

36/

L-1/T-I/BME

Date: 11/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-I B.Sc. Engineering Examination 2019-20 (January 2020 Term)

Sub: **BME 101** (Introduction to Biomedical Engineering)

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

---

**SECTION – A**

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

1. (a) What is antalgic gait? Describe stance phase. Can you detect a Parkinson patient (18)  
from his gait pattern?  
(b) The tibia is the major weight-bearing bone in the lower extremity. If 88% of body (12)  
mass is proximal to the knee joint, how much compressive force acts on each  
tibia when a 500 N person stands in anatomical position? How much compressive  
force acts on each tibia if the person holds two 20 N sacks of groceries?
2. (a) What are the advantages and disadvantages of ceramic materials? Write down the (15)  
different degradation mechanism of poly lactic acid (PLA).  
(b) Which type of biomaterial you would select for the construction of (i) dental (15)  
implants, (ii) skin substitutes, and (iii) scaffolds for hard tissue? Justify your  
answer.
3. (a) What is the most important component of an x-ray machine? Describe its (20)  
working principle.  
(b) What are the advantages of soft lithography? How is this technology used for (10)  
biomedical device development?
4. (a) Can stem cells transform into any type of cell? Explain your answer. Why iPSCs (18)  
are more preferable than hESC?  
(b) How can you design controlled drug delivery system? (12)

**SECTION - B**

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

5. (a) What is an amphiphilic molecule? What is the significance of the protein folding process? (15)
- (b) Why is the pH of blood or the digestive tract important? Can you measure gastric pH in the stomach? (15)
6. (a) A spirometer with a volume of 1 liter ( $V_1$ ) is filled with a mixture of oxygen and helium, with the helium concentration being 4 g/L. Helium does not move from the lungs into the blood or from the blood into the lungs. A subject is told to blow out all the air he possibly can (Fig 6(a)). Once he finishes that exhalation, his lung volume is  $V_2$ . He then puts the spirometer tube in his mouth and breathes quietly for several breaths. At the end of that time, the helium is evenly dispersed in the spirometer and the subject's lungs. A measurement shows the new concentration of helium is 1.9 g/L. What was the subject's lung volume at the start of the experiment? (17)

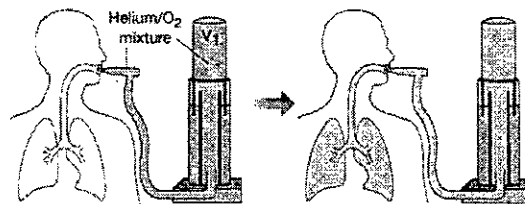


Fig. for Q6(a)

- (b) Describe the working principle of any point-of-care biosensor. (13)
7. (a) How do cardiac muscle action potentials differ from action potentials in neurons? (12)
- (b) How are the sounds of a heartbeat in a healthy heart created? What is the Korotkoff sound and what does it indicate? Describe different phases /steps of Korotkoff sounds. (18)
8. (a) Explain ECG waveform (P-Q-R-S-T wave). For a patient with a second degree of heart block, how will the waveform look like? Explain. (15)

= 3 =

(b) What is hypoxia? Describe different oxygen delivery devices.

(15)

The figures in the margin indicate full marks. Symbols have their usual meaning.

**USE SEPARATE SCRIPTS FOR EACH SECTION**

**SECTION-A**

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

1. (a) Analyze the resultant motion of a particle simultaneously acted upon by two simple harmonic vibrations at right angle to each other. Consider that two vibrations have equal amplitudes, different phases and the frequency of one vibration is twice that of another vibration. Discuss the resultant path of the particle when the phase difference between the incident vibrations is  $\pi/2$  rad. (20)
- (b) The equations of displacement of a particle due to two individual simple harmonic vibrations are  $y_1 = 2.5 \sin(3t + \pi/4)$  and  $y_2 = 2.2 \sin(5t + \pi/3)$ , respectively. Find the amplitude of the resultant vibration of the particle when it is acted upon each other simultaneously. (10)
2. (a) Consider an object experiences a resistive force while oscillating in a medium and a sinusoidal external force is applied to continue the oscillation. Construct the equation of motion of the oscillating object and find out the equation of displacement of the object. How resonance occurs and phase of resonance varies with the resistive force in the aforementioned oscillation? (20)
- (b) A pendulum of mass 7.5 g is oscillating in a medium which exerts a damping force constant  $0.2 \text{ N}\cdot\text{m}^{-1}\cdot\text{s}$  on the oscillator. It is enforced to oscillate freely under the influence of the damping and an elastic force constant of  $257 \text{ N}\cdot\text{m}^{-1}$  when an external periodic force of maximum value 4.5 N is applied to the particle. Calculate the resonant frequency of the pendulum and the amplitude of resonance. (10)
3. (a) Consider an open ended organ pipe in which a stationary wave is created. Deduce the equations of particle displacement, particle velocity, acceleration and strain related to the stationary wave. How the particle displacement in the wave varies with the position? (20)

