L-1/T-1/CHE

Date : 05/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The questions are of equal value.

SECTION – A

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

1. (a) Define for a Sine wave-Instantaneous Value, Peak Value, Time Period and Cycle.

(b) Find the phase relationship between the wave forms of each set.

(i) $v = 4\sin(\omega t + 50^\circ)$

$i = 6\cos(\omega t + 40^\circ)$

(ii) $v = 25\cos(\omega t - 80^\circ)$

$i = 5\sin(\omega t - 10^\circ)$

(c) Find the wave form for average voltage across the coil, if the current through a 4 mH coil is as shown in the figure.

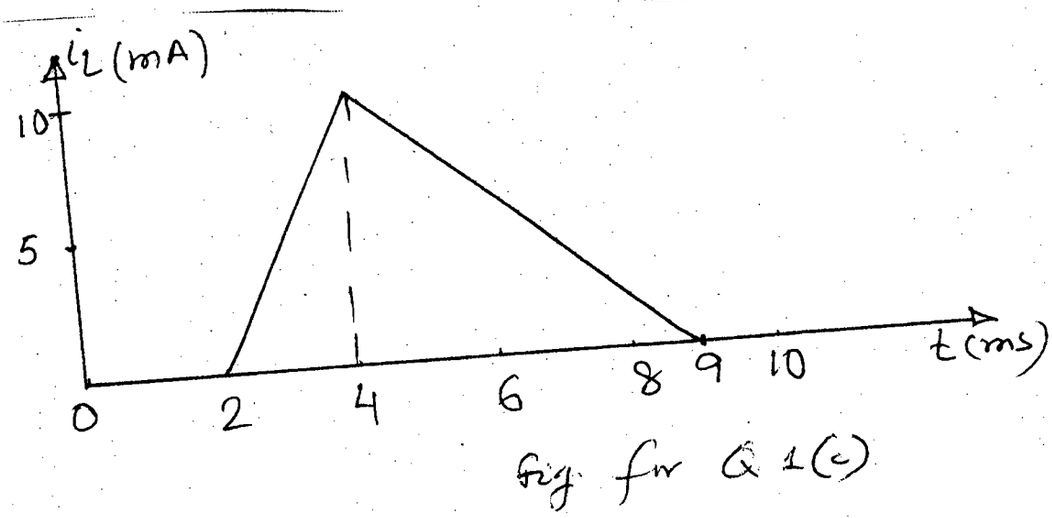

fig. for Q 1(c)

2. (a) For the network shown in the figure

(i) Calculate Z_T of the circuit of Fig. 2a

(ii) Determine I_S

(iii) Find I_C

(iv) Compute the Power delivered by the source.

Contd P/2

EEE 155 (CHE)

Contd. Q. No. 2(a)

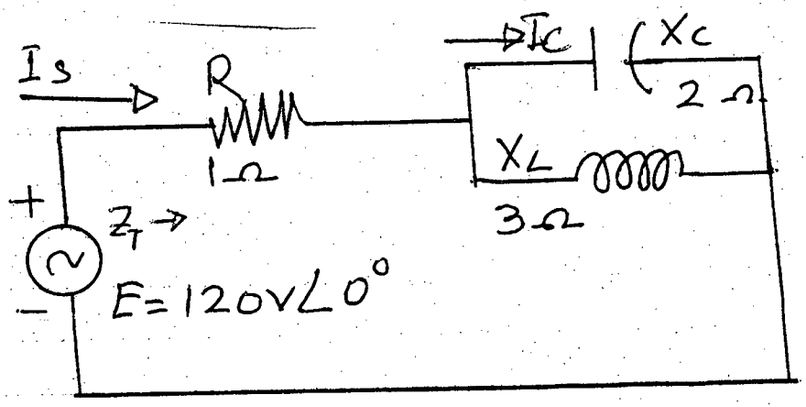

Fig. for Q. 2(a)

(b) For the network shown in the figure

(i) Calculate I_1 and I_2

(ii) Find the average power delivered to the circuit

(iii) Find the Power Factor at the source

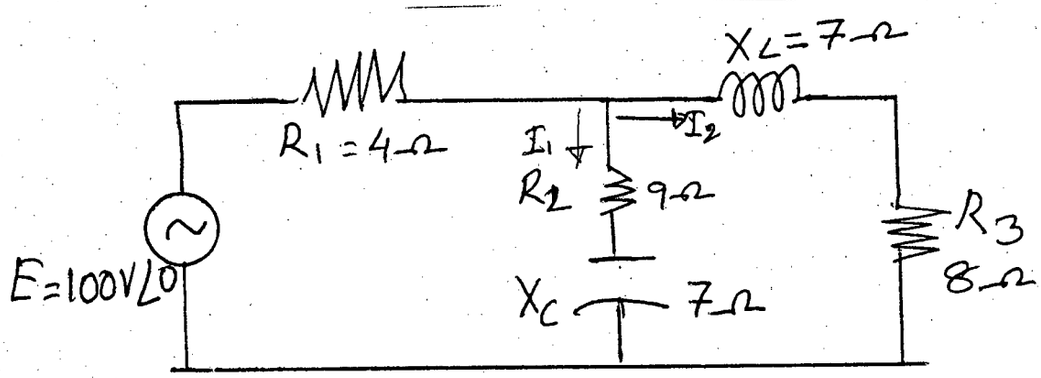

Fig. for Q. 2(b)

3. (a) For the network shown in the figure

(i) Find the average power of each element

(ii) Find reactive power for each element

(iii) Find apparent power for each element

(iv) Sketch Power Triangle.

