Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2021
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) State and explain superposition theorem. What is meant by linear bilateral element? (05)
   b) Determine R_{eq} of the circuit shown in Fig. 1(b). (11)
   c) Using nodal analysis, determine the voltages V_1 and V_2 of the circuit shown in Fig. 1(c). (11)

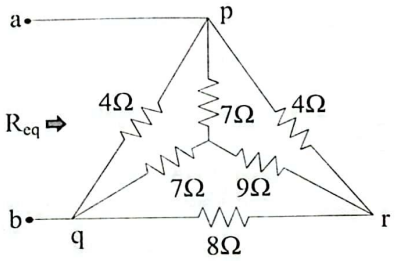

Fig. 1(b)

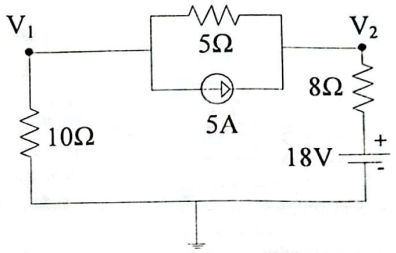

Fig. 1(c)

   d) An electrical heater takes 1 KW from main supply with certain voltage. If the voltage is increased by 20%, the current through the heater is 0.8 A. (08)
   (i) What is the original voltage?
   (ii) What is the resistance of the coil?

2. a) State the maximum power transfer theorem. Derive the condition for maximum power transfer from source to load. Also calculate the value of maximum power in this condition. (10)
   b) Determine the Thevenin's equivalent circuit between points *a* and *b* of the circuit in Fig. 2(b). Also find out I_L. (13)
   c) Using superposition theorem, determine the current I of the circuit shown in Fig. 2(c). (12)

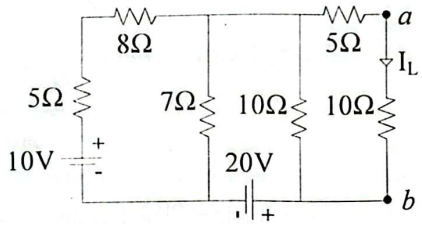

Fig. 2(b)

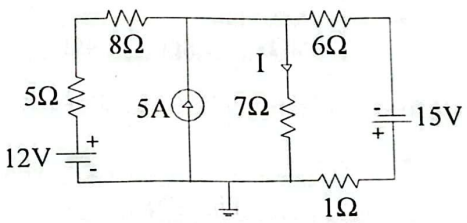

Fig. 2(c)

3. a) State and explain reciprocity theorem with proper examples. (10)
   b) Find the current through each branch using mesh analysis in the following Fig. 3(b). (12)
   c) Find the current using Norton's theorem through the load of 8 Ω in the following Fig. 3(c). (13)

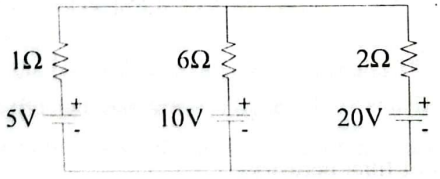

Fig. 3(b)

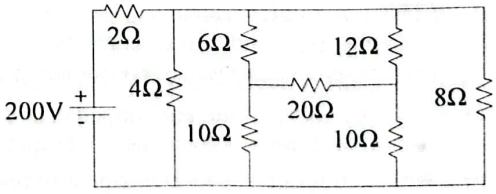

Fig. 3(c)

4. a) Shortly describe (i) Magnetic field (ii) Hysteresis and (iii) Ampere's circuital law. (09)

b) Find the value of I required to establish a magnetic flux of $\varphi = 0.5 \times 10^{-4}$ Wb in the series magnetic circuit shown in following Fig. 4(b). Use B-H curve if necessary. (14)

c) Define measuring instrument and classify. What are the techniques of range extension of ammeter and voltmeter? (12)

Section B

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

5. a) Define the terms: (i) alternating current (ii) phase (iii) impedance and (iv) reactance. (08)

b) Find $v(t)$ and $i(t)$ in the following integrodifferential equations using the phasor approach. (14)

(i) $v(t) + \int vdt = 10cost$ V

(ii) $10\int idt + \frac{di}{dt} + 6\,i(t) = 5\cos(5t + 22^o)$ A

c) Calculate $v_o(t)$ in the circuit of Fig. 5(c). (13)

