

Khulna University of Engineering & Technology
B. Sc. Engineering 1st Year 1st Term Examination, 2018
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 meant by to and fro motion? Explain the oscillatory behavior of SHM. (10)
b) Prove that the average value of potential energy or kinetic energy of the particle is equal to half of the total energy. (15)
c) A particle oscillating with simple harmonic motion whose time period is 6 sec. (10)
(i) When will the kinetic energy be half of the total energy?
(ii) When will the potential energy be the half of the total energy?
2. a) What are free, damped and forced vibrations? (09)
b) Obtain the differential equation for the particle that vibrating with forced harmonic oscillation and hence obtain- (18)
(i) Expression of amplitude and
(ii) General form of the solution of Differential equation.
c) Find whether the discharge of a condenser for the following inductive circuit is oscillatory. (08)
 $C=0.1\mu\text{F}$, $L=10\text{mH}$, $R=200$ ohms. If the circuit is oscillatory, Calculate its frequency.
3. a) Let two SHM at right angles to each other having equal frequency but different phase and amplitude. If they superimpose to each other, then: (15)
(i) Obtain the general equation of vibration;
(ii) Draw the Lissajous figures for angle 2π , $\frac{\pi}{2}$ and $\frac{\pi}{4}$.
b) What is Doppler's effect? Obtain the expression of apparent frequency when the source moves away from the stationary observer. (10)
c) Define Phase velocity and Group velocity. Find the relationship between them. (10)
4. a) What is meant by Bel and reverberation time? (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 has dimensions $6 \times 4 \times 5 \text{ m}^3$. Calculate, (10)
(i) The mean free path of sound wave in the room;
(ii) The number of reflection made per second by the sound wave with the walls of the room.
Assume, the velocity of sound in air= 345 m/s.

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 same wavelength cannot produce interference fringes. (10)
- b) Discuss Young's double slit experiment for the interference of light and hence, (15)
- (i) Obtain the conditions of constructive and destructive interference.
 - (ii) Show that, the spacing between two consecutive bright and dark fringes are same.
- c) In a Young's double slit experiment, the separation between the sources are 0.2mm. The fringes are observed on a screen 75cm away. If with certain monochromatic source of light, the third bright fringe is situated at a distance of 11.4mm away from the central bright fringe, find the wavelength of light. (10)

6. a) What is telescope? Discuss the classification of telescope. (05)
- b) In case of Astronomical telescope, (18)
- (i) Explain the action of the astronomical telescope with proper ray diagram for normal vision.
 - (ii) In case of distinct vision, show that, the angular magnification can be written by

$$M = \frac{f_0}{f_e} \left(1 + \frac{f_e}{D} \right)$$

where the symbols have their usual meanings.

- c) The focal lengths of objective and eye piece of a compound microscope are 1cm and 5cm respectively. An object of 0.1mm height is placed at a distance 11mm from the objective and the final image is formed at the least distance of the distinct vision from the eye piece. Find the height of the final image and also the distance of the apparatus. (12)
7. a) What is Quanta? According to the quantum theory of light, construct the following equation, (17)

$$E(\lambda)d\lambda = \frac{8\pi hc}{\lambda^5} \frac{d\lambda}{(e^{hc/\lambda KT} - 1)}$$

From this equation obtain-

- (i) Rayleigh-Jeans Law
 - (ii) Wein's distribution Law
- b) What is photoelectric effect? Construct Einstein's photoelectric equation. (10)
- c) With what velocity must an electron travel so that its momentum is equal to that of a photon with wavelength of 5200Å? (08)
8. a) State and explain radioactive decay law. (10)
- b) Explain nuclear fission and nuclear fusion reactions with examples. What is the source of energy release in nuclear fission? Calculate the energy released in fission of ${}_{92}^{235}\text{U}$ nucleus. (15)
- c) Radon has half life of 3.82 days. How long it takes for 60% of the sample to decay? (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.

Section A

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

1. a) Define continuous function and homogeneous function. If (10)

$$f(x) = \begin{cases} 0 & \text{where } 0 \leq x < 3 \\ 4 & \text{where } x = 3 \\ 5 & \text{where } 3 < x \leq 4 \end{cases}$$

Test the continuity and differentiability at $x = 3$.

- b) If $y = \frac{e^{x^2} \tan^{-1} x}{\sqrt{1+x^2}}$; find $\frac{dy}{dx}$. (10)

- c) If u is a homogeneous function of x, y of degree n and $v = f(u)$. Prove that (15)

$$x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y} = nu \frac{dv}{du}$$

2. a) Evaluate $\lim_{x \rightarrow \frac{\pi}{2}} (\sin x)^{\tan x}$. (10)

- b) Define Rolle's theorem. Verify Rolle's theorem for the function $f(x) = x^2 + 5x - 6$ in the interval $(-6, 1)$. (10)

- c) Define maxima and minima. Find the relative extreme (maxima/minima) of the following (15)

function: $f(x) = \frac{4}{x} + \frac{36}{2-x}$.

