Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2019
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 **Answer Script A**)

1. a) Who are Biomedical Engineers? Mention duties and career opportunities for biomedical Engineers. (11)

b) Write short notes on: (12)
i) Medical Imaging;
ii) Biomechanics;
iii) Human physiology and modeling.

c) Mention different types of human cells. Briefly describe different parts of human cell with neat sketch. (12)

2. a) What is the origin of Bioelectricity? Deduce the equation for calculating membrane potential due to one ion (i.e. Na^+, K^+ or Cl^-) at the equilibrium condition. (13)

b) What is meant by Donnan equilibrium? Show that Goldman equation can be reduced to Nernst equation. (10)

c) Approximate intracellular and extracellular concentrations of the important ions across a squid giant axon, ratio of permiabilities at resting and action conditions are given in Table Q2c below. At room temperature find E_k, E_{Na}, E_{Cl}, $V_{m,rest}$ and $V_{m,action}$. (12)

Table Q2c:

Ion	Cytoplasm (mM)	Extracellular fluid (mM)	Rate of permiabilities at rest	Rate of permiabilities at action
K^+	400	10	1	1
Na^+	50	470	0.03	15
Cl^-	40	550	0.1	0.1

3. a) Explain Different steps and mechanism of action potential generation with neat sketch. (10)

b) Define biomaterials. What are the desirable properties and the key applications of biomaterials? (13)

c) Write short notes on: (12)
i) Biocompatibility;
ii) Toxicology;
iii) Healing;
iv) Composite biomaterials.

4. a) Define signal and biosignal. What are the origins of three main bioelectric signals? Briefly explain them with neat sketch. (18)

b) What are the basic procedures for biosignal processing? Give a block diagram representation. (10)

c) Draw a diagram showing action potential propagation through neuromascular junction (NMJ). (07)

Section B

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

5. a) What is meant by biomedical instrumentation? Write short notes on In vivo and In vitro measurement. (10)

b) Briefly describe the factors that should be considered to design or specify a medical instrument. (15)

c) Define Biosensors. What are the features of a good biosensor? (10)

6. a) Briefly explain the components of medical instrument system with necessary diagram. (16)

b) What is transducer? Define active and passive transducer. (06)

c) What is LVDT? Discuss the working principle of a LDVT. (13)

7. a) Define biomechanics. Write down the applied subfields of biomechanics. (10)

b) What is bioelectrode? Draw the equivalent circuit of Biopotential electrode. Mention some applications of bioelectrodes. (10)

c) What is medical imaging? Briefly explain different imaging modalities with their applications. (15)

8. a) Define Biotechnology. Explain the branches of biotechnology. (10)

b) Write shot notes on: (10)
ii) Molecular Engineering;
iii) Rehabilitation Engineering.

c) What are the applied fields of biomedical engineering? (05)

d) Discuss about the future challenges of biomedical engineering. (10)

Khulna University of Engineering & Technology
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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 **Answer Script A**)

1. a) Define (i) Unilateral circuit; (ii) Bilateral Circuit; (iii) active element; (iv) passive element with proper example. (08)

b) Calculate equivalent circuit for the following circuit of Fig.Q1b below. Also calculate- (i) current flowing through branch AF, (ii) voltage drop across branch CD. (08)

c) Define primary and secondary cells. Why primary cell is not rechargeable. (07)

d) A moving coil instrument gives full scale deflection of 10 mA when the potential difference across the terminal is 100 mV. Find- (12)

I. The shunt resistance for full scale deflection corresponding to 100 A,
II. The series resistance for a full scale deflection of 1000 V,
III. Power dissipation in each case.

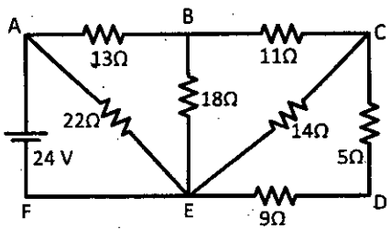

Fig.Q1b

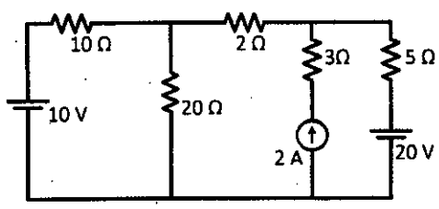

Fig.Q2b

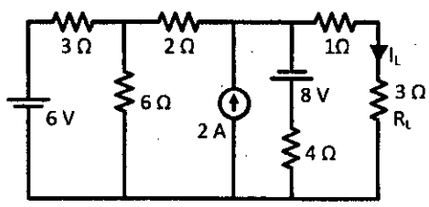

Fig.Q2c

2. a) State maximum power transfer theorem. Derive the condition of maximum power transfer and calculate the power. (08)

