L-1/T-1/ME **Date : 02/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **ME 101** (Introduction to Mechanical Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning and interpretation.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What do you understand by Package boilers? Mention some advantages and limitations of package boilers. **(8)**

   (b) How is boiler horsepower (BHP) related to the heat transfer surface area of boilers? Discuss the effect of using too low or too high BHP/sq.ft. **(10)**

   (c) Draw the schematic diagram of Lancashire boiler and mention its advantages over a fire tube boiler (say Cochran boiler)? Why do water tube boilers have a higher risk of bursting? **(17)**

2. (a) Why does the steam turbine diameter increase from inlet to outlet? **(8)**

   (b) What are the major components of a steam turbine? Why are diaphragms and glands necessary for the operation of steam turbine? **(10)**

   (c) Compare the principle of velocity compounding and pressure compounding in steam turbines. What are the main reasons for carrying out compounding in steam turbine? **(17)**

3. (a) Discuss the importance of the applications of refrigeration. **(8)**

   (b) In the selection of refrigerants, what environmental and safety properties should be considered? Explain how the environmental properties of refrigerants are expressed. **(12)**

   (c) Show that elevator or lift is an example of mechatronic system. **(15)**

4. (a) Are the 'Laws of Robotics' practicable? Why or why not? **(7)**

   (b) What are the advantages and disadvantages of gears in power transmission and motion control? **(8)**

   (c) Showing the "tetrahedron" of material science and engineering, discuss the importance of the properties of materials in engineering design. **(10)**

   (d) Characterize "Polymer" as an engineering material. Why is the use of polymer increasing in the modern days? **(10)**

Contd P/2

ME 101

SECTION – B

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

5. (a) Why is Mechanical Engineering called "The mother of Engineering?" How long will the need for Mechanical Engineering remain? What does a Mechanical Engineer do? Mention 5 key activities associated with Mechanical Engineers. **(10)**

   (b) What are the fundamental canons regarding the "Code of Ethics for Engineers" in the fulfillment of their professional duties? What are the rules of practice for an engineer for safety and welfare of the public? **(10)**

   (c) What are the major sources of Renewable Energy in Bangladesh? mention them with their installed capacities as appeared in the Renewable Energy Policy of Bangladesh. **(10)**

   (d) What targets were fixed for developing Renewable Energy resources in one of the objectives of the Renewable Energy Policy of Bangladesh? **(5)**

6. (a) With a schematic diagram and corresponding sequence table, show various modes of operation of a hybrid system having two different renewable energy sources including a storage battery and a backup electricity generator. **(15)**

   (b) How is nuclear energy available from U_{235}? Show the main components of a nuclear power plant with a schematic diagram. **(10)**

   (c) What is a fuel cell? What are its advantages? Draw a typical fuel cell and label it. **(10)**

7. (a) With a diagram, show how valves of an IC Engine operates. Mention the moving component parts involved in sequence from "piston" to "rocker arm". **(15)**

   (b) Draw and label the coil ignition system for a 4-stroke 4-cylinder spark ignition engine. **(10)**

   (c) A 175 cc motor bike has its engine cylinder diameter equal to its stroke length. Calculate the crank radius of the engine. If the clearance volume is 25 cc, determine its compression ratio. **(10)**

8. (a) Draw the schematic diagram of components of a closed cycle gas turbine that works on Brayton cycle with an intercooler and a reheater. Draw also the corresponding P-V and T-S plots. **(15)**

   (b) Identify the components of the "fluid machine" as labeled from "1" to "10" shown in the figure for question number 8(b). For example, 11 = inlet (please do not draw the figure). **(10)**

   (c) There are 5 categories of "Fan" according to types of blades. Mention them with corresponding simple sketches of blade orientation. **(10)**

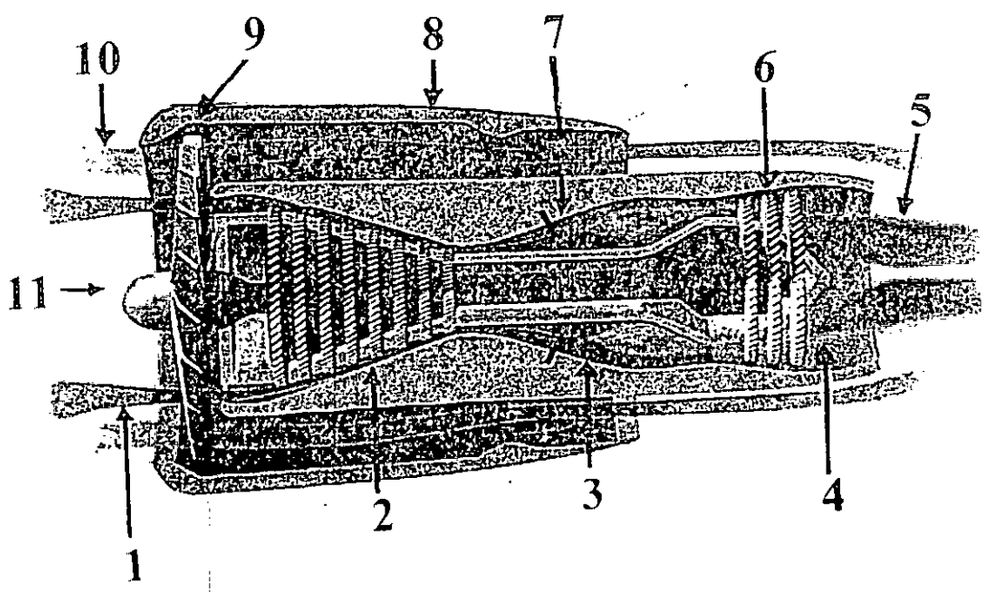

Figure for question number 8(b)

