Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2017
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 is interference of sound waves? Establish the differential equation of a damped harmonic oscillation. (12)

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

   c) Deduce the frequency and quality factor for a circuit with L = 2 mH, C = 5 μF and R = 0.2 ohm. (10)

2. a) What is the difference between echo and reverberation? Explain why reverberation cannot be heard if the distance between the source of sound and the obstacle is greater than 17 meters. (10)

   b) Derive an analytical expression for the growth and decay of sound intensity inside an auditorium and hence obtain Sabine's reverberation formula. (15)

   c) Find the reverberation time of a room 10m wide by 21m long by 4m high. The ceiling is acoustic, the walls are plastered, the floor is concrete and there are 27 people in the room. [Sound absorption are: acoustic ceiling = 0.60, plaster = 0.03, concrete = 0.02. Take the absorbing power per person to be 0.5] (10)

3. a) Draw Lissajous' figure using following equation (10)

   $$x = a\sin\omega t \text{ and } y = 2a\sin 2\omega t.$$

   b) What are free, damped and forced vibrations? Discuss the conditions under which the discharge of the capacitor is periodic, critically damped and oscillatory in the case of LCR circuit. (15)

   c) The apparent frequency of the whistle of an engine changes in the ratio 6:5 as the engine passes an stationary observer. If the velocity of sound is 352 m/sec, calculate the velocity of the engine. (10)

4. a) Explain the oscillatory behavior of SHM. (10)

   b) Prove that average kinetic energy and average potential energy are equal. (15)

   c) For a particle vibrating simple harmonically, the displacement is 8 cm at the instant the velocity is 6 cm/sec and the displacement is 6 cm at the instant the velocity is 8 cm/sec. Calculate amplitude, frequency and time period. (10)

Section B

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

5. a) Explain interference of light using suitable diagram. Discuss interference of light analytically and obtain the condition of maximum and minimum intensities. (12)

   b) Write down the conditions of interference. (08)

   c) Discuss the color of central ring. (05)

   d) In Young's double slit experiment the separation of the slits is 1.9 mm and the fringe spacing is 0.31 mm at a distance of 1m from the slits. Calculate the wavelength of light. (10)

6. a) What is angular magnification of optical instrument? (05)

   b) Derive magnification of a simple microscope when images are formed at the least distance of distinct vision and at infinity. (15)

   c) A convex lens of focal length 10 cm is used as a magnifying glass. Find the magnification when the images are formed at infinity and at the least distance of distinct vision (25 cm from the lens). (10)

   d) Write down the different parts of Telescope with figure. (05)

7. a) Write the examples of particle properties of wave. Explain one of them. (10)

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

   c) Calculate the magnitude of energy of the photon associated with the light of wavelength 6057.8 A°. (05)

   d) Derive an expression of De-Broglie wave velocity and comments on it. (05)

8. a) Show that the average life period of a radioactive atom is the reciprocal of the radioactive constant. (10)

   b) Show that $N_2 = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}[e^{-\lambda_1 t} - e^{-\lambda_2 t}]$, where the symbols have their usual meanings. (15)

   c) The half-life of ${}_{92}U^{238}$ is 4.51×10^9 years. In how many years will 1 gram of pure ${}_{92}U^{238}$ (i) lose one centigram and (ii) be reduced to one centigram. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2017
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.
iii) Assume reasonable data if missing any.

Section A

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

1. a) Define continuity of a function. If $f(x) = |x-1| + |x+3|$ then test continuity of $f(x)$ at $x = 1$ and differentiability at $x = -3$. (15)

   b) Evaluate $\lim_{x\to 0} \dfrac{e^x - e^{sinx}}{x - sinx}$ (10)

   c) Differentiate $tan^{-1}x$ with respect to $e^{tan^{-1}x}$. (10)

2. a) State Leibnitz's theorem. If $y = (x + \sqrt{x^2+1})^m$ then prove that (12)
   $$(1+x^2)y_{n+2} + (2n+1)xy_{n+1} + (n^2 - m^2)y_n = 0$$

   b) A container with an open top is to have $10m^3$ capacity and be made of thin sheet metal. Calculate the dimension of the box if it is to use the minimum possible amount of metal. (13)

   c) State mean value theorem. Verify the mean value theorem for the function $f(x) = x(1-x^2)$ in the interval $[-2, 1]$. (10)