(b) A wave is reflected at a free boundary while travelling along positive X-direction in a medium. The amplitude of the wave is 0.003 m, velocity is 335 m/s and frequency is 562 Hz. Find out the equation of the particles displacement and velocity of the resultant stationary waves at the position  $x = 0.25$  m. (10)

4. (a) Mention different types of aberration based upon the variations of refractive index, colours, size, shape and positions of objects and image. Also mention the name of the five monochromatic aberrations which are known as seidal sums. (08)

(b) Show that the ratio of angular and chromatic dispersions of the material of a prism is equal to  $\frac{2\sin\frac{A}{2}}{\sqrt{1-\mu^2\sin^2\frac{A}{2}}}$ , where the terms have their usual meaning. Find the angle of minimum deviation and hence ratio of the angular and chromatic dispersions of the material of a prism. (Prism angle  $A = 45^\circ$  and refractive index of the material of the prism  $\mu = 1.552$ ). (22)

### SECTION-B

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

5. (a) Consider two EM waves of light given as  $E_1 = E_0 \sin \omega t$  and  $E_2 = E_0 \sin(\omega t + \phi)$  in Young's double slit experiment. Draw the phasor diagram and show that the generalized equation for the intensity of the resultant light wave is given by  $I = I_{max} \cos^2\left(\frac{\pi d}{\lambda L} y\right)$ , where the terms have their usual meanings. How you represent the intensity in terms of sine function? (22)

(b) If the first-order maximum for monochromatic light falling on a double slit is at an angle of  $10.0^\circ$ , at what angle is the second-order maximum occur? What is the highest-order maximum possible here? (08)

6. (a) Mention some applications of diffraction of light. Derive an expression of resolving power of a prism which is directly proportional to the wavelength of the base length and the rate of change of refractive index with respect to wavelength for that particular material. (20)

(b) The refractive indices of a glass prism for the wavelengths of 6564 Å and 5280 Å are 1.6545 and 1.6636, respectively. Calculate the minimum thickness of the base of the prism which just resolve the two wavelengths. (10)

---

7. (a) Explain the corrections introduced by Van der Waals equation of state. What do you mean by critical constants in Van der Waals equation? Find out the expressions for the critical constants. (25)

(b) Calculate the Van der Waals constants for dry air. Given that  $T_c = 132$  K,  $P_c = 37.2$  atmospheres and gas constant per mole is  $82.07$  c.c. atm-K<sup>-1</sup>. (05)

8. (a) State and explain Carnot's theorem. What do you mean by the efficiency of a Carnot engine? Find out the expression for the efficiency of a Carnot engine. (15)

(b) Derive Clausius-Clapeyron latent heat equation in thermodynamic system. Calculate the change in the boiling point of water when the pressure of steam on its surface is increased from 1 atmosphere to 1.10 atmospheres. Given, latent heat of steam is  $540$  cal-gm<sup>-1</sup> and volume of one gram of steam is  $1674$  c.c. (15)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations- January 2020

Sub: **HUM 187** (English)

Full Marks: 180

Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 5 page(s) in this question paper.

**SECTION – A**

There are **FOUR** questions in this section. Answer **Q. No.1** and **any TWO** from the rest.