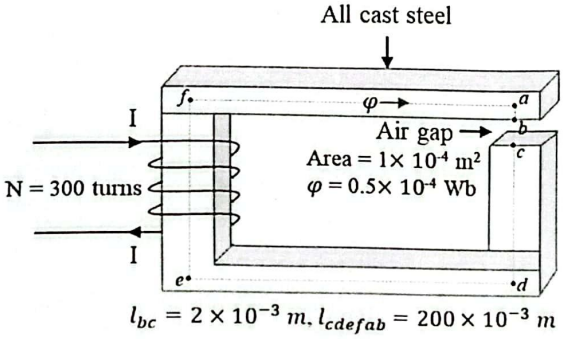

Fig. 4(b)

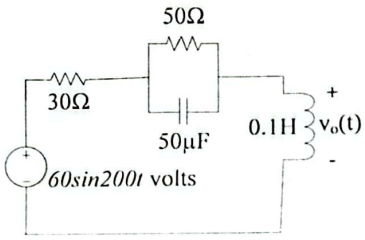

Fig. 5(c)

6. a) Find the relative heating effects of two current waves of equal maximum value, one semi-circular and the other sinusoidal in waveform. (12)

b) Determine the equivalent impedance of the circuit shown in Fig. 6(b). (13)

c) Find Z in the network of Fig. 6(c), given that $V_o = 4\angle 0^o$ (10)

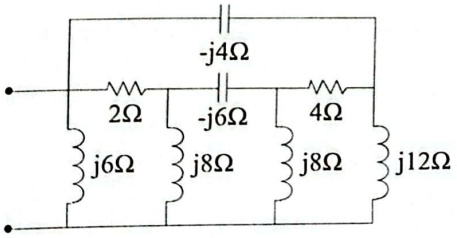

Fig. 6(b)

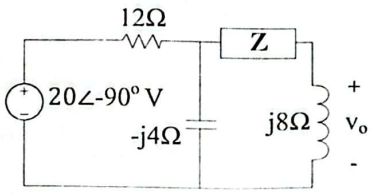

Fig. 6(c)

7. a) Briefly explain the characteristics of series and parallel resonances. (06)

b) Define real power, reactive power and apparent power of an ac circuit. (09)

c) Clearly draw the vector diagram of an RLC series circuit and also identify the p.f. (10)

d) Two circuits, the impedances of which are given by $Z_1 = 15 + j12\ \Omega$ and $Z_2 = 8 - j5\ \Omega$ are connected in parallel. If the potential differences across one of the impedance is $(250 + j0)\ volts$, calculate: (10)
(i) total current and branch currents
(ii) total power and power consumed in each branch

8. a) Describe the current and impedance characteristics of both series and parallel resonant circuits with respect to change in frequency. (15)

b) What is filter network? Describe different types of filter network. (07)

c) Describe the output voltage and phase characteristics of RC low pass and high pass filters. Also deduce the equation for cutoff frequency. (13)

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Section B

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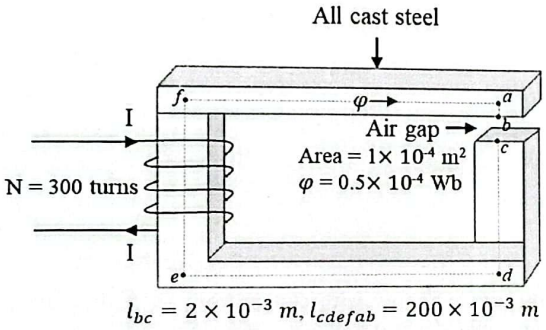
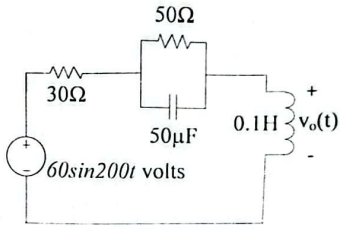


Fig. 4(b)



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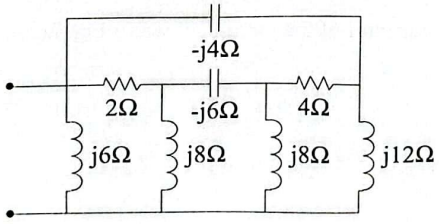
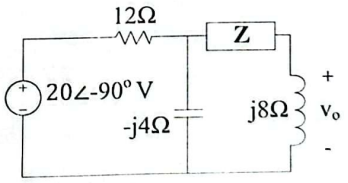


