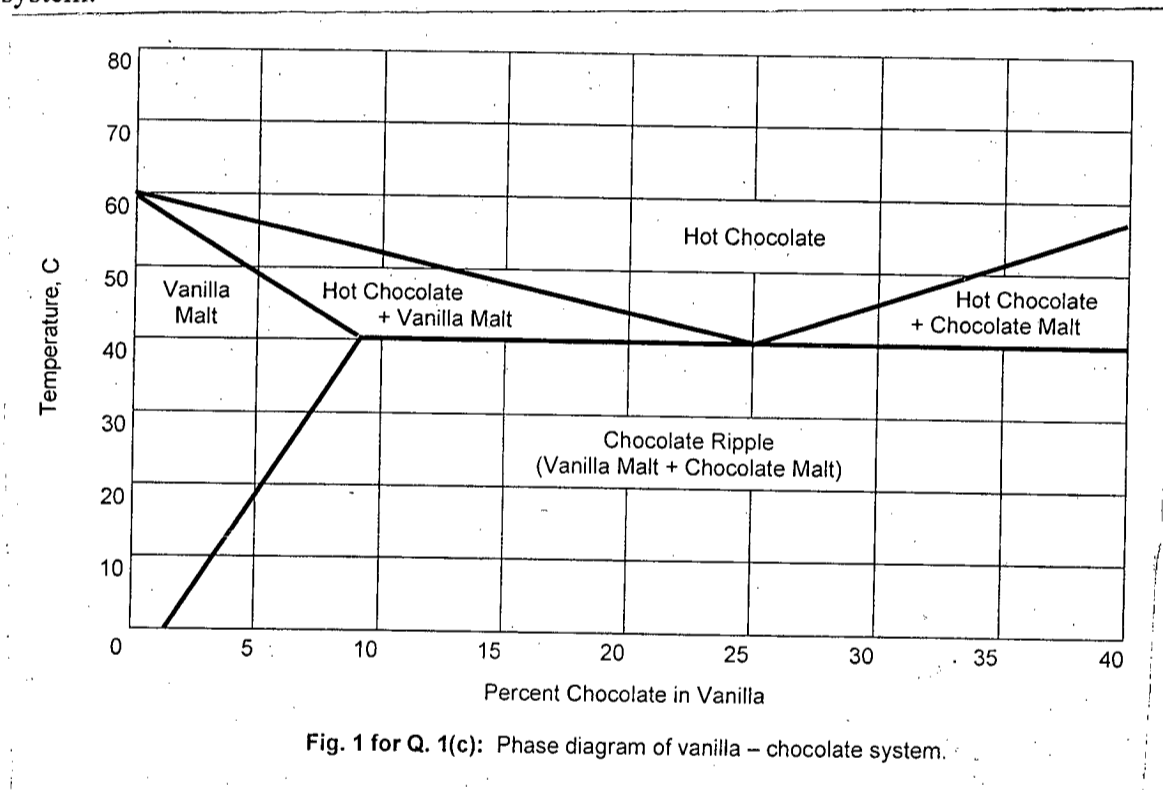


**SECTION – A**

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

1. (a) What are phase diagrams? Indicate its usefulness in materials science and engineering. Mention two important limitations of phase diagrams. **(2+4+2=8)**
- (b) Explain the characteristics of diffusional and martensitic transformations. **(4+4=8)**
- (c) Figure 1 shows a simplified and incomplete phase diagram of Vanilla – Chocolate system.



For a vanilla – chocolate mixture with 15 wt.% chocolate,

- (i) Determine the temperature at which vanilla malt starts to form from the liquid hot chocolate. At what temperature the liquid hot chocolate and the vanilla malt completely transform into a solid chocolate ripple? **(1+1=2)**
- (ii) Draw and label the cooling curve of this mixture. **(4)**
- (iii) If you cool the given vanilla - chocolate mixture to 45 °C, what will your product constitute? If the product consists of two phases, indicate their compositions and relative amounts. **(2+4+4=10)**
- (iv) Can you make 100% vanilla malt from the given composition? What is the maximum amount of chocolate you can add to a vanilla – chocolate mixture to obtain 100% vanilla malt at room temperature? **(1+2=3)**

**MME 131**

2. (a) Draw the iron – iron carbide phase diagram and label it completely. (10)  
(b) What are steels? Classify steels based on their carbon content and microstructure. (2+10=12)  
(c) Explain why grey cast iron is brittle while ductile iron is not. Draw the microstructure of a ferritic grey iron. (8+5=13)
3. (a) Explain why ceramics tend to show wide scatter in their mechanical properties. (5)  
(b) Discuss why and how one would perform annealing and tempering during glass making. (5+5=10)  
(c) Using suitable examples indicate the necessity of making composites. Analyse the role of matrix, reinforcement and interface in composite materials. (4+6=10)  
(d) Glass fibers in nylon provide reinforcement. If the nylon contains 30 vol% E-glass, what fraction of the force applied parallel to the fiber axis is carried by the glass fibers? The modulus of elasticity of nylon and E-glass are  $0.4 \times 10^6$  psi and  $10.5 \times 10^6$  psi, respectively. (10)
4. (a) A material is required for cheap column with a solid circular cross-section of diameter  $D$  that must support a load  $F$  without buckling. It is to have a height  $H$ . Write down an equation for the material cost of the column in terms of its dimensions, the price per kg of the material  $C$  and the material density  $\rho$ . The cross-section area  $A$  is a free variable. Write down clearly the design requirements and then determine the index for finding the cheapest material to construct the column. The load  $F^*$  at which a slender column buckles is given as  $F^* = C_1 EI/H^2$ , where  $C_1$  is a constant,  $E$  is the Young's modulus of elasticity, and  $I = \pi D^4/64$  is the second moment of area. (2+6+12=20)  
(b) As a quality control expert you are requested to determine the nature and presence, if any, of casting defects inside an aluminium casting. Select a suitable nondestructive testing method, indicating clearly the reasons for such selection, and explain how you would perform the test. (5+10=15)

