BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Write short notes on (any three): (i) ultrasound elastrography, (ii) PET imaging, (iii) registration in imaging, and (iv) smoothing filter in image processing. **(18)**

(b) For the following sequence: **(10)**

5'-G-G-C-A-U-G-G-A-C-C-C-C-G-U-U-A-U-U-A-A-A-C-A-C-U-A-A-3'

(i) Give the sequence of the bases in the strand of DNA that resulted in this sequence of mRNA.

(ii) What is the sequence of amino acids in the peptide encoded for by the given stretch of mRNA?

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU Phe, UUC Phe, UUA Leu, UUG Leu	UCU Ser, UCC Ser, UCA Ser, UCG Ser	UAU Tyr, UAC Tyr, UAA STOP, UAG STOP	UGU Cys, UGC Cys, UGA STOP, UGG Trp	U C A G
C	CUU Leu, CUC Leu, CUA Leu, CUG Leu	CCU Pro, CCC Pro, CCA Pro, CCG Pro	CAU His, CAC His, CAA Gln, CAG Gln	CGU Arg, CGC Arg, CGA Arg, CGG Arg	U C A G
A	AUU Ile, AUC Ile, AUA Ile, AUG Met	ACU Thr, ACC Thr, ACA Thr, ACG Thr	AAU Asn, AAC Asn, AAA Lys, AAG Lys	AGU Ser, AGC Ser, AGA Arg, AGG Arg	U C A G
G	GUU Val, GUC Val, GUA Val, GUG Val	GCU Ala, GCC Ala, GCA Ala, GCG Ala	GAU Asp, GAC Asp, GAA Glu, GAG Glu	GGU Gly, GGC Gly, GGA Gly, GGG Gly	U C A G

Fig. for Q 1(b)

(c) Describe the process of ultrasound image generation. **(7)**

2. (a) With a schematic, describe the working principle of the most important component of an x-ray imaging system. **(10)**

(b) One cause of kidney failure is diabetes mellitus, a condition characterized by high blood glucose (sugar) levels. Over time, the high levels of sugar in the blood damage the millions of tiny filtering units within each kidney. This eventually leads to kidney failure. What functions are lost due to kidney failure? **(10)**

(c) Qualitatively draw the pressure volume curve for the left ventricle during a cardiac cycle. Mark different points and segments of the curve corresponding to the different phases of a cardiac cycle. **(15)**

3. (a) The following equation can be considered as an enzymatic reaction: **(20)**

$$H_2O_2 \xrightarrow{\text{Catalase}} H_2O + O_2$$

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Contd... Q. No. 3(a)

You develop the enzyme kinetics data (reaction rate as a function of substrate concentration) as shown below:

Table for Q3(a)

Substrate Concentration (μM)	Reaction Rate (μM min^{-1})
2	2.9
3	3.8
4	4.4
5	5.0
6	5.4
7	5.8
8	6.2
9	6.4
10	6.7

Determine the maximum rate achieved by the system and the substrate concentration at which the reaction rate is half of the maximum rate.

(b) How are cardiac muscle action potentials different than action potentials in neurons? **(15)**

4. (a) Inulin is a polysaccharide that happens to be neither secreted nor reabsorbed by the tubules of the kidney, and its MW (5200 daltons) is low enough to permit it to pass freely through the glomerulus. It is infused at a steady rate into the blood of a person whose GFR is to be determined. After a while, a steady-state plasma concentration is achieved. Assume that blood samples taken after steady state has been reached show an inulin concentration of 0.1 g/100 mL of plasma. If a total of 180 mL of urine is collected over the next 2 hours, and analysis shows that there is 0.08 g inulin per milliliter in the urine, what is the GFR of the person? It is important to note that inulin is not metabolized by the body and is excreted only in the urine. **(15)**

(b) DNA polymerization can only proceed in the 5′ to 3′ direction. Then how is double-stranded DNA copied to ensure that daughter cells each receive an exact version of the parent DNA? **(15)**

(c) What are the factors that determine the alveolar partial pressure of oxygen? **(5)**

SECTION - B

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

5. (a) In the spinal column of human body, why are the lower parts larger than the higher parts? **(7)**

(b) In Fig. for Q 5(b), the length of arm, forearm and center of the hand is 70 cm. Axis of rotation is located at the shoulder. W = 3 kg and the weight of arm, forearm and hand is 7 kg. Find the total torque exerted by the arm-forearm-hand and the object, when the arm, forearm and center of the hand are an angle of 30° with the vertical. **(12)**

