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L-1/T-1/CHE Date : 06/12/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHEM 111** (Inorganic Chemistry)

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**.

1. (a) What are the limitations of Valence Bond Theory (VBT) and Crystal Field Theory (CFT) of complex compounds? Give justification of having both covalent and electrostatic nature of metal-ligand bonds in complexes. **(10)**

   (b) How did Alfred Werner develop the theory of coordination compounds? Discuss the main points of the theory. **(9)**

   (c) What will be the possible geometrical structure of each of the following molecules? Explain according to both hybridization and Valence Shell Electron Pair Repulsion (VSEPR) theory **(16)**

   NH_3, H_2O, SF_6, PCl_5

2. (a) How does splitting of d-orbitals occur when a tetrahedral ligand field interacts with a transition metal? Calculate Crystal Field Stabilization Energy (CFSE) for d^{1-10} electrons in a tetrahedral high spin ligand field case. **(15)**

   (b) Explain formation of $[PtCl_4]^{2-}$ and $[NiCl_4]^{2-}$ according to VBT of complex compounds and show the possible structures. Discuss any difference in their formation. Given: At. No. of Pt = 78; magnetic moment (μ) of $[NiCl_4]^{2-}$ = 2.83 BM. **(10)**

   (c) What is pairing energy? Discuss the relationship between pairing energy and $10D_q$ with the help of one electron wave function. **(10)**

3. (a) Show how a square planar geometry forms by the distortion of an octahedral geometry and also show the d-orbitals splitting in case of a square planar ligand field. **(10)**

   (b) What do you mean by the stability constant/ formation constants of complexes? Establish a relationship between stepwise and overall stability constants. **(10)**

   (c) Why do chelates have higher stability constants than those of open chain complexes? **(7)**

   (d) Mention some of the applications of stability constants in different fields. **(8)**

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CHEM 111

4. (a) What is lattice energy? How can you use Born-Haber cycle for NaCl to obtain its lattice energy? **(3+5)**

(b) Which has the larger radius of the following? **(3+3)**

(i) Mg or Mg^{2+} (ii) S or S^{2-}

Justify your answer.

(c) What would be the geometry of the molecules, NH_3 and NF_3? Explain why NF_3 has a very small dipole moment compared to that of NH_3. **(2+5)**

(d) Define bonding and antibonding molecular orbitals. Use both VBT and MOT to describe the bonding in O_2 molecule. Which theory would you pick to explain the paramagnetism of O_2? How do you obtain the bond order of O_2 using MOT? **(4+6+2+2)**

SECTION – B

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

5. (a) What is Heisenberg's uncertainty principle? Why do you think this principle is so important in quantum mechanics? **(3+3)**

(b) Sketch the graphs to show the probability of finding an electron within the shells at various distances from the nucleus (radial probability) for the hydrogen orbitals with n = 1 and 2. Indicate the 'nodes' (if any) on the graph for these orbitals. **(6+3)**

(c) List the possible subshells for n = 5 shell. What is the maximum number of electrons accommodated in n = 5, L = 2 orbitals? Show your reasons. **(2+4)**

(d) In your own words, explain the photoelectric effect. How does the photon concept explain this effect? **(4+3)**

(e) The photoelectric work function of a metal is the minimum energy needed to eject an electron by irradiating the metal with light. For calcium, this work function equals 4.34×10^{-19} J. Calculate the minimum frequency of light required to eject electron from calcium. What is the wavelength at the light? **(5+2)**

6. (a) Consider two hypothetical elements, X and Y.X has an ionization energy of 300 kJ/mol, and element Y has an ionization energy of 75 kJ/mol. **(3+3+3)**

(i) Which ion will more readily form the corresponding cation?

(ii) If elements X and Y are from the same period of ϕ the periodic table, which atom would you expect to have the smaller atomic radius?

(iii) The valence electron of which atom does feel a greater effective nuclear charge?

In each case, explain how you arrived at your answer.

(b) What is nuclear force? Plot number of neutrons against the number of protons to describe the stability of nuclides (or nuclear stability). **(3+5)**

(c) What are coinage metals? Give the unique properties of Cu, Ag and Au that allow their extensive use an coinage metal. **(2+6)**

(d) Write a note on the occurance and extraction of copper. **(10)**

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CHEM 111

7. (a) Give brief description of the preparation and uses of **(6+6)**

   (i) Nessler's Regent

   (ii) Calomel

   (b) Discuss the properties of group IV A elements in relation to their electronic structures. Explain why tin and lead do not form stable +4 oxidation states. **(6+5)**

   (c) What are silicones? Give methods for the formation of different types of silicones. **(12)**

8. (a) What is heat treatment of steel? Why heat treatment is important for steel? Discus about "Quenching or hardening" and "Tempering" of steel. **(2+3+5+5)**

   (b) What is cast iron? Discuss the properties of "White cast iron" and "Grey cast iron". **(2+5+5)**

   (c) Explain the following giving appropriate reasons: **(4+4)**

   (i) CCl_4 does not act as a Lewis acid while $SiCl_4$ and $SnCl_4$ do so.

   (ii) A solution of $FeCl_3$ is acidic.

L-1/T-1/CHE Date : 11/12/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **PHY 111** (Waves and Oscillation, Physical Optics and Heat and Thermodynamics)

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**.