3. a) Define normal of a curve. If $lx + my = 1$ is a normal to the parabola $y^2 = 4ax$ then show that $al^3 + 2alm^2 = m^2$. (12)

   b) Define homogeneous function. If $u = 3(ax+by+cz)^2 - (x^2+y^2+z^2)$ and $a^2 + b^2 + c^2 = 1$, then find the value of $u_{xx} + u_{yy} + u_{zz}$. (13)

   c) Define radius of a curvature. Find radius of curvature at any point of (10)
   $$x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}.$$

4. a) Find the asymptotes of the curve $4x^4 - 5x^2y^2 + y^4 - 3x^2y + 5x - 8 = 0$. (13)

   b) If $(secx)^{tanx} + (tanx)^{secx} = y$; find $\dfrac{dy}{dx}$. (10)

   c) Find the tangent and normal of the curve $x = a(\theta + sin\theta)$, $y = a(1 - cos\theta)$. Also find their lengths. (12)

Section B

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

5. Integrate any three of the following : (35)

a) $\int \frac{x^2}{x^4+x^2-2}\,dx$

b) $\int \frac{dx}{(1+x)\sqrt{1+x^2}}$

c) $\int \frac{1}{x^4+1}\,dx$

d) $\int \sqrt{4-3x-2x^2}\,dx$

6. Evaluate any three of the following: (35)

a) $\int_0^{\frac{\pi}{2}} \frac{\sqrt{sinx}}{\sqrt{sinx}+\sqrt{cosx}}\,dx$

b) $\int_0^{\pi} \frac{xsinx}{1+cos^2x}\,dx$

c) $\int_2^3 \frac{dx}{(x-1)\sqrt{x^2-2x}}$

d) $\int_0^1 \frac{\log(1+x)}{1+x^2}\,dx$

7. a) Define Gamma function and Beta function. (12)
Prove that $\Gamma n\ \Gamma(1-n) = \frac{\pi}{sinn\pi}$; $0 < n < 1$

b) Obtain the reduction formula for $\int tan^n x\ dx$ and hence find $\int tan^5 x\ dx$. (13)

c) Evaluate (10)

$$\lim_{n\to\infty}[\left(1+\frac{1}{n^2}\right)\left(1+\frac{2^2}{n^2}\right)\ldots\ldots\ldots(1+\frac{n^2}{n^2})]^{1/n}$$

8. a) Find the area of the segment of the parabola $y = (x-1)(4-x)$ cut off by x-axis. (17)

b) Find the whole length of a loop of the curve $3ay^2 = x(x-a)^2$. (18)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2017
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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 Script A)

1. a) Define primary and secondary cells. Why primary cell is not rechargeable? (08)

   b) How the power factor part is involved in wattmeter reading? (07)

   c) A moving coil instrument gives a full scale deflection of 10 mA when the potential difference across its terminal is 100 mV. Find (10)
   (i) The shunt resistance for a 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.

   d) Find the current of each branch for the following circuit as shown in figure 1(d). (10)

Figure 1(d)

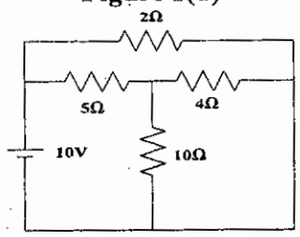
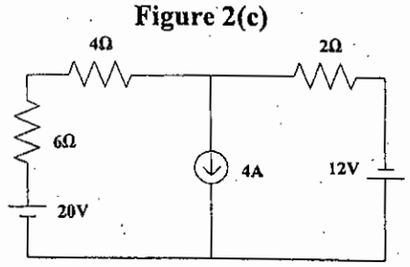


Figure 2(c)



2. a) State and explain KCL, KVL and Superposition theorem. (12)

   b) State maximum power transfer theorem. Derive the condition for maximum power and calculate that power. (13)

   c) Using mesh analysis determine the currents of the network of the above figure 2(c). (10)

3. a) Describe how to convert voltage and current sources? (05)

   b) Calculate the equivalent resistance between the terminals A and B of the following figure 3(b). (10)

Figure 3(b)

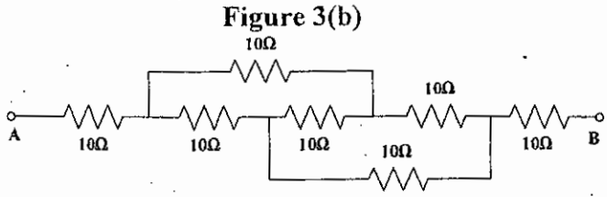
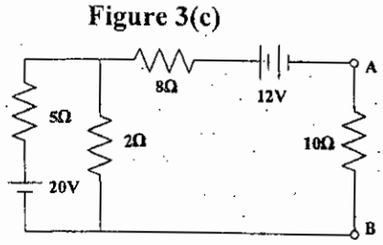