**SECTION – B**

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

5. (a) What are the major types of materials based on composition? Mention two applications and examples of each type. (18)  
(b) 'Metals are ductile, good conductors of electricity; ceramics are brittle, electrically insulators; polymers are soft and ductile having low melting points' – Justify from the nature of bonding in them. (12)  
(c) Why is  $\rho_{\text{metals}} \geq \rho_{\text{ceramics}} \geq \rho_{\text{polymers}}$ ? (5)

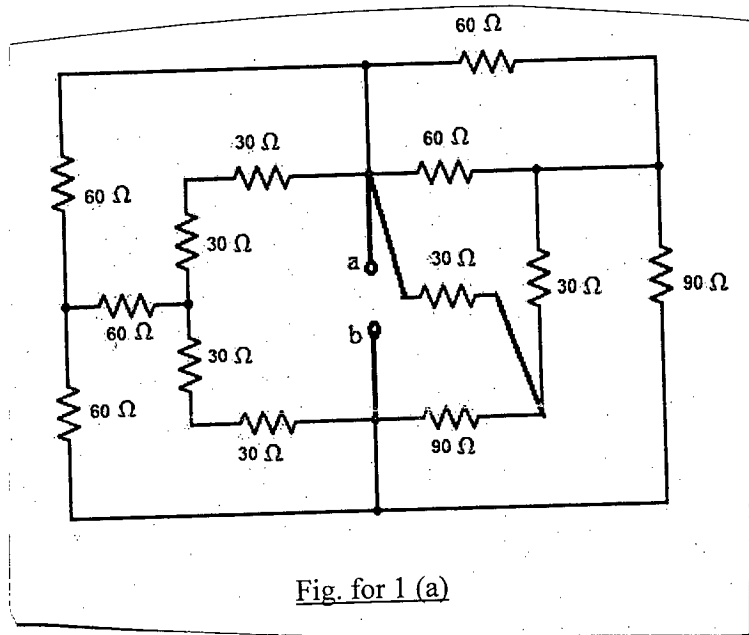
**MME 131**

6. (a) Define co-ordination number and atomic packing factor. Make a table showing the co-ordination number, number of atoms per unit cell and atomic packing factor for SC, BCC, FCC and HCP unit cells. (18)
- (b) What is dislocation and Burger's vector? With neat sketches, explain edge dislocation and screw dislocation. Mention the direction of Burger's vector to each dislocation line. (17)
7. (a) State and explain Fick's first law of diffusion. (10)
- (b) A 0.05 cm layer of MgO is deposited between layers of Ni and Ta to provide a diffusion barrier that prevents reactions between the two metals. At 1400 °C, Ni ions are created and diffused through the MgO ceramic to the Ta. Determine the number of Ni ions that pass through the MgO per second. The diffusion co-efficient of Ni ions in MgO is  $9 \times 10^{-12} \text{ cm}^2/\text{s}$  and the lattice parameter of FCC Ni at 1400 °C is  $3.6 \times 10^{-8} \text{ cm}$ . The interface area is  $2 \text{ cm} \times 2 \text{ cm}$ . (15)
- (c) Draw the typical stress-strain curves for the following materials under tensile test. (10)
- (i) Both a ferrous and a non-ferrous material.
- (ii) Low tough, brittle, ceramic; low tough, ductile polymer; high tough, ductile metal.
8. (a) Define ductile to brittle transition temperature. (5)
- (b) Draw a typical creep curve showing various stages. Define creep rate and rupture life. How is the nature of creep curve influenced by initial load and temperature? (17)
- (c) Explain how we can get useful information on the fatigue properly both for a ferrous metal and a non-ferrous metal from the curve produced by a series of test results. (13)
-

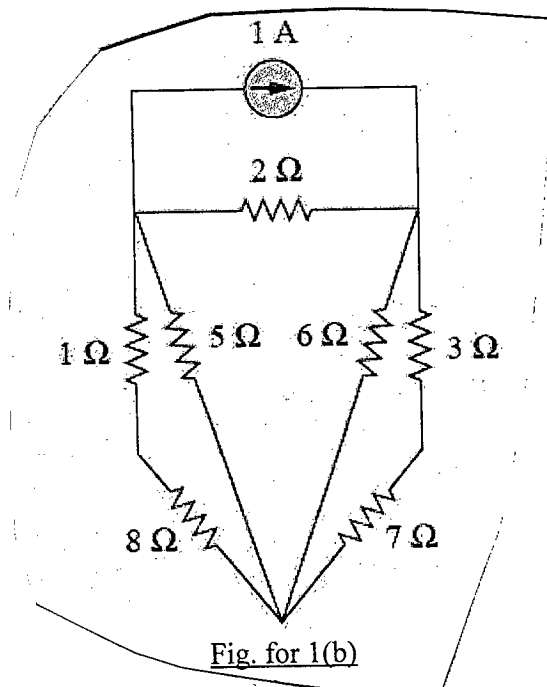
**SECTION – A**

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

1. (a) For the circuit shown in Fig. for Q. 1(a), find the equivalent resistance with respect to terminals 'a' and 'b'. (18)