3. a) State and prove Euler's theorem. (10)

- b) Define subtangent and subnormal. Prove that for the curve $by^2 = (x+a)^3$, the square of subtangent varies as the subnormal. (10)

- c) If $u = \operatorname{cosec}^{-1} \sqrt{\frac{x^{1/2} + y^{1/2}}{x^{1/3} + y^{1/3}}}$. Prove that (15)

$$x^2 \frac{\partial^2 u}{\partial x^2} + y^2 \frac{\partial^2 u}{\partial y^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} = \frac{\tan u}{12} \left[\frac{13}{12} + \frac{\tan^2 u}{12} \right]$$

4. a) Find the radius of curvature of the curve $y = e^{-x^2}$ at $(0, 1)$. (10)

- b) Find the asymptotes of the curve $(y-x)^2 x - 3y(y-x) + 2x = 0$. (10)

- c) If $y = \cos^2 x \cdot \sin^3 x$. Find y_n . (15)

Section B

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

5. Evaluate any three: (35)

(a) $\int \frac{x \, dx}{(x-a)(x-b)}$

(c) $\int \frac{\cos x}{1+\sin^2 x} \, dx$

(b) $\int \frac{x^2}{x^4-x^2-12} \, dx$

(d) $\int \frac{3x+2}{\sqrt{(5+3x-2x^2)}} \, dx$

6. a) Solve any three of the followings: (35)

(i) $\int_0^{\pi/2} \frac{\sqrt{\tan x}}{\sqrt{\tan x} + \sqrt{\cot x}} \, dx$

(ii) $\int_0^{\pi} \ln(1 + \cos x) \, dx$

(iii) $\int_0^1 \frac{x^3 \sin^{-1} x}{\sqrt{1-x^2}} \, dx$

(iv) $\int_2^{\infty} \frac{2x^2}{x^4-1} \, dx$

7. a) Define Gamma and Beta function. Prove that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$. (12)

b) If $I_{m,n} = \int_0^{\pi/2} \sin^m x \cos^n x \, dx$ then show that $I_{m,n} = \frac{n-1}{m+n} I_{m,n-2}$. (12)

c) Evaluate: $\lim_{n \rightarrow \infty} \left[\frac{n+2}{n^2+1} + \frac{n+4}{n^2+4} + \frac{n^2+6}{n^2+9} + \dots + \frac{n+2n}{2n^2} \right]$. (11)

8. a) Find the area of the region bounded by the curve $a^2 y^2 = x^3(2a-x)$, $a > 0$. (12)

b) Find the area of the cardioid $r = a(1 + \cos \theta)$. (12)

c) Find the whole perimeter of the curve $x^{2/3} + y^{2/3} = a^{2/3}$. (11)

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 term specific conductance and equivalent conductance. Explain clearly why at dilution equivalent conductance increases and specific conductance decreases. (10)
b) What are Faraday's laws of electrolysis? Discuss their importance. (09)
c) In a moving boundary experiment with 0.1 N KCl solution, the boundary moved 4.94 cm during 67 minutes when a current of 5.21A was used. The cross-sectional area of the tube was 0.230 cm^2 . Calculate the transport number of K^+ ions. (08)
d) Derive an expression for electrode potential of $M|M^{n+}$ electrode. (08)
2. a) What is Radio-chemistry? 'Radioactivity is a nuclear phenomenon' - Explain with examples. (09)
b) Draw and explain "nuclear power plant". Is it important to have nuclear power plant in Bangladesh and why? (10)
c) How many α -particles per second would be emitted from $4 \times 10^{-12} \text{ g}$ of ^{210}Po ($t_{1/2} = 138 \text{ days}$)? (07)
d) Write down the applications of radio-isotopes in medicine, in agriculture and in living molecules. (09)
3. a) What is Quantum yield? Write down three reasons of having low quantum yield photochemical reactions. (10)
b) Distinguish between photochemical and thermal reactions. (08)
c) Calculate the energy associated with (i) one photon; (ii) one Einstein of radiation of wavelength 8000 \AA . $h = 6.62 \times 10^{-27} \text{ erg-sec}$; light velocity $= 3 \times 10^{10} \text{ cm. sec}^{-1}$. (07)
d) Explain briefly fluorescence and phosphorescence. (10)
4. a) Draw and explain 'Blood glucose electrochemical monitoring device'. (include relevant chemical reactions) (12)
b) What is fuel cell? Give detail of one such cells. (10)
c) What is photonic sensor? (05)
d) Define 'Nuclear glue' and 'Packing fraction'. (08)

