**L-1/T-2/EEE** **Date: 15/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **EEE 105** (Electrical Circuits II)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) In the circuit of Figure 1(a), find the current $I_3$ and the energy stored in the coupled coils at t = 2 ms when ω = 1,000 rad/s, **(18)**

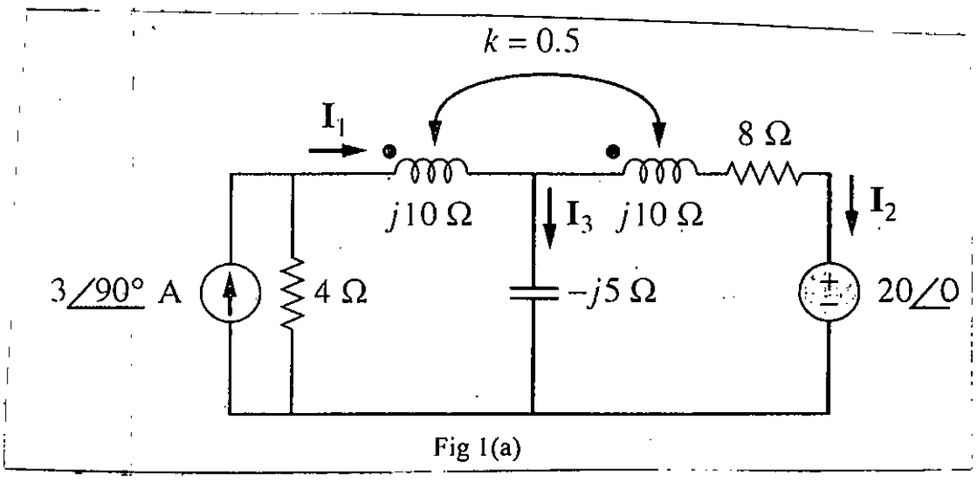


Fig 1(a)

(b) Construct the Bode magnitude and phase plots for **(17)**

$$H(\omega)=\frac{250(j\omega+1)}{j\omega(-\omega^2+10j\omega+25)}$$

2. (a) Find the input impedance *Z* for the circuit shown in Figure 2(a). **(18)**

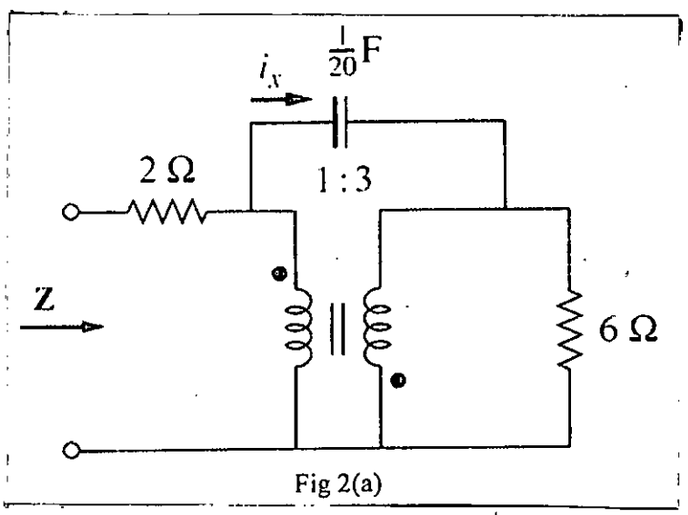


Fig 2(a)

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(b) In the circuit shown in Figure 2(b), find $v_0(t)$ when the Fourier series expansion of $v_s$ is **(17)**

$$v_s(t) = 3 + \frac{4}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin(n\pi t)\,Volt$$