- (b) For the circuit in Fig. for Q. 1(b), find the power dissipated in the 6Ω resistance. (17)

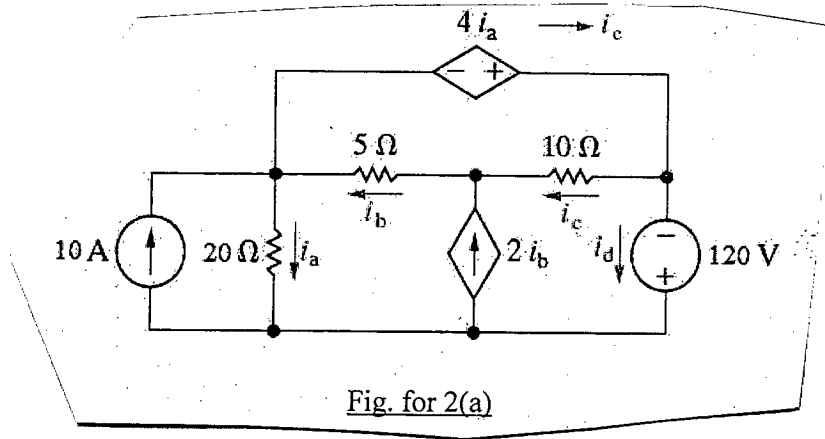


2. (a) For the circuit in Fig. for Q. 2(a), use Mesh Analysis to find the branch currents ( $i_a$  to  $i_e$ ). Also show that the total power generated is equal to the total power dissipated. (25)

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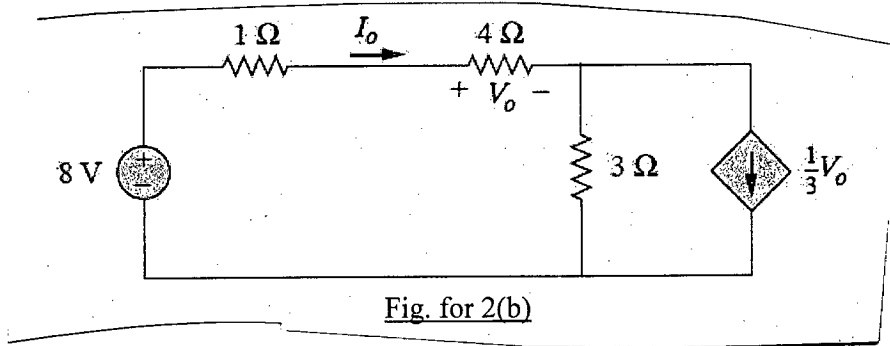
**EEE 155/MME**

**Contd... Q. No. 2(a)**



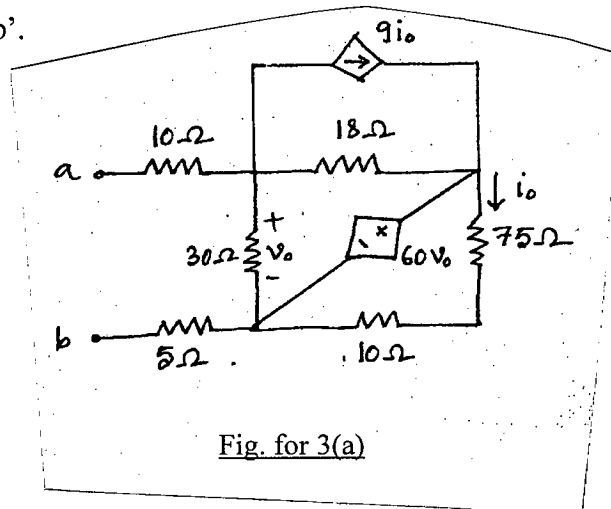
(b) Apply source transformation to find  $I_0$  in the circuit shown in Figure. for 2(b).

(10)



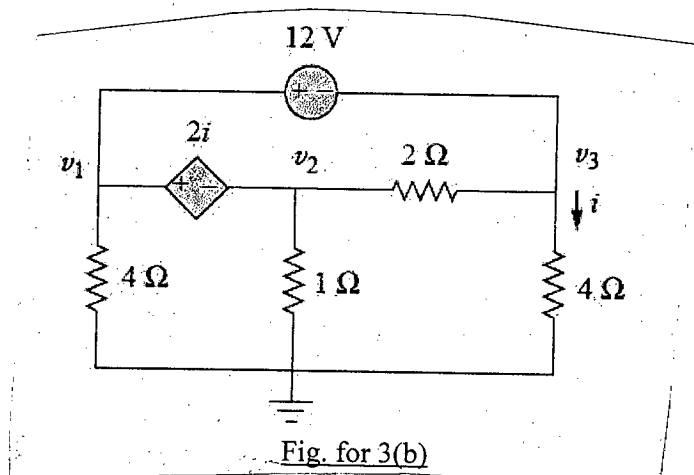
3. (a) For the circuit in Fig. for 3(a), find the Thevenin and Norton equivalent with respect to terminals 'a' and 'b'.

(18)



(b) For the circuit in Fig. for 3(b), use nodal analysis to find the node voltages  $v_1, v_2,$  and  $v_3$ .