1. (a) Define simple harmonic motion and write down its differential equation. **(5)**

   (b) What is a compound pendulum? Derive an expression for time period of a bar pendulum. Show that on each side of the center of gravity of a bar pendulum there are two positions for which the time periods are equal. **(20)**

   (c) A uniform bar of length 1 m is made to oscillate about an axis through its one end. It's moment of inertia about the axis of suspension is $\frac{1}{3}ML^2$, wher M is the total mass and L is the total length of the bar. Find the period of oscillation and equivalent length. **(10)**

2. (a) What is meant by Lissajous figure? Derive an expression for the resultant of two oscillations which are acting simultaneously on a particle perpendicular to each other having the same angular frequency but different amplitudes and phases. Under what conditions it will be a circle and straight line. **(3+17)**

   (b) Define phase velocity and group velocity. Establish the relationship between phase velocity and group velocity. Show that for non-dispersive medium phase velocity and group velocity are same. **(15)**

3. (a) What do you mean by reverberation and reverberation time? By using Sabine's assumptions deduce an expression for reverberation time. **(4+18)**

   (b) An auditorium has dimension $12 \times 10 \times 5$ in meter is found to have reverberation time of 2 seconds. The surfaces of the walls contain wood whose absorption coefficient is 0.03. What is the absorbing power and absorption coefficient of the ceiling and the floor? Also calculate the number of reflections per second. **(13)**

4. (a) What do you mean by the term interference of light? What is coherent light? **(8)**

   (b) Discuss in brief the formation of Newton's ring due to reflected light. Explain why the central spot in Newton's rings due to reflected light is dark. **(10+7)**

   (c) A Newton's rings apparatus is used to determine the radius of curvature of a lens. The radii of the nth and (n + 20)th bright rings are measured and found to be 0.162 cm and 0.368 cm respectively, in light of wavelength 546 nm. Calculate the radius of curvature of the lower surface of the lens. **(10)**

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PHY 111

SECTION – B

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

5. (a) What is diffraction of light? What does interference and diffraction phenomena suggest us about the nature of light? **(10)**

   (b) What do you mean by resolving power of an optical instrument? Show that the smallest detail that can be resolved in an optical microscopic is about the same size as the wavelength of light being used. **(7+10=17)**

   (c) Determine the slit separation 'd' for a diffraction grating that is labeled as 600 lines/mm. Using this 'd' value for the diffraction grating and considering the angle between the central maximum and first minimum 17.5°, determine the colour of light being used in a diffraction experiment. **(8)**

6. (a) What is meant by the term polarization of light? 'Light can be polarized but sound can not' – justify this statement. **(10)**

   (b) Write down the working principle of a Nicol prism. Explain how Nicol prism can be used as a polarizer as well as an analyzer. **(18)**

   (c) Explain optical activity. What is specific rotation for an optically active substance? **(7)**

7. (a) Explain with the help of Callendar and Griffith's bridge how a platinum resistance thermometer works. Write down its advantages and disadvantages. **(15)**

   (b) How does platinum thermometer of a body differ from its true temperature? **(12)**

   (c) If the platinum temperature is 70.25°C when the temperature on the gas scale is 70°C, what will be the temperature or the platinum scale corresponding to 140°C on the gas scale? **(8)**

8. (a) Define entropy. Draw T-S diagram for a Carnot cycle. Deduce the efficiency of the cycle using the T-S diagram. **(8)**

   (b) Obtain an expression for the change in entropy of a gas when it is heated in a general manner. **(15)**

   (c) Find the change in entropy when 1 gm of ice at 0°C in gradually changed to 1 gm of dry steam at 100°C at one atmospheric pressure. Assume latent heat of fusion of ice at 0°C = 80 cal/gm; specific heat of water between 0°C and 100°C = 1 cal/gm.°C, and latent heat of steam at 100°C = 540 cal/gm. **(12)**

L-1/T-1/CHE **Date : 03/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **MATH 121** (Differential Calculus and Coordinate Geometry)

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**.

Symbols used have their usual meaning.

1. (a) Discuss the continuity and differentiability of the function **(20)**

$$f(x)=\begin{cases} x\cos\frac{1}{x} & x\neq 0 \\ 0 & x=0 \end{cases}, \quad \text{at } x=0.$$

(b) If $y=\left[x+\sqrt{1+x^2}\right]^m$, find $(y_n)_0$. **(15)**

2. (a) State Rolle's theorem. Discuss the applicability of Rolle's theorem for the function $f(x)=2+(x-1)^{2/3}$ in the interval (0, 2). **(10)**

(b) State Euler's theorem. If $u=\sin^{-1}\left(\frac{x}{y}\right)+\tan^{-1}\left(\frac{y}{x}\right)$ then show that **(15)**

$$x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=0.$$

(c) Evaluate $\lim_{x\to\pi/2}(\sec x)^{\cot x}$. **(10)**

3. (a) Show that the right circular cylinder of given surface (including two ends) and maximum volume is such that its height is equal to the diameter of the base. **(15)**

(b) Find the maxima and minima of $u=x^3-y^3-63(x+y)+12xy$. **(20)**

4. (a) Expand $\sin x$ in powers of $\left(x-\frac{\pi}{2}\right)$ up to five terms. **(10)**

(b) Find the area of the triangle formed by the axes and the tangent to the curve **(10)**

$$x^{2/3}+y^{2/3}=a^{2/3}$$

(c) Find the length of subtangent, subnormal, normal and tangent at the point t on the curve $x=a(t+\sin t)$, $y=a(1-\cos t)$. **(15)**