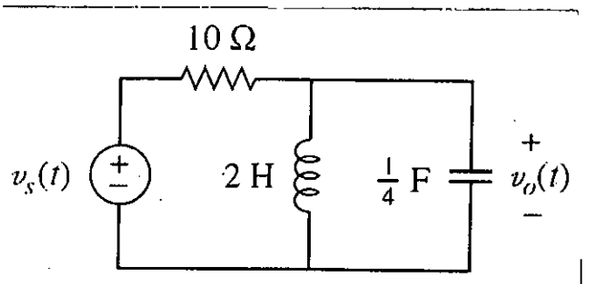


Fig 2(b)

3. (a) The switch in the circuit shown in Figure 3(a) has been opened for a long time. The initial charge on the capacitor is zero. If the switch is closed at $t$ = 0, find the expression for $v(t)$ for $t > 0$ when $Is = 10\cos(1000t)\text{mA}$. **(20)**

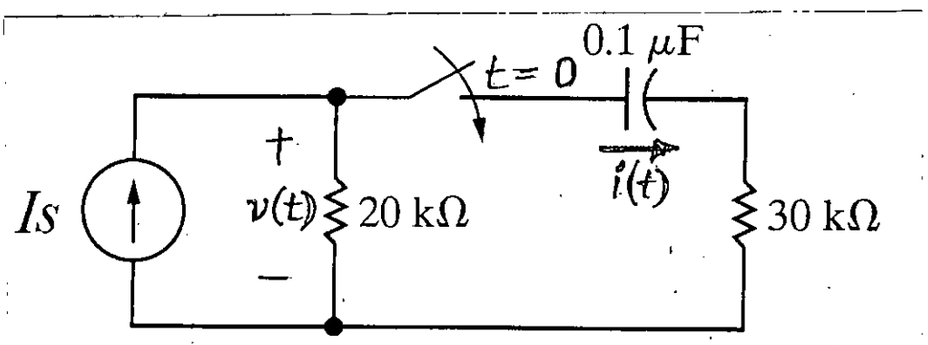


Fig 3(a)

(b) Calculate the average power absorbed by the load for the circuit in Figure 3(b), if the supply voltage is **(15)**

$v(t) = 7.5\cos(2t - 122^\circ) + 2.2\cos(6t - 122^\circ) + 1.3\cos(10t - 97^\circ) + 0.91\cos(14t - 95^\circ)\text{V}$.

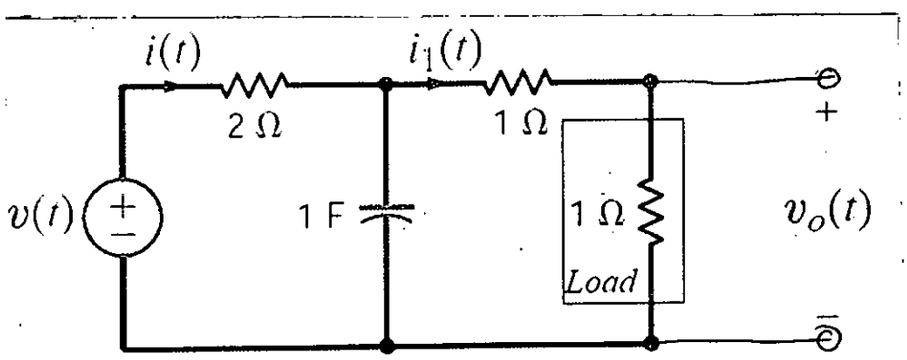


Fig 3(b)

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4. (a) Determine the center frequency and bandwidth of the bandpass filter circuit in Figure 4(a). **(16)**

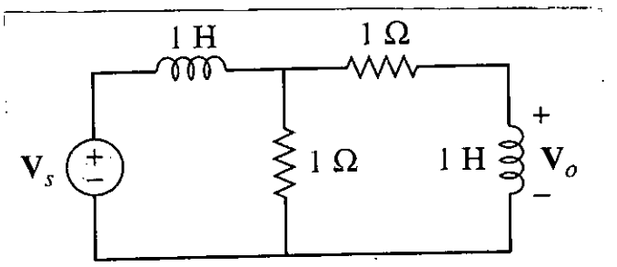


Fig 4(a)