(17)



**EEE 155/MME**

4. (a) For the circuit in Fig. for Q. 4(a), what should be the value of resistance  $R_0$  so that 4 mW power is dissipated in this resistance ( $R_0$ )? (20)

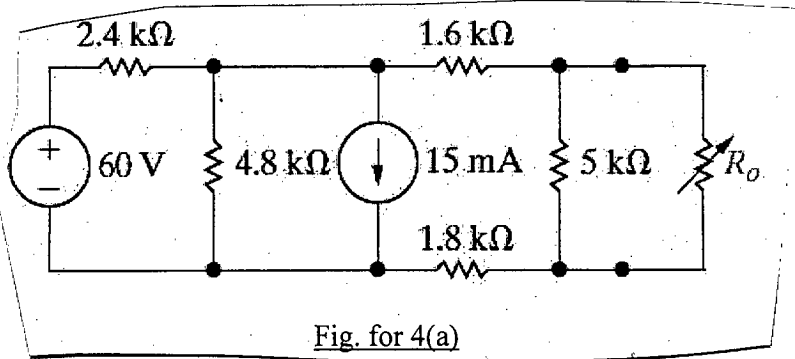


Fig. for 4(a)

- (b) Use the principle of superposition to find  $v_0$  in the circuit shown in Fig. for 4(b). (15)

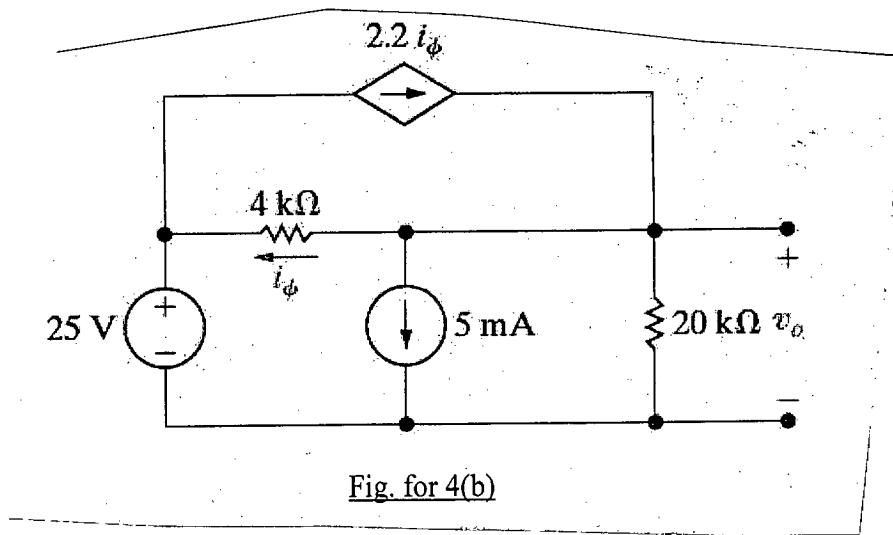
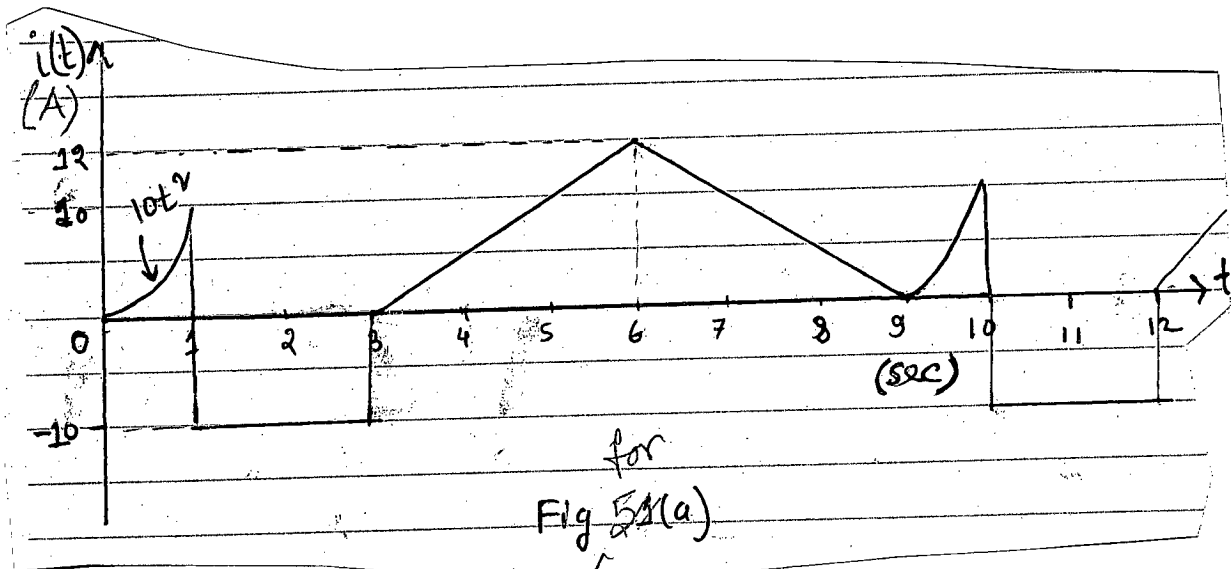


Fig. for 4(b)