1. Answer **any one** of the following: (20)
  - a) How did Orwell depict the moral dilemmas of an Englishman in the East in his short story "Shooting an Elephant"?
  - b) How does Paul's psychosis and tragic death portray the insignificance of human relationships in a materialistic society? Explain.
2. (a) Explain with reference to the context **any one** of the following: (15)
  - i. "I was young and ill-educated and I had had to think out my problems in the utter silence that is imposed on every Englishman in the East".
  - ii. "All the same, it was as much an honest man's labor as any other, and he deserved the wages he carried home at the end of the day."
- (b) Answer **any two** of the following: (20)
  - i. How do the characters of Ralph and Jack represent opposite leadership traits in "Fire on the Mountain"?
  - ii. How did the Astrologer deceive Guru Nayak in "An Astrologer's Day"?
  - iii. What does the rocking horse signify in "The Rocking Horse Winner"?

3. Amplify **any one** of the following: (35)
- (a) To see a World in a Grain of Sand  
And a Heaven in a Wild Flower  
Hold Infinity in the palm of your hand  
And Eternity in an hour
- (b) "Fear not for the future, weep not for the past."

4. Write a précis of the following passage with a suitable title: (35)

The term war crime has been difficult to define with precision, and its usage has evolved constantly, particularly since the end of World War I. The first systematic attempt to define a broad range of war crimes was the Instructions for the Government of Armies of the United States in the Field—also known as the "Lieber Code" after its main author, Francis Lieber—which was issued by U.S. President Abraham Lincoln during the American Civil War and distributed among Union military personnel in 1863. For example, the Lieber Code held that it was a "serious breach of the law of war to force the subjects of the enemy into service for the victorious government" and prohibited "wanton violence committed against persons in the invaded country," including rape, maiming, and murder, all of which carried the penalty of death. More recently, definitions of war crimes have been codified in international statutes, such as those creating the International Criminal Court and the war crimes tribunals in Yugoslavia and Rwanda, for use in international war crimes tribunals. In contrast to earlier definitions, modern definitions are more expansive and criminalize certain behaviours committed by civilians as well as by military personnel. Immediately following World War I, the victorious Allied powers convened a special Commission on the Responsibility of the Authors of the War and on Enforcement of Penalties. The commission's report recommended that war crimes trials be conducted before the victors' national courts and, when appropriate, before an inter-Allied tribunal. The Allies prepared an initial list of about 900 suspected war criminals and submitted the list to Germany. Although heads of state traditionally had enjoyed immunity from prosecution, the



---

commission's main target was Germany's Emperor (Kaiser) William II, whom most of the Allies (though not the United States) wished to hold responsible for numerous violations of the laws of war. William, however, took refuge in the Netherlands, which refused to extradite him, and he was never tried.

### SECTION – B

There are **FOUR** questions in this section. Answer **any THREE** questions including Question No. 5 as compulsory.

5. Read the passage carefully and answer the questions that follow: (20)

Many of us get a little more forgetful as we get older. Most people will need a bit longer to remember things, get distracted more easily or struggle to multi-task as well as they once did. This may become noticeable particularly from middle age - usually taken as during our 40s, 50s and early 60s - onwards. These changes are normal, but they can be a nuisance and at times frustrating. However, you may worry that these things are an early sign of dementia. It is important not to worry too much about this. For most people, these changes will be the result of normal ageing and will not be down to dementia. Dementia is the term for a group of symptoms that occur when the brain is damaged by diseases. This includes Alzheimer's disease or diseases of the blood vessels that can cause a stroke. These diseases can cause a significant decline in a person's mental abilities or 'cognitive function' - our capacity for things like memory, thinking and reasoning. For a doctor to diagnose dementia, a person's symptoms must have become bad enough to significantly affect his/her daily life, not just be an occasional minor irritation. This means having new problems with everyday activities about the house, in the community or at work. For example, starting to have problems paying household bills, using the phone, managing medicines, driving safely or meeting up with friends. If a person has symptoms that are worse than would normally be expected for a healthy person his/her age, but are not severe enough to significantly affect his/her daily life, a doctor may diagnose mild cognitive impairment (MCI). This is not a type of dementia; though some people who have MCI will go on to develop dementia.

Physiologically, dementia affects various parts of the brain, specifically, it affects the brain in such a way that people have a difficult time learning new information. This is why, for a long time into the disease, patients and/or loved ones can remember things that happened a long time ago. They can remember wedding dates, the war they fought in, where they went to high school—but they cannot remember the visit that they had with their daughter yesterday. This is because the disease affects certain parts of the brain—the temporal lobes — which are responsible for helping us learn new things. The reason they are able to hold onto the memories that happened a long time ago is because those memories are represented throughout the brain. Long-term memories do not require just one or two areas of the brain—they are probably represented in multiple systems—so the disease has to be quite advanced before patients and/or loved ones start losing those memories. In the brain of someone with dementia, there are actual holes in the brain that form. People who have dementia cannot control what is happening to them. They are not able to change their behaviour. As caregivers, we have control over *our* thoughts and behavior, so we are the ones who must change, learning new ways to relate to the person with the disease.