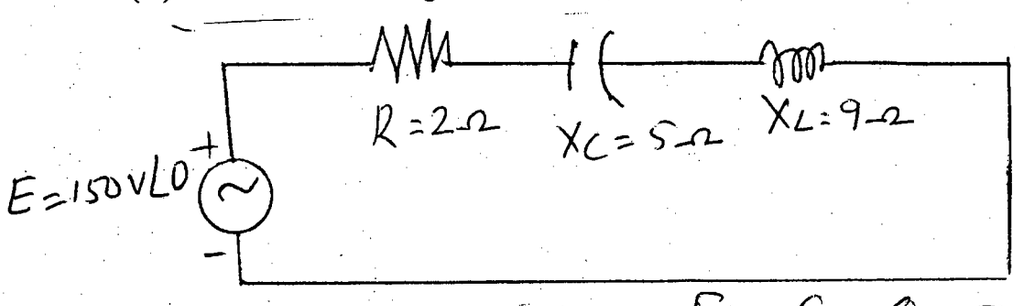

Fig. for Q. 3(a)

Contd P/3

EEE 155 (CHE)

Contd. Q. No. 3

(b) For the system shown in the figure- (i) find the total power, volt-amperes reactive volt-amperes and power factor.

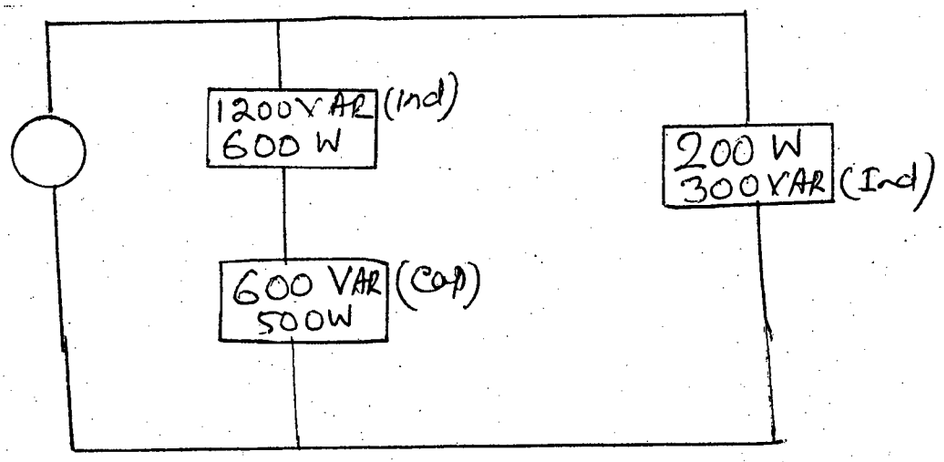

Fig 3b

4. Determine the total watts, volt-amperes reactive and volt-amperes for the network shown in the figure. Also, calculate the power factor of the load

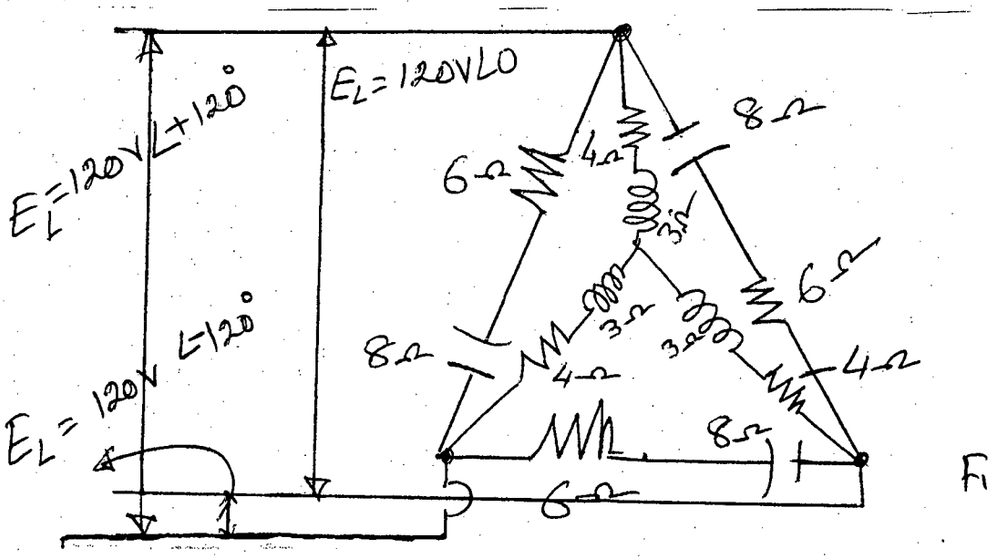

Fig 4.