**SECTION - B**

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

5. (a) If the current  $i(t)$  shown in Figure for 5(a) flows through a  $4\Omega$  resistor, calculate the average power absorbed by the resistor. (18)



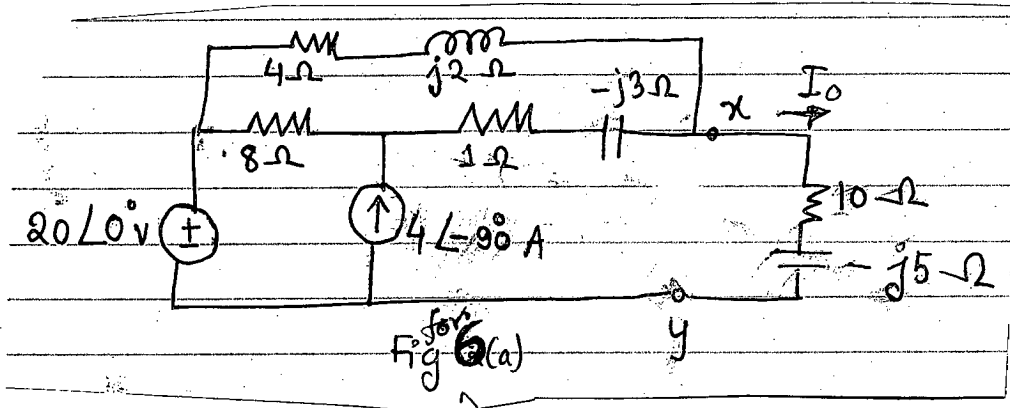
**EEE 155/MME**

**Contd... Q. No. 6**

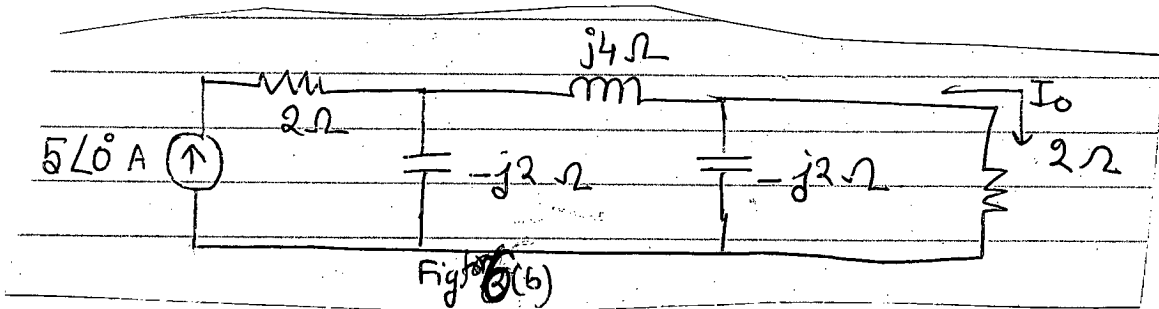
(b) Find the value of parallel capacitance needed to correct a load of 140 kVAR at 0.85 lagging pf to unity pf. Assume that the load is supplied by 110V(rms) 60-Hz line. (12)

(c) Prove that, for a sinusoid the effective or rms value is its amplitude divided by  $\sqrt{2}$ . (5)

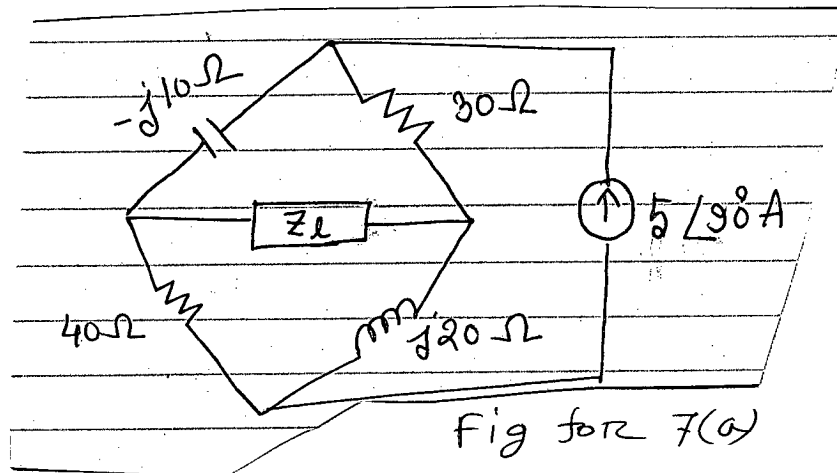
6. (a) Determine the Norton equivalent of the circuit in Fig for 6(a) as seen left from terminal x-y. Use the equivalent circuit to find  $I_0$ . (20)



(b) Find current  $I_0$  in the network of Fig 6(b). (15)



7. (a) Calculate the value of  $Z_1$  in the circuit of Fig for 7(a) in order for  $Z_1$  to receive maximum average power. What is the maximum average power received by  $Z_1$ ? (15)



(b) From the circuit given in Fig for 7(b) calculate total (i) real power, (ii) reactive power, (iii) power factor (iv) apparent power. (12)

EEE 155/MME

Contd... Q. No. 7(b)

