

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2015
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.
iii) Assume reasonable data if missing.

Section A

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

1. a) Two simple harmonic vibrations acting at right angles to each other have the time period in the ratio 1:2. The phase difference between the two vibrations is $\pi/2$. Show graphically that the resultant curve is parabola. (12)
- b) What are damped vibrations? Obtain an expression for the displacement in the case of a damped oscillatory motion. (13)
- c) Deduce the frequency and quality factor for a circuit with $L = 2\text{mH}$, $C = 6\mu\text{F}$, and $R = 2.2\Omega$. (10)
2. a) 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. (12)
- b) Discuss the formation of stationary waves. How can you indicate the positions of nodes and antinodes from the above equation? (13)
- c) A source of sound has a frequency of 550Hz and amplitude of 0.28cm. What is the flow of energy across cm per second if the velocity of sound in air is 332m/s and the density of air is 0.00129gm/cm. (10)
3. a) Define Doppler's effect. Find the expression for the apparent frequency of the note when the source and listener are (i) moving towards each other and (ii) moving away from each other. (13)
- b) What do you mean by acoustic intensity of a sound wave? Show that intensity is directly proportional to the square of the pressure. (12)
- c) An air conditioning unit operates at a sound intensity level of 75dB. If it is operated in a room with an existing sound intensity level of 70dB, what will be resultant intensity level? (10)
4. a) Explain what is meant by 'bel' and 'phon'. Discuss the factors influencing loudness. (10)
- b) Give the theory of growth and decay of sound in 'live room'. Find the reverberation time. (15)
- c) A room dimensions 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 the room. Velocity of sound in air 350m/s. (10)

Section B

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

5. a) What is interference of light? Discuss the important conditions for the interference of light. (10)
- b) Explain how Newton's rings are formed and describe the method for determination of wavelength of light with their use. (15)
- c) A biprism is placed at a distance of 5cm in front of a narrow slit, illuminated by sodium light and the distance between the virtual sources is found to be 0.05cm. Find the width of the fringes observed in an eyepiece placed at a distance of 75cm from the biprism. (10)
6. a) Give the construction and working principle of a compound microscope. (15)
- b) State and prove Bragg's law of X-ray diffraction. Why X-rays are used for crystal structure analysis? (10)
- c) A telescope with an objective of focal length 50cm is used to bring into view an object 150cm distant. When the eyepiece is adjusted to form the image at infinity, the magnifying power is 5. Calculate: (i) the focal length of the eyepiece and (ii) the magnifying power of the telescope, if the eyepiece is adjusted to view objects at infinity. (10)
7. a) Distinguish between Photoelectric effect and Compton effect. Discuss their significance in the development of modern physics. (10)
- b) Give the expression of Compton effect with the help of quantum theory and find an expression of the Compton effect $\Delta\lambda$. Discuss the results. (15)
- c) What will be the X-ray photon energy? (When its wavelength = 10^{-12}m) (10)
8. a) Explain radioactivity. Discuss the properties of α , β , and γ . (12)
- b) Explain the construction and working principle of a nuclear reactor. (13)
- c) Calculate the binding energy of a neutron in the ${}^7_3\text{Li}$ nucleus. Express the result in joules. [${}^7_3\text{Li} = 7.016004$, ${}^6_3\text{Li} = 6.015125$, and $m_n = 1.008665$] (10)

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. A function $f(x)$ is defined as follows: (13)

$$f(x) = \begin{cases} x - 2 & \text{when } x \geq 2 \\ -x + 2 & \text{when } x < 2 \end{cases}$$

Discuss the continuity and differentiability of $f(x)$.

- b) If $x^y + (\cosh x)^{x \ln y} = y^x + 3^y$ then find $\frac{dy}{dx}$ (09)

- c) Define homogeneous function. Test whether the function (13)

$$f(x, y) = \frac{x^{2/3} + 7y^{2/3}}{3xy^3 + 5x^2y^2 - 9x^3y}$$

is homogeneous or not and if possible find the degree of homogeneity. Also state the Euler's theorem on homogeneous function.