(b) Define distortion factor, displacement factor and true power factor for an electrical circuit. **(6)**

(c) What is Total harmonic distortion (THD)? Explain the effect of harmonics on electrical equipment. **(3+10)**

## SECTION – B

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

5. (a) Find the value of L or C in Fig. for Q. 5(a) that will make the overall power factor 0.8, if V = 100∠90° Volts at 50 Hz. **(17)**

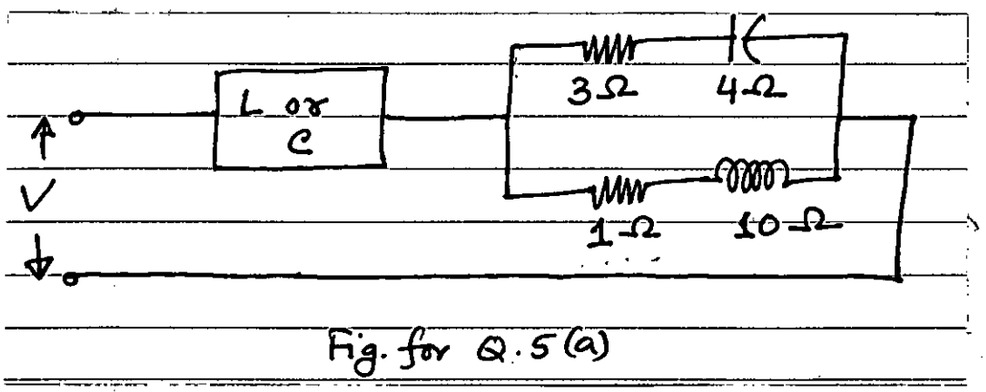


Fig. for Q. 5(a)

(b) Solve for $v_0(t)$ in the circuit of Fig. for Q. 5(b) using the superposition principle. **(18)**

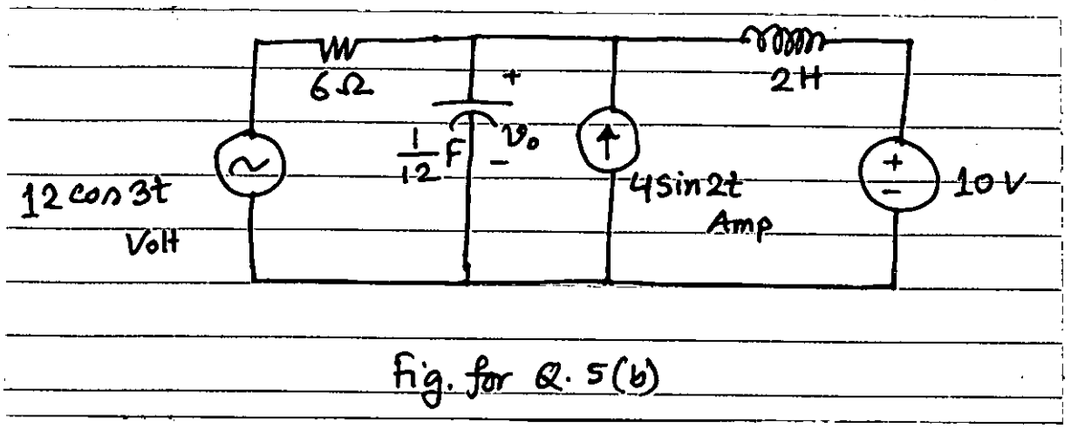


Fig. for Q. 5(b)

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6. (a) Find the average power absorbed by a 100 Ω resistor if current shown in Fig. for Q. 6(a) flows through the resistor. **(17)**