SECTION – B

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

5. (a) Using voltage divider rule, determine the voltages v_1 and v_3 for the series circuit shown in Fig. 5(a).

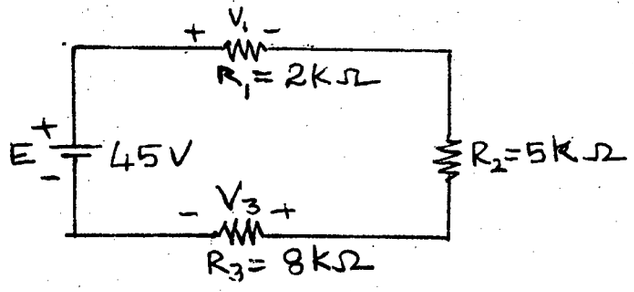

Fig. 5(a)

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EEE 155 (CHE)
Contd. Q. No. 5

(b) Find the voltage across the 3 ohm resistor shown in Fig. 5(b) by nodal analysis.

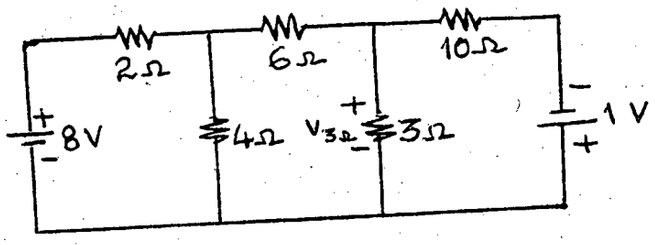

Fig. 5(b)

6. (a) Find the Thevenin equivalent circuit at terminals a, b in Fig. 6(a).

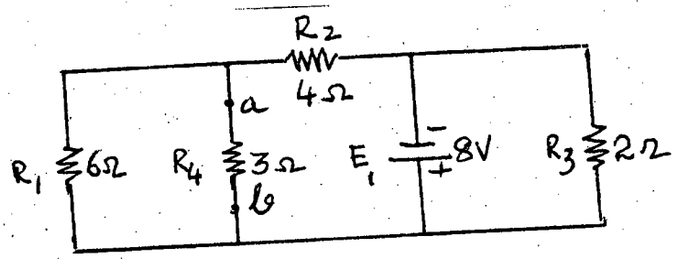

Fig 6(a)

(b) Find the Norton equivalent circuit of Fig. 6(b) with respect to terminals a, b.

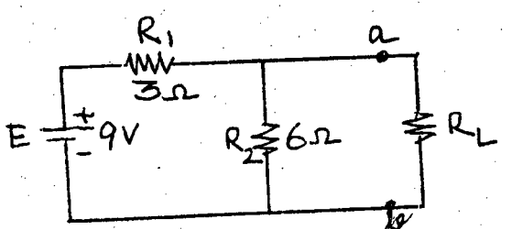

Fig 6(b)

7. (a) Using superposition theorem, find the current through the 6 ohm resistor of the network shown in Fig. 7(a).

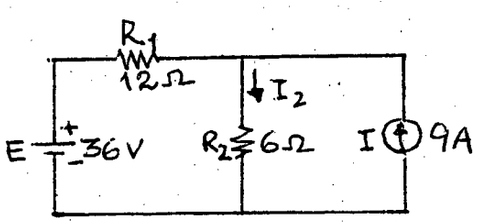

Fig. 7(a)

(b) Determine the current I flowing through the circuit shown in Fig. 7(b).

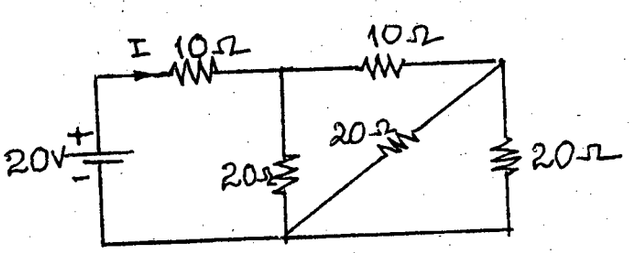

Fig. 7(b)

Contd P/5

EEE 155 (CHE)

8. (a) Using branch-current analysis, find the current through each resistor of each network shown in Fig. 8(a).

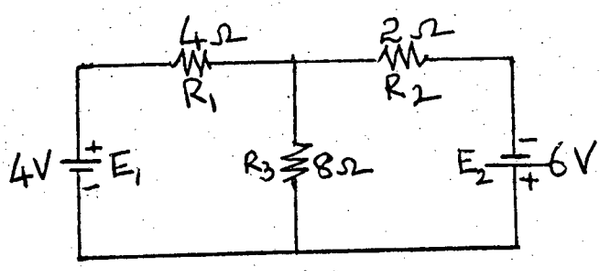

Fig 8(a)

(b) Calculate the current, I flowing through the battery using Δ-Y transformation (Fig. 8(b)).