L-1/T-1/ME Date : 09/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **EEE 159** (Fundamentals of Electrical Engineering)

Full Marks : 210 Time : 3 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) Determine I_0 in the circuit of Fig. for Q. No. 1(a). **(18)**

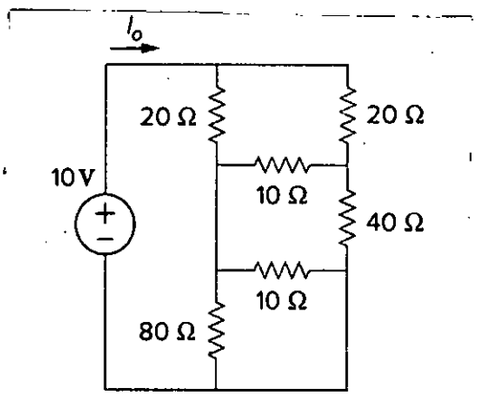

Fig. for Q. No. 1(a)

(b) For the circuit shown in Fig. for Q. No. 1(b), if the current through the 6Ω resistor is, $I_6 = 1$A, then find V_S and I_S. Calculate the power supplied by the source. **(17)**

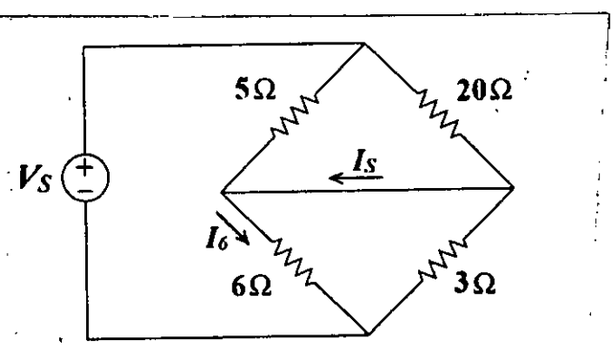

Fig. for Q. No. 1(b)

2. (a) Use mesh analysis to find v_x and i_x in the circuit shown in Fig. for Q. No. 2(a). **(18)**

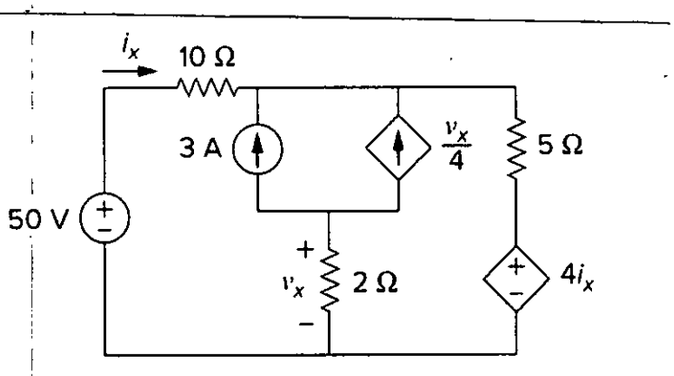

Fig. for Q. No. 2(a)

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EEE 159/ME

Contd ... Q. No. 2

(b) Find v_1, v_2, and v_3 in the circuit of Fig. for Q. No. 2(b) using nodal analysis. **(17)**

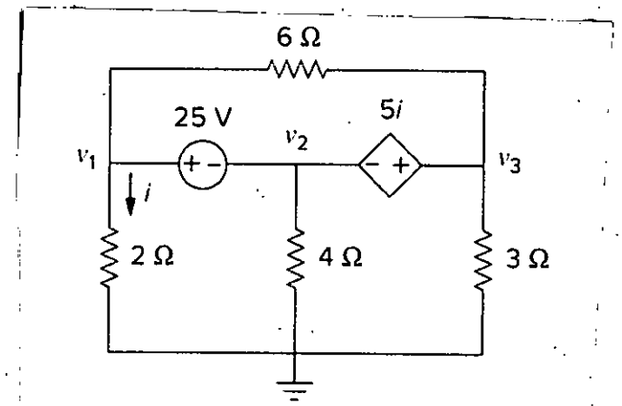


Fig. for Q. No. 2(b)

3. (a) Use superposition to find V_0 in the circuit of Fig. for Q. No. 3(a). **(20)**

