T.P. is 1.293 gm/L and γ for air is 1.4.)

Section B

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

5. a) Discuss visual angle and telephoto lens in constructing optical instruments. (10)

b) What is a compound microscope? Show that the magnifying power of a compound microscope is (15)

$$M = \frac{D(L - f_o - f_e) + f_e(L - f_o)}{f_e f_o}$$

where the symbols have their usual meanings.

c) A person has his near point at 15 cm and a range of distinct vision of 85 cm. What is his range of distinct vision when he wears close fitting spectacles having a power of -0.8 diopter? (10)

a) What is interference of light? Show that the distance between two successive bright and dark fringes formed in Young's experiment is (12)

$$\beta = \frac{\lambda D}{d}$$

where the symbols have their usual meanings.

b) What is Fresnel's bi-prism? How can you determine the wavelength of a monochromatic light using a bi-prism? (13)

c) In a bi-prism experiment, the eyepiece was placed at a distance of 120 cm from the source. The distance between the two virtual sources was found to be 0.075 cm. Find the wavelength of light of the source, if the eyepiece has to be moved through a distance 1.888 cm for 20 fringes to cross the field of view. (10)

a) Derive Einstein's photo-electric equation and explain the law of photoelectric emission. (10)

b) What is Compton scattering? Derive an expression for Compton red shift. (15)

c) A monochromatic x-ray beam whose wavelength is 0.558 Å is scattered through 46°. Find the wavelength of the scattered beam. (10)

a) What is the difference between natural and artificial radioactivity? Prove that $N = N_o e^{-\lambda t}$, where the symbols have their usual meanings. Hence show that (15)

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda}.$$

b) Discuss some applications of radioactivity in biomedical engineering. (10)

c) The half-life of $_{92}U^{238}$ against α-decay is 4.5×10^9 Y. How much disintegrations per second in 1 Kg of Uranium? (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2022
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
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Section A

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

1.	a)	State and explain the laws of photochemistry.	(08)
	b)	Compare photosensitized and photosynthesis reactions.	(10)
	c)	A photochemical reaction was conducted by absorbing one mole photon having quantum yield 100. Calculate the total number of molecules of products.	(07)
	d)	How would you explain very high and very low quantum efficiencies of some photochemical reactions?	(10)
2.	a)	What is radioactivity? Mention the properties of alpha and beta particles.	(08)
	b)	Discuss the uranium disintegration series.	(10)
	c)	Outline the work principle of nuclear power plant.	(10)
	d)	How many α and β particles are emitted in passing down from ${}^{232}_{90}Th$ to ${}^{208}_{82}Pb$.	(07)
3.	a)	What do you understand by crystal lattice and unit cell?	(08)
	b)	Derive Brag's equation for NaCl system.	(10)
	c)	What is metallic bonding? Explain the hexagonal and cubic close packed structures of metal crystal.	(10)
	d)	What do you mean by vacancy defect and interstitial defect? Explain.	(07)
4.	a)	Give an account of the use of x-ray diffraction studies in the determination of the structure of crystals.	(10)
	b)	Differentiate between fluorescence and phosphorescence.	(08)
	c)	Define binding energy. Discuss the relationship between binding energy and mass number of atoms.	(10)
	d)	What is mass defect? Explain.	(07)

Section B

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

5. a) What are three main steps of polymerization reaction? Describe them in brief with suitable examples. (10)

b) Distinguish between low density polyethylene (LDPE) and high density polyethylene (HDPE). (10)

c) What are basic requirements of synthetic fibers? Discuss the important properties of synthetic fiber. (07)

d) "Polyethylene made by the free-radical process has highly branched chains"- Explain. (08)

6. a) Discuss the mechanism of formation of n-dopped and p-dopped conducting polymer. (10)

b) Mention the importance of conducting polymers in electronics world. (07)

c) "Ziegler-Natta catalysts permit stereochemical control"- Explain with suitable example. (10)

d) Write down the structure of urea-formaldehyde resins. (08)

7. a) What is transport number? Discuss a suitable technique for determination of transport number. (12)

b) Discuss the abnormal transport numbers with suitable examples. (10)

c) Draw a schematic figure using current density vs. applied potential and explain all the terms used in the figure. (13)