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MATH 121 (CHE)

SECTION – B

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

5. (a) Transform the equation of the curve given by $11x^2 + 24xy + 4y^2 - 20x - 40y - 5 = 0$ when the origin of the coordinate system is transferred to the point (2, –1) and the axes are rotated through an angle $\tan^{-1}\left(-\frac{4}{3}\right)$. **(18)**

(b) Identify the conic represented by the equation $8x^2 + 4xy + 5y^2 - 24x - 24y = 0$ and reduce it to its standard form. Also find its centre and equation of the axes. **(17)**

6. (a) If one of the lines represented by $ax^2 + 2hxy + by^2 = 0$ be perpendicular to one of the lines represented by $a_1x^2 + 2h_1xy + b_1y^2 = 0$, show that **(10)**

$$(aa_1 - bb_1)^2 + 4(ah_1 + b_1h)(a_1h + bh_1).$$

(b) Find the angle between the lines joining the origin to the points of intersection of the line $y = 3x + 2$ and the curve $x^2 + 3y^2 + 2xy + 4x + 8y - 11 = 0$. **(10)**

(c) If the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents a pair of straight lines equidistant from the origin, show that $h(g^2 - f^2) = fg(a - b)$. **(15)**

7. (a) Find the coordinates of the limiting points of the co-axial system determined by the circles, **(17)**

$$x^2 + y^2 - 2x + 8y + 11 = 0 \quad \text{and}$$

$$x^2 + y^2 + 4x + 2y + 5 = 0.$$

(b) Show that the locus of the points such that two of the three normals to the parabola $y^2 = 4ax$ from them coincide is $27ay^2 = 4(x - 2a)^3$. **(18)**

8. (a) Find the locus of the point of intersection of the tangents at two points on the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, whose eccentric angles differ by 2θ. **(18)**

(b) Show that the locus of the middle points of all normal chords of the rectangular hyperbola $x^2 - y^2 = a^2$ is given by $(y^2 - x^2)^3 = 4a^2x^2y^2$. **(17)**

L-1/T-1/CHE Date : 08/01/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 141** (Engineering Mechanics)

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**.

Symbols indicate their usual meaning. Assume any missing data.

1 (a) Slider block A moves to the left with a constant velocity of 6 m/s as shown in the Fig. Q. 1(a). Determine (i) the velocity of block, B (b) the velocity of portion D of the cable (iii) the relative velocity of portion C of the cable with respect to portion D. **(20)**

(b) The sled and the rider have a total mass of 85 kg and start from rest at A (10 m, 0) as shown in the Fig. Q. 1(b). If the sled descends the smooth slope which may be approximated by the parabola, $y = \frac{x^2}{20} - 5$, determine the normal force that the ground exerts on the sled at the instant it arrives at point C. **(15)**

2. (a) The 10-kg block A rests on a 50-kg plate B as shown in the Fig. for Q. 2(a). Neglecting the mass of the rope and pulley and using the coefficient of kinetic friction as indicated in the figure, determine the time necessary for the block A to slide a distance of 0.5 m on the plate when the system is released from the rest. **(20)**

(b) The 600-gm flyballs of a centrifugal governor revolve at a constant speed of v in the horizontal circle of 150 mm radius as shown in the Fig. for Q. 2(b). Neglecting the weight of the links AB, BC, AD and DE and requiring that the link supports only tensile forces, determine the range of allowable values of v so that the magnitudes of the forces in the links do not exceed 80 N. **(15)**

3. (a) The spring as shown in Fig. for Q. 3(a), is used to stop a 50 kg cart which is moving down a 20° incline. The spring has a constant of k = 30 kN/m and is held by a cables so that it is initially compressed 50 mm. Knowing that the velocity of the package is 2 m/s when it is 8 m from the spring and neglecting friction, determine the maximum additional deformation of the spring in bringing the package to rest. **(20)**

(b) As depicted in the Fig. for Q. 3(b), a 1-kg block B is moving with a velocity $V_0 = 2$ m/s as it hits the 0.5-kg sphere A, which is at rest and hanging from a cord hanging at O. Knowing that $\mu_k = 0.6$ between the block B and horizontal surface and the coefficient of restitution of collision between the block B and the sphere A, e = 0.8, determine (i) The maximum height h reached by the sphere, A after impact (ii) The maximum distance x traveled by the block, B after impact **(15)**

Contd P/2

ME 141 (CHE)

4. (a) A pulley and two loads (A and B) are connected by inextensible cords as shown in the Fig. for Q. 4(a). Load A has a constant acceleration of 300 mm/s^2 and an initial velocity of 240 mm/s; both directed upward. Determine (i) the number of revolutions executed by the pulley in 3 s. Also determine, the velocity and position of the load B after 3 s. **(15)**

(b) Referring to the Fig. for Q. 4(b), knowing that at any instant of time, the velocity of the collar D is 1.6 m/s upward, determine (i) the angular velocity of rod AD, (ii) the velocity of point B (iii) the velocity of point A. **(20)**

SECTION – B

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

Make reasonable assumptions in case of any missing data.