b) Find the voltage across 2 Ω resistor for the above Fig.Q2b by using superposition theorem. (08)

c) Use source conversion technique to find the load current I_L in the following circuit as shown in the above Fig.Q2c. (06)

d) Using Y/Δ transformation find the network resistance measured between (i) A and B, (ii) B and C and (iii) C and A, for Fig.Q2d below. (13)

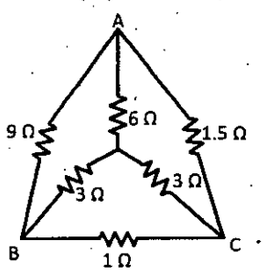

Fig.Q2d

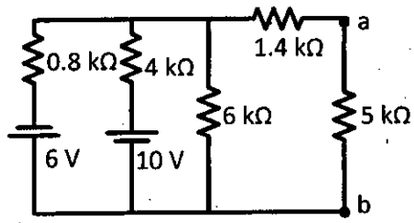

Fig.Q3a

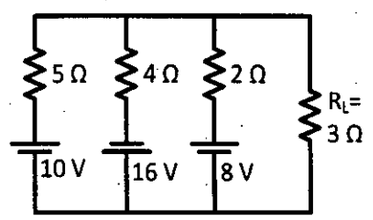

Fig.Q3b

3. a) State Thevenin's theorem. Find the Thevenin's equivalent circuit for the above Fig.Q3a. (10)

b) State Millman's theorem. Find the current through and voltage across the resistor R_L of above Fig.Q3b. (07)

c) Using Norton's theorem, calculate current through the 6 Ω resistance for Fig.Q3c below. (10)

d) Find the voltage and current of the resistor R_2 for the following circuit of Fig.Q3d below using superposition theorem. $R_1 = R_3$ =last two digits of your roll number. (05)

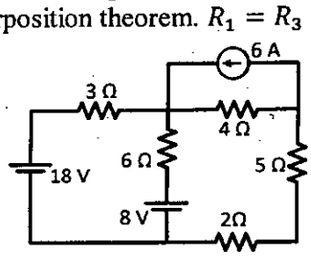

Fig.Q3c

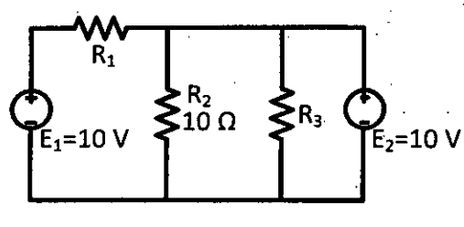

Fig.Q3d

e) Describe how to convert voltage and current sources? (03)

4. a) What is magnetic circuit? What are the differences between electric and magnetic circuit? (10)

b) State reciprocity theorem. Verify reciprocity theorem for the circuit shown in Fig.Q4b below. (10)

c) State Ohm's law and Ampere's circuital law of magnetic circuit with examples. Define coercive force and magnetizing force. (08)

d) Describe the working principle of Ammeter and Voltmeter and mention their functions in circuit analysis. (07)

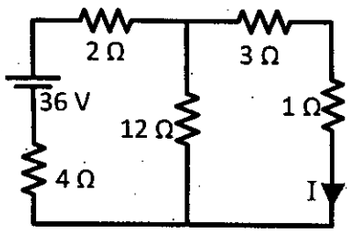

Fig.Q4b

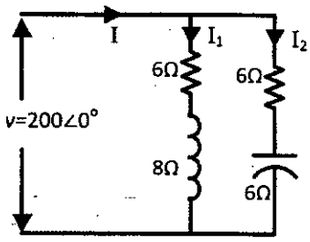

Fig.Q8b

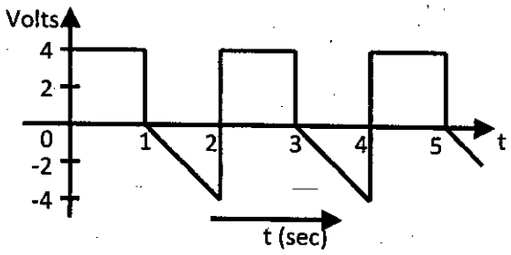

Fig.Q8c

Section B

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

5. a) Define alternating current. Why ac generation is necessary? (05)

b) Drive the expression of energy storage for inductor and capacitor of $\frac{T}{4}$ cycle. (10)

c) Define RMS and average value. Show that for a pure sinusoidal wave the form factor is 1.11 and crest factor is $\sqrt{2}$. (10)

d) If R=10 Ω, L=0.056 Henry, C=50 μF, find impedance of this circuit when $f = 60$ Hz. If $v = 200\sin(\omega t + 30°)$, find the expression of i. (10)