2. a) If $x = \tan\left(\frac{1}{m} \log y\right)$ (11)

then obtain a relation between y_{n+2} , y_{n+1} and y_n

- b) State Rolle's theorem. Using Maclauren's theorem expand $(1-x)^{-2}$ in powers of x . (12)

- c) Find the equations of the tangent and the normal to the curve (12)
 $f(x) = 3x^2 + 5x - 9$ at $x = 1$

3. a) Calculate the value of $\sin 46^\circ$ using Taylor's theorem (correct upto 4 decimal places). (11)

- b) Show that (09)
 $f(x, y, z) = \frac{1}{\sqrt{x^2 + y^2 + z^2}}$

is a solution of the Laplace equation $f_{xx} + f_{yy} + f_{zz} = 0$

- c) List the indeterminate forms. Find $\lim_{x \rightarrow 0} (1 + \sin x)^{1/x}$ (15)

4. a) Obtain the angle between the circle $x^2 + y^2 - 14x - 33 = 0$ and the ellipse (10)
 $16x^2 + 25y^2 = 400$

- b) Find the curvature at the point $(0, b)$ of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (10)

- c) An open box is to be built to contain 32 c.c. of fluid, whose base be square. Find (15)
 the dimensions so that the surface area be minimum.

Section B

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

5. Integrate any three of the following with respect to 'x': (35)

a)
$$\frac{1}{x^4\sqrt{2+3x^2}}$$

b)
$$\frac{2x+5}{\sqrt{x^2-2x+2}}$$

c)
$$\frac{1}{(x-2)^{5/2}(x+3)^{7/2}}$$

d)
$$\frac{1}{2+3\cos x + \sin x}$$

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

a)
$$\int_3^5 \frac{dx}{(2x+3)\sqrt{3x-4}}$$

b)
$$\int_0^1 x^6(1-x^2)^{1/2} dx$$

c)
$$\int_0^{\pi/2} \frac{x dx}{(3-2\sin 2x)}$$

d)
$$\int_0^1 \frac{\log x}{\sqrt{1-x^2}} dx$$

7. a) Obtain reduction formula for $\int \tan^n x dx$ (07)

b) If $x = u + v$ and $y = u - v$ then obtain the Jacobian of the transformation. Hence obtain the area bounded by the lines $x = y, y = x - 5, x = 0, x = 3$ using integration. (15)

c) Find the volume of solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ & $z = 0$. (13)

8. a) Evaluate $\int_0^{\pi} \frac{d\theta}{a + b\cos\theta}$ (16)

where $a > b$. Hence use the method of differentiation under sign of integration to evaluate

$$\int_0^{\pi} \frac{\cos\theta d\theta}{(5-4\cos\theta)^3}$$

b) Define Euler's 1st and 2nd integral. Write the relation between them. (09)

c) Evaluate $\lim_{n \rightarrow \infty} \left[\frac{n}{n^2+1^2} + \frac{n}{n^2+2^2} + \frac{n}{n^2+3^2} + \dots + \frac{n}{2n^2} \right]$ (10)

Khulna University of Engineering & Technology
 B. Sc. Engineering 1st Year 1st Term Examination, 2015
 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 independent and dependent sources. Classify dependent sources. (08)
 - b) Why primary cell is not rechargeable? (07)
 - c) Write short notes on: (i) Ammeter, (ii) Multimeter, and (iii) Galvanometer. How the range of an ammeter and voltmeter can be extended? (09)
 - d) A moving-coil milliammeter has a resistance of 5Ω and a full-scale deflection of 20mA . Determine the resistance of a shunt to be used so that the instrument could measure currents upto 500mA at 20°C . What is the percentage error in the instrument operating at temperature of 40°C ? Temperature coefficient of copper = $0.0039/^\circ\text{C}$. (11)
2. a) State and explain KVL and KCL. (06)
 - b) Find the input resistance between points A and B of Fig. 2(b). (10)

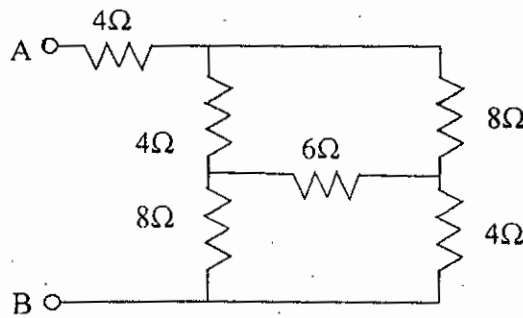


Fig. 2(b)

- c) Using nodal analysis method, find the current through the 4Ω resistor of Fig. 2(c) (12)