5. (a) Three cables are connected at A, where the forces **P** and **Q** are applied as shown in Fig. for Q. No. 5(a). Knowing that P = 1200 N, determine the values of Q for which cable AD is taut. **(18)**

(b) A 2.6-kip force is applied at point D of the cast-iron post shown in Fig. for Q. No. 5(b). Replace that force with an equivalent force-couple system at the center A of the base section. Show the components of force and couple on a sketch with proper direction and magnitude at the center A of the base section. **(17)**

6. (a) A vertical load P is applied at end B of rod BC as shown in Fig. for Q. No. 6(a). (i) Neglecting the weight of the rod, express the angle θ corresponding to the equilibrium position in terms of P, l, and the counterweight W. (ii) Determine the value of θ corresponding to equilibrium if P = 2W. **(18)**

(b) Locate the centroid of the plane area shown in Fig. for Q. No. 6(b). **(17)**

7. (a) Using the method of joints, determine the force in each member of the truss shown in Fig. for Q. No. 7(a). State whether each member is in tension or compression **(18)**

(b) For the frame and loading shown in Fig. for Q. No. 7(b), determine the components of all forces acting on member ABE. **(17)**

8. (a) The cylinder shown in Fig. for Q. No. 8(a) is of weight 'W' and radius 'r'. Express in terms 'W' and 'r' the magnitude of the largest couple M that can be applied to the cylinder, if it is not to rotate, assuming the coefficient of static friction to be (i) zero at A and 0.30 at B. (ii) 0.25 at A and 0.30 at B. **(18)**

(b) Determine by direct integration the moment of inertia of the shaded area shown in Fig. for Q. No 8(b) with respect to the y axis. **(17)**

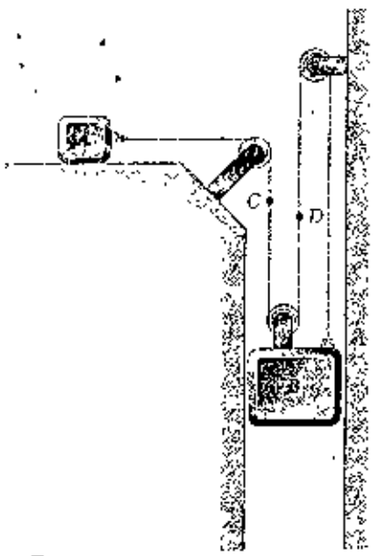

Fig for Q. 1.(a)

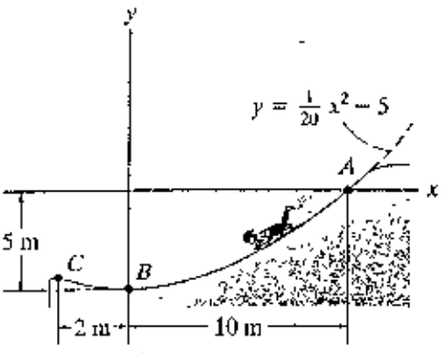

Fig. for Q 1(b)

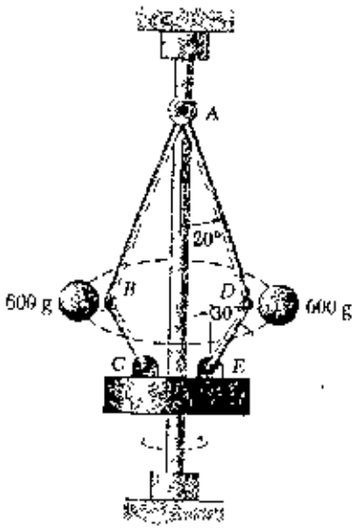

Fig. for Q. 2(b)

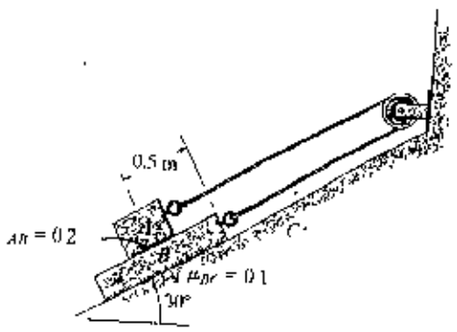

Fig. for Q. 2(a)

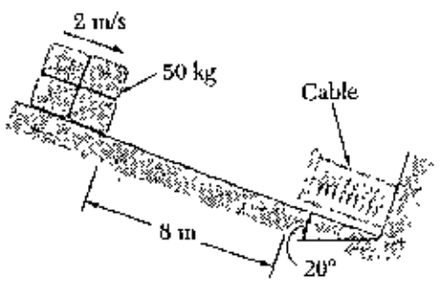

Fig. for Q. 3(a)

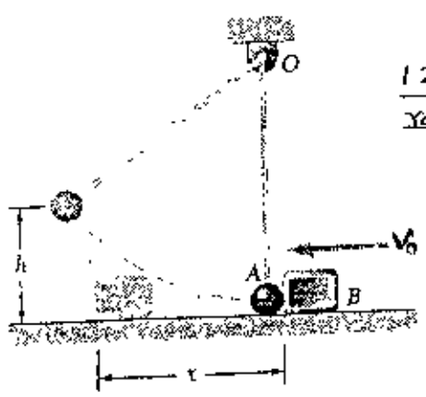

Fig. for Q 3(b)

