

L-1/T-II/BME

Date: 10/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-II B.Sc. Engineering Examination 2018-19 (January 2020 Term)

Sub: **BME 103** (Introduction to Living Cells and Human Anatomy)

Full Marks: 180

Time 2 Hours

The Figures in the margin indicate full marks.

All the symbols have their usual meanings.

Assume reasonable values for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

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**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What is the most important concept of fluid-mosaic model? (15)  
(b) Compare and mention the clinical significance of different types of cytoskeleton in tabular form. (15)
2. (a) What are the characteristic features of synovial joints? With example, mention different types of synovial joints. (15)  
(b) Write down the cellular, matrix, organic and inorganic composition of bones. (15)  
What are the factors affecting bone growth?
3. (a) What are the differences between cartilage and bone? Write down the functions of the skeletal muscle. (16)  
(b) Write the contents of superior mediastinum and posterior mediastinum. (14)
4. (a) What is the integumentary system? What are the main functions of this system? (12)  
(b) Differentiate between exocrine and endocrine gland. Explain why pituitary gland is connected with hypothalamus. Name the hormones of anterior pituitary gland. (18)

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Describe the interior of ventricles of heart mentioning differences between them (use diagram). (20)
- (b) Show the circulation of cerebrospinal fluid (CFS) in a flow chart. (10)
6. (a) Trace the pathway of a tube inserting through the nose into the stomach. (10)
- (b) Draw and label the layers of eyeball with its refractive structures/media. (20)
7. (a) Explain how different diameter of chest cavity increases during inspiration. (15)  
Mention the parts of respiratory zone of bronchial tree.
- (b) Define and classify neuron (use diagram). (15)
8. (a) Write about the location and functions of different parts of urinary system. (20)
- (b) List the contents of vertebral canal and mention the parts of internal ear. (10)

Bangladesh University of Engineering and Technology, Dhaka  
L1/T2 B.Sc. Engineering Examinations of January 2020  
Subject: Chem 127 (Physical Chemistry)

Full Marks: 180

Time: 2 Hours

Figure in the margin indicate the full marks

Use separate scripts for each section and upload in the LMS system separately

**Section A**

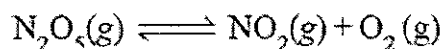
(There are FOUR questions in the section. Answer any THREE)

- 1a. Explain why the boiling point of a solution containing a nonvolatile solute is higher than the boiling point of a pure solvent. 10
- b. What energy terms are being involved in the solution making processes? Briefly describe each of them in terms of molecular view of solution processes. 20
- 2a. Which will experience a greater freezing point depression, a 0.1 m solution of benzene in carbon tetrachloride or a 0.1 m solution of carbon tetrachloride in benzene? Explain. 10
- b. Explain why it is essential that fluids used in intravenous injections have approximately the same osmotic pressure as blood. 10
- c. A solution of 0.5 g of an unknown nonvolatile, nonelectrolyte solute is added into 100 mL of water and then placed across a semipermeable membrane from a volume of pure water. When the system reaches equilibrium, the solution compartment is elevated 5.6 cm above the solvent compartment. Assuming that the density of the solution is 1.0 g / mL, calculate the molecular mass of the unknown solute. 10
- 3a. What are the relationships among intermolecular forces in a liquid and the liquid's boiling point and critical temperature? Why do aerosol containers display the warning "Do not incinerate"? 15
- b. Under what conditions do the postulates of the kinetic theory break down? The Boyle temperature is the temperature at which the virial coefficient B in the Virial equation of state is considered as zero. Therefore, a real gas behaves like an ideal gas at this temperature. Give a physical interpretation of this behavior. 15
- 4a. Explain why hydrogen and hydroxide ions exhibit exceptionally large ionic mobilities. 8
- b. The Debye-Hückel limiting law is more reliable for 1:1 electrolytes than for 2:2 electrolytes. Explain. 8
- c. How would you distinguish a fuel cell from a voltaic cell? How are the concepts of both a voltaic cell and an electrolytic cell being utilized in the proper functioning of a lead-acid car battery? 14

## Section B

(There are **FOUR** questions in the section. Answer any **THREE**)

