Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2016
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 any.

Section A

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

1. a) What are Lissajou's figures? Briefly explain how these figures are useful in the laboratory. (10)

b) Establish the differential equation of a damped harmonic oscillator. Discuss in detail the condition under which the oscillations become over-damped, damped and critically damped. (15)

c) The positions of a particle executing simple harmonic motion along the x-axis are $x = P$ and $x = Q$ at time t and $2t$ respectively. Show that its period of oscillation is given by (10)

$$T = \frac{2\pi t}{\cos^{-1}\left(\frac{Q}{2P}\right)}$$

2. a) Show that the energy of a plane progressive wave is given by $E = 2\pi^2\rho v^2 a^2$, where the symbols have their usual meanings. (12)

b) Discuss Doppler's effect in sound and obtain an 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)

c) An observer in a railway platform observed a train passing through the station at a speed "a". Show that the frequency of the whistle changes by (10)

$$nv\left(\frac{2a}{v^2 - a^2}\right)$$

3. a) What are the requisites for good acoustics? How would you measure the absorption coefficient of a material? (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) A room dimensions 4×6×8 meters. Calculate (i) the mean free path of the sound wave in the room and (ii) the number of reflections made per second by the sound wave with the walls of the room. Velocity of the sound in air = 350 m/s. (10)

4. a) What do you mean by resonance and quality factor of an oscillator? (10)

b) Distinguish between phase velocity and group velocity of a train of waves and establish a relationship between them. (15)

c) Two oscillations are acting on a particle simultaneously, given by $x_1 = a_1\cos(\omega t+\varphi_1)$ and $x_2 = a_2\cos(\omega t+\varphi_2)$. Show that the result of the two oscillations is also simple harmonic and drive an expression for resultant amplitude. (10)

Section B

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

5. a) What are coherent sources? Discuss why two independent sources of light of the same wavelength cannot produce interference fringes. Give a diagram showing clearly how coherent sources are produced in a biprism. Derive the formula for the fringe width in the biprism experiment. (12)

   b) Explain the formation of Newton's rings. Show how you would use them to determination the wavelength of light. (13)

   c) Newton's rings are observed in reflected light of $\lambda = 5.9\times10^{-5}$ cm. The diameter of the 10^{th} dark ring is 0.5 cm. Find the radius of curvature of the lens and the thickness of the air film. (10)

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

   b) What is Compton effect? For Compton effect show that (15)

$$\lambda' - \lambda = \Delta\lambda = \frac{h}{m_o c}(1 - cos\varphi)$$

   where the symbols have their usual meanings.

   c) A photon of energy 5.1×10^5 eV is incident on aluminium foil. The photon is scattered at an angle of 90^o. Calculate: (i) wavelength of scattered photon and (ii) energy of recoiled electron. (10)

7. a) What is radioactivity? State and explain radioactive decay law. From the decay law deduce an expression for half life of a radioactive sample. (12)

   b) Explain nuclear fission and nuclear fusion reaction with examples. What is the source of energy release in nuclear fission? Calculate the energy released in fission of ^{235}U nucleus. (13)

   c) The ratio of ^{235}U to ^{238}U in natural uranium deposits today is 0.0072. What was the ratio 2×10^9 y ago? The half-lives of the two isotopes are 7.04×10^8y and 44.7×10^8y respectively. (10)

8. a) What do you figure out by electroacoustic phenomena? Explain briefly the following terms: (12)
   (i) Aeroacoustics (ii) Architectural acoustics
   (iii) Bioacoustics (iv) Musical acoustics

   b) Draw a block diagram of a basic acoustic optic modulator and driver. Derive an equation for Bragg's angle and efficiency. (13)

   c) Light from a sodium lamp (λ = 589 nm) forms an interference pattern on a screen 0.95 m from a pair of slits. The bright fringes in the pattern are 0.4 cm apart. What is the slit separation? (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2016
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. A function $f(x)$ is defined as follows: (15)

$$f(x) = \begin{cases} x^2, & when\ x \le 0 \\ x, & when\ 0 < x < 1 \\ \frac{1}{x}, & when\ x \ge 1 \end{cases}$$

Discuss the continuity and differentiability of $f(x)$ at $x = 0$.