Contd P/3

BME 101

Contd... Q. No. 5(b)

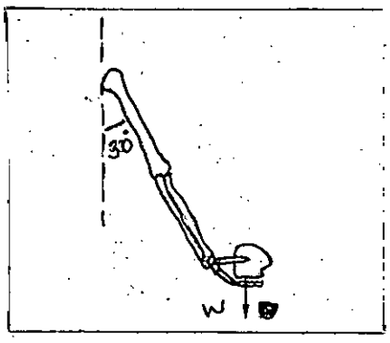


Fig. for Q5(b)

(c) Draw and label a typical stress-strain curve. What is strain hardening? **(8)**

(d) How bone responses to stress? Why the astronauts need to do exercise in space? **(8)**

6. (a) Describe the stance phase of gait cycle. **(10)**

(b) Which type of biomaterial you would select for the construction of (i) skin substitute, (ii) hip replacement stem, and (iii) dental braces. Explain which properties will be important and why. **(15)**

(c) Compare between stereo lithography and fused deposition modeling technology. If you need to create dental implants, which one of these two technologies would you prefer? Why? **(10)**

7. (a) How surface morphology of an implant can be characterized? Name and describe the working principles of two surface characterization tools. **(14)**

(b) Compare different types of thermal sensors in terms of temperature range, sensitivity, linearity and output type. **(16)**

(c) What are the applications of patch clamp technique? **(5)**

8. (a) With schematic, describe different types of sensors used in a dialysis machine. Mention their purpose. **(11)**

(b) What is biosensor? Describe the working principle of glucose sensor? **(10)**

(c) Explain the ECG waveform (P-Q-R-S-T wave). For a patient with first and second degree of heart block, how the waveform will look like? Explain. **(14)**

L-1/T-1/BME Date : 11/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **PHY 123** (Wave and Oscillation, Optics and Thermal Physics)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) State the principle of superposition. Distinguish between constructive and destructive interference of light. **(10)**

   (b) Describe Newton's rings experiments. Write down the necessary theory of the Newton's rings method for measuring and wavelength of light. **(15)**

   (c) What is Fringe width? In a double slit experiment using sodium light of wavelength 5.89×10^{-5} cm, an interference pattern is obtained in which 20 equally special fringes occupied a distance of 2.0 cm on a screen. On replacing the sodium lamp with another monochromatic source but making no other changes, 30 fringes are found to occupy a distance of 2.4 cm. What is the wavelength of light from this source? **(10)**

2. (a) What is diffraction of light? Define the resolving power of a grating. **(7)**

   (b) Derive the intensity distribution for the Fraunhofer diffraction due to a single slit. Write the positions of maxima and minima condition and show that the intensity of the first maximum is about 4.96% of the central maximum. **(20)**

   (c) In a Fraunhofer diffraction due to a narrow slit of width 0.02 cm, the screen is placed 2 m away from the lens used to obtain the pattern. If the First minima lie 5 mm on either side of the central maximum, find the wavelength of light used. **(8)**

3. (a) What is meant by polarization of light? What is polarizing angle? State Brewster's law. **(10)**

   (b) (i) Write a short note on: Double refraction. (ii) What is optical activity? Define specific rotation. (iii) Briefly describe chromatic aberration. **(18)**

   (c) How will you orient the polarizer and the analyzer so that a beam of natural light is reduced to (i) 0.5 and (ii) 0.75 of its original intensity? **(7)**

4. (a) What do you mean by stationary wave? Briefly describe the characteristics of stationary wave. **(7)**

   (b) Assume that a string of length 'L' and mass 'M' is stretched to a tension T. Derive an expression for the normal mode of the string. **(18)**

Contd P/2

PHY 123

Contd ... Q. No. 4

(c) In figure 4(c), block-2 of mass 2.0 kg oscillates on the end of a spring in SHM with a period of 20 ms. The block's position is given by x = (1.0 cm) cos (ωt + π/2). Block-1 of mass 4.0 kg slides toward block-2 with a velocity of magnitude 6.0 m/sec, directed along the spring's length. The two blocks undergo a completely inelastic collision at time t = 5.0 ms (The duration of the collision is much less than the period of motion). What is the amplitude of the SHM after the collision? **(10)**