- 5a. Write two reactions that can be completed in minutes or seconds. 4
- b. Explain-half life is always defined with respect to the smallest amount of species present in the pseudo order reaction. 10
- c. Write the characteristics of a catalyst. Whether enzyme-catalyzed reactions are examples of homogeneous or heterogeneous catalysis? Explain. 16
- 6a. In a thermochemical reaction, it is necessary to mention the physical state of each substance. Why? 8
- b. Explain-all spontaneous processes lead to an increase the entropy of the universe. 10
- c. Oxygen gas expands from 29.3 mL to 81.4 mL at a constant temperature. Calculate the work done (in joules) if the gas expands (a) against a vacuum and (b) against a constant pressure of 2.1 atm. 12
- 7a. What is metastable equilibrium? How will you recover silver from argentiferrous lead? 14
- b. Give an example of the natural precipitation process and explain how it is formed. 16
- 8a. The common ion effect is simply an application of Le Chatelier's principle-justify. 16
- b. Draw the state of equilibrium for the following reaction by considering the following cases: 14
- Case i) When the reaction starts with  $N_2O_5$
- Case ii) When the reaction starts with  $NO_2$  and  $O_2$



**USE SEPARATE SCRIPTS FOR EACH SECTION****SECTION-A**There are **FOUR** questions in this Section. Answer any **THREE**

1. (a) What do you mean by normalization of wave function? Briefly explain how a wave function can be normalized. (10)

(b) A wave function is defined as

$$\Psi(x, 0) = \begin{cases} 3x^2 - 5x & -5 < x < 5 \\ A \frac{4-x}{7} & 5 < x < 10 \\ 0 & \text{otherwise} \end{cases}$$

- (i) Normalize the wave function.
- (ii) Plot  $\Psi(x, 0)$  as a function of  $x$ .
- (iii) What is the probability of finding the particle to the right of  $x = 3$ ? (20)
2. (a) What do you mean by quantum mechanical operator? Verify whether the operators  $\widehat{p^3 x^3}$  and  $\widehat{x^3 p^3}$  are equal or not. (10)

(b) A wave function is defined as  $(x, t) = Ax e^{(9i\omega t^3 - 7hx^2)}$ , where  $\omega$  and  $h$  are constants.

- (i) Normalize the wave function. (20)
- (ii) Calculate the expectation value of  $x^2$  and  $p^2$ .
3. (a) What do you mean by stationary states? Write down the properties of stationary states. (10)

(b) With proper mathematical proof explain why it is impossible for a particle with negative energy to stay inside an infinite square well. (20)

4. (a) Explain why travelling at the speed of light is so impossible according to the special theory of relativity? Is time travel possible? Justify your answer. (20)

(b) Through what potential difference does an electron have to be accelerated, starting from rest, to achieve a speed of  $0.935 c$ ? What is the kinetic energy of the electron at this speed? Express your answer in electron volts. (10)

### SECTION-B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Which phenomenon of radiation is required to explain Compton effect and why? On which factors does Compton's shift depend? Relate de Broglie wavelength with the phenomenon of wave-particle duality? (20)

(b) X-rays with an energy of  $300 \text{ keV}$  undergo Compton scattering with a target. If the scattered X-rays are detected at  $30^\circ$  relative to the incident X-rays, determine the Compton shift at this angle, the energy of the scattered X-ray, and the energy of the recoiling electron. (10)

6. (a) Why beta ( $\beta^-$ ) decay occurs in spite of huge positive charge in the nucleus? When control rod is required in the nuclear power plant? What are the advantages and limitations of nuclear fusion reactor? (20)

(b) What is the power output of a reactor fueled by uranium-235 if it takes 30 days to use up 2 Kg of fuel and if each fission gives  $198 \text{ MeV}$  of energy? (10)

7. (a) Discuss Ohm's law from an atomic point of view. Write down the scalar and vector form of Ohm's law and define each term in these two equations. Derive an equation for the drift velocity  $v_d$ . Distinguish drift velocity, drift speed, current, and current density. (15)

(b) A nichrome heater dissipates 500 watts when the applied potential difference is 110 volts and the wire temperature is 800 °C. How much power would it dissipate if the wire temperature were held to 200 °C by immersion in a bath of cooling oil? The applied potential difference remains the same; ( $\alpha = 4 \times 10^{-4}/^{\circ}\text{C}$ ). (15)

8. (a) Discuss Coulomb's law and Gauss's law in electrostatics. Apply Gauss's law to derive an equation for the electric field  $E$  due to a sheet of charge with surface charge density  $\sigma$ . (15)

(b) Derive an equation for electric field due to a dipole at a distance  $x$  along the perpendicular bisector of the dipolar axis. Plot the electric field  $E$  as a function of  $x$  due to a dipole and a point charge. (15)

L-1/T-2/BME

Date: 17/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2019-2020

Sub: **MATH 115** (Complex Variable and Vector Calculus)