8 a) Discuss the principle of determination of P^H of a solution with the help of glass electrode. (10)

b) Classify electrodes into different classes. Give a brief description of each type electrode with example. (10)

c) Calculate the emf of the cell, (07)

$$Cr/Cr^{3+}\ (0.1M)\ ||\ Fe^{2+}\ (0.01M)/Fe$$

The standard electrode potentials are: $E^o_{Cr^{3+}/Cr} = -0.45V$ and $E^o_{Fe^{2+}/Fe} = -0.45V$.

d) What is over potential? Explain. (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2022
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) What is the distinction between $\lim_{x\to a} f(x)$ and $f(a)$? Discuss the continuity of $f(x)$ at $x = \pi/2$, where (12)

$$f(x) = \begin{cases} 1 + sinx & ;\ 0 \le x \le \frac{\pi}{2} \\ 1 & ;\ x < 0 \\ 2 + \left(x - \frac{\pi}{2}\right)^2 & ;\ x \ge \frac{\pi}{2} \end{cases}$$

b) A function $f(x)$ is defined as follows: (12)

$$f(x) = \begin{cases} 5x - 4 & \text{for } 0 < x \le 1 \\ 4x^2 - 3x & \text{for } 1 < x < 2 \\ 3x + 4 & \text{for } x \ge 2 \end{cases}$$

Discuss about the differentiability i.e., $f'(x)$ at $x = 2$.

c) (i) If $sinx = \frac{2t}{1+t^2}$ and $tany = \frac{2t}{1-t^2}$, then find $\frac{dy}{dx}$. (11)
(ii) Differentiate $\log_5 x$ with respect to x^4.

2. a) State Leibnitz's theorem. If $y = log\left(x + \sqrt{1+x^2}\right)$, then find the connection among y_{n+2}, y_{n+1}, and y_n. (13)

b) What is meant by minimum of a function? Find the minimum value of $\frac{x}{\log_e x}$. (11)

c) State Euler's theorem with an example. If $f = 4(ax + by + cz)^2 - (x^2 + y^2 + z^2)$ and $a^2 + b^2 + c^2 = 1$, then find the value of $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$. (11)

3. a) Find the Taylor's series of $f(x) = tan^{-1}x$ about $x = \pi/4$. (11)

b) What is meant by indeterminate form? Evaluate $\lim_{x\to 0}\left(\frac{sinx}{x}\right)^{1/x}$. (12)

c) Find the equations of the tangent and the normal to the curve $xy^2 = 4(4 - x)$ at the point where it cuts the x-axis. (12)

4. a) Show that the largest rectangle with 48 cm length of perimeter is a square. Determine also its area. (12)

b) If $u = cos^{-1}\left(\frac{x^2+y^2}{x^3+y^3}\right)$, then find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$. (11)

c) Find the radius of curvature at the origin of the curve, $5xy^2 + 3x^2 + 2y^2 - 4x = 0$. (12)

Section B

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

5. a) Integrate any two of the followings: (23)

i. $\int \frac{dx}{x^4\sqrt{x^2-1}}$

ii. $\int \frac{2+3sinx-cosx}{1+cosx+sinx}dx$

iii. $\int e^x\left\{\frac{x^2+5x+7}{(x+3)^2}\right\}dx$

b) Integrate $\int 2xsin^{-1}xdx$. (12)

6. a) Evaluate any two of the followings: (23)

i. $\int_0^{\pi/2} \frac{\sqrt{sinx}}{\sqrt{sinx}+\sqrt{cosx}}dx$

ii. $\int_0^{\infty} \frac{dx}{(x^2+1)(x^2+4)}$

iii. $\int_0^{1} \frac{Log(1+x)}{1+x^2}dx$

b) Using Walli's formula, evaluate $\int_0^{\pi/2} sin^5x\,cos^6x\,dx$. (12)

7. a) Evaluate $\lim_{n\to\infty}\left[\frac{1}{\sqrt{2n-1^2}}+\frac{1}{\sqrt{4n-2^2}}+\frac{1}{\sqrt{6n-3^2}}+\cdots+\frac{1}{n}\right]$. (11)

b) Define Gamma function. Express the integral (12)

$$\int_0^{\infty} xe^{-x^4}dx$$

in terms of Gamma function.