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

c) Evaluate $\lim_{x\to 0}\left[\frac{1}{x^2} - \frac{1}{sin^2 x}\right]$ (10)

2. a) State Leibnitz's theorem. If $y = \left(sin^{-1}x\right)^2$ then find y_{n+2}. (13)

b) State Rolle's theorem. Verify the mean value theorem for the function $f(x) = x - x^3$ in the interval $[-2, 1]$. (12)

c) Find the extremum points of the function $f(x) = 2x^3 - 3x^2 - 12x$ and determine its extreme value. (10)

3. a) 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 (13)

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}$$

b) Define radius of curvature. Find the radius of curvature of the curve $(x^2 + y^2)^2 = a^2(y^2 - x^2)$ at the point $(0, a)$. (12)

c) If $y = \frac{x}{x^2 + a^2}$ then find y_n. (10)

4. a) State Euler's theorem on homogeneous function in x, y, z. If $u = f(r)$ and $r = \sqrt{x^2 + y^2}$, then prove that (15)

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f''(r) + \frac{f'(r)}{r}$$

b) Find where the tangent is perpendicular to the x-axis for the curve $ax^2 + 2hxy + by^2 = 1$. (10)

c) Find the equation of the normal at $\Theta = \pi/2$ to the curve $x = a(\Theta + sin\Theta)$, $y = a(1 + cos\Theta)$ (10)

Section B

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

5. Integrate any three of the followings:

a) $\int \frac{dx}{x^{\frac{1}{2}}(1+x)^{\frac{5}{2}}}$

b) $\int \frac{dx}{2+cosx-2sinx}$

c) $\int \frac{x}{(x-1)(x^2+4)}dx$

d) $\int \frac{dx}{(1-x)\sqrt{x^2-1}}$

6. Evaluate any three of the following: (3

a) $\int_0^{\pi} sin2xlogsinx\, dx$

b) $\int_0^{\pi/2} (acos^2x + bsin^2x)\, dx$

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

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

7. a) Define Gamma and Beta function. Prove that $\left[\left(\frac{1}{2}\right)\right] = \sqrt{\pi}$ (1

b) Evaluate $\lim_{n\to\infty}\left[\frac{n}{n^2+1^2}+\frac{n}{n^2+2^2}+\frac{n}{n^2+3^2}+\ldots\ldots\ldots\ldots+\frac{n}{2n^2}\right]$ (1

c) Obtain the reduction formula for $\int sec^n x dx$ (1

Hence find out $\int sec^5 x dx$

8. a) Find the area bounded by the parabola $y = \frac{1}{2}x^2$ and the line $y = 2x$ using double (1 integral.

b) Use polar coordinate to evaluate (1

$$\int_0^2 \int_0^{\sqrt{4-x^2}} (x^2+y^2)\, dy\, dx$$

c) Use the transformation $u = x + y$, $v = x - y$ to evaluate (1

$$\iint_R \frac{x-y}{x+y}\, dA$$

where R is the region enclosed by the lines $x - y = 0$, $x - y = 1$, $x + y = 1$ and $x + y = 3$.