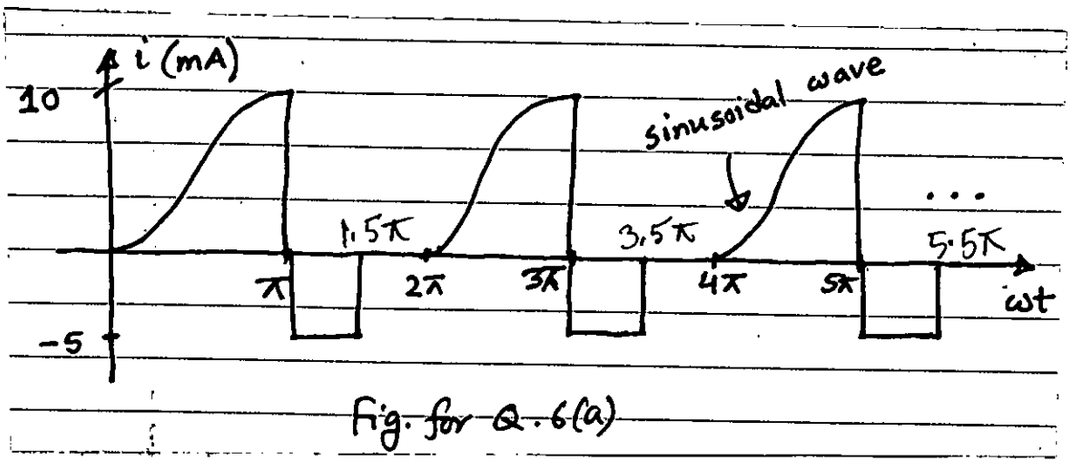


Fig. for Q. 6(a)

(b) A 240 V rms 50 Hz supply serves three parallel loads. Load1 absorbs 60 kVAR at p.f. 0.85 lagging, load2 absorbs 90 kW and 50 kVAR leading, and load3 absorbs 100 kW at p.f. = 1. **(18)**

(i) Find the equivalent impedance.

(ii) Calculate the power factor of the combined load.

(iii) Determine the current supplied by the source.

7. (a) Determine the load impedance $Z_{load}$ to receive maximum power for the network given in Fig. for Q. 7(a). Also calculate the maximum power received by the load. Find the power factor of the circuit under this condition. **(17)**

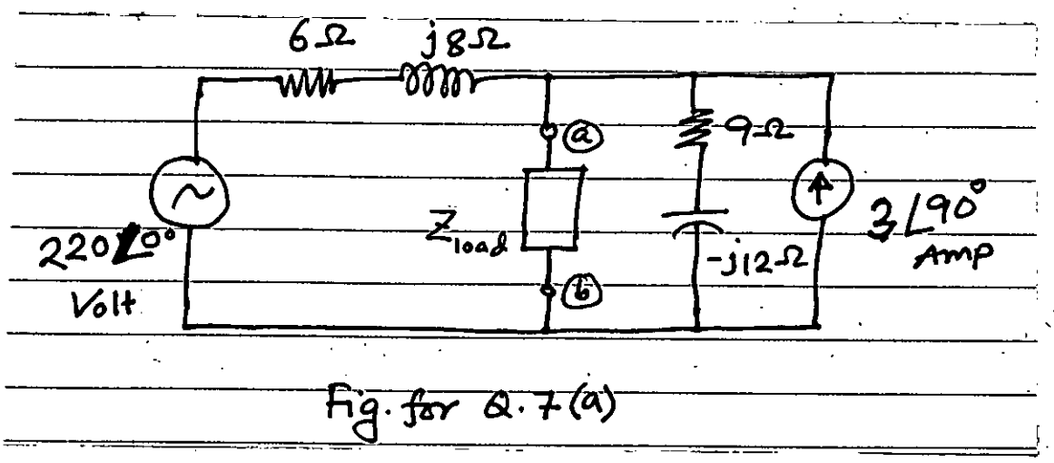


Fig. for Q. 7(a)

(b) An industry has the following three balanced loads with power connection of 440 V, 50 Hz with a-b-c sequence. **(18)**

Load1: 60 kW at 0.6 p.f. lagging

Load2: 90 kVAR at 0.8 p.f. lagging

Load3: 100 kW at 0.5 p.f. lagging.