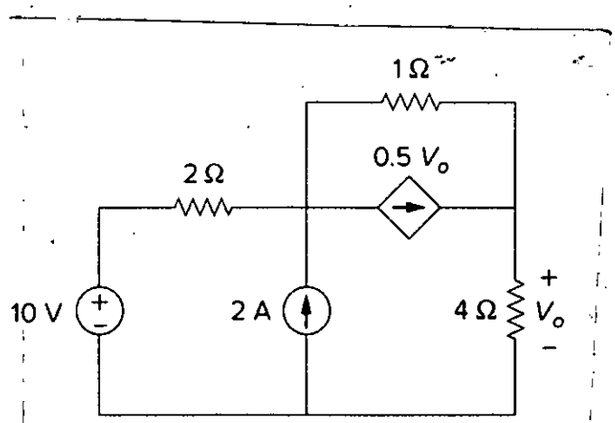


Fig. for Q. No. 3(a)

(b) Use source transformation to find i_x in the circuit of Fig. for Q. No. 3(b). **(15)**

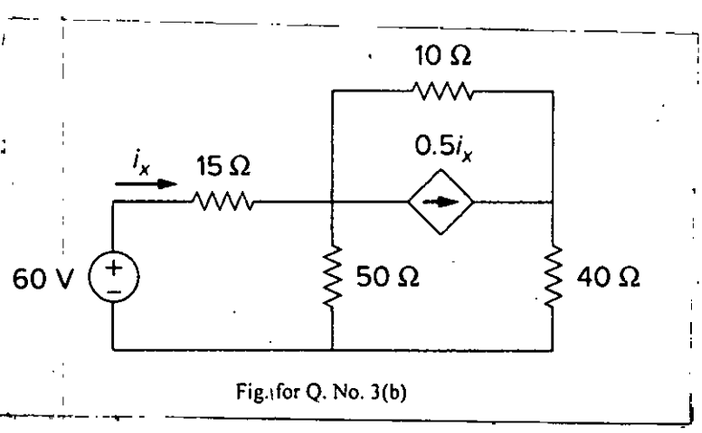


Fig. for Q. No. 3(b)

Contd P/3

EEE 159/ME

4. (a) For the circuit in Fig. for Q. No. 4(a), what resistor connected across terminals a-b will absorb maximum power from the circuit? What is that power? **(20)**

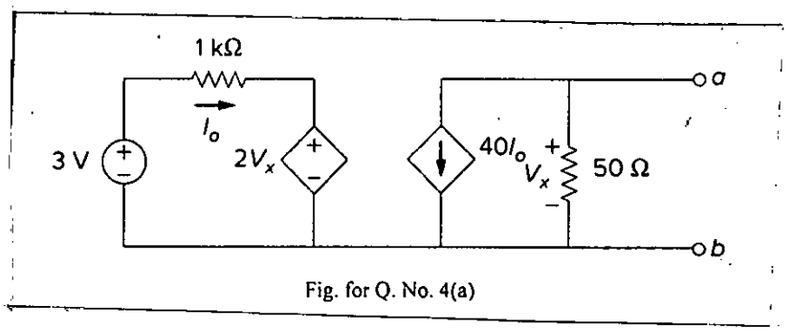


Fig. for Q. No. 4(a)

(b) The current through a 10μF Capacitor. $i_C(t)$ is shown in Fig, for Q. No. 4(b). Express and plot the charge stored in the capacitor, q and voltage across the capacitor, v_C as function of time. Assume initial charge was 0. **(15)**

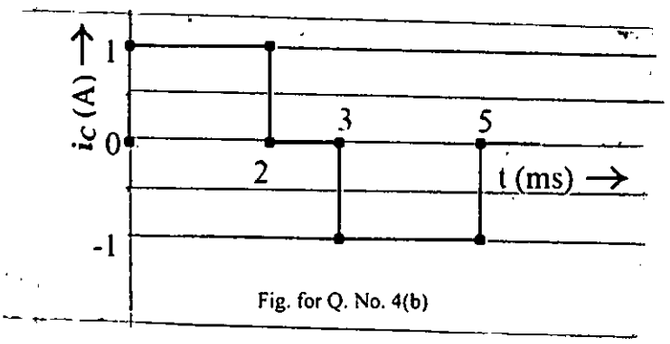


Fig. for Q. No. 4(b)

SECTION – B

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

5. (a) Using phasors, determine $v(t)$ from the following equations: **(12)**

(i) $2\frac{dv}{dt} + 3v = 4\cos(2t - 45°)$

(ii) $2\frac{d^2v}{dt^2} + 60v + 25\int v\,dt = 110\cos(6\pi t - 10°)$

(b) Determine the voltage V_{DC} as indicated in Fig. for Q. No. 5(b) to establish a flux of 10^{-4} Wb in the section of the core with the air gap. Given, N = 200. Necessary B-H curves are attached to the question paper. **(23)**