Full Marks: 180

Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

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**SECTION-A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) An airplane travels 100 miles southeast, 50 miles due west, 200 miles  $30^\circ$  north of east and then 150 miles northeast. Determine (a) analytically and (b) graphically how far and in what direction it is from its starting point. (15)
- (b) Prove that the function  $u(x, y) = 2x(1 - y)$  is harmonic. Find a function  $v$  such that  $f(z) = u + iv$  is analytic, hence express  $f(z)$  in terms of  $z$ . (15)
2. (a) Use the polar form of the Cauchy–Riemann equations to verify that  $f(z) = (3r^3 \cos 3\theta + r \cos \theta + 1) + i(3r^3 \sin 3\theta + r \sin \theta)$  is an entire function and hence express  $f(z)$  as a function of  $z$ . (15)
- (b) Evaluate  $\oint_C |z|^2 dz$  around the square with vertices at  $(0, 0)$ ,  $(1, 0)$ ,  $(1, 1)$  and  $(0, 1)$  taken in the counter clockwise direction. (15)
3. (a) Use Taylor's theorem to find the first three terms of the expansion of  $f(z) = \frac{z}{(z+3i)(z-2i)}$  about the given center  $i$  and its radius of convergence. (20)
- (b) Without determining the series, specify the region of convergence for a Laurent series representing  $f(z) = 1/(z^4 + 4)$  in powers of  $z - 1$  that converges at  $z = i$ . (10)
4. (a) Evaluate  $\oint_C \left( \frac{5}{z-2i} - \frac{6}{(z-2i)^2} \right) dz$ ,  $C$  is the circle  $|z - 2i| = 4$ , taken in clockwise direction. (10)
- (b) Evaluate the following around the unit circle taken in counterclockwise direction. (20)
  - (i)  $\oint_C \frac{e^z \cos z}{(z-\pi/4)^3} dz$ ; (ii)  $\oint_C \frac{\cosh 2z}{(z-1/2)^4} dz$ .



### SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Find the unit tangent, the principal normal, curvature and the binormal (15)  
for the space curve  $x = t - \frac{t^3}{3}$ ,  $y = t^2$ ,  $z = t + \frac{t^3}{3}$  ;
- (b) Find the equations of the tangent plane and the normal line to the (15)  
surface  $z = x^2 + y^2$  at the point  $(2, -1, 5)$ .
6. (a) Find the directional derivative of the function  $f = x^2 - y^2 + 2z^2$  at the (15)  
point  $P(1, 2, 3)$  in the direction of the line  $PQ$ , where  $Q$  is the point  $(5, 0, 4)$ .
- (b) Show that the vector field  $\mathbf{F} = (6xy + z^3)\mathbf{i} + (3x^2 - z)\mathbf{j} + (3xz^2 - y)\mathbf{k}$  is (15)  
irrotational. Find a scalar function  $\phi$  such that  $\mathbf{F} = \nabla\phi$ .
7. (a) Find the total work done in moving a particle in a force field given by (15)  
 $\mathbf{F} = 3x^2\mathbf{i} + (2xz - y)\mathbf{j} + z\mathbf{k}$  along the space curve  $x = 2t^2$ ,  $y = t$ ,  $z = 4t^2 - t$  from  $t = 1$  to  $t = 2$ .
- (b) If  $\mathbf{F} = (2x^2 - 3z)\mathbf{i} - 2xy\mathbf{j} - 4xz\mathbf{k}$  evaluate  $\iiint_V \nabla \cdot \mathbf{F} \, dv$ , where  $V$  is the (15)  
closed region bounded by the planes  $x = 0$ ,  $y = 0$ ,  $z = 0$  and  $2x + 2y + z = 4$ .
8. (a) Using Stokes' theorem evaluate  $\oint_C (\sin z \, dx - \cos x \, dy + \sin y \, dz)$ , where (15)  
 $C$  is the boundary of the rectangle  $0 \leq x \leq \pi$ ,  $0 \leq y \leq 1$ ,  $z = 3$ :
- (b) Using divergence theorem evaluate  $\iiint_S \mathbf{F} \cdot \mathbf{n} \, ds$ , where  $\mathbf{F} = 2xy\mathbf{i} + yz^2\mathbf{j}$  (15)  
 $+ xz\mathbf{k}$  and  $S$  is the surface of the parallelepiped bounded by  $x = 0$ ,  $y = 0$ ,  $z = 0$ ,  $x = 2$ ,  $y = 1$  and  $z = 3$ .