Determine (i) real and reactive power of the combined load (ii) line current, (iii) the kVAR rating and the value of each capacitor of a Y-connected capacitor bank to improve the overall power factor to 0.98 lagging.

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8. (a) The unbalanced load shown in Fig. for Q. 8(a) is connected to a 440 V, 50 Hz power supply with positive phase sequence. Determine the line currents, the real and reactive power supplied to the load. **(17)**

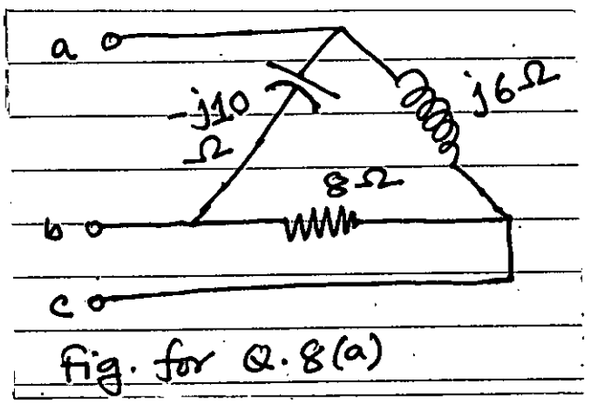


Fig. for Q. 8(a)

(b) Two balanced loads are connected to a 220 V, 50 Hz line as shown in Fig. for Q. 8(b). Assuming a-b-c sequence, determine (i) the wattmeter readings, total power and overall power factor, (ii) The kVAR rating of Δ-connected capacitor bank connected in parallel to the existing load to obtain minimum line current. **(18)**

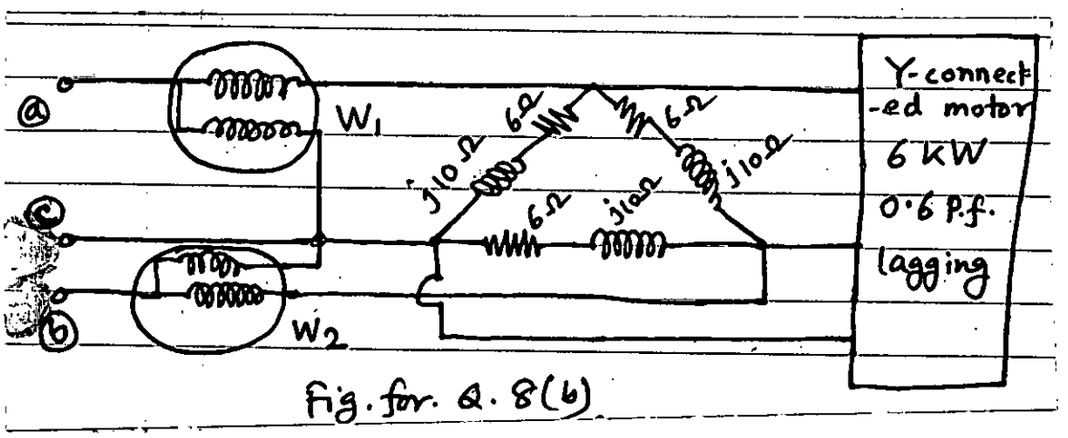


Fig. for Q. 8(b)

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L-1/T-2/EEE **Date : 30/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **PHY 165** (Electricity & Magnetism, Modern Physics and Mechanics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Explain the terms electric flux and solid angle. Derive Gauss's law of electrostatics for an isolated point charge, Q. Discuss the advantages of Gauss's law. **(12)**

   (b) Deduce Coulomb's law from Gauss's law. Using Gauss's law, calculate $\vec{E}$ for an infinitely long line of charge (e.g. a wire with negligible diameter) with a constant charge per unit length $\lambda$. **(15)**