6. a) What is meant by series resonance and half power point? Describe the characteristic of series resonance circuit. (12)

b) Assume the current $i = I_m \sin \omega t$ flows through a given RLC branch. Show that the voltage across the branch is $v = I_m z \sin(\omega t + \theta)$. Where, $z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$ and $\theta = \tan^{-1}(\frac{\omega L - \frac{1}{\omega C}}{R})$. (12)

c) Define form factor and crest factor. Find the form factor and crest factor of alternating current. (11)

7. a) Mention the significance of the operator j. (06)

b) Show that the average power consumed by inductor or capacitor is zero. (11)

c) Draw the string and polar vector diagram of a series RLC circuit. (09)

d) A voltage $v = 200\sin 377t$ volts is applied to an inductive branch and the maximum current is found to be 10 A. Find the value of L in milihenrys. (09)

8. a) Explain real and reactive power. Deduce the expression for conjugate method of calculating real and reactive power. (07)

b) For the above circuit shown in Fig.Q8b, find- (10)
   i. Conductance and susceptance of each branch;
   ii. Total conductance and susceptance;
   iii. Necessary vector diagram.

c) Find the form factor for the above voltage wave as shown in the above Fig.Q8c. (10)

d) How to calculate root and logarithmic value of a complex quantity. (08)

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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 **Answer Script A**)

1. a) Discuss the continuity and differentiability of $f(x)$ at $x = 1$, where (13)

$$f(x) = -2x + 1 \ for \ x < 0$$
$$= 1 \quad for \ 0 \le x < 1$$
$$= 2x - 1 \ for \ 1 \le x$$

b) Evaluate $\lim_{x\to 0} (e^x + x)^{\frac{1}{x}}$. (10)

c) State Rolle's theorem. Find the point C (if exist) where the tangent is parallel to x-axis on $[-\sqrt{2}, \sqrt{2}]$ of $f(x) = 2x^3 + x^2 - 4x - 2$. (12)

2. a) Differentiate $\tan^{-1}(\frac{\sqrt{1+x^2}-1}{x})$ with respect to $\tan^{-1} x$. (10)

b) If $u = \log(\sqrt{x^2 + y^2 + z^2})$, then find the value of $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = 0$. (12)

c) Find the Taylor's finite series of $f(x) = \cos^2 x$ about $x = \frac{\pi}{4}$. (13)

3. a) Find the relative extrema (if exist) of the following function: $f(x) = x^3 - 6x^2 + 9x + 5$. (11)

b) Find the differential coefficient of $(\tan x)^{\sec x} + (\cot x)^{cosec\, x}$. (10)

c) If ρ_1 and ρ_2 be the radii of curvature at the ends of a focal cord of the parabola $y^2 = 4ax$, then show that $\rho_1^{-2/3} + \rho_2^{-2/3} = (2a)^{-2/3}$ (14)

4. a) If $x\cos\alpha + y\sin\alpha = P$ touches the curve, $\frac{x^m}{a^m} + \frac{y^m}{b^m} = 1$, then show that $(a\cos\alpha)^{\frac{m}{m-1}} + (b\sin\alpha)^{\frac{m}{m-1}} = P^{\frac{m}{m-1}}$. (12)

b) State Leibnitz's theorem. If $y = e^{a\sin^{-1}x}$, then find y_{n+2} by using Leibnitz's theorem. (11)

c) Find the asymptotes of the cubic $x^3 - 2y^3 + xy(2x - y) + y(x - y) + 1 = 0$. (12)

Section B

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

5. a) Calculate $\int \frac{dx}{(x+1)\sqrt{1+2x-x^2}}$. (12)

b) Calculate $\int \frac{1-\sin x+\cos x}{1+\sin x-\cos x}\, dx$. (11)

c) Calculate $\int \frac{dx}{1+3e^x+2e^{2x}}$. (12)