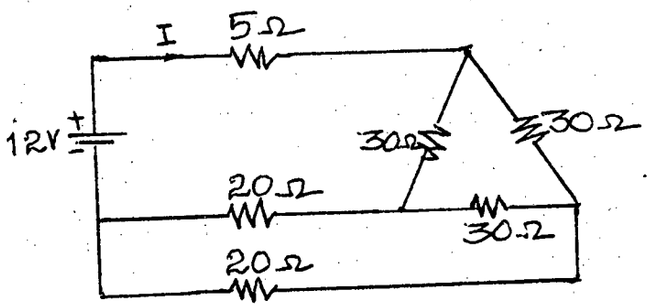

Fig. 8(b)

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L-1/T-1/ChE **Date : 29/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **PHY 111** (Physical Optics, Waves and Oscillations, 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. Show that the total energy of a simple harmonic oscillator is conserved. **(14)**

   (b) Derive a general expression for the resultant vibration of a particle simultaneously acted upon by two perpendicular simple harmonic vibrations having the same period but different amplitudes and phase angles. What happens if the phase difference is (i) 0 and (ii) $\pi/2$ radians? **(11)**

   (c) An object of mass 0.5 kg undergoing simple harmonic motion takes 0.25 sec to travel from one point of zero velocity to the next such point. The distance between these points is 20 cm. **(10)**
   Calculate (i) amplitude (ii) time period (iii) velocity at the equilibrium position (iv) Force constant and total energy of the system.

2. (a) Write down the characteristics of a mechanical wave. Derive expressions for energy density and intensity of a plane progressive wave. **(27)**

   (b) The displacement equation of a plane progressive wave is $\psi = 2.0 \sin 2\pi (400\,t - 0.1x)$ in centimeter. Find (i) amplitude, (ii) Wave velocity, (iii) Wavelength, and (iv) Intensity of the wave. Given density of the medium is 0.0015 gm/cm^3. **(8)**

3. (a) What is forced oscillation? Derive the differential equation of a forced oscillator. **(10)**

   (b) Discuss the theory of forced oscillation in presence of damping force and obtain the expression for amplitude at steady state. **(19)**

   (c) A particle of mass 5 kg is vibrating in presence of damping force of damping coefficient 2 sec^{-1} is under a driving force F = 25 cos 30 t. This particle is in its resonance condition. Find (i) amplitude, (ii) frequency of the driven, and (iii) what happens if the damping force is zero? ~~(15)~~ 06

4. (a) Deduce an expression for Maxwell's law of distribution of velocities of a gas containing N molecules. **(15)**

   (b) Evaluate the most probable velocity of a molecule using the Maxwell's law of distribution of velocities. **(10)**

   (c) What is the most probable velocity of a molecule of hydrogen at 27°C. Given Boltzmann's constant K = ~~1.32~~ 1.38 $\times 10^{-16}$ erg/K and molecular weight of hydrogen m = 3.34×10^{-24} gm. **(10)**

Contd P/2

PHY 111(ChE)

SECTION – B

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

5. (a) State second law of thermodynamics. **(5)**

   (b) State and prove Carnot's theorem. **(15)**

   (c) Show that entropy remains constant in a reversible adiabatic process and increases in an irreversible process. **(15)**

6. (a) State the Law of equipartition of energy. What are the thermodynamic functions? **(10)**

   (b) Deduce Clausius-Clapeyron's equation for latent heat. **(15)**

   (c) One gram molecule of a gas expands isothermally to four times its volume. Calculate the change in its entropy. Given R = 8.31 J/mole.K and J = 4.2 J/cal. **(10)**

7. (a) What are coherent sources? Discuss why two independent sources of light of same wavelength can not produce interference fringes? **(7)**

   (b) Explain how interference fringes may be obtained with the help of a Fresnel's biprism. How can the arrangement be used to determine the wavelength of a given monochromatic source of light? **(20)**

   (c) A biprism is placed 5 cm from a slit illuminated by sodium light of wavelength 5890 Å. The width of the fringes obtained on a screen 80 cm from the biprism is 9.424×10^{-2} cm. What is the distance between the coherent sources? **(8)**

8. (a) What is meant by diffraction gratings? Derive an expression for dispersive power of a grating. **(9)**

   (b) Explain the terms **(6)**

   (1) Polarization

   (2) Double refraction

   (3) Optically active substance.

   (c) Describe the construction of a Nicol prism and explain how it produces plane polarized light. **(20)**

L-1/T-1/CHE **Date : 15/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) Test the continuity and differentiability of the function $f(x)=\begin{cases}\sqrt{1-x^2}, & |x|\le 1\\ \sin \pi x, & |x|>1\end{cases}$ at the point x = 1. Also sketch the graph of f(x). **(17)**

   (b) Find the n-th derivative of $\sin^4 x \cos^3 x$. **(8)**

   (c) Evaluate $\lim_{x\to 0} \cot x \ln\frac{1-x}{1+x}$. **(10)**

2. (a) If $y = A \cos[m \sin^{-1}(ax + b)]$, then show that **(10)**

   $\{1-(ax+b)^2\}y_{n+2} - (2n+1)a(ax+b)y_{n+1} + (m^2-n^2)a^2y_n = 0$.