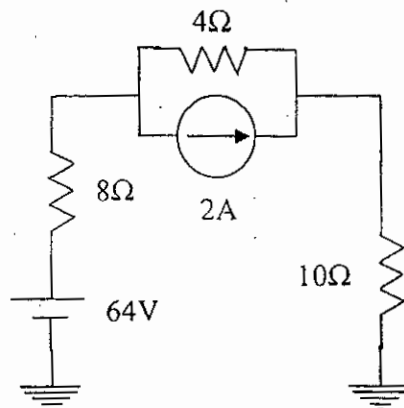


Fig. 2(c)

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

3. a) State Thevenin's theorem. Find the Thevenin equivalent circuit for the network in (12) the shaded area of the network of Fig. 3(a).

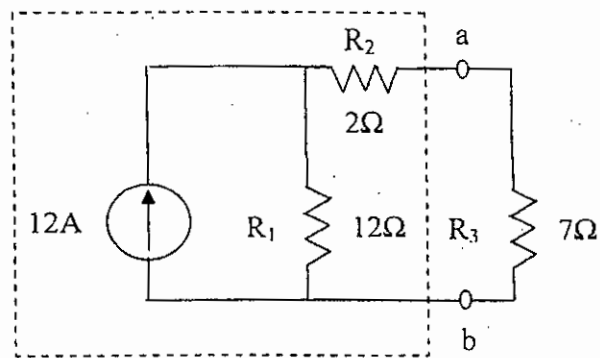


Fig. 3(a)

- b) Find the Norton equivalent circuit for the network external to the 9Ω resistor of (12) Fig. 3(b).

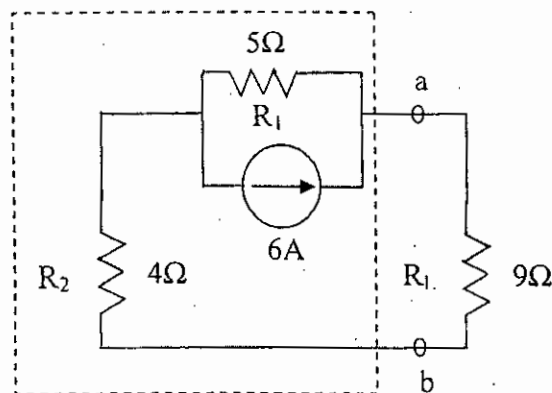


Fig. 3(b)

- c) State Millman's theorem. Using Millman's theorem, find the current through and (11) voltage across the resistor R_L in the network shown in Fig. 3(c).

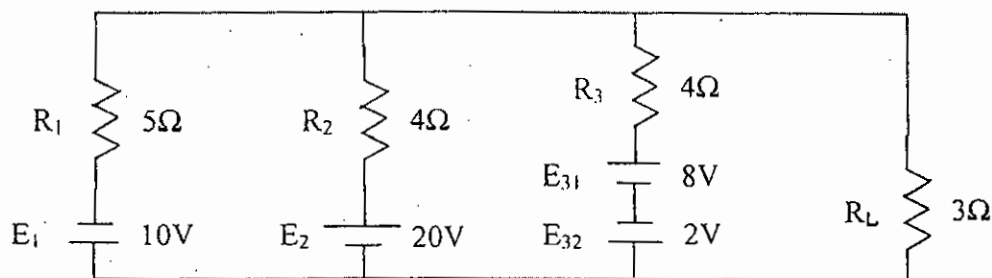


Fig. 3(c)

4. a) Define and classify filter. Write down the significance of 3dB point. (10)
- b) Design a high pass RL filter that has a cutoff frequency of 4KHz when $R = 3K\Omega$. (10) It is connected to a 10 $\angle 0^\circ$ variable frequency supply. Calculate- (a) Inductance L, (b) Output voltage and decibel decrease at i) $f = 0$, ii) $f = f_c$, and iii) 8KHz.
- c) Write down the step equations to find the frequency response of different (10) elementary filter sections.
- d) The gain function of a filter is given by

$$G(s) = \frac{1}{s^3 + 2s^2 + 2s + 1} \quad (05)$$

Find its parameters using Butterworth approximation.