Questions:

- (i) Give an appropriate title with justification.
  - (ii) How is dementia different from normal ageing?
  - (iii) What does dementia mean? What are the symptoms of dementia?
  - (iv) How does the disease affect the brain?
6. (a) Discuss the functions of a sales letter. (10)
- (b) Write a letter to H.M.T. Corporation Dhaka, complaining that the wrist watch you have recently bought from them does not function properly, and requesting a replacement of the wrist watch. (25)

- 
7. (a) Write about your idea of a dialogue. (10)
- (b) Write a dialogue between two friends about their personal experiences on the academic impact of COVID-19. (25)
8. Write an essay on **any one** of the following topics: (35)
- (i) Habits That Keep Us Healthy
- (ii) Entrepreneurship.

L-1/T-1/BME

Date: 14/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub: **MATH 113** (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.

**SECTION-A**

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

1. (a) (14)

Consider the function  $f(x) = \begin{cases} 1, & x < 0 \\ 1 + \sin x, & 0 \leq x < \frac{\pi}{2} \\ 2 + \left(x - \frac{\pi}{2}\right)^2, & x \geq \frac{\pi}{2}. \end{cases}$

Check the continuity and differentiability at  $x = \frac{\pi}{2}$ .

- (b) If  $y = \sin(m \sin^{-1} x)$ , show that (16)

$$(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} + (m^2 - n^2)y_n = 0.$$

2. (a) Verify Euler's theorem for  $u = \frac{x^{\frac{1}{4}} + y^{\frac{1}{4}}}{x^{\frac{1}{3}} + y^{\frac{1}{3}}}$ . (15)

- (b) If the line  $x \cos \alpha + y \sin \alpha = p$  touches the curve  $\left(\frac{x}{a}\right)^m + \left(\frac{y}{b}\right)^m = 1$ , show that (15)

$$(a \cos \alpha)^{\frac{m}{m-1}} + (b \sin \alpha)^{\frac{m}{m-1}} = p^{\frac{m}{m-1}}.$$

3. (a) Assuming that the petrol burnt/hour in driving a motor boat varies as the cube of its velocity, show that the most economical speed going against a current of 'c' km/hour is  $\frac{3}{2}c$  km/hour. (16)

- (b) Show that the radius of curvature at the extremity of the major axis of the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  is half its latus rectum. (14)

4. (a) Find all the asymptotes of the curve represented by (19)

$$x^3 - 2y^3 + xy(2x - y) + y(x - y) + 1 = 0.$$

- (b) Verify Rolle's theorem for the function  $f(x) = \ln \frac{x^2 + ab}{(a + b)x}$  in the interval  $(a, b)$ . (11)

**MATH 113(BME)**

**SECTION - B**

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

5. (a) Evaluate:  $\int \frac{1}{1 + \cos x + \sin x} dx.$  (15)

(b) Evaluate:  $\int \frac{x^2}{\sqrt{x^2 - 2x + 2}} dx.$  (15)

6. (a) Find a reduction formula for  $I_{m,n} = \int \sin^m x \cos^n x dx$  and hence evaluate: (15)

$$\int \sin^5 x \cos^3 x dx .$$

(b) Evaluate:  $\lim_{n \rightarrow \infty} \left[ \frac{1}{n} + \frac{n^2}{(n+1)^3} + \frac{n^2}{(n+2)^3} + \dots + \frac{1}{8n} \right].$  (15)

7. (a) Show that  $\int_0^{\frac{\pi}{6}} \cos^6(3x) \sin^4(6x) dx = \frac{3\pi}{256}.$  (15)

(b) Evaluate:  $\int_0^1 x^5 \sqrt{\frac{1+x^2}{1-x^2}} dx$  (15)

8. (a) Find the area of the region bounded by the curve  $r = a(1 + \cos x).$  (10)