Figure 3(c)



   c) State Thevenin's theorem. Using Thevenin's theorem find the current in the 10Ω resistor of the network shown in the above figure 3(c). (10)

   d) Using Millman's theorem, find the current through and voltage across the 3Ω resistor shown in figure 3(d). (10)

Figure 3(d)

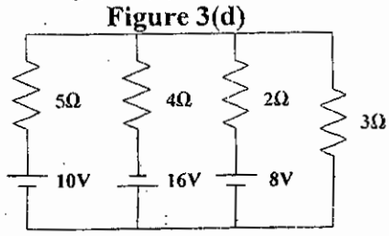
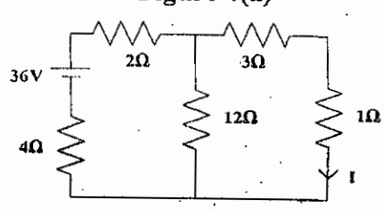


Figure 4(a)



4. a) State reciprocity theorem. Verify reciprocity theorem for the circuit shown in the above figure 4(a). (10)

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

c) What do you mean by reluctance and permeability? (05)

d) State Ohm's law and Ampere's circuital law of magnetic circuit with illustration. What is the significance of air gap in magnetic circuit? (10)

Section B

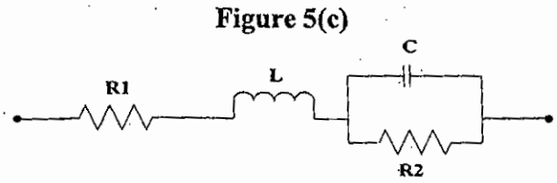
(Answer **ANY THREE** questions from this section in Script B)

5. a) Define alternating current. Why is ac generator needed? (06)

b) Derive the energy storage equation of inductor and capacitor. (08)

c) Draw the vector diagram for the following circuit 5(c) and also indicate power factor angle. (09)

Figure 5(c)



d) Assume that the current $i = I_m sin\omega t$ flows through a given RLC branch. Show that the voltage across the branch is $v = I_m z sin(\omega t + \theta)$ (12)

where $z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}$ and $\theta = tan^{-1}\frac{\left(\omega L - \frac{1}{\omega c}\right)}{R}$.

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

b) A voltage $v = 200\ sin377t$ volts is applied to an inductive branch and the maximum current is found to be 10A. Find the value of L in milihenrys. (08)

c) Define form factor and crest factor. Find the form factor and crest factor of alternating current. (09)

d) Mention the significance of the operator j. (06)

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

b) Evaluate the following complex number: (05)

$$\frac{10\angle -30^o + (3 - j4)}{(2 + j4)(3 - j5)}$$

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

d) Show that the average power consumed in a RL circuit is $P_{av} = \frac{1}{2}V_m I_m cos\theta$. (10)

8. a) Define real power, reactive power and apparent power of an ac circuit. (06)

b) Why the internal resistance of voltmeter is high and ammeter is low? Describe the operation of wattmeter. (10)

c) Define and classify filter. Draw the frequency response curve of different filters. (10)

d) Define rms value and instantaneous value of an ac circuit. Show that, for a sine wave, the average value is 0.636 times the maximum value. (09)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2017
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) Discuss the characteristics of solids and their classifications. What is crystallization? (10)

b) Discuss crystal systems and classification of crystals into different systems. (10)

c) What is meant by Bravais lattice? Write down the fourteen Bravais lattice systems. (08)

d) Symmetry is an important property of crystals- Explain in detail. (07)

2. a) Find the miller indices of the planes that intersect the crystallographic axes at the distances (1a, 3b, -c) and (2a, 2b, ∞c). (11)

b) What is X-ray? How is X-ray used in analyzing crystals? (07)

c) What are defects in crystals? Describe interstitial defect, schottky defect and colour centres. (10)

d) What is meant by
(i) Crystal lattice (ii) Space lattice (iii) Unit cell (07)

3. a) State Beer-Lambert's law and deduce a mathematical expression for the law. (10)

b) Define quantum yield. What are the reasons for abnormal quantum yield? (08)

c) What is photosensitized reaction? Give suitable examples. (05)

d) Write short notes on: (12)
(i) Fluorescence (ii) Phosphorescence (iii) Chemiluminescence

4. a) What is radioactivity? Describe the properties of α, β and γ rays. (08)

b) The binding energy per nucleon of $_{90}Th^{232}$ is 8.67×10^{-13} Joules. Calculate the actual mass of $_{90}Th^{232}$ in amu. (07)