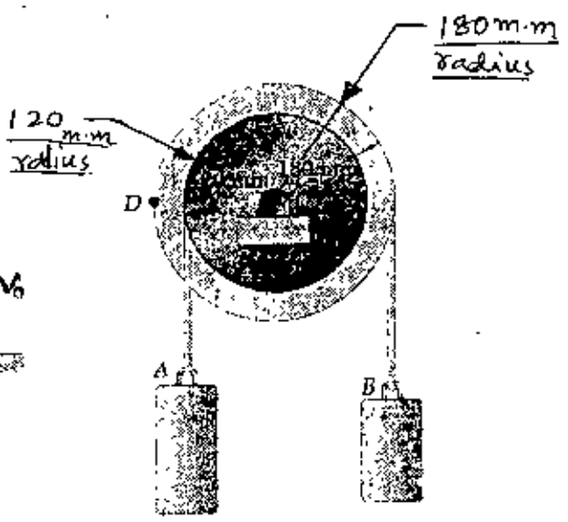

Fig. for Q. 4(a)

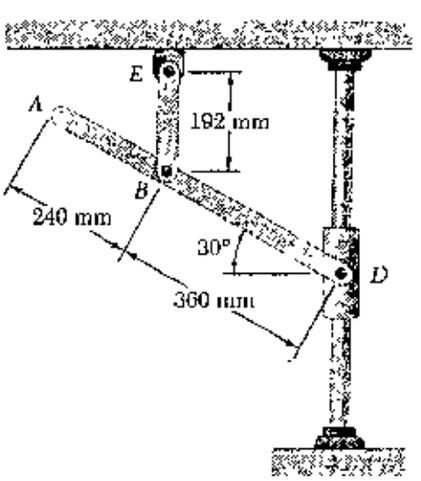

Fig. for Q. 4(b)

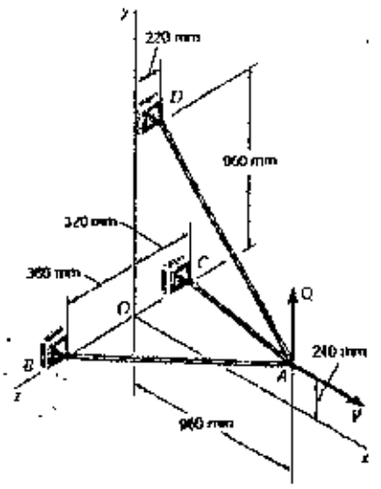

Fig. for question no. 5(a)

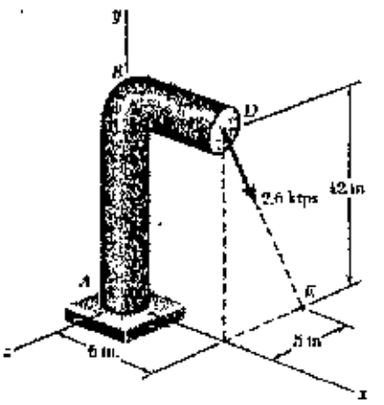

Fig. for question no. 5(b)

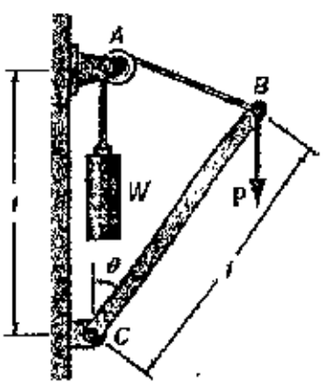

Fig. for question no. 6(a)

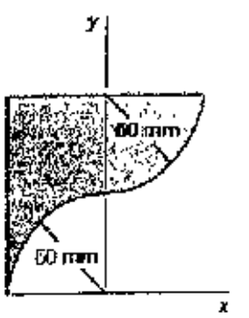

Fig. for question no. 6(b)

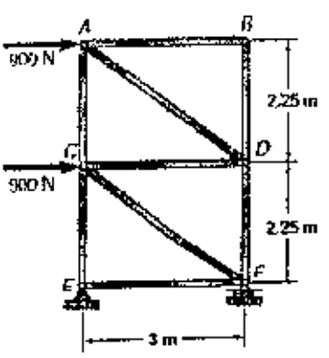

Fig. for question no. 7(a)

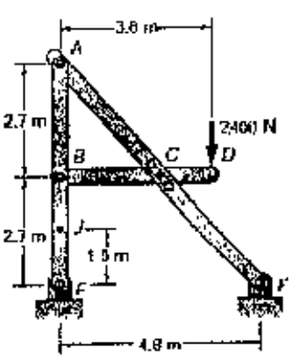

Fig. for question no. 7(b)

Fig. for question no. 8(a)

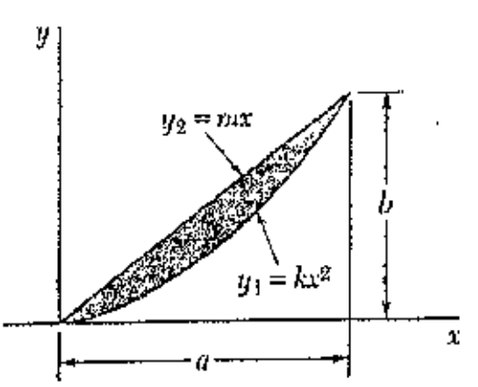

Fig. for question no 8(b)

(4)

L-1/T-1/CHE Date : 13/01/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **EEE 155** (Electrical Engineering Fundamentals)

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**.