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2016
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) What is crystal lattice? Describe different types of lattice symmetry. (10)

   b) Mention the names of seven crystal systems. Write down the relation between axes and angles of the system. (12)

   c) What is unit cell? How does a crystal grow? Describe a suitable and facile method of NaCl crystal growth. (13)

2. a) What is Copolymer? Shortly discuss different types of copolymer with relevant examples. (09)

   b) What do you mean by living polymer? "Addition polymerization is also called chain reaction polymerization"- illustrate this statement. (10)

   c) What is conducting polymer? Briefly describe the advantages and applications of conducting polymer over traditional polymer. (10)

   d) How would you differentiate between thermosetting polymer and thermoplastic polymer? (06)

3. a) What is X-ray? How is X-ray used in analyzing crystals? (08)

   b) Describe one method of determining crystal structure by X-ray. (10)

   c) What are defects in crystal? Describe Schottky and Frenkel defect. (10)

   d) "There is no perfect crystal in real system"- explains. (07)

4. a) What are Isotopes and Isomers? Shortly describe the natural decay chain. (09)

   b) Write down a short note on Neutron-Induced Fission and Fusion. (08)

   c) Derive an expression for the rate of radioactive decay. (09)

   d) What is Binding Energy (B.E)? Calculate the B.E per nucleon (in G/s) in Helium atom $^{4}_{2}He$, which has a mass of 4.00259 amu, mass of an electron = 1.008655 amu, and mass of one hydrogen atom = 1.007825 amu. (09)

Section B

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

5. a) What is transport number? Discuss the moving boundary method for the determination of transport number. (10)

   b) Shortly discuss the emf method for the measurement of p^H of a solution. (08)

   c) What is fuel cell? Describe the hydrogen fuel cell and its advantages. (10)

   d) The emf of the following cell is 0.086V at 25^0c. (07)

   $$Ag|(0.0093M)AgNO_3||(x)AgNO_3|Ag$$

   Find the concentration (x) of the unknown solution.

6. a) Explain Beer-Lambert law. (10)

   b) What is photo-chemistry? State and explain the laws of photochemistry. (10)

   c) What are the causes of high and low quantum yield? (07)

   d) A system is irradiated for 25 minutes and is found to absorb 5×10^{18} quantum per second. If the amount decomposed is 3×10^{-3} mole and $N = 6.023\times10^{23}$, calculate the quantum efficiency of the reaction. (08)

7. a) What are liquid junction potential and overpotential? Derive a relationship between free energy and e.m.f. of the cell. (10)

   b) Explain the terms: i) Conductance, ii) Equivalent conductance and iii) Lithium-ion battery. (09)

   c) What is supporting electrolyte? What are the roles of supporting electrolyte in polarography? (08)

   d) What is standard hydrogen electrode (SHE)? Mention the drawback of using SHE. (08)

8. a) What is triplet state? Explain the term phosphorescence. (10)

   b) Draw a cyclic volammogram and mention the anodic peak current and cathodic peak current. (09)

   c) What is diffusion current? Write down the advantages of dropping mercury electrode. (10)

   d) Write down the relation between potential and current for reversible reduction of a metal ion in mercury. Mention the name of each term. (06)

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2016
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 dependent and independent source. What do you mean by constant voltage and constant current source? Explain it. (10)

b) Calculate V_{ab}, V_b, and V_c for the circuit shown in Fig. 1(b). (09)

c) Find the voltage across the 3Ω resistor of Fig. 1(c) by nodal analysis. (16)

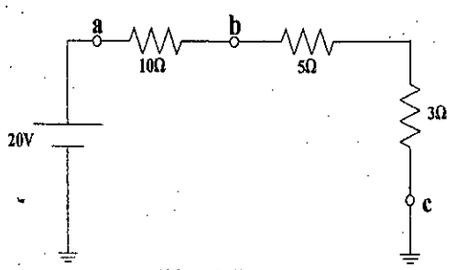


Fig. 1(b)

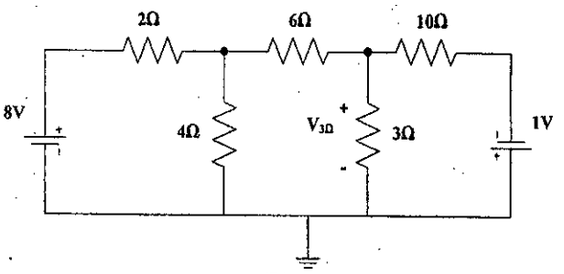


Fig. 1(c)