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

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

Section B

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

5. a) Define Telechelic polymer and star polymer. (06)

   b) Write down the differences between thermoplastic and thermosetting polymer. (08)

   c) What is conducting polymer? Discuss the mechanism of anionic polymerization reaction. (12)

   d) Define degree of polymerization. Calculate the molar mass of a particular polymer sample, $-(CH_2-CH_2)-_n$, where, $D_p = 4600$. (09)

6. a) Sketch a typical current-voltage curve. Discuss how current change in a typical current-voltage polarogram on changing the applied voltage. (12)

   b) What is half-wave potential? What does it indicate in a typical polarogram? (08)

   c) Write down the Ilkovic equation for diffusion current and also mention the meaning of each term in that equation. (08)

   d) Draw a typical excitation signal in cyclic voltametry and the corresponding voltammogram. (07)

7. a) What are electrolytes? Distinguish between strong and weak electrolytes. (06)

   b) What is meant by molar conductance? What is the significance of molar conductance at infinite dilution? (09)

   c) Explain clearly the term "transport number". Describe one method for measurement of transport number. (10)

   d) What is fuel cell? Discuss the working principle of a fuel cell. (10)

8. a) Iron reacts spontaneously with copper (II) ions. (10)

   $$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$$

   Obtain half-reactions for this, then draw a voltaic cell using these half-reactions.

   b) What is a salt bridge? Why is it used? (07)

   c) Discuss the principle of determination of pH of a solution with the help of a glass electrode. (12)

   d) What is the emf of the following cell at 25^0C? (06)

   $$Zn(s)|Zn^{2+}(1.00 \times 10^{-5}M)||Cu^{2+}(0.100M)|Cu(s)$$

   The standard emf of this cell is 1.10V.

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2017
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. Briefly describe applications and main fields of biomedical engineering. (12)

   b) What is meant by biological cell? Briefly describe different parts of human cell with net sketch. (13)

   c) Draw a neuron and specify its different parts. (05)

   d) Mention physical and chemical structure of a cell membrane. (05)

2. a) What are the conditions to maintain resting membrane potential across cell membrane? Deduce Nernst equation for equilibrium condition. (15)

   b) Write short notes on: ion channel, ion pump, stimulus, threshold and synapse. (10)

   c) Approximate intracellular and extracellular concentrations of the important ions across a squid giant axon, ratio of permeabilities at resting and action conditions are given in the table 2(c). At room temperature find E_k , E_{Na} , E_{Cl} , $V_{m,rest}$, $V_{m,action}$. (10)

Table: 2(c)

Ion	Cytoplasm (mM)	Extracellular fluid (mM)	Rate of permeabilities in rest	Rate of permeabilities in action
K^+	140	2	1	1
Na^+	13	110	0.02	10
Cl^-	3	90	0.4	0.3

3. a) Explain the mechanism of action potential generation with net sketch. (10)

   b) Describe how action potential is propagated from one neuron to next neuron? (12)

   c) How biomaterials are different from other materials? Briefly describe most common classes of biomaterials. (13)

4. a) Define biosignal processing. What are the steps of biosignal processing? (10)

   b) What are the origins of EEG, ECG and EMG signals? Briefly explain them. (15)

   c) "The neural communication in our body is digital", explain. (10)

Section B

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

5. a) What do you mean by biomedical instrumentation? Briefly discuss about in vivo and in vitro measurement. (09)

b) Write short notes on: (09)
(i) Sensitivity
(ii) Frequency response
(iii) Accuracy

c) Briefly explain about the components of medical instrument system with associated block-diagram. (17)

6. a) Explain the working principles of a biosensor with schematic diagram. (12)

b) What do you mean by piezoelectric effect? (06)

c) Briefly explain the working principles of a strain gage. (12)

d) Write down five medical instruments with their uses. (05)

7. a) What is bio-electrode? Draw the equivalent circuit of a biopotential electrode. (07)

b) Define biomechanics. Write down the applied subfields of biomechanics. (08)

c) Write short notes on: (15)
(i) X-ray imaging
(ii) Magnetic Resonance Imaging
(iii) Ultrasound imaging

d) Write down the applications of bio-electrodes. (05)

8. a) Define biotechnology. Briefly discuss about the branches of biotechnology. (10)

b) Distinguish between Bio-nanotechnology and Nano-biotechnology. (08)

c) Write short notes on: (10)
(i) Molecular Engineering
(ii) Rehabilitation Engineering

d) What are the future challenges of biomedical engineering? (07)