Section B

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

5. a) What is alternating current? Why is ac generation needed? (08)
- b) A sinusoidal voltage $e = 200\sin 100\pi t$ is applied to a load having $R = 200\Omega$ in series with $L = 600\text{mH}$. Estimate: (i) expression for current in $i = I_m\sin(\omega t \pm \theta)$, (ii) power consumed by the load, (iii) reactive power of the load, and (iv) voltage across R and L. Where, each of the symbols carries their specific meanings. (10)
- c) Assume that the current $i = I_m\cos\omega t$ flows through a given RLC branch. Find out the voltage drop and the impedance of this branch. Also show the power variation with their necessary expressions. (11)
- d) Define Real power, Reactive power, and Apparent power of an ac circuit. (06)
6. a) Define RMS value of an alternating current. Calculate the exact amount of energy delivered to and received by the inductor and capacitor respectively during a quarter cycle. (14)
- b) Given the parallel circuit shown in Fig. 6(b). Find I , I_1 , I_2 , and total power consumed. (10)

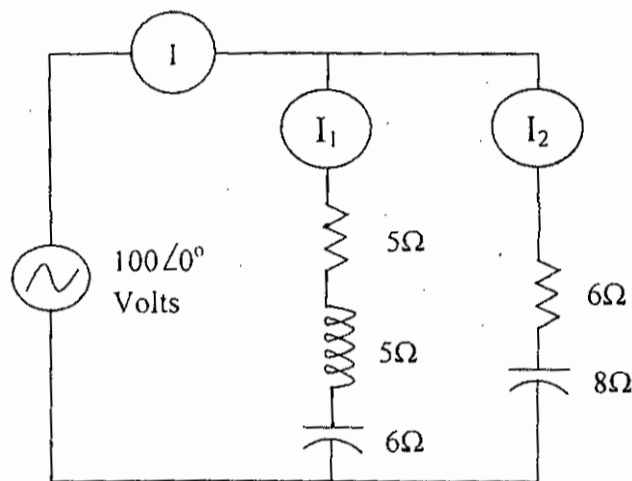


Fig. 6(b)

- c) Find the cubic roots of A, where $A = 3.08 + j18.455$. Also find $\log_e A$. (06)
- d) Define Quality factor of a RLC series circuit. (05)
7. a) An useful equation in filter circuit analysis is (11)

$$\alpha + j\beta = 2\log_e \left(\sqrt{1 + \frac{Z_1}{4Z_2}} + \sqrt{\frac{Z_1}{4Z_2}} \right)$$

If $Z_1 = 25.1410 \angle -90^\circ$ and $4Z_2 = 795 \angle 90^\circ$, evaluate α and β .

- b) Define Form factor, Crest factor, Power factor, and Reactive factor of an AC circuit. (12)
- c) Calculate the average and rms value of the voltage wave shown in Fig. 7(c). (12)

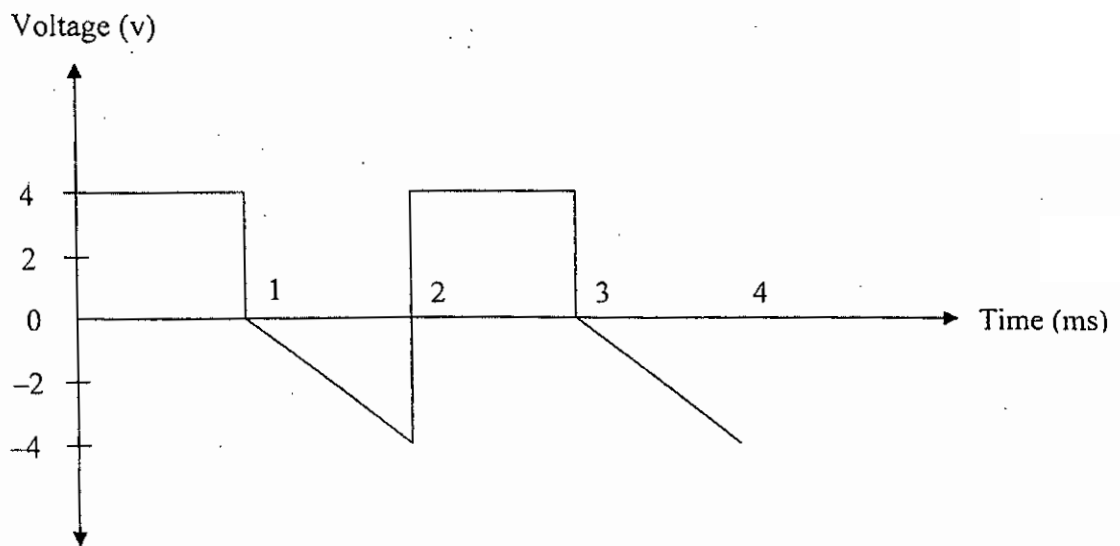
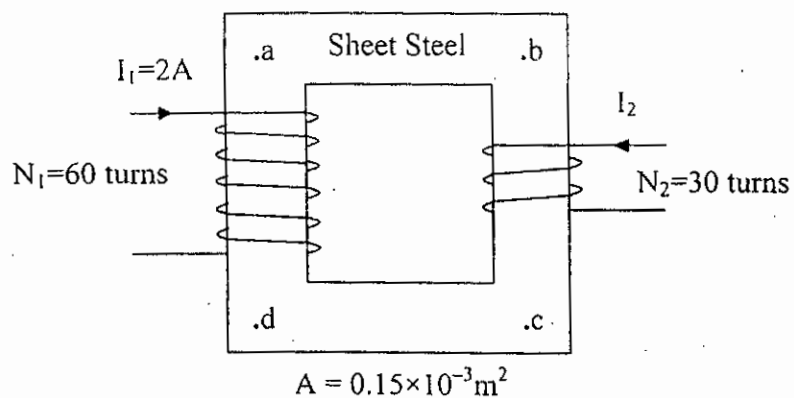