1. (a) Find the phasor relationship between voltage and current for a capacitor. Find the impedance of the capacitor and draw the corresponding phasor diagram. **(20)**

   (b) Find v(t) and i(t) for the following circuit. **(15)**

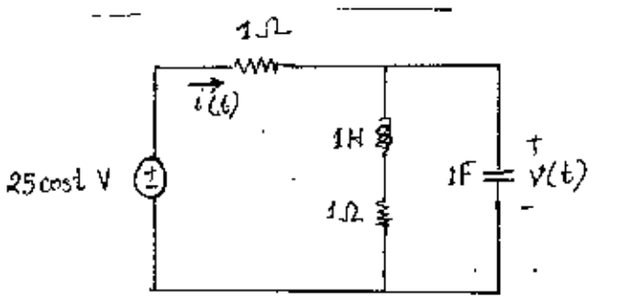

Figure for ques. no. 1(b)

2. (a) Prove that, average power in an AC circuit is given by, $P = \frac{1}{2}\mathrm{Re}[VI^*]$, where symbols have their meaning. **(20)**

   (b) Determine the power delivered/absorbed by each source and the average power absorbed by each passive element in the circuit given in the Fig. for Q. No. 2(b). **(15)**

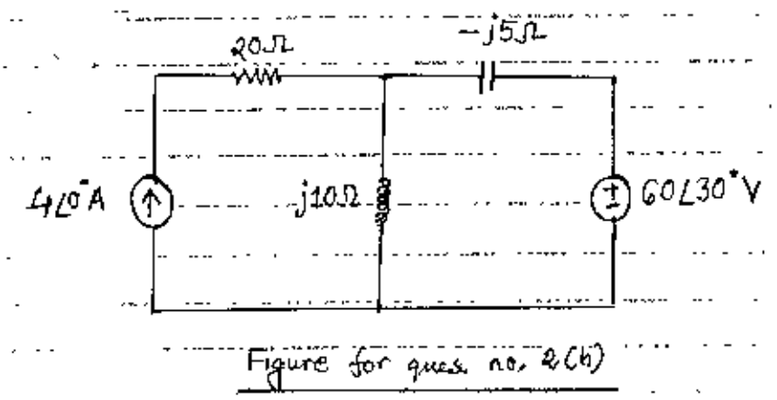

Figure for ques. no. 2(b)

3. (a) A 110-V rms, 60 Hz source is applied to a load impedance Z. The apparent power entering the load is 120 VA at a power factor of 0.707 lagging. **(20)**

   (i) Calculate the complex power.

   (ii) Find the rms current supplied to the load.

   (iii) Find the real and reactive power.

   (iv) Determine Z.

   (v) Assuming that $Z = R + j\omega L$, find the values of R and L.

Contd P/2

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Contd ... Q. No. 3

(b) A 120 V (rms) 60 Hz source supplies two loads connected in parallel, as shown in Fig. for Q. No. 3(b). **(15)**

(i) Find the power factor of the parallel combination.

(ii) Calculate the value of the capacitance connected in parallel that will raise the power factor to unity.

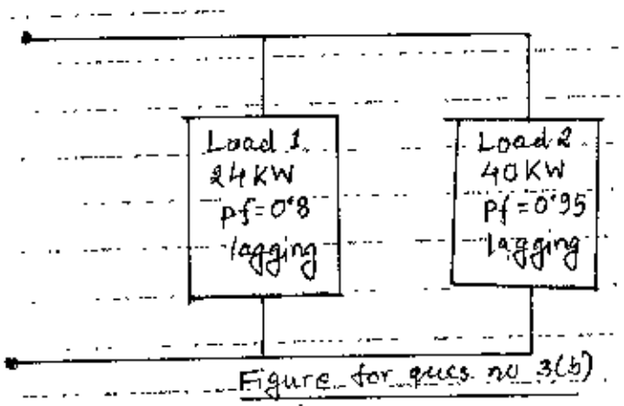

Figure for ques. no. 3(b)

4. (a) Obtain the rms value of the current waveform shown in the Fig. for Q. No. 4(a). If the current is passed through a 10 Ω resistor, find the average power absorbed by the resistor. **(10)**

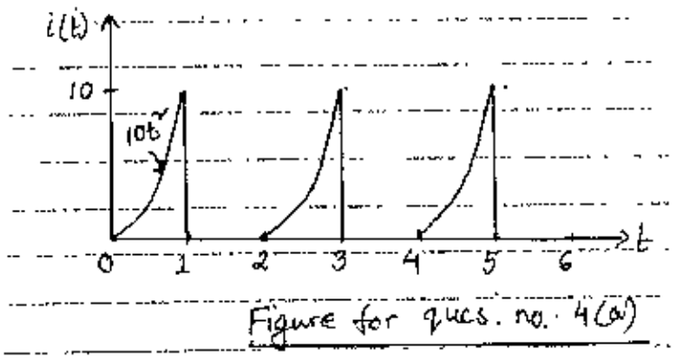

Figure for ques. no. 4(a)

(b) For the magnetic circuit in Fig. for Q. No. 4(b), find the value of I required to establish a flux in the air gap of $\phi_g = 2 \times 10^{-4}$ wb. **(25)**

SECTION – B

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

5. (a) The current through and the voltage across a device is shown in Fig. 5(a). Find the total energy absorbed by the device for the period of $0 < t < 4$s. **(15)**