   (b) State and prove Rolle's theorem. Verify the theorem for the function

   $f(x) = x^2 + 5x - 6$ in $(-6, 1)$. **(13)**

   (c) Applying Mean value theorem prove that **(12)**

   $$\sqrt{\left(\frac{1-x}{1+x}\right)} < \frac{\ln(1+x)}{\sin^{-1}x} < 1, \quad \text{when } 0<x<1.$$

3. (a) If $u = \tan^{-1}\left(\frac{x^2+y^2+z^2}{x+y+z}\right)$ then show that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z} = \frac{1}{2}\sin u$. **(12)**

   (b) If $u = f(x, y)$, $x = r\cosh\theta$, $y = r\sinh\theta$, then show that **(12)**

   $$\left(\frac{\partial u}{\partial r}\right)^2 - \frac{1}{r^2}\left(\frac{\partial u}{\partial \theta}\right)^2 = \left(\frac{\partial u}{\partial x}\right)^2 - \left(\frac{\partial u}{\partial y}\right)^2.$$

   (c) Find the maximum and minimum value of the function $f(x) = 4 \sin x \cos^2 x$. **(11)**

4. (a) The cost of fuel to run a locomotive is proportional to the square of the speed and is \$25/h for a speed of 25 mi/h. Other costs amount to \$ 100/h, regardless of the speed. Find the speed that minimizes the cost per mile. **(12)**

   (b) If $x\cos\alpha + y\sin\alpha = p$ touch the curve $\frac{x^m}{a^m} + \frac{y^m}{b^m} = 1$, then show that **(12)**

   $$(a\cos\alpha)^{\frac{m}{m-1}} + (b\sin\alpha)^{\frac{m}{m-1}} = p^{\frac{m}{m-1}}.$$

   (c) Find the pedal equation of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. **(11)**

Contd P/2

MATH 121(CHE)

SECTION – B

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

5. (a) Remove the first degree terms and the product term from the equation

$$17x^2 + 18xy - 7y^2 - 16x - 32y - 18 = 0.$$

by suitable transformation of the co-ordinate system. **(20)**

(b) Show that the value of $g^2 + f^2$ in the equation

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ remains unaffected by orthogonal transformation without change of origin. **(15)**

6. (a) Show that the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$

represents a pair of parallel straight lines if $\frac{a}{h} = \frac{h}{b} = \frac{g}{f}$ and also that the distance between the parallel lines is $2\sqrt{\frac{g^2 - ac}{a(a+b)}}$. **(18)**

(b) If one of the straight lines given by $ax^2 + 2hxy + by^2 = 0$ coincide with one of the lines given by $a_1x^2 + 2h_1xy + b_1y^2 = 0$ and the other lines represented by them are perpendicular, then prove that $\frac{ha_1b_1}{b_1 - a_1} = \frac{h_1ab}{b-a} = \frac{1}{2}\sqrt{-aa_1bb_1}$. **(17)**

7. (a) Find the equation of the pair of lines joining the origin to the points of intersection of the line $\frac{x}{a} + \frac{y}{b} = 1$ with the circle $x^2 + y^2 = c^2$ and hence deduce that if the line is a tangent to the circle, then $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c^2}$. **(18)**

(b) Show that the locus of the point of intersection of two normals to the parabola $y^2 = 4ax$ which are perpendicular to each other is the parabola $y^2 = a(x - 3a)$. **(17)**

8. (a) Find the locus of the middle points of the chords of contact of the tangents drawn to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ from any point on the director circle. **(17)**

(b) Chords of the hyperabola $x^2 - y^2 = a^2$ touch the parabola $y^2 = 4ax$. Prove that the locus of their middle points is the curve $y^2(x - a) = x^3$. **(18)**

Shubhra Kanti
23/12/12

L-1/T-1/ChE **Date : 23/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2011-2012

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 is pairing energy? Discuss how is paring energy related with the splitting energy of d-orbitals and distribution of electrons in different orbitals. **(7)**

   (b) What is the difference between an octahedral geometry and a square planar geometry? Show the d-orbital splitting in the case of square planar ligand field. Explain why is Au^{2+} unstable compare to Au^{3+}. **(14)**

   (c) Discuss how the splitting of d-orbital occurs in a tetrahedral ligand field. Calculate the Crystal Field Stabilization Energy (CFSE) for d^{1-10} electrons in the tetrahedral ligand field of high spin situation. **(14)**

2. (a) Discuss the limitation of CFT of complex compounds. **(6)**

   (b) How did Wevner develop the theory of coordination or complex compounds? What are the main features of the theory? **(10)**

   (c) Explain formation of $[NiCl_4]^{2-}$ and $[PtCl_4]^{2-}$ complex ions according to valence bond theory and show their possible geometrical structures. (Atomic number of Pt is 78 and the magnetic moment of nickel complex ion is 2.83 B.M). **(13)**

   (d) Name the following complexes: **(6)**

   $[Co(NH_3)_4\,(NO_3)\,(CN)]Cl$; $[Zn(H_2O)_3\,(NO_2)(Cl)_2]^{\ominus}$; $[Cr(en)_3]Cl_3$

3. (a) What do you mean by the stability constants of complexes? How are they expressed? Are they related to each other? **(10)**

   (b) Discuss two of the important applications of stability constants. **(7)**

   (c) What is Valence Shell Electron Pair Repulsion (VSEPR) theory? Discuss the theory with two suitable examples. **(10)**