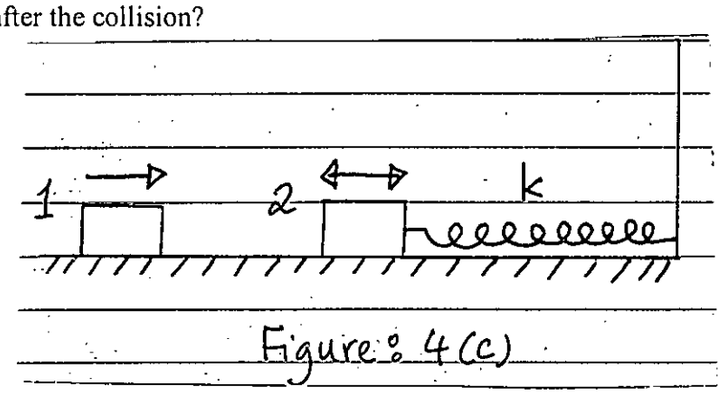


Figure: 4 (c)

SECTION – B

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

5. (a) What do you mean by damped vibration? Distinguish between free vibration and damped vibration. **(7)**

(b) Set up the differential equation of motion for damped vibration and show how the displacement of an object varies during damped vibration. **(18)**

(c) A free, damped harmonic oscillator, consisting of a mass $m = 0.1\ kg$ moving in a viscous liquid of damping coefficient b ($F_{viscous} = -bv$) and attached to a spring of spring constant $k = 0.9\ N/m$, is observed as it perfume damped oscillatory motion. Its average energy decays to $1/e$ of its initial value in $4\ sec$. What is the Q-*value* of the oscillator? What is the value of b? **(10)**

6. (a) Define forced oscillation. Discuss the characteristics of this type of motion. **(7)**

(b) Due to damping, the energy of harmonic oscillation dissipates in every successive cycle and the oscillation dies out. One ways to sustain the harmonic oscillation is to feed energy to the system in each cycle from an outside source. Derive an expression for the average power output need to be supplied per cycle to an oscillatory system from an outside periodic source in order to maintain the simple harmonic motion. **(16)**

(c) An object of mass 2 *kg* hangs from a spring of negligible mass. The spring is extended by 2.5 *cm* when the object is attached. The top end of the spring is oscillated up and down in SHM with an amplitude of 1 mm. The Q-value of the system is *15*. **(12)**

(i) What is the natured frequency (ω_0) of the system?

(ii) What is the amplitude of forced oscillation when $\omega = \omega_0$?

(iii) What is the mean power input to maintain the forced oscillation at a frequency 2% greater than ω_0?

Contd P/3

PHY 123

7. (a) Draw the circuit diagram of a thermocouple thermometer. What happens when you get a null point in this circuit, and why does the galvanometer stop deflecting? **(8)**

(b) What is calibration curve of a thermocouple? Explain with a diagram how a thermocouple thermometer to be used for measurement of temperature. **(20)**

(c) A copper constantan thermocouple having a mean thermoelectric power of *40 $\mu V/^{\circ}C$* is used to measure an unknown temperature. The potentiometer wire is *1000 cm* long having a resistance of *0.01 ohm per cm* and is used in series with a cell of emf *2 volts* and a resistance of *2000 ohm*. The balance point is obtained with a length of *402 cm* of the wire between the thermocouple terminals. **(7)**

8. (a) What are thermodynamic functions? Starting from such functions obtain the following Maxwell's relations: (i) $\left(\frac{\delta S}{\delta V}\right)_T = \left(\frac{\delta P}{\delta T}\right)_V$ and (ii) $\left(\frac{\delta S}{\delta P}\right)_T = -\left(\frac{\delta V}{\delta T}\right)_P$, where the symbols have their usual meaning. **(20)**

(b) Using the equations of 8(a), derive the following relations:

(i) $\left(\frac{\delta P}{\delta T}\right)_V = \frac{1}{T(V_2 - V_1)}$ and (ii) $\left(\frac{\delta P}{\delta T}\right)_V = -TV\alpha$ where the symbols have their usual meaning and discuss their applications in boiling point and thermal expression of a substance. **(15)**

L-1/T-1/BME Date : 04/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CHEM 125** (Organic and Inorganic Chemistry)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) How is the concept of electron density used to describe the position of an electron in the quantum mechanical treatment of an atom? **(7)**

(b) Describe the experimental basis for believing that the electrons in atom behave as tiny bar magnets. **(12+1=13)**

(c) Crystal diffraction can be studied by electron diffraction as well as by neutron diffraction. What should be the ratio of the velocities of electrons and neutrons for the de-Broglie wavelength to be the same? **(8)**