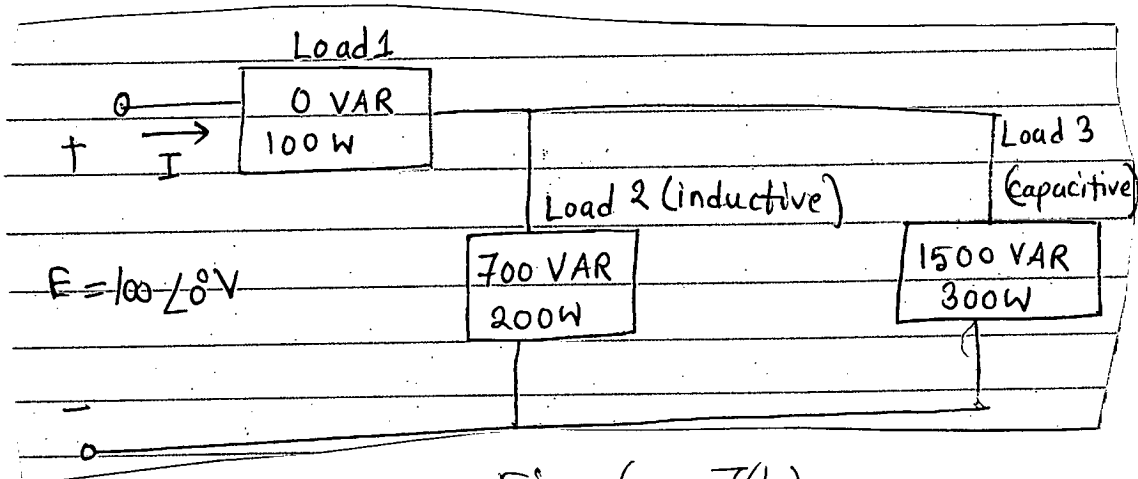


Fig for 7(b)

(c) Find  $i(t)$  and  $v(t)$  in the circuit. Shown in fig. for 7(c).

(4+4)

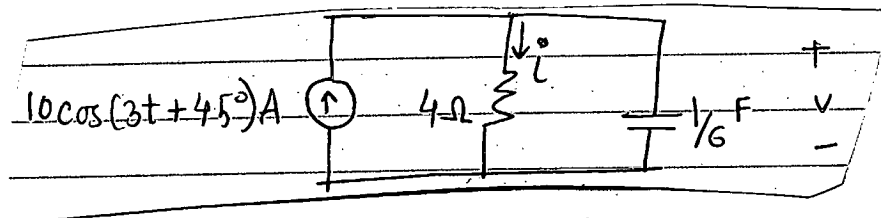


Fig for 7(c)

8. (a) Determine  $i_0$  in the circuit of Fig. for 8(a) using the superposition principle.

(24)

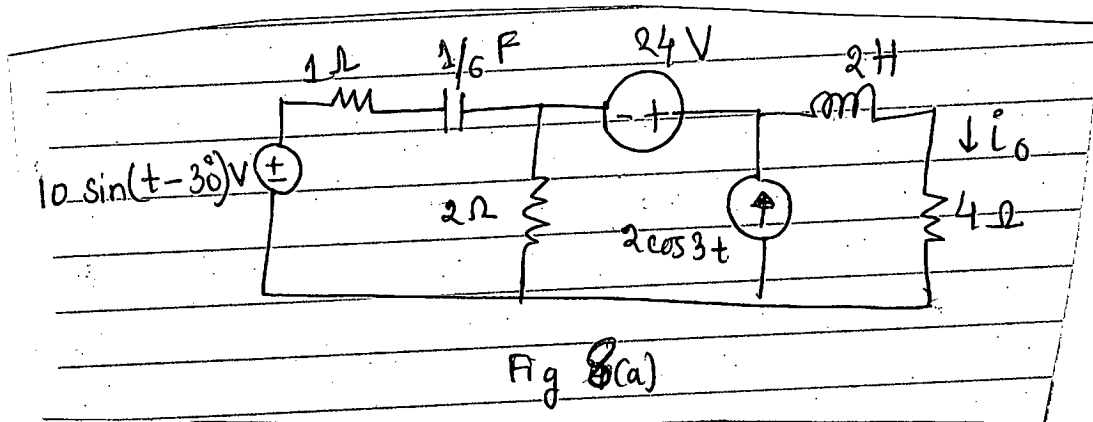


Fig 8(a)

(b) At  $\omega = 10^3$  rad/s, find the input impedance of the circuit in Fig. for 8(b).

(11)

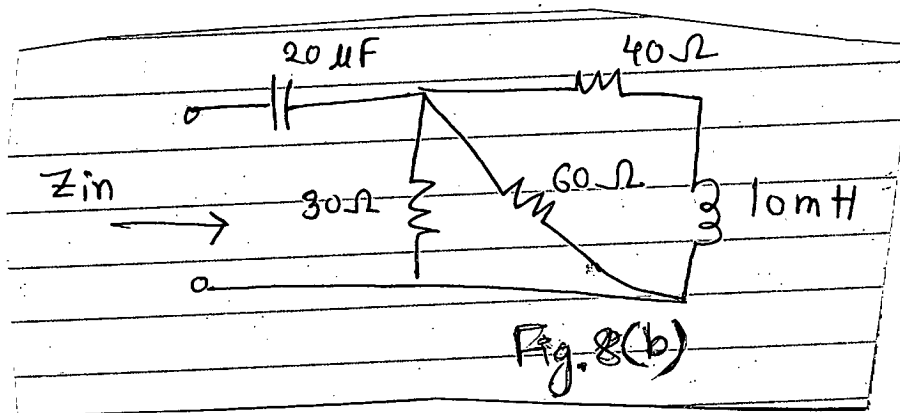


Fig. 8(b)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations 2017-2018

Sub : **MATH 171** (Calculus and Differential Equation)

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) A function  $f(x)$  is defined as follows: (15)

$$f(x) = \begin{cases} -2x+3, & x < 1 \\ 1, & 1 \leq x \leq 2 \\ 2x-3, & x > 2 \end{cases}$$

Discuss the continuity of the function at  $x = 1$  and differentiability at  $x = 2$ . Also sketch the graph of the function.