c) Obtain the reduction formula for $\int sec^nxdx$ and hence evaluate $\int sec^5xdx$. (12)

8. a) Use the transformation $u=x+y, v=x-y$ to evaluate $\iint_R \frac{e^{x-y}}{x+y}dA$, where R is the region enclosed by the lines $x-y=0, x-y=5, x+y=2$, and $x+y=4$. (15)

b) Evaluate $\iiint_Q 2xe^ysin3z\,dV$, where Q is the rectangle defined by (09)

$Q=\{(x,y,z): 1\le x\le 2, 0\le y\le 1, 0\le z\le \pi\}$

c) Find the volume of the solid bounded by the cylinder $x^2+y^2=4$ and the planes $y+z=4$ and $z=0$. (11)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2022
Department of Biomedical Engineering

BME ~~1115~~ 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) What is meant by biomedical engineering? Briefly explain the roles of biomedical engineers. (10)
   b) What is rehabilitation engineering? In what roles, can biomedical engineers serve to improve the healthcare? Give your opinions. (12)
   c) What is active transport? Exemplify an active transport event that takes place in regular cellular mechanism. (07)
   d) How many molecules of sodium and potassium ions would a cell that has a volume of 1 nl contain? Assume intracellular concentrations of Na^+ and K^+ are 12 mM and 125 mM. (06)

2. a) When does the Nernst equation fail to describe the cell membrane potential appropriately? Derive a mathematical formula to account the impacts of more than one type of ions presence in and out of the cell. (17)
   b) State the Fick's law, Ohm's law, and Einstein's relationship in terms of ion exchange in cells. (10)
   c) What is space charge neutrality? Calculate V_m for a giant squid axon at 6.3°C using the data from Table 1. (08)

Table 1

Ion	Cytoplasm (mM)	Extracellular fluid (mM)	Ratio of permeabilities (mM)	Nernst potential (mV)
K^+	140	2.5	1.0	-105
Na^+	13	110	0.019	56
Cl^-	3	90	0.381	-89

3. a) Define prosthetics. Mention some medical problem areas and name of prosthetics to solve them. (06)
   b) Define biomaterials with examples. What are the conditions that a biomaterial should have? What does biocompatibility mean? (11)
   c) In which category of biomaterials, do the calcium phosphate belong to? Write down its distinguished features and advantages. (10)
   d) Briefly explain the wound healing response after biomaterial implantation. (08)

4. a) What is biosignal? Mention the physiological origins of different biosignals. (07)
   b) Draw the unique structure of a cardiac action potential. Briefly discuss its various phases. (14)
   c) Write short notes on (any two): (06)
      (i) Biomagnetic signal
      (ii) Biomechanical signal
      (iii) Bio-optical signal
   d) Draw and briefly explain the block diagram of a biomedical signal processing system. (08)

Section B

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

5. a) Draw a block diagram of the medical instrument system and explain each component in brief. (12)

b) Define following terms with example: (15)

i) Sensitivity
ii) Linearity
iii) Frequency response
iv) SNR
v) Stability
vi) Isolation

c) What is transducer? How does it work? What are the factors to be considered in choice of a particular transducer? (08)

6. a) What is LVDT? Explain the working principle of LVDT with neat sketch. (13)

b) What are the different coupling between bio and receptor elements? Briefly explain with neat sketch. (08)

c) Mention some properties of bioelectrodes. Why floating electrodes are used? (08)

d) Sketch the total electrical equivalent circuit of a body-surface electrode when the electrode is placed against skin. (06)

7. a) Write he name and function of ten basic medical instruments. (10)

b) Define biomechanics. Briefly explain the different applied subfield of biomechanics. (13)

c) What is medical imaging? Write short notes on: (12)

i) X-ray imaging
ii) CT scan

8 a) Write down some applications of MRI and ultrasound imaging. What are PET and SPECT? (12)

b) Write short notes on: (10)

i) Molecular engineering
ii) Biotechnology

c) Briefly explain the contemporary issues in biomedical engineering. (13)