(d) A microwave oven heats by radiating food with microwave radiation, which is absorbed by the food and converted to heat. Suppose an oven's radiation wavelength is 12.5 cm. A container with 0.250L of water was placed in the oven, and the temperature of the water rose from 20°C to 100°C. How many photons of this microwave were required? **(5+2=7)**

2. (a) What is the difference between electron affinity and electronegativity? Why is it difficult to determine electron affinities for metals? **(7)**

(b) Arrange each of the following in order to increasing of ionization energy and explain your reasoning: Calcium, Iron, Copper, Bromine and Krypton. **(10)**

(c) Distinguish between a primary cell and a secondary cell. Give one example of each of the electrochemical cells and explain the functions of each of them in detail. **(12)**

(d) What property of an atom does nuclear magnetic resonance depend on? How is it possible for a diamagnetic material to be levitated by magnetic field? **(6)**

3. (a) Sketch the shape or three-dimensional structure of each of the following: BrO_3^- and PF_4^-.

Name the shapes and state the status of hybridization in the central atoms of the above ionic species. **(8)**

(b) Describe the bonding in H_3CCN using valence Bond Theory Concept. Draw and clearly label one or more pictures to show the types of orbitals that you are using to form the various σ and π bonds. **(12)**

Contd P/2

CHEM 125

Contd... Q. No. 3

(c) What energy terms are being involved in the formation of anionic solid from atoms? In what way should these terms change (become larger or smaller) to give the lowest energy possible for the solid? Explain in detail. **(10)**

(d) Why does sodium chloride normally exist as a crystal rather than a molecule composed of one cation and one anion? **(5)**

4. (a) Molecular oxygen (O_2) and nitric oxide (NO) molecules are quite similar when it comes to their bonding. **(15)**

(i) Sketch and fill up a molecular orbital diagram for NO.

(ii) Provide the molecular orbital electron configuration of NO.

(iii) What is the bond order of NO? Should it be diamagnetic or paramagnetic?

(b) Arrange the following molecular ions in order to increasing stability: **(8)**

$$O_2^+,\ Be_2^+,\ NO^+,\ Li_2^+$$

(c) Draw a potential energy diagram for molecule such as Cl_2. Indicate the bond length (194 pm) and the bond dissociation energy (240 kJ/mol). **(7)**

(d) Why do NH_3 molecules have such larger dipole moment in comparison to NF_3? Explain. **(5)**

SECTION - B

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

5. (a) What are conformations? Draw the Newman Projection formula of n-pentane with plausible energy diagram. **(8)**

(b) Discuss the stereoisomerism of disubstituted cyclohexane. Among different structures of disubstituted cyclohexane, in which case, two isomers can be equally stable? Explain with example. **(12)**

(c) How can you prepare isobutene from 2- methlpropene? Give mechanism. **(8)**

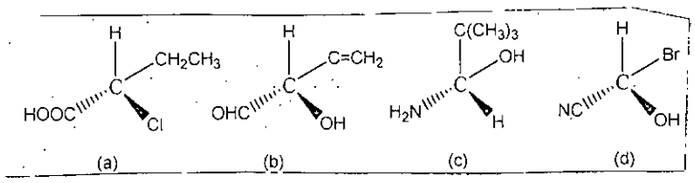
(d) Write down the reaction mechanism involved in the chlorination of propane in the presence of diffuse sunlight. **(7)**

Contd P/3

CHEM 125

6. (a) What are the differences between cis-trans isomers and E-Z isomers? Why Z-isomer is more polar than E-isomer? **(6)**

(b) Identify the R-and S-configuration for following compounds: **(2×4=8)**



(c) Show the mechanism for the preparation of amine from ketone through reductive amination method. **(10)**

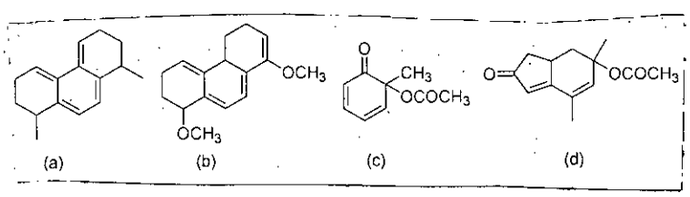
(d) How can you prepare heptylamine from heptanoic acid? **(5)**

(e) Give the mechanism for the electrophilic addition of HBr to 1-butyne. **(6)**

7. (a) Discuss the principle of UV-VIS spectroscopy. Explain $n \rightarrow \sigma^*$ transition with example. **(9)**