6. a) Obtain a reduction formula for $\int \sec^n x \ dx$ and hence calculate $\int \sec^6 x \ dx$. (11)

b) Evaluate $\int_0^{\frac{\pi}{4}} \frac{\sin 2x}{\sin^4 x+\cos^4 x}\, dx$ (12)

c) Evaluate $\int_0^1 \frac{\ln(1+x)}{1+x^2}\, dx$ (12)

7. a) Evaluate $\int_0^{\pi} \frac{x\tan x}{\sec x+\cos x}\, dx$ (12)

b) Evaluate $\lim_{n\to\infty} [\frac{1}{n} + \frac{n^2}{(n+1)^3} + \frac{n^2}{(n+2)^3} + \cdots + \frac{1}{8n}]$. (11)

c) Define Beta function and Gamma function. Evaluate $\int_0^{\infty} \frac{x^4(1+x^5)}{(1+x)^{15}}\, dx$. (12)

8. a) Use double integral, find the area of the common portion of the curves $y^2 = 12x$ and $x^2 = 12y$. (11)

b) Use double integral, find the volume of the solid bounded by the cylinder $x^2 + y^2 = 9$ and the planes $z = 0$ and $x + z = 3$. (11)

c) Evaluate $\iint_R \frac{x-y}{x+y} dA$, where R is region enclosed by $x - y = 0$, $x - y = 1$, $x + y = 1$ and $x + y = 3$. (13)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2019
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 **Answer Script A**)

1. a) Mention the various crystal systems and show the characteristics feature of the crystals. (10)

b) Crystals are imperfect–why? Discuss about Schottky and Frankel defects in crystal. (12)

c) Draw the planes having miller indices (111), (010), and (210). (06)

d) What is X-ray? The distance between two consecutive 110 planes of crystal is 1.678×10^{-10} m. What will be the glacing angle for an X-ray of wavelength 0.65×10^{-10} m incident on the planes for the first order reflection? (07)

2. a) How can the Beer's law be used for the estimation of analytes? Explain. (10)

b) What are the causes of very high and very low quantum yield of some photochemical reactions? (10)

c) Write down the differences between fluorescence and phosphorescence. (08)

d) What is photon? The quantum yield for the reaction $2H_2O_2 \rightarrow 2H_2O + O_2$ is 3. Calculate the number of photons absorbed in an experiment in which 0.015 mole of H_2O_2 are decomposed. (07)

3. a) What is nuclear reactor? How electricity can be generated with the help of nuclear reactor? (10)

b) State group displacement law giving examples. Half life of a radioelement is independent of its total mass–Explain. (10)

c) Calculate the binding energy in MeV in ${}^{11}_{5}B$ nucleus if its mass defect is 0.08181 amu. (08)

d) Prove that for a radio active element half life period is $0.693/\lambda$. (07)

4. a) State and explain the laws of photochemistry. (08)

b) Describe the Bridgmen method and Flux method of crystal growth. (10)

c) Illustrate the following term of a cubic crystal lattice: (09)
(i) Centre of symmetry,
(ii) Axis of symmetry, and
(iii) The Plane of symmetry.

d) Calculate the energy (in erg) associated with one photon of radiation of wavelength 8000 Å. (08)

Section B

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

5. a) Establish thermodynamically the relation between emf and free energy of cell reaction. Explain the significance of this relation. (11)

b) Discuss the effect of nature of solvent on degree of dissociation of an electrolyte. (10)

c) State whether the cell reaction will occur spontaneously or not: $cd/cd^{2+}\|Ag^{+}/Ag$. [Here, $E_{cd/cd^{2+}} = 0.398\,V, E_{Ag/Ag^{+}} = -0.99\,V$]. (07)

d) Conductivity of H^{+}(aq) and OH^{-}(aq) are exceptionally high, Explain. (07)

6. a) Distinguish between Thermodynamic Potential and Zeta Potential from double layer mechanism. (08)

b) Write down the negative and positive electrode materials and electrolyte used in lithium-ion battery. Write down the charge and discharge of this battery. (10)

c) The standard reduction potential of Zn/Zn^{2+} and Ag/Ag^{+} electrodes are –0.76 and 0.08V respectively. Calculate the (i) EMF of the cell at 25°C, (ii) write down the cell reaction, and (iii) calculate ΔG for the following cell: $Zn/Zn^{2+}(0.0001M)\|\, Ag^{+}(0.1M)/Ag$. (10)

d) Write down the limitations of standard hydrogen electrode. (07)