2. a) State and explain KVL and KCL. (06)

b) Using Star/Delta transformation find the network resistance measured between (i) A and B, (ii) B and C, and (iii) C and A of Fig. 2(b). (12)

c) Using nodal analysis, determine the potential across the 4Ω resistor in Fig. 2(c). (12)

d) Write short note on source conversion process. (05)

3. a) Define branch, node, mesh and loop of an electrical circuit. (09)

b) Find the loop currents of the network of Fig. 3(b). (12)

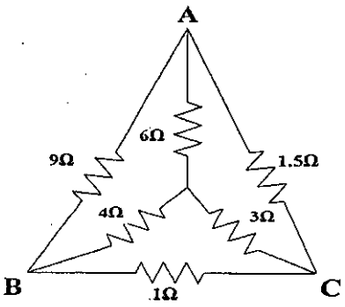


Fig. 2(b)

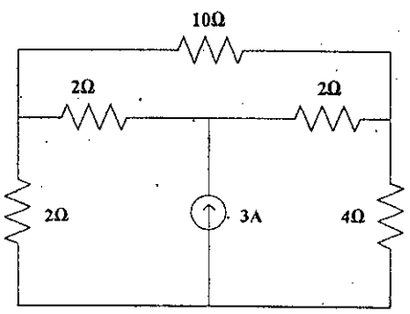


Fig. 2(c)

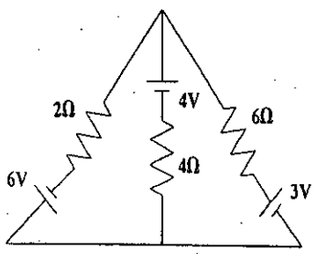


Fig. 3(b)

c) State superposition theorem. Find the current through the 2Ω resistor using superposition theorem in Fig. 3(c). (14)

4. a) State Thevenin's theorem. Find the thevenin circuit for the network shown in Fig. 4(a). (14)

b) State maximum power transfer theorem. Derive the condition for maximum power and calculate the power. (11)

c) Using Millman's theorem, find the current through and voltage across the resistor R_L of Fig. 4(c). (10)

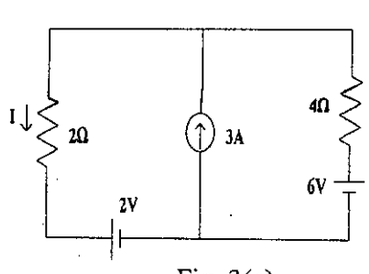


Fig. 3(c)

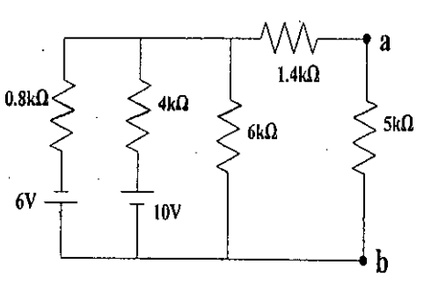


Fig. 4(a)

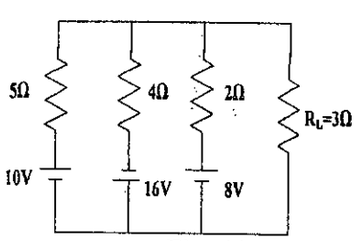


Fig. 4(c)

Section B

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

5. a) What do you mean by alternating current? Show that the r.m.s value of alternating current is equal to 0.707 time of its maximum value. (1(

b) The maximum values of the alternating voltage and current are 400V and 20A respectively in a circuit connected to 50 Hz supply and these quantities are sinusoidal. The instantaneous values of the voltage and current are 283V and 10A respectively at t=0 and both rising positively. (1:
(i) Write down the equation of voltage and current at time t.
(ii) Determine the power consumed in the circuit.