   (d) How would you establish the geometrical structures of the molecules PCl_5 and SF_6 according to hybridization? **(8)**

4. (a) With the help of potential energy diagram, discuss the formation of a chemical bond between two atoms. **(8)**

   (b) What do you mean by Bonding orbitals and Antibonding orbitals? Discuss with energy level diagram. **(10)**

Contd P/2

CHEM 111(ChE)

Contd ... Q. No. 4(a)

(c) Show the shapes of s, p and d orbitals. **(5)**

(d) Draw the molecular orbital diagram of the following molecules/ion

(i) F_2 (ii) O_2^- (iii) CO

Calculate the bond order and mention the magnetic properties in each case. **(12)**

SECTION – B

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

5. (a) What are silicones? Describe methods for the formation of different types of silicones. Give their applications in technology. **(3+9+3=15)**

(b) Write a note on "chain and cyclic silicates". **(3+3=6)**

(c) Justify, by giving at least two examples, the fact that carbon and silicon form similar type of compounds with a great difference in their properties. **(5+5=10)**

(d) $SnCl_2$ is a solid while $SnCl_4$ is a liquid. - Explain. **(04)**

6. (a) Compare the compositions, properties and uses of pig iron, cast iron, wrought iron and steel. **(4×3=12)**

(b) Write notes on: (i) Tempering of steel, (ii) Hardening of steel and (iii) Case Hardening **(4×3=12)**

(c) What are hard and soft acids and bases? Mention about the applications of hard and soft acids and bases concept. **(3+8=11)**

7. (a) Give a comparative study of the chemistry of copper, silver and gold. **(12)**

(b) Describe briefly the properties and uses of : (i) Calomel and (ii) Nessler's Reagent **(6+6=12)**

(c) Hg occurs in nature mostly as HgS while Zn occurs in several forms like ZnS, $ZnCO_3$, ZnO etc. Explain the fact. **(6)**

(d) Write short notes on physical significance of ψ and ψ^2. **(5)**

8. (a) Write down the postulates of Bohr atomic theory. Why did it need to modify? **(12)**

(b) Derive the energy equation of an electron in an orbit. **(10)**

(c) State modern periodic law. Classify the elements and discuss each type briefly. **(3+10=13)**

L-1/T-1/CHE

Date : 17/11/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) The elevator E shown as in figure for Q. 1(a), starts from rest and moves upward with a constant acceleration. If the counterweight W moves through 12 m in 4 s, determine (i) the acceleration of the elevator, (ii) the acceleration of cable C, (iii) the velocity of the elevator after 8 s. **(15)**

   (b) Block A as shown in figure for Q. 1(b) has a mass of 30 kg and Block B a mass of 15 kg. The co-efficients of friction between all surfaces in contact are $\mu_s = 0.15$ and $\mu_k = 0.10$. Knowing that $\theta = 30°$ and the magnitude of the force P applied to block A is 250 N, determine (i) the acceleration of block A (ii) the tension in the cord. **(20)**

2. (a) A series of small packages, each weighing $\frac{3}{4}$ lb as shown in figure for Q. 2(a), are discharged from a conveyor belt as shown. Knowing that, the coefficient of static friction between each package and the conveyor belt is 0.40, determine (i) the force exerted by the belt on a package just after it has passed point A (ii) the angle θ defining the point B where the packages first slip relative to the belt. **(20)**

   (b) Two blocks as shown in figure for Q. 2(b) are joined by an inextensible cable. If the system is released from rest, determine the velocity of block A after it has moved 2 m. Assume that $\mu_k = 0.25$ between block A and the plane and neglect the mass and friction of the pulleys. **(15)**

3. (a) The system as shown in figure for Q. 3(a) is initially at rest. Neglecting friction determine (i) the force P required if the velocity of collar B is to be 5 m/s after 2 s, (ii) the corresponding tension in the cable. **(12)**

   (b) Ball B as shown in figure for Q. 3(b) is hanging from an inextensible cord. An identical ball A is released from rest when it is just touching the cord and drops through the vertical distance $h_A = 150$ mm before striking ball B. Assuming perfectly elastic impact ($e = 1.0$) and no friction, determine the resulting maximum vertical displacement h_B of ball B. **(23)**

Contd P/2

ME 141 (CHE)

4. (a) In the position as shown in figure for Q. 4(a), bar AB has a constant angular velocity of 3 rad/s counter clock wise. Determine the angular velocity of bars BD and DE. (15

(b) The rod BDE as shown in figure for Q. 4(b) is partially guided by a wheel at D which rolls in a vertical track. Knowing that at the instant shown the angular velocity of crank AB is 5 rad/s clockwise and that $\beta = 30°$, determine (i) the angular velocity of the rod (ii) the velocity of point E. (20

SECTION – B

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

Symbols indicate their usual meaning. Assume any missing data.