- (b) Evaluate (i)  $\lim_{x \rightarrow 0} \left[ \frac{e^x + e^{-x} - 2 \cos x}{x \sin x} \right]$  (ii)  $\lim_{x \rightarrow 0} (\cos x)^{\cot^2 x}$  (10+10)

2. (a) State Leibnitz's theorem and use this theorem to find  $(y_n)_0$ , where  $y = (\sin^{-1} x)^2$ . (15)

(b) If  $v$  is a function of  $x$ ,  $y$  and  $z$  and  $F(v^2 - x^2, v^2 - y^2, v^2 - z^2) = 0$ , show that

$$\frac{1}{x} \frac{\partial v}{\partial x} + \frac{1}{y} \frac{\partial v}{\partial y} + \frac{1}{z} \frac{\partial v}{\partial z} = \frac{1}{v}. \quad (20)$$

3. (a) Determine the maximum and minimum value of the function  $\frac{(2x-1)(x-8)}{(x-1)(x-4)}$ . (15)

(b) A farmer with a field adjacent to a straight river wishes to fence a rectangular area for grazing. If no fence is needed along the river and has 1600 m of fencing, what should be the dimension of the field in order that it has a maximum area? (10)

(c) Find the condition that the curves  $\frac{x^2}{a} + \frac{y^2}{b} = 1$  and  $\frac{x^2}{a_1} + \frac{y^2}{b_1} = 1$  shall cut

orthogonally. (10)

4. Find the following:

(a)  $\int \frac{1}{(x+1)\sqrt{1+2x-x^2}} dx$  (11)

(b)  $\int \frac{3 \cos x + 2}{\sin x + 2 \cos x + 3} dx$  (12)

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

**MATH 171**

**SECTION-B**

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

5. (a) Evaluate:  $\lim_{n \rightarrow \infty} \left[ \frac{1}{n} + \frac{n^2}{(n+1)^2} + \frac{n^2}{(n+2)^2} + \dots + \frac{1}{8n} \right]$ . (12)

(b) Evaluate:  $\int_0^{\frac{\pi}{2}} \frac{x \sin x \cos x}{(a^2 \cos^2 x + b^2 \sin^2 x)^2} dx$ . (12)

(c) Show that  $\int_0^{\frac{\pi}{4}} \frac{x}{1 + \cos 2x + \sin 2x} dx = \frac{\pi}{16} \ln 2$ . (11)

6. (a) Find the area of the region described by the curve  $r = a(1 - \cos \theta)$ . (17)

(b) Find the volume of the solid generated by revolving the curve (18)

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

7. (a) Solve:  $xy' + (1+x)y = e^{-x} \sin 2x$ . (11)

(b) Solve:  $2 \frac{dy}{dx} = \frac{y}{x} - \frac{x}{y^2}$ . (12)

(c) A certain radioactive material is known to decay at a rate proportional to the amount present. If initially, there is 30 milligrams of material present and after two hours it is observed that the material has lost 10% of its original mass. Find (i) an expression for the mass of the material remaining at any time t, (ii) the mass of the material after four hours, and (iii) the time at which the material has decayed to one half of its initial mass. (12)

8. Solve the following differential equations:

(a)  $x^3 \frac{d^3y}{dx^3} + y = 0$  (10)

(b)  $\frac{d^2y}{dx^2} - 5 \frac{dy}{dx} + 6y = e^{-x} \cos 2x$  (14)

(c)  $y''' - 2y'' + y' = x^4 + 5$  (11)

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations 2017-2018

Sub : **CHEM 107** (Inorganic and Physical 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) State Raoult's law of lowering of vapor pressure. Using Raoult's law deduce an expression relating the molecular weight of a solute with the lowering of vapor pressure of a solvent on the addition of a solute. (11)
- (b) State Van't Hoff's laws of osmotic pressure. Show how the osmotic pressure equation is exactly analogous to the ideal gas equation. (10)
- (c) A solution contains 0.0653 g of a compound in 8.31 g of ethanol. The molality of the solution is 0.0368 m. Calculate the molecular mass of the compound. (8)
- (d) Solution process may absorb or releases heat. In case of ideal solution no heat is absorbed or released on mixing the two liquids. Give one example of each when there is evolution, release or no change of heat during solution process. (6)
  
2. (a) Why  $\text{PCl}_5$  is formed, but  $\text{NCl}_5$  is not? Explain. (5)
- (b) Draw the structures and name the geometries of  $\text{SF}_4$ ,  $\text{XeF}_4$ , and  $\text{PCl}_5$  on the basis of VSEPR theory. (9)
- (c) What hybrid orbitals would be expected for the central atom in each of the following? (6)
- (i)  $\text{XeF}_4$  (ii)  $\text{H}_2\text{O}$  (iii)  $\text{PCl}_5$ .
- (d) Draw molecular orbital diagram of  $\text{O}_2$  molecule and write down the valence electron configuration of this molecule. Based on the molecular orbital diagram, explain why  $\text{O}_2$  is paramagnetic in nature? (15)
  
3. (a) Define crystal lattice and unit cell. Name seven crystal systems corresponding to the seven distinct types of unit cells. (7)
- (b) What is Born-Haber cycle? Explain how it is used for calculating lattice energy of  $\text{NaCl}$ ? (15)
- (c) Using periodic table, arrange the following elements in order of increasing ionization energies. Ar, Se, S. (3)
- (d) Explain the following: (10)
  - (i) Atomic radius tends to increase within each group, but decrease within each period of periodic table.
  - (ii) Ionization energy tends to decrease going down any column of the main group elements.