Section B

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

5. a) Define the terms: - Repeat unit and degree of polymerization. (08)
b) Distinguish between thermoplastic and thermosetting polymer in terms of their structure. (10)
c) What is bio-degradable polymer? What are the advantages and disadvantages of using bio-degradable polymer based materials over polyethylene based materials in everyday life. (10)
d) Calculate the molecular weight of a particular polymer sample, $(-CH_2 - CH_2 - CH_2-)_n$, where, $D_p = 1182$. (07)
6. a) Define living polymer. Discuss the mechanism of free radical polymerization. (10)
b) What is conducting polymer? Briefly describe the advantages and applications of conducting polymers over traditional polymers. (10)
c) Write short notes on :-
i) Polyvinyl chloride (PVC); ii) Polytetrafluoroethylene (TEFLON). (10)
d) Calculate the number average molecular weight of polymer sample containing equal number of particles with molecular weight 15000 and 23000. (05)

7. a) What is meant by unit cell of a crystal? Tabulate all possible crystal systems along with geometrical characteristics of their lattices. (10)
- b) Calculate the number of atoms for a unit cell of an atomic crystal having-
- | | | |
|------------------------------|-------------------------------|------|
| i) Body-centered cubic unit; | ii) Face-centered cubic unit. | (06) |
|------------------------------|-------------------------------|------|
- c) Draw the following crystal plane-
- | | | |
|-----------|------------|------|
| i) (100) | iii) (001) | (08) |
| ii) (010) | iv) (101) | |
- d) What is defect? Briefly discuss different types of defects with relevant schematic diagram. (11)
8. a) What is polarography? Draw a current-voltage polarographic curve and explain it. (12)
- b) What is polarographic maxima? What are the ways to eliminate or suppress this maxima? (06)
- c) Discuss about different types of current of polarographic analysis. (12)
- d) What does it mean 'Dropping Mercury Electrode (DME)'? (05)

Khulna University of Engineering & Technology
 B. Sc. Engineering 1st Year 1st Term Examination, 2018
 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. Write down roles and responsibilities of a Biomedical Engineer. (10)
- b) Define Electrophysiology. State Nernst equation, Fick's law and Einstein relationship between electric field and pressure. (10)
- c) Draw and label a neuron. (07)
- d) Briefly discuss conduction through myelinated nerves. (08)
2. a) Write short notes on: muscle cell and cell membrane. (08)
- b) Briefly discuss how action potential is propagated from one neuron to next neuron. (10)
- c) Show that Goldman equation can be reduced to Nernst equation. (07)
- d) Intracellular (ICF) and Extracellular (ECF) concentrations of the important ions across a frog skeletal muscle, ratio of permeabilities at resting and action conditions are given in Table Q2(d) below. Find E_K , E_{Na} , E_{Cl} , $V_{m,rest}$ and $V_{m,action}$ at room temperature. (10)

Table:Q2(d)

Ion	ECF (mM)	ICF (mM)	Rate of Permeabilities at rest	Rate of permeabilities at action
Na ⁺	112	12	0.02	12
Cl ⁻	95	3	0.4	0.3
K ⁺	3	135	1	1

3. a) Define and classify major groups of Biomaterials. (10)
- b) What are the subjects of study in Biomaterials? What are the basic properties of Biomaterials? (10)
- c) 'Coding of neural information does not depend on amplitude of action potential'-justify this statement. (10)
- d) Define biosignal. State names of different types of biosignal. (05)
4. a) Discuss origin and applications of ECG signal with net sketch. (12)
- b) What are the basic procedure for bio-signal processing? Give a block diagram representation? (10)
- c) Write down electrode position and frequency range of the following signal: EEG and EMG. (08)
- d) Write short notes on biosignal classification in biosignal processing. (05)

Section B

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

5. a) What do you mean by biomedical instrumentation? What are the basic objectives of any instrumentation system? (12)
- b) What is sensitivity? Why we need an optimum sensitivity of an instrument? (07)
- c) Briefly explain about components of medical instrument system with block diagram. (16)
6. a) What is transducer? Briefly discuss about the working principles of a Linear Variable Differential Transformer (LVDT). (12)
- b) What do you mean by Piezoelectric effect? (06)
- c) Explain the working principles of a biosensor with schematic diagram. (12)
- d) Write down some applications of bio-electrodes. (05)
7. a) What is bio-electrode? Briefly describe any four bio-electrodes. (12)
- b) What is medical imaging? Write down different imaging modalities and their applications. (15)
- c) Define Biomechanics. Write down the applied subfields of biomechanics. (08)
8. a) Define Biotechnology. Briefly discuss about the branches of biotechnology. (10)
- b) Write short notes on: i) Molecular Engineering; ii) Rehabilitation Engineering (10)
- c) What are the future challenges of Biomedical Engineering? (10)
- d) Write down five medical instruments with their uses. (05)