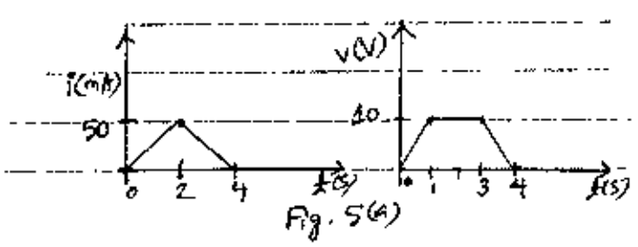

Fig. 5(a)

Contd P/3

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Contd ... Q. No. 5

(b) Find equivalent resistance R_{ab} for the circuit shown in Fig. 5(b). **(20)**

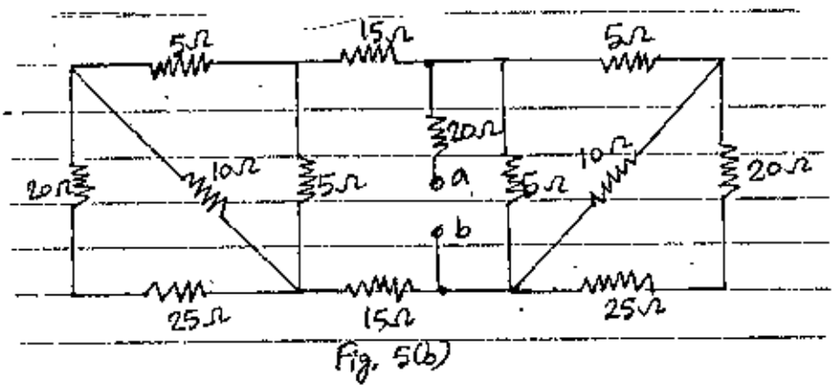

Fig. 5(b)

6. (a) Using nodal analysis, find V_0 and I_0 in the circuit shown in Fig. 6(a). **(17)**

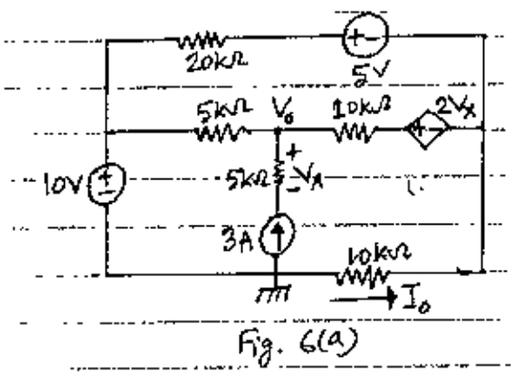

Fig. 6(a)

(b) Using mesh analysis, find the power delivered by 10 V source for the circuit shown in Fig. 6(b). **(18)**

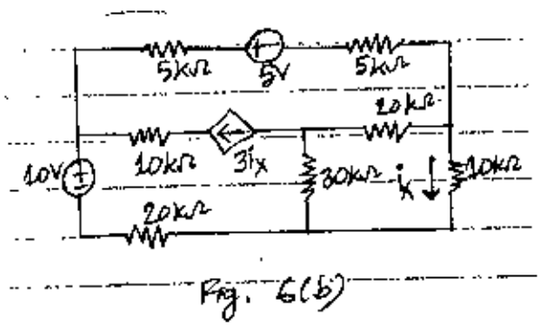

Fig. 6(b)

7. (a) For the circuit shown in Fig. 7(a), calculate V_x and the power dissipated by the 20 Ω resistor using superposition. **(18)**

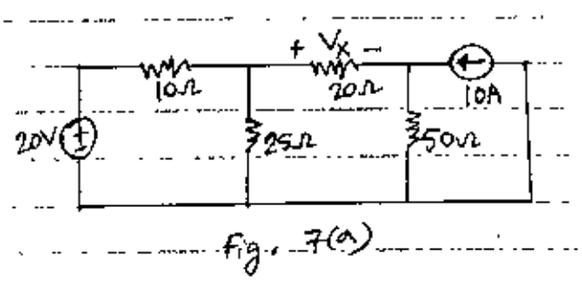

Fig. 7(a)

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Contd ... Q. No. 7

(b) For the circuit shown in Fig. 7(b), calculate V_x using source transformation. **(17)**

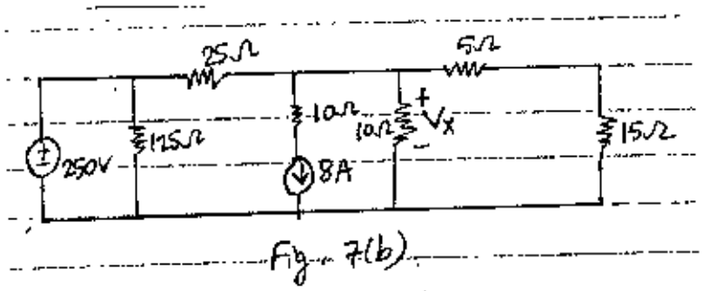


Fig. 7(b)

8. (a) Find the Thevenin equivalent circuit by looking into terminals a-b for the circuit shown in Fig. 8(a). If a load of 20 Ω is connected between a-b, find the load current. **(18)**