   (c) An $\alpha$-particle, approaching the surface of a nucleus of gold, is a distance equal to one nuclear radius ($6.9 \times 10^{-15}$ m) away from that surface. What are the forces on the $\alpha$-particle and its acceleration at that point? The mass of the $\alpha$-particle, which may be treated here as a point, is $6.7 \times 10^{-27}$ kg. **(8)**

2. (a) What is electric potential? Derive an expression for electric potential due to a dipole. **(12)**

   (b) What is volume charge density? A solid nonconducting sphere of radius $R$ has a total charge $Q$. Find the electric potential (i) inside, and (ii) outside the charged sphere. **(15)**

   (c) What is the electric potential energy of a system of point charges? Suppose three charges + q, + 2q, and – 4q are arranged at the corner of an equilateral triangle of sides 15 cm. Assume the value of q is 100 *nC*. What is their mutual potential energy? **(8)**

3. (a) What are solenoid and toroid? Derive expressions of magnetic field $\vec{B}$ for solenoid and toroid. **(12)**

   (b) Briefly explain the term self-inductance and hence derive expressions for self-inductances for toroids having circular and rectangular cross sections. **(15)**

   (c) A rectangular loop of $N$ turns and of length, $a$, and width, $b$, is rotated at a frequency, $\nu$, in a uniform field of induction $B$. (i) Show that an induced emf given by $E = 2\pi\nu NabB\sin(2\pi\nu t) = E_0\sin(2\pi\nu t)$ appears in the loop. (ii) Design a loop that will produce an emf with $E_0 = 220$ $V$ when rotated at 50 *rev/s* in a field of the magnetic induction of 5000 *Gauss*. **(8)**

4. (a) What do you understand by the activity of a radioactive sample? **(6)**

   (b) Discuss the theory of successive disintegration of radioelements. **(21)**

   (c) It is found that 46.3 mg of naturally available potassium ($K$) shows a $\beta$-activity of *1.5* disintegrations per sec. The isotope responsible for this activity is $^{40}K$, which makes up *0.012%* of the natural mixture. Calculate the half-life of $^{40}K$. **(8)**

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## PHY 165/EEE

### SECTION – B

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

5. (a) What were the difficulties in physics which led to introduce the concept of the relativity theory? **(8)**

(b) (i) Define the following kinematical effects: length contraction and time dilation and derive their expressions on the basis of Lorentz transformation, and (ii) show that two simultaneous events at different positions in a frame of reference are not in general simultaneous in another inertial frame in relative motion. **(12+8=20)**

(c) The speed of an electron in a uniform electric field changes from 0.95c to 0.98c (where c is the speed of light). Calculate the change in work done on the electron to change the velocity. **(7)**

6. (a) State de Broglie hypothesis and obtain an equation for the wavelength of matter waves. **(12)**

(b) Show that the group velocity of matter waves associated with a moving body is equal to the velocity of the body. **(15)**

(c) In case of a hydrogen atom, show that de Broglie wavelength of an electron is equal to the length of the Bohr orbit. **(8)**

7. (a) State Heisenberg's uncertainty principle. If two matter-waves superimpose to each other, then show that, $\Delta x.\Delta p \geq \frac{h}{4\pi}$ where, the symbols have their usual meanings. **(15)**

(b) Suppose a physical observable that is represented by a linear Hermitian operator $\hat{A}$, which operates on a wavefunction $\psi$. In this regard, **(20)**

(i) Define Hermitian operator. Show that, the eigenvalue of $\hat{A}$ is real.

(ii) If $\psi$ is defined by, $\psi(x) = e^{-x^2/2}$ then show that, $\psi(x)$ is an eigenfunction of the operator $\left(\frac{d^2}{dx^2} - x^2\right)$. Also find the corresponding eigenvalue.