5. (a) Two cables which have known tensions are attached to the top of pylon *AB*. A third cable *AC* is used as a guy wire. Determine the tension in *AC*. Knowing that the resultant of the forces exerted at *A* by the three cables must be vertical (see Fig. 5(a)). (1

(b) Two 8° wedges of negligible weight are used to move and position the 800 kg block. Knowing that the coefficient of static friction is 0.30 at all surfaces of contact, determine the smallest force *P* which should be applied as shown to one of the wedges (see Fig. 5(b)). (

6. (a) A precast concrete wall section is temporarily held by two cables as shown in Fig. 6(a). Knowing that the tension in the cable *BD* is 900 N, determine the moment about point *O* of the force exerted by the cable at *B*. (

(b) A slender rod of length *L* is lodged between peg *C* and the vertical wall as shown in Fig. 6(b). It supports a load *P* at end *A*. Neglecting friction and the weight of the rod, determine the angle θ corresponding to equilibrium.

7. (a) Locate the centroid of the plane area shown in Fig. 7(a).

(b) Determine the volume of the solid generated by rotating the parabolic spandrel as shown in Fig. 7(b) about (i) the *x*-axis, (ii) the axis *AA'*.

8. (a) Using the method of section, determine the forces in members *AB* and *AD* of the truss shown in Fig. 8(a).

(b) Determine the components of the reactions at *A* and *B* if the 500 N load is applied at point *E* as shown in Fig. 8(b).

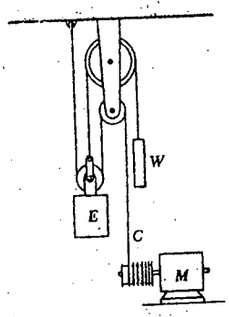


Figure for Q. 1. (a)

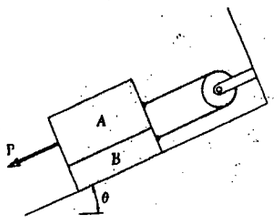


Figure for Q. 1. (b)

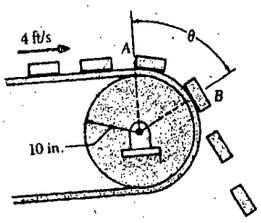


Figure for Q. 2. (a)

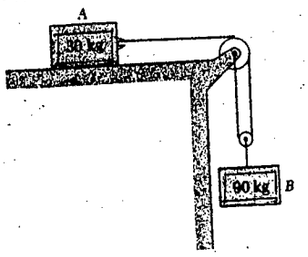


Figure for Q. 2. (b)

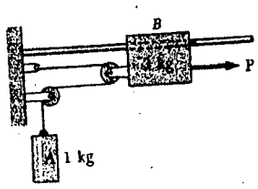


Figure for Q. 3. (a)

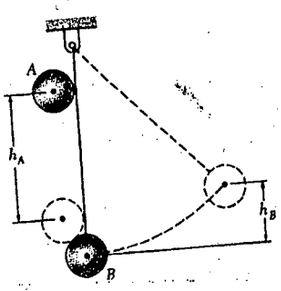


Figure for Q. 3. (b)

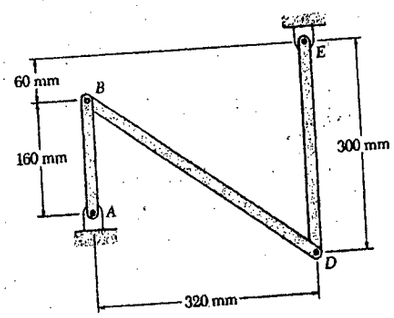


Figure for Q. 4 (a)

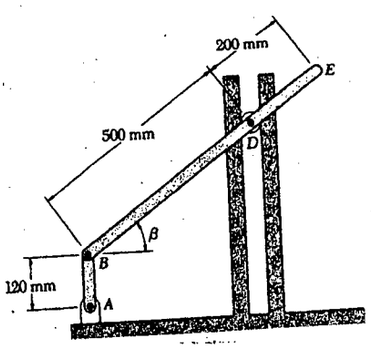


Figure for Q. 4. (b)

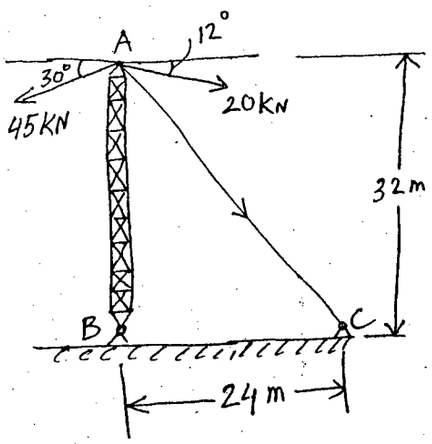


Fig. 5(a)

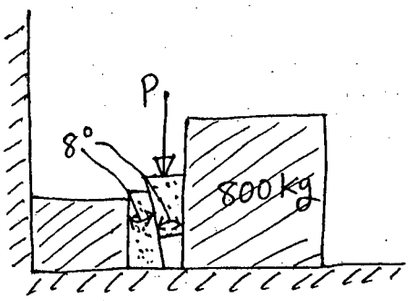


Fig. 5(b)