(b) Define auxochrome with examples. **(6)**

(c) Calculate the value of λ_{max} for the following organic compounds: **(4×3=12)**



(d)Why do asymmetric stretches occur at higher wave numbers than symmetric stretches? Explain with example. **(8)**

8. (a) What is internal standard used in NMR solvent? Why TMS can be used as suitable internal standard? **(7)**

(b) What factors are affecting the value of chemical shift? Explain with example. **(10)**

(c) Why proton in benzene ring is more deshielded than acetylenic proton? **(8)**

(d) An ester, having molecular formula $C_5H_{10}O_2$, shows peak in the ^{1}H-NMR spectrum at δ4.2 ppm (quartet), δ2.4 ppm (quartet), δ1.3 ppm (triplet) and δ1.2 ppm (triplet), find the structure of the compound. Justify your answer. **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **MATH 113** (Calculus)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Discuss the continuity and differentiability of the function **(12)**

$f(x)=|x+2|+|x+3|$ at the point $x=-2$. Sketch the graph and interpret your answer.

(b) Evaluate: $\lim_{x\to 0}(\cos x)^{\cot^2 x}$ **(11)**

(c) Find the n-th derivative of $y=\sin^5 x\cos^4 x$. **(12)**

2. (a) State Leibnitz's theorem . If $y=x\cos(\ln x)$ then show that **(12)**

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

(b) Expand the polynomial $2x^3+7x^2+x-1$ in power of $(x-2)$. **(11)**

(c) State Mean Value theorem and verify the theorem for the function **(12)**

$f(x)=3x/x+7$ on the interval [-2, 6].

3. (a) Find the maximum and minimum value of the function **(11)**

$$f(x)=(1-x)^2e^x.$$

(b) If $x=r\cos\theta$, $y=r\sin\theta$ then show that $\frac{\partial^2 r}{\partial x^2}\cdot\frac{\partial^2 r}{\partial y^2}=\left(\frac{\partial^2 r}{\partial y\partial x}\right)^2$. **(12)**

(c) Find the pedal equation of the parabola $y^2=4ax$ with respect to its focus. **(12)**

4. (a) If $lx+my=1$ is normal to the parabola $y^2=4ax$, then show that $al^3+2alm^2=m^2$. **(11)**

(b) Find the radius of curvature of the curve $r=a\sin n\theta$ at the origin. **(12)**

(c) Find all asymptotes of the curve $x^3+x^2y-xy^2-y^3-3x-y-1=0$. **(12)**

Contd P/2

MATH 113

SECTION - B

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

5. Perform the following integrals:

(a) $\int \frac{dx}{1-2\cos x+3\sin x}$ **(11)**

(b) $\int \sqrt{\frac{2x+1}{3x+2}}dx$ **(12)**

(c) $\int \frac{dx}{(x+1)^3\sqrt{x^2+3x+2}}$ **(12)**

6. (a) Obtain a reduction formula for **(10)**

$$I_{m,n} = \int \cos^m x \cos nx\, dx$$

And hence evaluate $\int_0^{\pi/2} \cos^4 x \cos 3x\, dx$.

(b) Evaluate the following:

(i) $\int_0^{\pi/2} \ln(\tan x + \cot x)dx$ **(8)**

(ii) $\int_0^{\pi} x\sin^6 x\cos^4 x\, dx$ **(8)**

(c) Show that $\int_0^1 \frac{\sin^{-1} x}{x}dx = \frac{\pi}{2}\ln 2$. **(9)**

7. (a) Prove that **(9)**

$$\int_0^1 \frac{x^2 dx}{\sqrt{1-x^2}} \times \int_0^1 \frac{dx}{\sqrt{1+x^4}} = \frac{\pi}{4\sqrt{2}}.$$

(b) Evaluate (i) $\int_0^{\infty} e^{-x^2}\, dx$ **(8)**

(ii) $\int_{-1}^1 x^2\left(1-x^2\right)^{5/2} dx$ **(8)**

(c) Fins the area of the loop of the curve $x(x^2+y^2) = a(x^2-y^2)$ **(10)**

8. (a) Find the area of the region bounded by the curves $xy^2 = a^2(a-x)$ and $y^2(a-x) = a^2x$. **(12)**

(b) Find the volume of the solid obtained by revolving the region enclosed by the curve $x = y^2$ and the line $x = y+2$ around the y-axis. **(11)**

(c) Find the surface area of the solid generated by revolving one arch of the cycloid $x = a(\theta - \sin\theta)$, $y = a(1-\cos\theta)$ around the x-axis. **(12)**
