Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2020
Department of Biomedical Engineering

BME 1101
Basic Biomedical Engineering

Time: 1 Hour 30 Minutes **Full Marks: 120**

N.B. i) Answer **ANY TWO** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A

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

1. a) What is Rehabilitation Engineering? Explain the process of how passive and active transport take place across the cell membrane with proper examples. (10)

b) What is graded response? Briefly discuss the graded response. (08)

c) Define hypotonic solution. Deduce the equation for calculating membrane potential due to single ion (i.e. Na^+, K^+, or Cl^-) at the equilibrium conditions stating required biophysical laws. (12)

2. a) What is biocompatibility? Briefly explain some applications of biomaterials. (08)

b) Briefly explain the classification of biomaterials in terms of structures. (10)

c) Write down the possible tissue-bio-material interactions that occur for implantation of an in vivo device. (12)

3. a) What are the origins of physiological signals? Briefly describe any three of the origins of physiological signals with proper graphs. (12)

b) Discuss about Cardiac Action Potential demonstrating its each phase. (12)

c) What are the processes involved in converting an analog biosignal into a digital one? (06)

Section B

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

4. a) What is meant by biomedical instrumentation? Draw a block diagram of the medical instrument system and explain each component in brief. (15)

b) Briefly explain the working principle of Piezoelectric transducer. (07)

c) A thin wire has a length of 30 mm, a cross-sectional area of 0.01 mm^2, and a resistance of 1.5 Ω. A force is applied to the wire that increases the length by 10 mm and decreases cross-sectional area by 0.0027 mm^2. Find the change in resistance. Note: resistivity of the wire is 5×10^{-7} Ωm. (08)

5. a) What is bio-electrode? Classify it. Mention some applications of bio-electrode. (07)

b) Define biosensors. What are the features of a good biosensor? (07)

c) What is meant by biomechanics? What are the applied subfields of biomechanics? Explain each subfield in brief. (16)

6. a) Define medical imaging. Briefly explain different imaging modalities with their applications. (15)

b) Write short notes on: (15)
(i) Tissue Engineering (ii) Molecular Engineering (iii) Biotechnology

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EEE 1115
Electrical Circuits

Time: 1 Hour 30 Minutes **Full Marks: 120**

N.B. i) Answer **ANY TWO** questions from each section in separate scripts.
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Section A

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

1. a) Define dependent and independent sources. What is meant by constant voltage and constant current sources? Explain elaborately. (12

b) For the network shown in Fig. 1(b), find out the currents I_S and I_4. You may use $\Delta - Y$ conversion and mesh analysis. (18

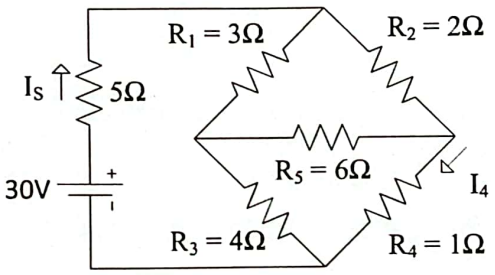

Fig. 1(b)

2. a) State and shortly explain the following theorems: (10
(i) Superposition theorem (ii) Thevenin's theorem

b) Mathematically prove the maximum power transfer theorem. (08

c) For the network shown in Fig. 2(c), find out the Thevenin equivalent circuit pointed between points a and b. (12

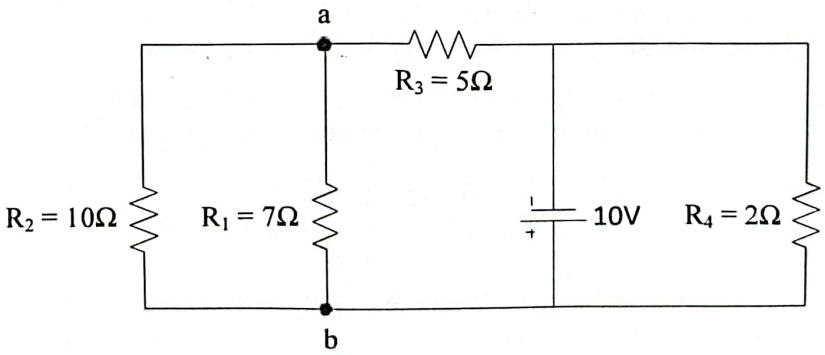

Fig. 2(c)

3. a) Find the energy stored in a capacitor. (10)

b) Find the value of I required establishing a magnetic flux of $\varphi = 0.5 \times 10^{-4}$ Wb in the series magnetic circuit shown in Fig. 3(b). Note that the magnetic flux density (B) and magnetizing force (H) are related by $B = 4.3 \times 10^{-3}$ H. (15)