## CHEM 107/MME

4. (a) Write down the equation that shows wave-particle dual nature of light. Explain the meaning of each symbol in the equation. (5)
- (b) The work function of cesium metal is  $3.42 \times 10^{-19} \text{J}$ . (i) Calculate the minimum frequency of light required to release electrons from the metal. (ii) Calculate the kinetic energy of the ejected electron if light of frequency  $1.00 \times 10^{15} \text{S}^{-1}$  is used for irradiating the metal. (10)
- (c) Write short notes on Heisenberg Uncertainty principle. (6)
- (d) What is the notation for the subshell in which  $n = 4$  and  $l = 3$ ? How many orbitals are in this subshell? (4)
- (e) Write down electronic configurations of fourth period transition elements. (10)

### SECTION - B

There are four questions in this section. Answer any three questions.

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

5. (a) What are the difference between order and molecularity of reaction? Explain how you can determine the order of a reaction by half life method. (12)
- (b) Derive rate expressions for a first order reaction which is opposed by another first order reaction. Explain how you can determine the equilibrium constant of such a reaction. (15)
- (c) 1.0 ml ethyl acetate was added to 25 ml 0.5 M HCl. 2.0 ml of the mixture was withdrawn from time to time during the progress of the hydrolysis of the ester and titrated against standard NaOH solution. The amount of NaOH required for titration at various intervals is given below: (8)
- |                |       |       |       |       |       |          |
|----------------|-------|-------|-------|-------|-------|----------|
| Time (min)     | 0     | 20    | 75    | 119   | 183   | $\infty$ |
| NaOH used (ml) | 20.24 | 21.73 | 25.20 | 27.60 | 30.22 | 43.95    |
- Show that the reaction is of first order and find the average value of the rate constant.
6. (a) Explain the following terms: (i) Phase, (ii) degree of freedom, (iii) Eutectic point and (iv) reduced phase rule. (12)
- (b) Describe the features of a simple two-component system where the components show both eutectic and congruent melting points. (15)

## CHEM 107/MME

### Contd... Q. No. 6

- (c) Calculate the number of phases, components and degree of freedom for the following: (8)
- (i)  $\text{N}_2\text{O}_4(\text{g})$  in equilibrium with  $\text{NO}_2(\text{g})$
  - (ii) Solid carbon in equilibrium with  $\text{CO}$ ,  $\text{CO}_2$  and  $\text{O}_2$  at  $100^\circ\text{C}$ .
  - (iii) Mixture of  $\text{N}_2$  and  $\text{O}_2$
7. (a) Mention the points of difference for the following : (12)
- (i) Electrochemical cell and electrolytic cell
  - (ii) Reversible cell and irreversible cell.
- (b) How is the emf of a cell related to the free energy change of a reaction occurring in the cell? Explain how you can determine  $\Delta\text{H}$  and  $\Delta\text{S}$  of a chemical reaction from emf measurement. (15)
- (c) At  $25^\circ\text{C}$ , the value of the emf for the reversible cell (8)
- $$\text{Pb, PbCl}_2(\text{s}) \mid \text{KCl}(\text{aq}) \mid \text{AgCl}(\text{s}), \text{Ag}$$
- is 0.4902 volt and  $(\partial E/\partial T)_p = -1.86 \times 10^{-4} \text{ volt deg}^{-1}$ . Show the half cell reactions, overall reaction and the direction of the flow of electrons. Also calculate the values of  $\Delta\text{G}$ ,  $\Delta\text{H}$  and  $\Delta\text{S}$  for the cell reaction.
8. (a) Define the following terms: (12)
- (i) Heat of solution
  - (ii) Heat of formation and
  - (iii) Heat of neutralization.
- (b) Derive an expression for the variation of heat of reaction with temperature. (15)
- (c) For the reaction  $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) = 2\text{NH}_3(\text{g})$ , the value of  $\Delta\text{H}^\circ$  is -22.08 KCal at  $25^\circ\text{C}$ . The molar heat capacities at constant pressure of  $\text{N}_2$ ,  $\text{H}_2$  and  $\text{NH}_3$  can be expressed as function of the absolute temperature in the following manner: (8)
- $$C_{\text{N}_2} = 6.449 + 1.41 \times 10^{-3}T - 0.807 \times 10^{-7}T^2 \text{ cal deg}^{-1}$$
- $$C_{\text{H}_2} = 6.947 - 0.200 \times 10^{-3}T + 4.807 \times 10^{-7}T^2 \text{ cal deg}^{-1}$$
- $$C_{\text{NH}_3} = 6.189 + 7.887 \times 10^{-3}T - 7.28 \times 10^{-7}T^2 \text{ cal deg}^{-1}$$
- Calculate the standard heat of formation at  $125^\circ\text{C}$ .
-