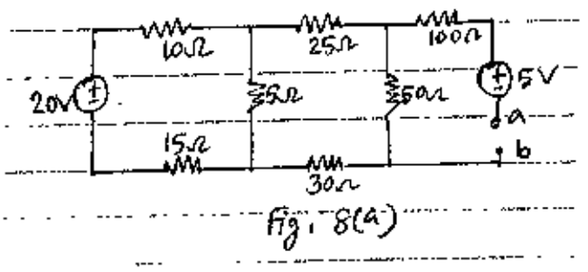


Fig. 8(a)

(b) For the circuit shown in Fig. 8(b), for what value of R, maximum power will be dissipated in it? Calculate that power. **(17)**

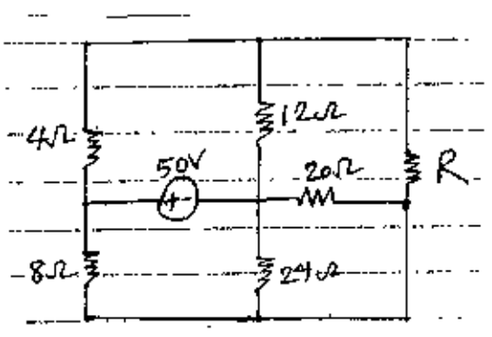


Fig. 8(b)

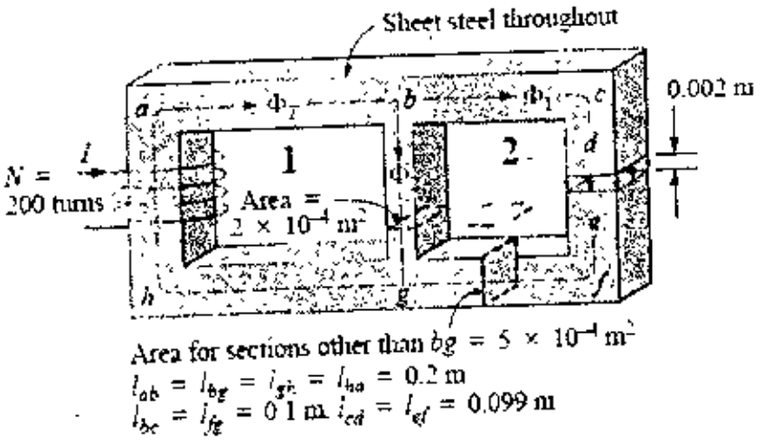
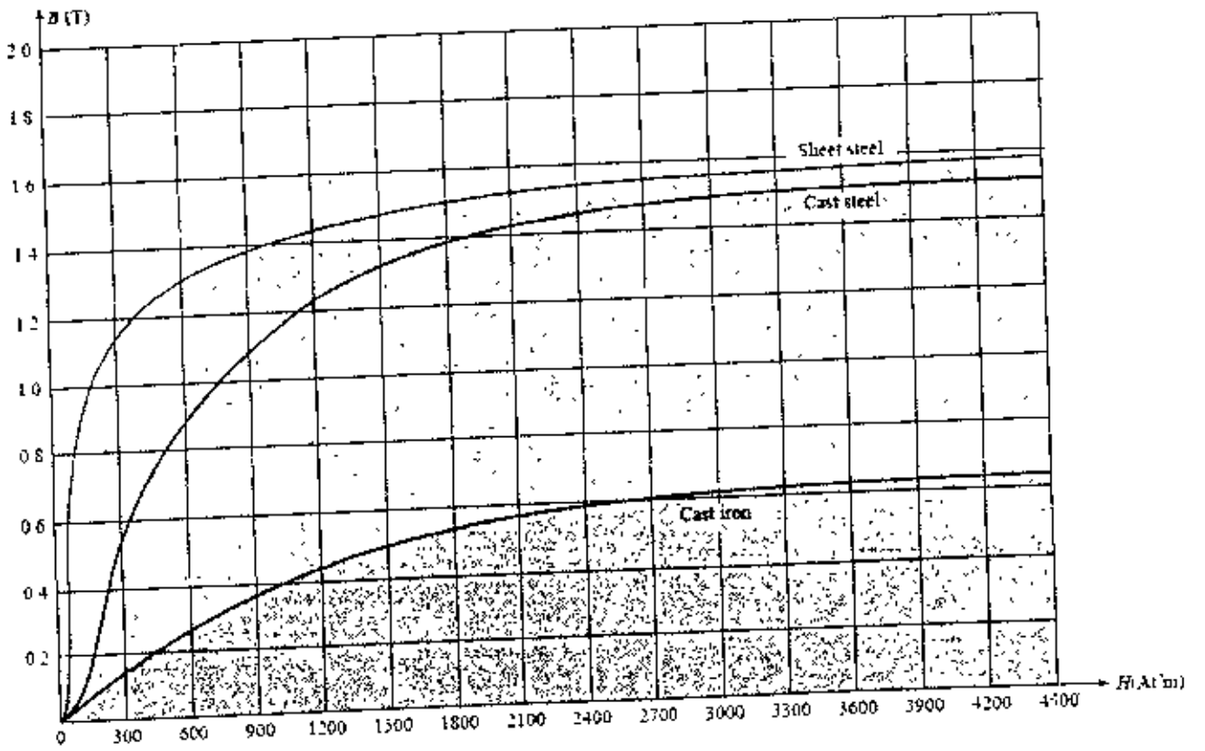


Figure for ques. No. 4(b)



B-H Curve for ques. No. 4(b)