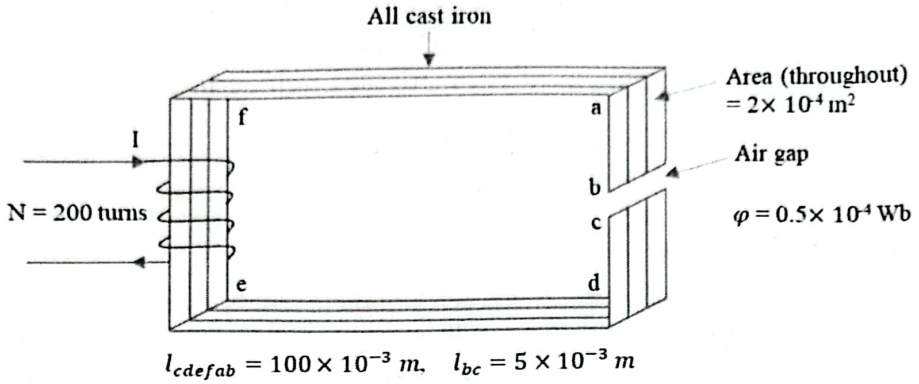

Fig. 3(b)

c) Mention the names and their applications of five measuring instruments used in electrical systems. (05)

Section B

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

4. a) What is alternating current? Define phase and impedance. Find the impedance of an R-L branch. (15)

b) A voltage $v = 200sin377t$ is applied to an inductive branch and the maximum current is found 10 amperes. (15)
(i) Find the value of L in millihenrys.
(ii) If it is known that this inductance coil actually possesses 1.0 ohm resistance, what is the true value of L?

5. a) Define r.m.s. and average values. Show that for a pure sinusoidal wave the form factor is 1.11 and crest factor is $\sqrt{2}$. (15)

b) Express as a single complex number in both cartesian and polar forms. (10)

$$\frac{(-8.66 + j5.0)(50\angle -100^0)(2e^{j70})}{j5}$$

c) Define phasor and write the significance of operator j. (05)

6. a) Explain series and parallel resonances. Also note down the characteristics of series resonance circuit. (10)

b) For the circuit shown in Fig. 6(b), draw the complete string vector diagram. Finally, write down the expression of total impedance and power factor. (10)

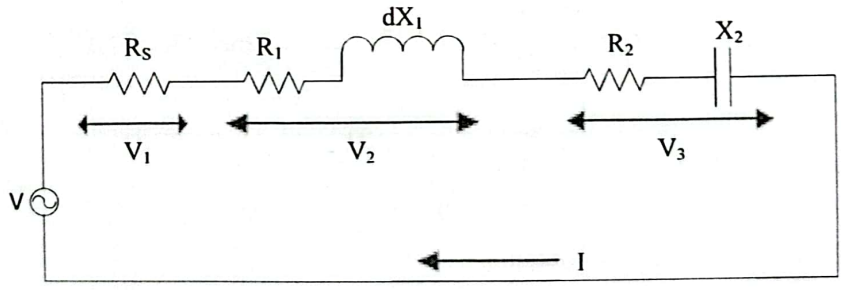

Fig. 6(b)

c) Classify filter. Draw the typical frequency responses of different filters. (10)

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Ch 1115
Chemistry

Time: 1 Hour 30 Minutes **Full Marks: 120**

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Section A

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

1. a) Define isomorphism. Illustrate with examples- unit cell of seven crystal systems. (11)
   b) What is miller indices? Draw the following crystal planes in a cubic crystal: d_{100}, d_{110}, and d_{111} (12)
   c) Find the interplanar distance in a crystal in which a series of planes produce a first order reflection from a Cu-xray tube ($\lambda = 1.539A^o$) at an angle of 22.5^oC. (07)

2. a) What is artificial radioactivity? Write down the comparison between nuclear reaction and chemical reaction. (10)
   b) What is nuclear binding energy? Explain why the intermediate nuclei are stable whereas the lighter nuclei and heavy nuclei are unstable. (20)

3. a) What is quantum yield? Mention the law of photochemistry. (16)
   b) Write a short note on "photosensitized reaction". (06)
   c) Calculate the number of α and β particles emitted in the conversion of Thorium ($^{232}_{90}Th$) to Lead ($^{208}_{82}Pb$). (08)

Section B

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

4. a) How does Kholrausch law help in determination of equivalent conductance of weak electrolyte at infinite dilution? (10)
   b) Discuss the principle of determination of p^H of a solution with the help of glass electrode. (10)
   c) Calculate the emf of the cell: (10)

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

Here, $E^o_{Cr^{3+}/Cr} = 0.75V$ and $E^o_{Fe^{2+}/Fe} = -0.45V$

5. a) Explain the charging and discharging process for Li-ion batteries. (12)
   b) What is supporting electrolyte? What are the roles of supporting electrolyte in polarography? (10)
   c) What is polarographic maxima? Why and how it can be suppressed? (08)