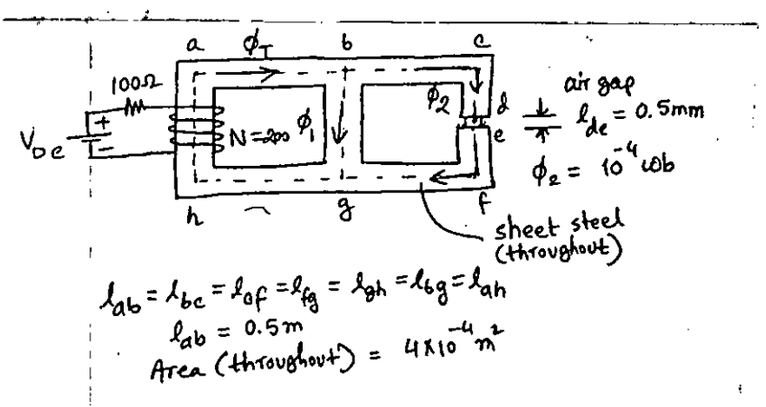


Fig. for Q. No. 5(b)

Contd P/4

EEE 159/ME

6. (a) Use nodal analysis to determine the voltage v_x from the circuit of Fig. for Q. No. 6(a). **(15)**

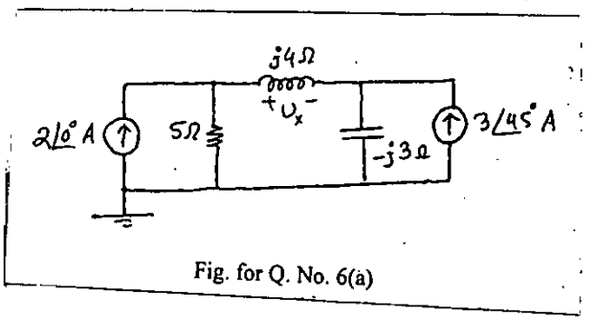


Fig. for Q. No. 6(a)

(b) Determine $v_0(t)$ using the principle of superposition from the circuit of Fig. for Q. No. 6(b). **(20)**

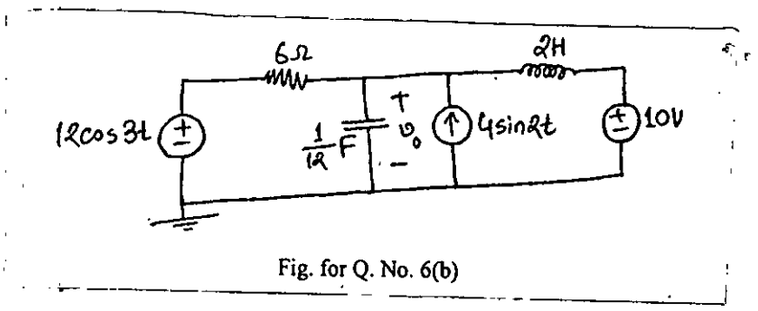


Fig. for Q. No. 6(b)

7. (a) When connected to a 220 V (rms), 50-Hz power line, a certain load absorbs 4 kW at a power factor of 0.8 (lagging). Find the value of the capacitance required to raise the power factor to 0.9 (lagging). Also, roughly sketch the phasor diagrams before and after the power factor improvement. **(17)**

(b) From the circuit in Fig. for Q. No. 7(b), determine the line currents, power loss in the transmission lines, and the total power dissipated by the three phase load. **(18)**

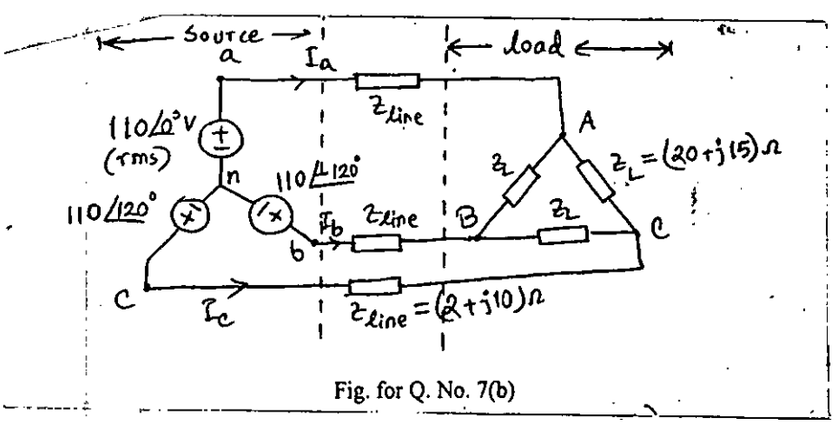


Fig. for Q. No. 7(b)

Contd P/5

EEE 159/ME

8. (a) Consider the current waveform given in Fig. for Q. No. 8(a). The effective value is given as $2\sqrt{2/3}\ A$. The zero segment in each period lasts for 2 seconds. Determine the frequency F of the same waveform in Hz. **(18)**

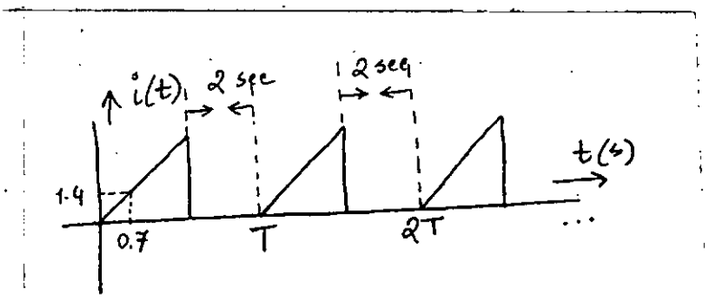


Fig. for Q. No. 8(a)