(b) Find the volume and surface area of the solid generated by revolving

$$\left(\frac{x}{4}\right)^{\frac{2}{3}} + \left(\frac{y}{3}\right)^{\frac{2}{3}} = 1 \text{ about x-axis.} \quad (20)$$

---

Bangladesh University of Engineering and Technology, Dhaka  
L-1/T-1 B.Sc Examinations of January 2021  
Subject: Chem-125 (Organic and Inorganic 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. Give two pieces of evidence for the wave model and two for the particle model of light. Why does the photoelectric effect exhibit a threshold frequency but not a time lag? 10
- b. What phenomenon causes a neon sign to have a characteristic color? Why can't we overcome the uncertainty predicted by Heisenberg's principle by building more precise instruments to reduce the error in measurements below the  $h/4\pi$  limit? ( $h = 6.626 \times 10^{-34}$  kg.m<sup>2</sup>/s) 10
- c. Show the mathematical relationship between energy and mass and between wavelength and mass. What is the effect of doubling the - (i) mass of an object on its energy? (ii) mass of an object on its wavelength? (iii) frequency on its mass? 10
- 2.a Explain what it means for the peak in the radial probability distribution plot for the  $n = 1$  level of an H atom to be at 0.529 Å. Orbital energies of species with only one electron are defined by only one quantum number. Which one? 10
- b. Describe the relationship between electron shielding and  $Z_{eff}$  on the outermost electrons of an atom. Predict how chemical reactivity is affected by a decreased effective nuclear charge using period 2 elements as examples. 10
- c. Sketch the shape of the periodic table if there were three possible values of  $m_s$  for each electron ( $+\frac{1}{2}$ ,  $-\frac{1}{2}$ , and 0); assume that the Pauli principle is still valid. 10
- 3a. Describe the differences in behavior between NaOH and CH<sub>3</sub>OH in aqueous solution. Which solution would be a better conductor of electricity? 10
- b. Explain your reasoning. Ionic compounds consist of crystalline lattices rather than discrete ion pairs: Why? 10
- c. The concentration of K<sup>+</sup> ion in the interior and exterior of a nerve cell are 400 mM and 15 mM, respectively. Find the electrical potential across the membrane. [ $K^+ + e^- = K$ ;  $E^\circ = -2.92$ ]. Which direction the K<sup>+</sup> movement will be spontaneous? 10
- 4a. Write Lewis structures for the following species, including all resonance forms, show formal charges, name the geometry around the central atom: (i) SO<sub>2</sub> (ii) OCN<sup>-</sup> (iii) NNO (atom order as indicated). 10
- b. In AB<sub>4</sub>E arrangement (A is the central atom and E represents lone pair), why does the lone pair occupy an equatorial position rather than axial position? Molecules/ions can be nonpolar, even when bond moments are present—how? 10
- c. Why is a  $\sigma_{1s}$  molecular orbital lower in energy than the two s atomic orbitals from which it is derived? Draw a diagram that illustrates how atomic p orbitals can form both  $\sigma$  and  $\pi$  molecular orbitals. What effect of 2s-2p mixing is observed in relative energy level of molecular orbitals (MOs) in homonuclear diatomic molecules of period 2 elements? 10

### Section B

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

- 5.a Compare stereoisomers and conformational isomers with example? Discuss the stability of *cis-trans* stereoisomers of disubstituted cyclohexane. 15
- b. Write down the hydroboration-oxidation mechanism to prepare alcohol from alkene. Discuss regioselectivity for this process. 15
- 6.a Label the stereogenic centers and draw all possible stereoisomers of  $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{Cl})\text{CH}_3$  10
- b. Draw all possible stereoisomers and pair up all possible enantiomers and diastereomers of 3-ethyl-cyclopentanol. 10
- c. How to prepare  $1^\circ$  amines through i) Gabriel synthesis process and ii) Reductive amination process? 10
- 7.a. By which concept, IR spectrophotometer works? Why the asymmetric stretching vibrations of a bond gives IR peak at higher wavenumber than bending vibrations and symmetric vibrations? 15
- b. How to differentiate alkane, alcohol and carboxylic acid by using IR spectroscopic analysis? 15
- 8.a. What factors are affecting the chemical shift value of an organic molecules in  $^1\text{H-NMR}$ ? Why aromatic protons are highly deshielded? 15
- b. Explain the possible spectroscopic analysis of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$  15