c) Evaluate the following complex numbers: (1:
(i) $(40\angle 50^0 + 20\angle -30^0)^{1/2}$
(ii) $\dfrac{10\angle -30^0 + (3-j4)}{(2+j4)(3-j5)^*}$

6. a) What do you mean by real and reactive power? Show that the average power consumed by inductance or capacitance is zero. (1:

b) Assume that the current $i = I_m \sin\omega t$ flows through a given R-L branch. Show that the voltage across the branch is $v = I_m Z \sin(\omega t + \theta) = V_m \sin(\omega t + \theta)$. (1)

Where, $Z = \dfrac{V_m}{I_m} = \sqrt{R^2 + (\omega L)^2}$ and $\theta = \tan^{-1}(\dfrac{\omega L}{R})$

c) Define Form factor and Crest factor. Determine the r.m.s. value of the current waveform shown in Fig. 6(c). If the current is passed through 2Ω resistor, find the average power absorbed by the resistor. (11

7. a) What do you mean by series resonance? How RLC series circuit can be used as frequency selector, at resonance condition? (1C

b) For the circuit arrangement and constants shown in Fig. 7(b), calculate the frequency, power, power factor and voltage drop across each part of the circuit at resonance. (1C

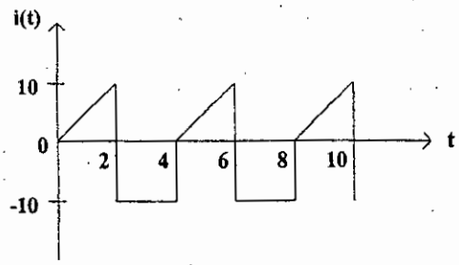


Fig. 6(c)

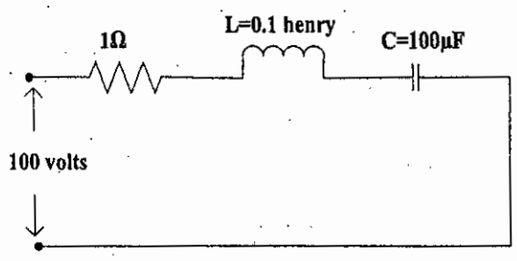


Fig. 7(b)

c) Given the parallel circuit shown in Fig. 7(c), Find I, I_1, I_2 and total power consumed. (10

d) Define Quality factor of a RLC series circuit. 05

8. a) What do you mean by filter? Classify it. Also draw the ideal response of different types of filter. (09

b) What is magnetic circuit? Mention the differences between electrical and magnetic circuit. (07

c) A rectangular iron core is shown in Fig. 8(c). It has a mean length of magnetic path of 100cm, cross section of (2cm×2cm), relative permeability of 1400 and an air-gap of 5mm cut in the core. The three coils carried by the core have number of turns N_a=335, N_b=600 and N_c=600; and respective currents are 1.6A, 4A and 3A. The directions of the currents are as shown. Find the flux in the air gap. (13

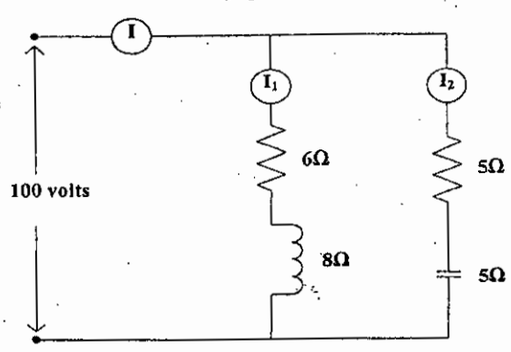


Fig. 7(c)