(b) Find the Thevenin equivalent circuit to the left of terminals a-b for the circuit in Fig, for Q. No. 8(b). **(17)**

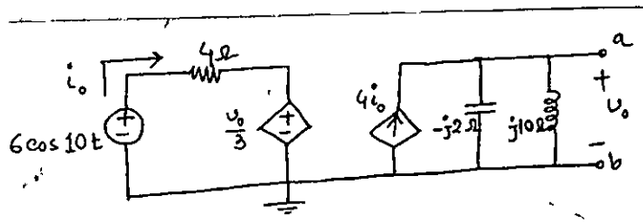
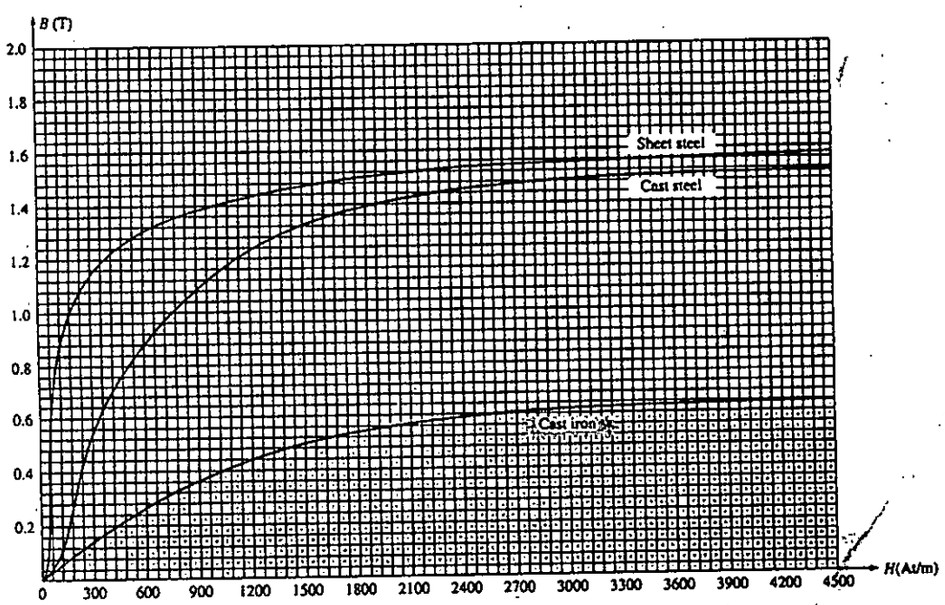


Fig. for Q. No. 8(b)



L-1/T-1/ME Date : 25/03/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **MATH 161** (Differential Calculus, Solid Geometry and Vectors)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Examine the continuity and differentiability of $f(x)$ at $x = 1$ and $x = 3$, where **(16⅔)**

$$f(x)=\begin{cases}|x|, & 0<x<1\\ 2+x, & 1\le x\le 3\\ x+\frac{1}{2}x^2, & x>3\end{cases}$$

Then sketch the graph of $f(x)$.

(b) Using Taylor's series find the first three non-zero terms of $f(x)=(1+x)^3\,e^{-5x^2}$ about $x-2$. **(15)**

(c) Use Leibnitz's theorem to find $y_n(x)$ at $x=0$ both for even and odd n, where **(15)**

$$y=\left(x+\sqrt{1+x^2}\right)^m.$$

2. (a) Evaluate (i) $\lim\limits_{x\to 0}\dfrac{e^x+e^{-x}-x^2-2}{\sin^2 x-x^2}$, and (ii) $\lim\limits_{x\to 0}\dfrac{\left(e^x-1\right)\tan^2 x}{x^3}$. **(16⅔)**

(b) If $u(x,y)=\sin^{-1}\left(\dfrac{x}{y}\right)+\tan^{-1}\left(\dfrac{y}{x}\right)$, then find the value of $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}$. **(14)**

(c) State Euler's theorem for homogeneous functions. If $u=\tan^{-1}\dfrac{5x^4-3xy^3+7y^2z^2}{x^2-2y^2+3yz}$, find the value of $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}+z\dfrac{\partial u}{\partial z}$. **(16)**

3. (a) Find the radius and height of the right circular of largest volume that can be inscribed in a right circular cone with radius 6 inches and height 10 inches. **(16⅔)**

(b) In the curve $x=\dfrac{y^2-a^2}{4a}-\dfrac{a}{2}\log\dfrac{y}{a}$, show that the difference between the lengths of tangent and subtangent is a constant. **(15)**

(c) Find the angle between the tangent to the curve $r=a(1-\cos\theta)$ and the radius vector. **(15)**

4. (a) Find the envelopes of the straight line $\dfrac{x}{a}+\dfrac{y}{b}=1$, where the parameter a and b are connected by the relation $ab=c^2$, c being a constant. **(15)**