6. a) Explain the free radical mechanism of addition polymerization by taking ethylene as an example. (10)
   b) Interpret cationic polymerization process with suitable example. (11)
   c) Draw isotactic, syndiotactic, and atactic structure of polypropylene. (09)

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Math 1115
Differential and Integral Calculus

Time: 1 Hour 30 Minutes **Full Marks: 120**

N.B. i) Answer **ANY TWO** questions from each section in separate scripts.
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Section A

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

1. a) Discuss the continuity and differentiability of the function

$$f(x) = |2x + 1| + |x - 1| \quad \text{at} \quad x = 1$$ (15)

b) If $y^{\frac{1}{m}} + y^{-\frac{1}{m}} = 2x$, then find the relation between y_{n+2}, y_{n+1} and y_n (15)

2. a) Is Rolle's theorem applicable to the function $f(x) = \frac{3}{5 - x^2}$ in $[-2, 2]$?
Justify your answer. (10)

b) If $y = \frac{2x - 5}{x^2 - 2x - 3}$, then find y_n (10)

c) Evaluate $\lim_{x \to 0} (3cot^2 x)^{sinx}$ (10)

3. a) Show that $f(x) = 3x^3 - 9x^2 + 10x - 20$ has neither a maximum nor a minimum. (10)

b) Find the asymptotes of the curve $x^3 + y^3 = 3axy$ (10)

c) Show that the two curves $x^2 + 2y + 3 = 0$ and $2x^2y + 1 = 0$ cut orthogonally at $\left(1, -\frac{1}{2}\right)$ (10)

Section B

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

4. Integrate the followings: (30)

a) $\int \frac{dx}{2 + 3cotx}$ b) $\int \frac{dx}{x^3 - 1}$

5. Evaluate the followings:

a) $\lim_{n \to \infty} \left\{ \left(1 + \frac{1^2}{n^2}\right)\left(1 + \frac{2^2}{n^2}\right) \ldots\ldots\ldots \left(1 + \frac{n^2}{n^2}\right) \right\}^{\frac{1}{n}}$ (10)

b) $\int_0^{\infty} \frac{log\left(x + \frac{1}{x}\right)}{1 + x^2} dx$ (10)

c) $\int_0^{\frac{\pi}{2}} cos^9 x dx$, using Walli's formula (10)

6. a) Find the reduction formula for $\int cot^n x dx$
and hence evaluate $\int cot^4 x dx$ (17)

b) Evaluate the double integral $\iint (x^2 + y^2)\, dxdy$ over the positive quadrant to the circle $x^2 + y^2 = a^2$ (13)

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Ph 1115
Physics

Time: 1 Hour 30 Minutes **Full Marks: 120**

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Section A

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

1. a) What is meant by damped vibrations and forced vibrations? (06)

b) Obtain an expression for the displacement in the case of a damped oscillatory motion. (16)

c) A scale of a spring balance reading from 0 to 10 kg is 0.5 m long. A body suspended from the balance is found to oscillate vertically with a frequency of $10/\pi$ hertz. Calculate the mass of the body attached to the spring. (08)

2. a) What is the difference between echo and reverberation? (05)

b) Show that the number of beats produced per second is equal to the difference in frequency of the two notes. (15)

c) Two simple harmonic motion acting simultaneously on a particle are given by the equation: (10)

$$x_1 = 5\sin\left(\omega t + \frac{\pi}{6}\right)$$

$$x_2 = 7\sin\left(\omega t + \frac{\pi}{4}\right)$$

Find out the equation of the resultant vibrations.

3. a) Discuss the factors influencing loudness. (06)

b) Give the theory of growth and decay of sound in 'live room'. Find the reverberation time. (16)

c) A room dimension is 10×8×6 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 room. Velocity of sound in air is 350 m/s. (08)

Section B

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

4. a) Define coherent sources. What are the conditions of coherent sources? (06)

b) Explain Fresnel Bi-prism theory. (16)

c) Calculate the De-Broglie wavelength of an electron and alpha particle. (08)

5. a) Explain nuclear fission and nuclear fusion reaction with examples. (08)

b) What is chain reaction? Explain the construction and working principle of a nuclear reactor. (16)

c) Radon has half-life of 3.82 days. How long it takes for 75% of the sample to decay? (06)

6. a) Derive the expression of De-Broglie wave velocity and comments on it. (05)

b) Prove the statement "change in the wavelength in Compton effect is independent of the wavelength of the incident photon". (15)

c) What is the maximum energy in electron volts of photoelectrons when ultraviolet light of wavelength $3500A^o$ falls on a potassium surface? The work function of potassium is 2.2 eV. (10)