7. a) What is cyclic voltametry? Draw a typical voltammogram and explain its features. (12)

b) Explain the different region of the current-voltage curve in d-c polarography. (12)

c) What are the characteristics of Dropping Mercury Electrode? (06)

d) Write down the Ilkovic equation for diffusion current with usual meaning. (05)

8. a) Write down the name of three main steps of Polymerization reaction and describe them briefly with suitable example. (10)

b) What is conducting Polymer? Outline the mechanism to show conductivity of Polymers. (10)

c) Write down the differences between thermosetting and thermoplastic polymers. (08)

d) In modern time polymers are the best engineering's material–Explain. (07)

Khulna University of Engineering & Technology
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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 **Answer Script A**)

1. a) What is Simple harmonic motion? Show that the simple harmonic motion is an oscillatory motion in the terms of its displacement, velocity and acceleration. (13)

b) Show that, the average power dissipation, $P = 2\lambda E$; where the symbol's have their usual meanings. (12)

c) A particle is moving simple harmonically in a straight line. If the distance of the particle from the equilibrium position are x_1, and x_2 correspondingly to the velocity are u_1 and u_2, show that, the time period is given by, (10)

$$T = 2\pi\left[\frac{x_2^2 - x_1^2}{u_1^2 - u_2^2}\right]^{1/2}$$

Find also its maximum velocity and acceleration.

2. a) What is meant by resonance and quality factor of an oscillator? (10)

b) Discuss analytically the formation of beats and show that the number of beats produced per second is equal to the difference in frequency of the two notes. (15)

c) Calculate the velocity at which a source of frequency 10^4 per second should approach the observer at rest in order to produce Doppler' shift of 450 per second. (Velocity of second $= 340\ m/s$). (10)

3. a) What is meant by electroacoustic music and electroacoustic modulator? (10)

b) Show that $I = 2\pi^2 a^2 n^2 ev$; where the symbol's have their usual meanings. (15)

c) A harmonic oscillator consisting of a 60 gm mass attached to a massless spring has a quality factor 180. If it oscillates with an amplitude of 1.9 cm in resonance with a periodic force of frequency 25 c.p.s., calculate (i) the average energy stored in it and (ii) the rate of dissipation of energy. (10)

4. a) What is meant by 'bel' and 'phon'? Discuss the factors influencing loudness. (10)

b) Give the theory of growth and decay of sound inside a room. Hence obtained an expression for Sabine's formula. (15)

c) A room has dimensions 6×5×6 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 $= 350\ m/s$. (10)

Section B

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

5. a) What is interference of light? Discuss Young's double slit experiment for the interference of light and hence, (i) Obtain the conditions for constructive and destructive interference; (ii) Show that, the spacing between two consecutive bright and dark fringes are same. (13)

b) Explain how Newton's rings are formed and describe the method for determination of wavelength of light with their use. (12)

c) In young's double slit experiment, the separation of the slits is 2.2 mm and the fringe spacing is 0.4 mm at a distance 1.5 m from the slits. Calculate the wavelength of light. (10)

6. a) What is angular magnification of optical instrument? Derive magnification for an astronomical telescope for both normal vision and distinct vision. (15)

b) What is mass defect and binding energy of a nucleon? In case of binding energy, (i) Draw the binding energy curve, (ii) show that, $B.E. = \{A(M_n - 1 - f) + Z(M_P - M_n)\}c^2$; where the symbol's have their usual meanings. (12)

c) Discuss the differences between β-decay and electron capture. (08)

7. a) What is successive radioactivity? In case of successive radioactivity, show that, (15)

$$N_2 = \frac{\lambda_1 N_o}{\lambda_2 - \lambda_1}\left[e^{-\lambda_1 t} - e^{-\lambda_2 t}\right],$$

where the symbol's have their usual meanings.

b) A nuclear reaction is given below, (13)

$$^{235}_{92}U + {}^{1}_{o}n \rightarrow [^{236}_{92}U]^* \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{o}n + Q$$

(i) What type of reaction is it?
(ii) Calculate the released energy (Q) from the reaction.

c) Radon has half life of 3.82 days.How long it takes for 60% of the sample to decay? (07)

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

b) What is quanta? For Compton effect, show that $\lambda' - \lambda = \Delta\lambda = {}^{h}/_{m_o c}(1 - cos\phi)$; where the symbol's have their usual meanings. (15)

c) With what velocity must an electron travel so that its momentum is equal to that of a photon with wavelength of 5200Å? (10)