Contd P/2

MATH 161/ME

Contd ... Q. No. 4

(b) Find the pedal equation of the curve $r^m = a^m \sin m\theta + b^m \cos m\theta$. **(15⅔)**

(c) Find all the asymptotes of the curve **(16)**

$$x^3 - x^2y - xy^2 + y^3 + 2x^2 - 4y^2 + 2xy + x + y + 1 = 0.$$

SECTION – B

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

5. (a) Show that AB and BC are perpendicular to each other, where $A(-11, 8, 4)$, $B(-1, -7, -1)$ and $C(9, -2, 4)$. **(15)**

(b) Find conditions such that the lines whose direction cosines are given by the equations $l + m + n = 0$ and $bl^2 + am^2 + cn^2 = 0$ are perpendicular and parallel. **(15)**

(c) A variable plane passes through a fixed point (α, β, γ) and meets the axes in A, B, C. Show that the locus of the point of intersection of the planes through A, B, C parallel to the coordinate plane is $\frac{\alpha}{x} + \frac{\beta}{y} + \frac{\gamma}{z} = 1$. **(16⅔)**

6. (a) Find the equations to the perpendicular from the origin to the line **(23)**

$$x + 2y + 3z + 4 = 0,\ 2x + 3y + 4z + 5 = 0$$

Find also the coordinates of the foot of the perpendicular.

(b) Find the shortest distance between the lines **(23⅔)**

$$\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4};\ \frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}.$$

Find also the equation of shortest distance line and points in which it meets the given lines.

7. (a) Let **a**, **b** and **c** have the same initial point and **(15)**

$$\mathbf{a}\alpha + \mathbf{b}\beta + \mathbf{c}\gamma = 0 \text{ with } \alpha + \beta + \gamma = 0.$$

If α, β, γ are scalars, not all of which are zero, then show that the terminal points of **a**, **b** and **c** lie in a line.

(b) Examine whether the vectors (5, 6, 7), (7, –8, 9) and (3, 20, 5) are linearly independent or dependent. If dependent find a linear relation among them. **(15)**

(c) A line makes angles α, β, γ, δ with four diagonals of a cube; prove that **(16⅔)**

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma + \cos^2\delta = \frac{4}{3}$$

8. (a) Define the moment of a vector about a point. A force given by $\mathbf{F} = 3\mathbf{i} + 2\mathbf{j} - 4\mathbf{k}$ is applied at the point (1, –1, 2). Find the moment of **F** about the point (2, –1, 3). Find also the moment **F** about the line passing through that point having direction ratios 1 : 1 : 1. **(16⅔)**

(b) Prove that $[\mathbf{a} \times \mathbf{p}\ \ \mathbf{b} \times \mathbf{q}\ \ \mathbf{c} \times \mathbf{r}] + [\mathbf{a} \times \mathbf{q}\ \ \mathbf{b} \times \mathbf{r}\ \ \mathbf{c} \times \mathbf{p}] + [\mathbf{a} \times \mathbf{r}\ \ \mathbf{b} \times \mathbf{p}\ \ \mathbf{c} \times \mathbf{q}] = \mathbf{0}$. **(15)**

(c) Solve the vector equation for **x**: $\mathbf{a} \times \mathbf{x} + (\mathbf{a}.\mathbf{x})\mathbf{a} + \mathbf{b} = 0$ where **a**, **b** are two given vectors. **(15)**

L-1/T-1/ME **Date : 29/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **PHY 105** (Structure of Matter, Electricity & Magnetism and Modern Physics)

Full Marks : 210 Time : 3 Hours.

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Define lattice parameters, coordination number, Wigner-Seitz primitive cell. **(6)**

   (b) Draw crystal structures of an orthorhombic system, primitive cell of a sodium crystal, and zinc blend structure mentioning their lattice points per unit cell? **(22)**

   (c) What are the similarities and differences between the cubic close packed and hexagonal close packed (hcp) structures? **(7)**

2. (a) What is atomic packing factor (APF)? Find the unit cell axial ratio (c/a) and APF of an hcp structure. **(17)**

   (b) Draw crystal directions and crystal planes for a cubic lattice system corresponding to the Miller indices [100], $[01\bar{1}]$ and (101), (020), respectively. **(8)**

   (c) Derive an expression for the interplanar distances between two consecutive parallel planes for an orthorhombic crystal system. **(10)**

3. (a) Show that for X-ray diffraction the wavelength of X-rays must not be greater than twice the interplanar spacing of a crystal. Calculate the angle of 1^{st} order diffraction from (131) planes of KCl (a = 6.36 Å) when Cu k_α radiation (λ = 1.5405 Å) is used. Why the X-rays diffraction spectra of KCl is different from that of KBr in spite of their similar crystal structure? **(18)**

   (b) Write down the importance of point defects in crystals from a Mechanical engineering point of view giving suitable examples. Explain Schottky and Frankel defects in case of ionic crystals. **(11)**