Fig. 7(c)

8. a) Define magnetic circuit. Mention the differences between electrical circuit and magnetic circuit. (07)
- b) Explain Biot-Savart law. When a wire of finite length carrying current of I (12) ampere, find the magnetic field strength at point P which is placed at a finite distance from that wire.
- c) Determine the secondary current I_2 for the transformer of Fig. 8(c), if the flux in (10) the core is 1.5×10^{-5} wb and $H = 15 \text{ At/m}$.



$$A = 0.15 \times 10^{-3} \text{ m}^2$$

$$l_{abcd} = 0.16 \text{ m}$$

Fig. 8(c)

- d) State and explain Ohm's law and Ampere's circuital law of magnetic circuit. (06)

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 the terms: i) Diffusion current, ii) Migration current, and iii) Convection current. (06)
- b) What do you mean by Dropping Mercury Electrode (DME)? What are the characteristics of the DME? (08)
- c) What is polarogram? Explain the different regions of the current-voltage curve in direct current polarography. (12)
- d) What is alternating current (AC) polarography? Write down the advantages of AC polarography. (09)
2. a) What is supporting electrolyte? What are the roles of supporting electrolyte in polarography? (06)
- b) What is cyclic voltammetry? Draw a typical cyclic voltammogram and explain its features. (10)
- c) Sketch a cyclic voltammogram of a hypothetical reversible redox couple: $A + e \rightleftharpoons \bar{A}$. What are the advantages of cyclic voltammetry over other polarography? (09)
- d) How can you determine electron transfer number and reaction mechanism from the cyclic voltammogram? (10)
3. a) What do you mean by oligomer and polymer? Discuss the mechanism for the polymerization of propylene in the presence of H_2SO_4 catalyst. (10)
- b) What is conducting polymer? What are the advantages of conducting polymer over traditional polymer? (08)
- c) What is degree of polymerization? What are the differences between chain polymerization and step polymerization? (09)
- d) Write short note on: i) Co-polymer, and ii) Bio-degradable polymer. (08)
4. a) How would you differentiate between thermosetting polymer and thermoplastic polymer? (08)
- b) State and explain Einstein's law of photochemical equivalence. How would you explain very high and very low quantum efficiencies of some photochemical reactions? (12)
- c) A system is irradiated for 20 minutes and is found to absorb 4×10^{18} quantum per second. If the amount decomposed is 3×10^{-3} mole and $N = 6.023 \times 10^{23}$, calculate the quantum efficiency of the reaction. (08)
- d) Distinguish between photochemical and thermal reactions. (07)