(iii) If $\psi$ is defined by, $\psi(x, t) = Ne^{i(kx - \omega t)}$ then find out the Energy operator.

8. (a) The one-dimensional wavefunction of a surmountable particle is defined by, **(6+9=15)**

$$\psi(x, t) = Ae^{i(px - Et)/\hbar}$$

(i) Write down the properties of $\psi$ and the postulate regarding expectation value.

(ii) Obtain the time independent Schrödinger equation in steady state form.

(b) At time $t = 0$, a particle is represented by the wavefunction, **(5+3+5+7=20)**

$$\psi(x, 0) = \begin{cases} A\frac{x}{a}, & 0 \leq x \leq a \\ A\frac{(b-x)}{(b-a)}, & a \leq x \leq b \\ 0, & \textit{for otherwise} \end{cases}$$

where, A, a and b are constants.

(i) Normalize $\psi$ to obtain the value of A in terms of a and b.

(ii) Sketch $\psi$ as a function of $x$.

(iii) What is the probability of finding the particle to the left of $a$? Check your result in the limiting cases $b = a$ and $b = 2a$.

(iv) Obtain the expectation value of $x$.

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L-1/T-2/EEE **Date: 19/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CHEM 101** (Chemistry I)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

Symbols used here bear usual meaning. Assume reasonable values for any missing data.

1. (a) Define polymorphism. Draw the phase diagram for sulphur system and show the degrees of freedom for the areas, lines, and triple points. **(15)**

   (b) Distinguish between specific heat capacity, molar heat capacity, and heat capacity. Mention their units. **(10)**

   (c) Define heat of combustion. When 1 mol of NO(*g*) forms from its elements, 90.29 kJ of heat is absorbed. What would be the change of heat when 3.50 g of NO decomposes to its elements? **(10)**

2. (a) Show the reactions take place during rusting of iron. Iron in contact with Zn does not corrode— explain. **(15)**

   (b) A voltaic cell consists of two $H_2/H^+$ half-cells. Half-cell A has $H_2$ at 0.95 atm bubbling into 0.10 M HCl. Half-cell B has $H_2$ at 0.60 atm bubbling into 2.0 M HCl. Which of the half-cells is the anode? What is the voltage of the cell? **(10)**

   (c) In an aqueous electrolytic cell, nitrate ions ($NO_3^-$) never react at the anode, but nitrite ions ($NO_2^-$) do. Explain. **(10)**

3. (a) Explain- **(15)**

   (i) High molecularity reactions are rare

   (ii) The physical state of the reactants influences reaction rate

   (b) The rate constants of some reactions double with every 10-degree rise in temperature. Assume that a reaction takes place at 22°C and 32°C. What must the activation energy be for the rate constant to double? **(10)**

   (c) Define order of a reaction. Discuss the Ostwald's isolation method to determine order of a reaction. **(10)**

4. (a) Derive Raoult's law. 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. The molar mass of ethylene glycol is 62.01 g and the freezing point depression constant for water is 1.86 °C/m. **(15)**

   (b) Solubility of a gas solute and a solid solute does not change in the same way with temperature— explain. **(10)**

   (c) Define hypotonic medium. The concept of osmosis can be applied to purify sea water — explain with appropriate diagram. **(10)**

Contd ..... P/2

## SECTION – B

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

5. (a) Derive Schrödinger wave equation for the wave mechanical model of an atom and discuss its application to hydrogen atom. **(20)**

   (b) Write a note on Heisenber's uncertainty principle. How this principle goes against Bohr's theory? **(10)**

   (c) Derive an expression for the radius of any orbit in the atom. **(5)**

6. (a) Compare and contrast between valence bond theory (VBT) and molecular orbital theory (MOT). **(10)**

   (b) Predict the geometry (shape, bond angle, lone pairs) of the following molecules/ions using VSEPR theory: (i) $AlCl_3$ (ii) $NO_2^-$ (iii) $ICl_3$ (iv) HF. **(10)**