   (c) Define Fermi level. What happened to the Fermi level when doping is introduced in an intrinsic semiconductor? **(6)**

4. (a) What is meant by 'charge is quantized'? Define an electric flux. How do you obtain Coulomb's law of electrostatics using Gauss' law? **(12)**

   (b) If an electric dipole is placed in a uniform external electric field ($\vec{E}$), show that (i) the torque exerted on the dipole by the field is $\vec{\tau} = \vec{p} \times \vec{E}$ and (ii) the change in potential energy is $U = -\vec{p}.\vec{E}$, when $\vec{p}$ indicates the electric dipole moment. **(16)**

   (c) Draw a typical magnetic hysteresis for a ferromagnetic substance and explain the coercive field (H_c). **(7)**

Contd P/2

PHY 105

SECTION – B

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

5. (a) Define the following terms: **(7)**
   (i) Electric potential,
   (ii) Dielectric constant.
   (b) (i) Consider a capacitor is charged through a resistance for a constant emf. Show that the charge across the capacitor at any instant of time t is given by $q = q_0 (1 - e^{-t/RC})$, where the symbols have their usual meaning. **(14+6=20)**
   (ii) Let a circuit is containing a series combination of a resistance (R) and a capacitor (C) with an alternating emf. Find the total impedance (Z) and phase angle (θ) of this circuit.
   (c) A 1 μF capacitor is allowed to discharge through an unknown resistance. If the charge on the capacitor takes 35 sec to drop to half of its original value, what is the value of the resistance? **(8)**

6. (a) Define the following terms: **(10)**
   (i) Lorentz force,
   (ii) Self inductance.
   (b) Write down the Biot-Savart law. Consider a circular coil of radius (R) is carrying a current, i. Calculate the magnetic field (B) at a distance x on the axis from the center of the coil. What will be the value of B at the center of the coil? **(15)**
   (c) Write down the differential equation that describes the oscillations of an LC circuit. Show that the frequency of oscillation of an LC circuit is given by $\omega = \sqrt{\frac{1}{LC}}$, where the symbols have their usual meaning. **(10)**

7. (a) State the postulates of special theory of relativity. Distinguish between inertial and non-inertial frame of reference. **(10)**
   (b) Describe the Michelson-Morley experiment. Explain the physical significance of the result of this experiment. **(17)**
   (c) The length of an evacuated tube is 20 m which is in rest. A 15 MeV electron moves along the axis of that tube. What length of the tube would be measured by the observer moving with the electron? **(8)**

8. (a) What is chain reaction? Describe different required conditions for chain reaction. **(10)**
   (b) Draw a schematic diagram of nuclear fission reactor and briefly describe various components of a nuclear reactor. **(16)**
   (c) Solar energy received by the earth at the outer atmosphere is about 1.4 kW/m^2. The average distance from the earth to the sun is 1.5×10^8 km. Calculate the decrease in mass of the sun per sec. **(9)**

L-1/T-1/ME Date : 03/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **CHEM 109** (Chemistry I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What are the different factors that control the solubility of solids in liquid? The effect of temperature on the solubility of solid in liquid can be applied for the determination of heat of solution of the solute – justify. **(15)**

   (b) Define 'ideal solution' and give a molecular interpretation of ideal behavior of a solution. Draw a graphical relation between the vapor pressure as function of mole fraction for an ideal solution of components A and B. What are the deviations of the law if the solution is non-ideal? Give the molecular interpretation of such non-ideal behavior. **(8+12=20)**

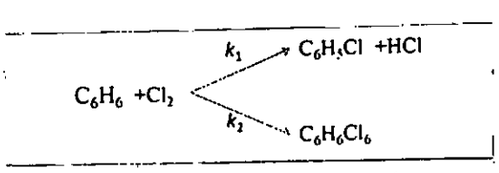
2. (a) Draw a suitable P-T diagram showing the freezing point of the solvent and solution. Apply Clausius-Clapeyron equation and show that the depression of the freezing point due to the addition of non-volatile and non-electrolyte is directly proportional to the molality of the solute. **(15)**

   (b) Consider an electrolyte with the degree of dissociation is α, the total number of ions due to the dissociation is n and Van 't Hoff factor during the measurement of colligative properties is i. Derive a relation among the terms mentioned above. **(12)**

   (c) Ethylene glycol (EG), $CH_2(OH)CH_2(OH)$, is a common automobile antifreeze. It is water soluble and fairly nonvolatile (b.p. 197°C). Calculate the freezing point of a solution containing 651 g of this substance in 2505 g of water. Would you keep this substance in your car radiator during the summer? The molar mass of ethylene glycol is 62.01 g. [$k_f = 1.86$°C/m] **(8)**

3. (a) According to Lindemann hypothesis for unimolecular reaction, the order of the reaction depends on the reactant concentration of the reactants. Explain with the mechanism proposed by Lindemann. **(15)**

   (b) For the following reaction, what will be your approach to determine the rate constants for the branches? If $k_1 > k_2$, draw the reaction profile. **(12)**