Section B

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

5. a) What is unit cell? Write down the lattice parameter of Cubic and Tetragonal crystal system. (06)
- b) What is lattice? Draw the Tetragonal-I, Orthorhombic-C, and Cubic-F unit cell and find the lattice points per unit cell. (08)
- c) What do you mean by point symmetry and space symmetry? Briefly discuss the point symmetry and space symmetry. (08)
- d) What is defect? Shortly discuss different types of defects with relevant schematic diagram. (08)
- e) "Growing a single crystal is an art" explain this statement. (05)
6. a) What is meant by Origin of X-ray? Draw schematic diagram of a side-window X-ray tube for the generation of X-ray. (08)
- b) What do you mean by Isotopes and Isomers? Shortly describe the classification of nuclides on the basis of nuclear stability. (08)
- c) Briefly illustrate the natural decay chain. (06)
- d) Discuss the nuclear stability on the basis of the neutron to proton ratio N/Z . (08)
- e) What are the transfer processes occurs in the direct interactions between projectile and target nuclides in nuclear reaction mechanism? (05)
7. a) What do you mean by Binding Energy? Calculate the binding energy per nucleon (in MeV) in Helium atom ${}^4_2\text{He}$ which has a mass of 4.00260amu, mass of an electron = 1.008655amu, and mass of one hydrogen atom = 1.007825amu. (10)
- b) β -emission results in a change of Z value with no change of A value. What are the possibilities of electron captured decay over positron emission? (05)
- c) Derive an expression for the rate of radioactive decay. (10)
- d) Shortly describe the Neutron-Induced Fission and Fusion reactions. (10)
8. a) What is transport number? How is mobility of an ion related to the transport number? (10)
- b) What do you mean by abnormal transport number? Derive a relationship between free energy and e.m.f. of the cell. (08)
- c) Write down the different types of fuel cell. Shortly explain the hydrogen fuel cell and its advantages. (10)
- d) Calculate the cell potential of $\text{Sn}/\text{Sn}^{2+} (0.05\text{M}) // \text{Fe}^{2+} (0.1\text{M})/\text{Fe}$. (07)
[Given, $E_{\text{Fe}/\text{Fe}^{2+}}^{\circ} = 0.44\text{V}$ and $E_{\text{Sn}/\text{Sn}^{2+}}^{\circ} = 0.14\text{V}$]

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2015
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. What are the main fields of Biomedical Engineering? Mention some applications of Biomedical Engineering. (10)
- b) Write short notes on: i) Human physiology and modeling (12)
ii) Biomechanics
iii) Rehabilitation Engineering
- c) What is cell? Briefly explain different types of cells in human body. (13)
2. a) State and explain the following biophysical terms: i) Fick's law (12)
ii) Ohm's law
iii) Einstein relationship
- b) Define membrane potential. Derive the expression of resting potential of a membrane permeable to one ion. (12)
- c) What do you mean by $\text{Na}^+ - \text{K}^+$ pump? Briefly explain the pumping mechanism of $\text{Na}^+ - \text{K}^+$ pump. (11)
3. a) Define Biomaterials. Explain the following types of Biomaterials: i) Polymers (14)
ii) Metals
iii) Ceramics
- b) What are the properties of Biomaterials? Briefly explain the applications of Biomaterials. (11)
- c) What is Biocompatibility? What are the steps should be followed to select a Biomaterial? (10)
4. a) Define Biomedical signal with examples. Classify Biomedical signals and explain each category in brief. (15)
- b) What is ECG? Sketch ECG. What are the information that an ECG can convey to the trained clinician? (12)
- c) Write some applications of EEG and EMG. (08)

Section B

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

5. a) What is Biomedical Instrumentation? What are the different types of measurements possible through Biomedical Instrumentation? Explain briefly. (10)
- b) Write short notes on: i) Sensitivity (09)
ii) Accuracy
iii) Signal to noise ratio
- c) Briefly explain the components of Medical Instrumentation System with the help of block diagram. (16)
6. a) Define Biosensor. Explain the working principle of a Biosensor. (12)
- b) What is Bio-electrode? Draw the equivalent circuit and mention some applications of Bio-potential electrode. (11)
- c) What is Piezoelectric effect? Briefly explain the working principle of Piezoelectric transducer. (12)
7. a) What are the applied subfields of Biomechanics? Mention some applications of Biomechanics. (10)
- b) Explain the working principle of Strain Gage. (10)
- c) Write short notes on: i) X-ray Imaging (15)
ii) Magnetic Resonance Imaging
iii) Ultrasound Imaging
8. a) Define Biotechnology. What are the branches of Biotechnology? What are the differences between Bionanotechnology and Nanobiotechnology? (15)
- b) Write short notes on: i) Molecular Engineering (10)
ii) Tissue Engineering
- c) What are the future challenges in Biomedical Engineering? (10)