   (c) Strength of hydrogen bond in H–F is more than in $H_2O$ but still HF is a gas and $H_2O$ is a liquid at room temperature. Explain. **(10)**

   (d) Define Lattice energy. Discuss the factors on which it depends. **(5)**

7. (a) Compare the relative stability of $N_2$ molecule with $O_2$ molecule by using molecular orbital theory. **(15)**

   (b) Differentiate bonding, anti-bonding and non-bonding molecular orbital. **(10)**

   (c) Categorize salts according to how they affect the pH of a solution. **(10)**

8. (a) Demonstrate the physical reality of the wave nature of electrons. **(10)**

   (b) How does the strength of an oxoacid depend on the electronegativity and oxidation number of the central atom? **(10)**

   (c) Use the first-row transition metals (Sc to Cu) as an example to illustrate the characteristics of the electron configurations of transition metals. **(10)**

   (d) Electron affinity measurements are made with gaseous atoms. Why? **(5)**

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L-1/T-2/EEE Date : 03/11/2022

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **HUM 277** (Fundamentals of Economics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) When does a firm emerge as a monopolist? **(10)**

   (b) What is the relation among marginal revenue (MR), price (P) and price elasticity of demand (e) of a firm under monopoly? **(10)**

   (c) Explain the long run equilibrium of a firm under monopoly. **(15)**

2. (a) Show that price elasticity of demand varies from zero to infinity along any straight-line demand curve. **(15)**

   (b) There are two parallel straight line demand curves. Show that the curve which is nearer to the origin has a higher price elasticity of demand at any point. Explain graphically. **(10)**

   (c) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result. **(10)**

| Point | Px | Qy |
|---|---|---|
| A | 50 | 130 |
| B | 60 | 150 |
| C | 70 | 170 |

3. (a) How is price determined in an economy under competition? What will happen to the equilibrium price and equilibrium quantity because of simultaneous changes in demand and supply? Explain graphically. **(15)**

   (b) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph. **(20)**

   $P = 0.30Q + 100$

   $P = -0.50Q + 180$

   (i) What will happen to the equilibrium price and quantity if government imposes a unit tax of Tk 10 per unit?

   (ii) What will happen to the equilibrium price and quantity if government gives a subsidy of Tk 20 per unit?

   (iii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

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**HUM 277**

4. (a) Make a hypothetical indifference schedule and plot the curve. Explain the properties of an indifference curve. **(15)**

   (b) Explain consumer's equilibrium with the help of budget line and indifference curve. **(10)**

   (c) From the following budget line and the utility function, calculate the amount of two commodities that maximizes satisfaction. What is the maximum amount of satisfaction? **(10)**

   $2000 = 15X + 25Y$

   $U = 500\, X^{0.6}Y^{0.7}$

## SECTION – B

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

5. (a) What is inflation tax? Discuss the social costs of inflation. **(15)**

   (b) Discuss Fisher's 'Quantity Theory' of money and its implication. **(20)**

6. (a) Discuss different methods of GDP calculation? What is the difference between real and nominal GDP? **(15)**

   (b) Discuss how national income and real wage are determined according to the classical economist. **(20)**

7. (a) Discuss Keynesian Consumption Function. **(10)**

   (b) Discuss the effectiveness of fiscal policy in a Keynesian closed economy. **(15)**

   (c) As price always remains constant in Keynesian model, how firms get signal to increase or decrease the production level. **(10)**

8. (a) What are the assumptions of a perfectly competitive market? Explain them. **(10)**

   (b) Explain the short run equilibrium of a firm under perfect competition. **(15)**

   (c) From the following revenue and cost functions, calculate the profit maximizing level of output and maximum profit. **(10)**

   $R = 100Q - Q^2$

   $C = \frac{1}{3}Q^3 - 7Q^2 + 111Q + 90$

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