   (c) The value of the Arrhenius factor and activation energy are 4×10^{13} s^{-1} and 98.6 kJ mol^{-1}, respectively for a first-order reaction. Calculate the temperature at which its half-life is 10 mins. **(8)**

Contd P/2

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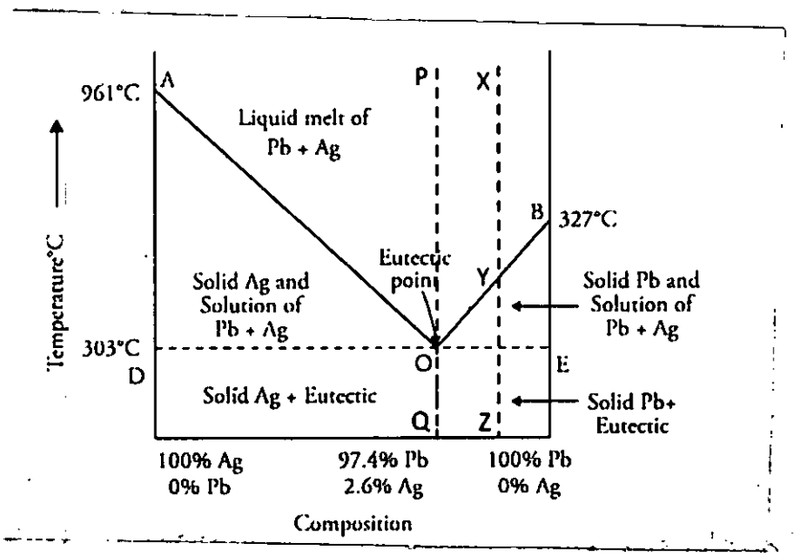
4. (a) In the phase diagram of Ag-Pb system, draw the cooling curves along the lines POQ and XYZ and explain the nature of the curves. **(15)**



(b) Differentiate melting point, triple point, and eutectic point. **(12)**

(c) 0.5 g of a carbon sample is placed in a calorimeter with excess oxygen at 25°C and 1 atm pressure. On reaction, the temperature of the calorimeter rises from 25°C to 25.89°C. The heat capacity of the calorimeter is 20.7 kJ/°C. Determine the heat of the reaction at 25°C. **(8)**

SECTION – B

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

5. (a) What do you mean by quantization of angular momentum? How de-Broglies hypothesis provides an explanation for Bohr's second postulate of quantization of angular momentum? Find the ratio of the velocities of electrons and protons for the de-Broglie wavelength to be same. **(15)**

(b) Define radial probability distribution curves. Discuss the radial probability distribution curves of 1s and 2s orbitals by highlighting their respective radial and angular nodes. **(10)**

(c) Draw energy level diagrams valid for single and multi-electron systems. Why is the orbital energy levels pattern different in these two systems? **(10)**

Contd P/3

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6. (a) What is effective nuclear charge? What relation does it have with shielding phenomena? On the basis of Slater's rule, calculate the value of effective nuclear charge, Z_{eff} for (i) 3d electron in iron (z = 26) and (ii) 6s electron of tungsten (Z = 74). **(15)**

   (b) How could you demonstrate an experimental basis for providing evidence that the 4s electrons are lost before the 3d electrons in Ti^{2+} ions? **(10)**

   (c) Distinguish between electron affinity and electronegativity. Write down the equations representing the following processes: **(10)**

   (i) The electron affinity of S^-

   (ii) The third ionization energy of titanium

   (iii) The electron affinity of Mg^{2+}

   (v) The ionization energy of O^{2-}

7. (a) How does molecular orbital theory differ from valance bond theory? The bond dissociation energy of O_2 is smaller than dioxygenyl ion; the opposite is true for the dissociation energies of N_2 and dinitrogenyl ion. Explain this behavior in terms of the molecular orbital energy diagrams of O_2 and N_2. **(15)**

   (b) For each of the following use formal charges to choose the Lewis formula that give the best description of the electron distribution and hence predict the hybridization and geometry of the following compounds using VSEPR modl: NO_2^-, SO_3, XeF_2 and H_3O^+. **(10)**

   (c) Illustrate bonding in N_2F_2 molecule using hybrid orbitals. **(10)**

8. (a) What is meant by ionic product constant of water (K_w)? At 60 °C the value of K_w is 1×10^{-13}. Predict whether the reaction $2H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + OH^-\ (aq)$ is exothermic or endothermic? Calculate the concentration of H^+ and OH^- ions in water at 60 °C. **(10)**

   (b) For the following reaction identify the conjugated acid-base pairs and decide which species (reactant of product) is favored at the completion of the reaction? **(10)**

   $SO_4^{2-}\ (aq) + HCN\ (aq) \rightleftharpoons HSO_4^-\ (aq) + CN^-\ (aq)$;

   Here HCN is considered as the weakest acid.

   (c) Explain Pearson's concept of hard and soft acids and bases (HSABs). Based on HSABs concept explain why do the solubilities of silver halides decrease in water while going down the column of halogens in the periodic table? **(10)**

   (d) Write down the chemical reactions involve during the isolation of nobel gases from the mixture of various gases in air. **(5)**