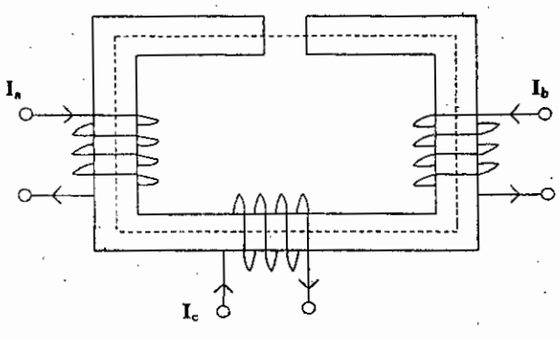


Fig. 8(c)

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

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2016
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 meant by Biomedical Engineering? Who are Biomedical Engineers? Mention some fields of employment for Biomedical Engineers. (09)

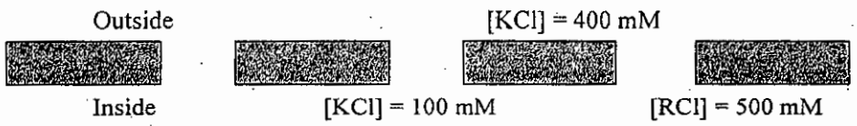
   b) What are the main fields of Biomedical Engineering? Write short notes on: (12)
   i) Bio-signal processing ii) Biomechanics iii) Rehabilitation Engineering

   c) Briefly explain basic laws and relationships in Biophysics. Define the following terms: (14)
   i) Cell ii) Cell membrane
   iii) Membrane potential iv) Resting potential

2. a) Deduce the expression where symbols have their usual meanings: (12)

$$E_K = 26ln\frac{[K^+]_o}{[K^+]_i}\,\text{mV}$$

   b) 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. Also find the Nernst potential for each ion. Sketch steady-state conditions by showing all forces and concentrations. (14)



   c) Briefly explain the pumping mechanism of Na^+–K^+ pump with net sketch. (09)

3. a) What is action potential? Approximate intracellular and extracellular concentrations of the important ions across a squid giant axon, ratio of permeabilities at resting and action conditions are given below. At room temperature, find E_K, E_{Na}, E_{Cl}, $V_{m,rest}$, $V_{m,action}$. (11)

Ion	Cytoplasm (mM)	Extracellular fluid (mM)	Rate of Permeabilities in rest	Rate of Permeabilities in action
K^+	400	20	1	1
Na^+	50	460	0.03	15
Cl^-	40	540	0.1	0.1

b) Define Biomaterials. Write short notes on the following biomaterials: (14)

i) Polymer ii) Metals iii) Ceramics

c) What are the basic properties of Biomaterials? Briefly explain the applications of Biomaterials. (10)

4. a) Define Biomedical signal. Classify Biomedical signals and explain each category with example. (13)

b) What is meant by ECG? Sketch a complete ECG signal showing different waves, segments and intervals. If an ECG of a patient with tachycardia contains 110 numbers of R–R intervals in 65 seconds, calculate the heart rate in BPM. (12)

c) What is meant by EEG and EMG? Write some applications of EEG and EMG. (10)

Section B

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

5. a) Briefly describe the components of medical instrument system with block diagram. (17)

b) Why we need an optimal sensitivity of an instrument? (06)

c) Write short notes on: (12)

i) Accuracy ii) Sensitivity
iii) Range iv) Signal to noise ratio

6. a) What is Transducer? Briefly describe the working principle of a Piezoelectric transducer. (14)

b) What is Bio-electrode? Draw the equivalent circuit of a Bio-potential electrode. (08)

c) What is LVDT? Briefly explain the working principle of a LVDT. (13)

7. a) Describe the working principle of a Biosensor with schematic diagram. (11)

b) What is medical imaging? Briefly describe different imaging modalities with their applications. (15)

c) Briefly explain the applied sub-fields of biomechanics. (09)

8. a) Write short notes on: (12)

i) Molecular Engineering
ii) Tissue Engineering

b) Define Biotechnology. What are the applications of Biotechnology? Distinguish between Bionanotechnology and Nanobiotechnology. (15)

c) What are the future challenges of Biomedical Engineering? (08)