Fig. 6(b)



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Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2021
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)

.	a)	Define periodic motion, oscillation motion, and simple harmonic motion. Show that the difference between periodic, oscillation, and SHM.	(10)
	b)	Two simple harmonic vibrations acting at right angles to each other have the time periods in the ratio of 1:2. The phase difference between the two vibrations is $\pi/2$. Show mathematically that the resultant motion is parabolic in motion.	(15)
	c)	Two SHMs acting simultaneously on a particle are given by $y_1 = 2\sin\omega t$ and $y_2 = \sin(\omega t + \pi/3)$. Find the equation of the resultant vibration.	(10)
.	a)	Discuss the characteristics of stationary waves. How do they differ from progressive waves?	(10)
	b)	Prove that energy is not transferred in case of stationary waves.	(10)
	c)	Define resonance and give some of its practical applications.	(05)
	d)	The equation of a progressive wave is given by, $y = 20\sin\left(\frac{2\pi t}{T} + \alpha\right)$. The time period is 60 s. At time $t = 0$, the displacement is 5 cm. Calculate (i) phase angle at $t = 8.5$ s and (ii) phase difference between two positions at a time interval of 6 s.	(10)
.	a)	Define the terms (i) Diffraction of sound, (ii) Phase velocity, and (iii) Group velocity.	(12)
	b)	State and explain Doppler's effect. Derive an expression for the apparent frequency of the note when the source and the listener are (i) moving towards each other and (ii) moving away from each other.	(13)
	c)	The apparent frequency of the whistle of an engine changes in the ratio 7:5 as the engine passes a stationary observer. If the velocity of the sound is 350 m/s, calculate the velocity of the engine.	(10)
.	a)	Define Phon and Bel. Mention the properties and applications of ultrasound wave.	(10)
	b)	What is meant by acoustic intensity? Show that the acoustic intensity of sound varies directly as the square of the excess pressure.	(13)
	c)	Calculate (i) acoustic intensity and (ii) acoustic pressure of plane acoustic wave in air of intensity level of 100 dB with reference to 10^{-12} watt/m^2.	(12)

Section B

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

.	a)	What is interference of light? Discuss how energy will be conserved in case of interference phenomena.	(10)
	b)	Discuss the working principle and application of Fresnel Bi-Prism.	(15)
	c)	A biprism is placed at a distance of 10 cm in front of a narrow slit illuminated by sodium light and the distance between the virtual sources is found to be 0.05 cm. Find the width of the fringes observed in an eye piece place at a distance of 75 cm from the biprism.	(10)
5.	a)	What is meant by visual angle and angular magnification?	(08)
	b)	Give the construction and working principle of an astronomical telescope. Give some practical applications of this telescope.	(17)
	c)	Prove that wave properties of particles are normally observed only when we study very small particles.	(10)
7.	a)	Explain the laws of photo electric effect and also derive the Einstein's photo electric effect equation.	(15)
	b)	Discuss the dual character of light.	(10)
	c)	Calculate the De-Broglie wavelength of an electron and alpha particle.	(10)
8.	a)	Write down the difference between α, β, and γ rays. Electron cannot take place inside the nucleus. then how electrons emitted from β decay.	(12)
	b)	Explain the construction and working principle of a nuclear reactor.	(13)
	c)	Half life of radium is 1672 years. Calculate the time in which 1.0 gm of radium is reduced by 2.1 mg.	(10)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2021
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 photo synthesis and photosensitized reactions giving examples.	(08)
	b)	Derive Beer-Lamberts Law.	(10)
	c)	What is quantum yield? Explain the reasons of low and high quantum yield.	(10)
	d)	Calculate the quantum yield of a reaction where 1000 mole photons are absorbed giving 10^6mole products. ($\lambda = 4600A°$)	(07)
2.	a)	What is group displacement law? Explain.	(09)
	b)	Define nuclear reactions giving examples.	(08)
	c)	Outline the action mechanism of a nuclear power plant.	(10)
	d)	The half-life period of radon is 3.825 days. Calculate the activity of radon. (Atomic weight of radon = 222).	(08)
3.	a)	Define unit cell and centre of symmetry.	(08)
	b)	Discuss the seven fine crystal system.	(10)
	c)	Derive Brag's law for a fine cubic crystal system.	(10)
	d)	Explain different types of defects in crystal system.	(07)
4.	a)	Define half-life and decay constant of a radioactive substance.	(10)
	b)	Present the actinium series.	(10)
	c)	Discuss the energy generation mechanism of the sun.	(08)
	d)	The amount of ^{14}C in a piece of wood is found to be one-sixth of its amount in a fresh piece of wood. Calculate the age of the old piece of wood.	(07)

Section B

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

5.	a)	What do you understand by polymers? Classify polymers based on branching with examples.	(08)
	b)	Define polydispensity index. Briefly euplicate the molecular weight distribution curves.	(08)
	c)	Define oxidative polymerization? Describe different types of oxidative polymerization with suitable mechanism.	(11)
	d)	What is meant by elastomers? Describe vulcanization of rubber with proper reaction.	(08)
6.	a)	Define glass transition temperature (T_g). Describe briefly different factors that affect T_g.	(08)
	b)	Demonstrate the preparation, characteristics, and application of Bakelite.	(09)
	c)	What is meant by composites materials? Indicate the prominent feature, advantage and application of conducting polymers.	(10)
	d)	What are the requirement of synthetic fiber? Enumerate the manufacturing process of synthetic fiber.	(08)
7.	a)	What is meant by flux? Write down Nernst-Plank equation and construe each term therein.	(08)
	b)	Define electrical double layer. Articulate the double layer model proposed by Grahame with proper diagram.	(10)
	c)	Define cyclic voltammetry. Draw the cyclic voltammograms for reversible, quasireversible, and irreversible systems in the same curve. Mention the diagnostic criteria of reversible system.	(09)
	d)	Describe why removal of oxygen is essential in the electro analytical technique. What are the ways of remediation of oxygen?	(08)
8.	a)	Ionic mobility increases descending order for group I element even though the size increases. Interpret the statement.	(08)
	b)	Enumerate the phosphoric acid fuel cell with schematic representation and redox reaction.	(10)
	c)	Define ionic mobility. Demonstrate the Hittorf's method for determination of transport number.	(10)
	d)	Delineate why molar conductance increases at infinite dilution for strong electrolytes.	(07)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2021
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) What is biomedical engineering? Who is biomedical engineer? What are the duties of biomedical engineers? (10)

b) Draw and level a cell membrane structure. Justify "Ions cross the cell membrane through various transport mechanisms". (12)

c) Deduce the Goldman equation to describe the cell membrane potential taking the influences of two or more ions into consideration. (13)

2. a) State and explain different biophysical laws and use these laws to derive the Nernst equation. (13)

b) State Donnan equilibrium. A membrane is permeable to k^+ and cl^- but not to a large cation R^+. Find the steady state equilibrium concentration for the following initial conditions in Figure 2(b). (12)

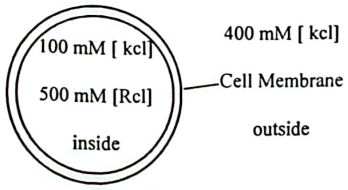

Fig. for Q 2(b).

c) Draw and label a neuron. Briefly describe how the sensory information is transported from neuron to neuron. (10)

3. a) Define Biomaterial. What are the conditions to be satisfied for a material to be biomaterial? (08)

b) If you design a cardiovascular stent, which type of materials would you choose among metal, ceramics, polymers, and composites? Give a comparative overview discussing various features of them. (15)

c) How does the wound heal after implantation of a biomaterial disrupting the anatomical continuity? (12)

4. a) What are the sources of biomechanical signals? Show the waveform of any biomechanical signal and explain the significance of various regions of the graph. (10)

b) How does a stimulus generate an all or none action potential involving various ions movements across the cell membrane? Explain with figures. (12)

c) Explain different steps of biomedical signal processing with block diagram. (13)

Section B

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

5. a) Define transducer. What is transduction principle? What are the factors considered in choice of a particular transducer? (10)

b) Define following terms with suitable example. (15)
(i) Sensitivity, (ii) Frequency response, (iii) Linearity, (iv) Stability, and (v) Isolation.

c) What is biosensor? State and explain the working principle of Linear Variable Differential Transformer (LVDT). (10)

6. a) Mention applications of some basic medical equipment. (10)

b) What are the properties of bioelectrodes? Why floating electrodes are used? Draw the total electrical equivalent circuit of a body-surface electrode when the electrode is placed against skin. (14)

c) Briefly explain piezoelectric properties of a transducer. (11)

7. a) What is biomechanics? What are the applied subfields of biomechanics? Briefly explain the applications of biomechanics. (15)

b) What is medical imaging? Briefly discuss various medical imaging modalities and their applications. (20)

8. a) Write short notes on: (i) Tissue engineering and (ii) Rehabilitation engineering. (12)

b) What is biotechnology? Briefly explain different branches of biotechnology with examples. (12)

c) Briefly discus some biological and medical problems where engineering principles are applied. (11)

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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 Script A)

1. a) Given $f(x) = \begin{cases} 1 & \text{for } x < 0; \\ 1+\sin x & \text{for } 0 \le x < \frac{\pi}{2}; \\ 2+\left(x-\frac{\pi}{2}\right)^2 & \text{for } \frac{\pi}{2} \le x; \end{cases}$ (12)

Check that $f'(x)$ exists at $\frac{\pi}{2}$ and $x = 0$ or not.

b) Differentiate $\tan^{-1}\left(\frac{2x}{1-x^2}\right)$ with respect to $\sin^{-1}\left(\frac{2x}{1+x^2}\right)$. (11)

c) What do you mean by indeterminate form? Evaluate $\lim_{x \to 0} \frac{x-\cos x}{x^3}$. (12)

2. a) If $\sin y = x\sin(a+y)$, find $\frac{dy}{dx}$. (10)

b) Expand $\tan^{-1} x$ in power of $\left(x-\frac{\pi}{4}\right)$. (12)

c) If $y = e^{a\sin^{-1}x}$, then find y_{n+2}. (13)

3. a) Find maximum and minimum values of $x+\sin 2x$ for $0 < x < 2\pi$. (10)

b) What is homogeneous function? If $u = \varphi(r)$ and $r^2 = x^2 + y^2$, then prove that (15)
$\frac{\delta^2 u}{\delta x^2} + \frac{\delta^2 u}{\delta y^2} = \varphi''(r) + \frac{1}{r}\varphi'(r)$.

c) State Euler's theorem on homogeneous function in x, y, z. If $u = e^{xyz}$, then find u_{xyz}. (10)

4. a) State Rolle's theorem. Verify Mean value theorem for the function $f(x) = x(x-1)(x-3)$ in the interval of $0 \le x \le 4$. (10)

b) Find where the tangent is parallel and perpendicular to the x-axis for the curve $ax^2 + 2hxy + by^2 = 1$. (13)

c) Find the radius of the curvature at the origin for the curve $x^3 + y^3 - 2x^2 + 6y = 0$ (12)

Section B

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

5. Integrate the followings: (35)

(i) $\int \frac{3x+2}{\sqrt{x^2+5x+1}}dx$, (ii) $\int \frac{x\sec x}{1+\operatorname{cosec} x}dx$, (iii) $\int \frac{dx}{\sqrt{x}(1+x)^{3/2}}$

6. Evaluate the followings:

a) $\int_0^1 \frac{\log(1+x)}{1+x^2}dx$ (12)

b) $\int_{\pi/4}^{3\pi/4} \frac{x}{1+\sin x}dx$ (12)

c) $\lim_{n\to\infty}\left[\frac{n!}{n^n}\right]^{1/n}$ (11)

7. a) What is Beta function? Show that $\int_0^\infty e^{-x^2}dx = \frac{1}{2}\sqrt{\pi}$. (13)

b) Obtain the reduction formula for $\int x^n e^{ax}dx$. (12)

c) Find the relations between Bea and Gamma functions. (10)

8. a) Evaluate $\int_0^\infty \frac{\log(1+a^2x^2)}{1+b^2x^2}dx$ by using the rule differentiation under integral sign. (13)

b) Find the volume bounded by the surface $z = 2, z = 2 + x + y, x = 0, y = 0$ and $x + y = 2$. (10)

c) Evaluate the double integral $\iint(x^2+y^2)dxdy$ over the positive quadrant to the circle $x^2 + y^2 = a^2$. (12)