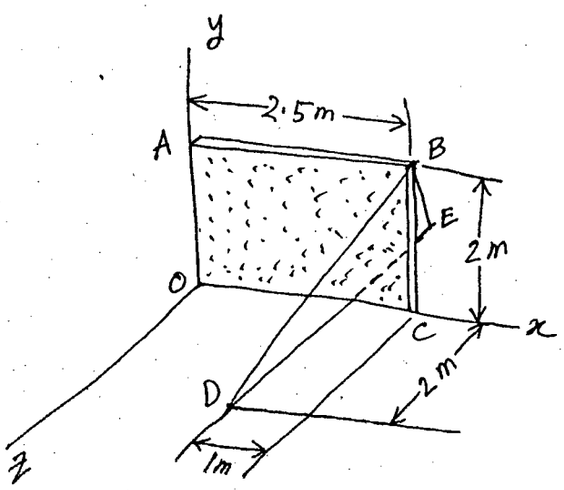


Fig. 6(a)

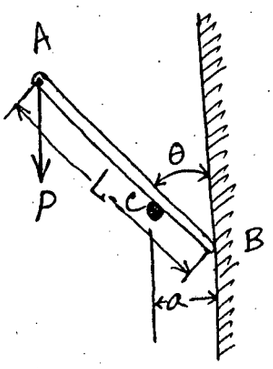


Fig 6(b)

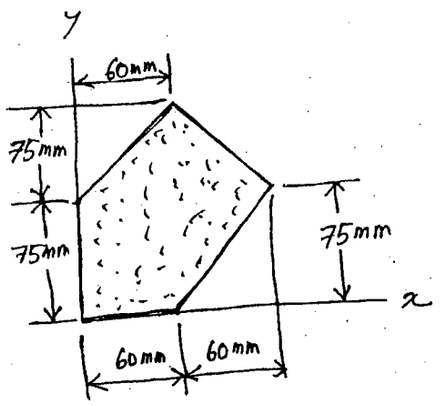


Fig. 7(a)

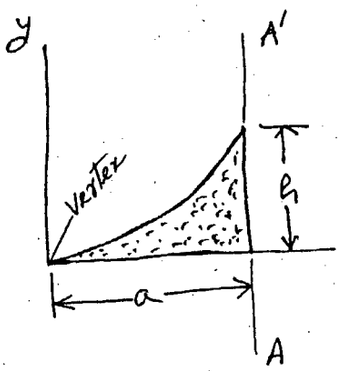


Fig. 7(b)

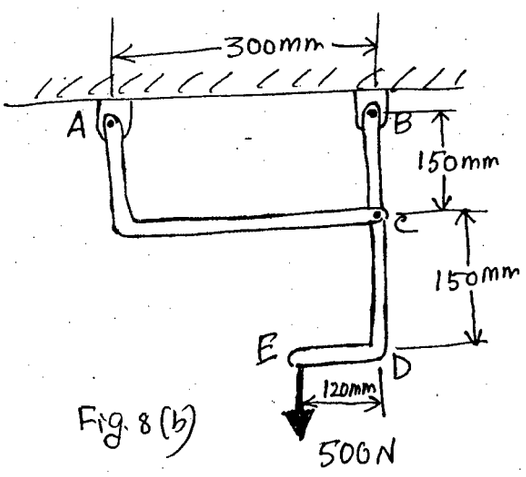


Fig. 8(b)

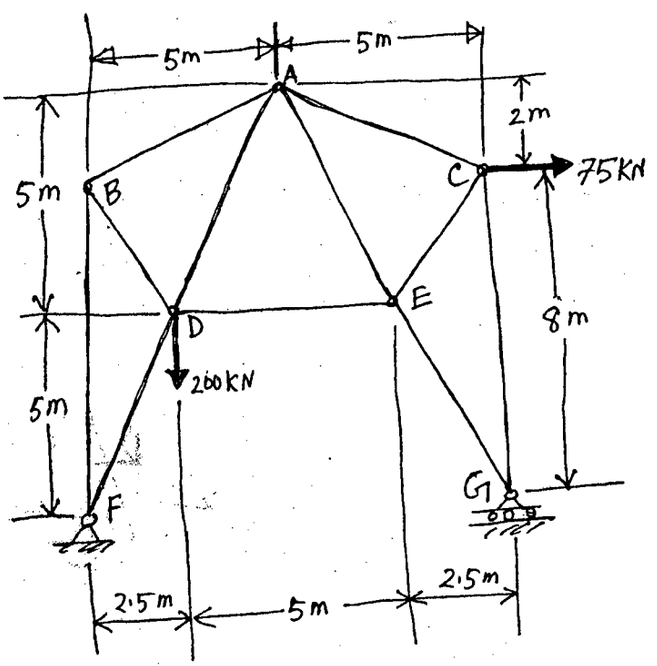


Fig. 8(a)

L-1/T-2/ChE Date : 15/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **ChE 111** (Elements of Chemical Engineering)

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**.

A booklet containing all relevant data to be provided.

1. (a) The density of a fluid is given by the empirical equation $\rho = 70.5 \exp(8.27 \times 10^{-7}P)$ Where ρ is density (lbm/ft^3) and P is pressure (lb_f/in^2.). **(20)**

(i) What are the units of 70.5 and 8.27×10^{-7}? Assume that the given equation is dimensionally homogeneous?

(ii) Derive a formula for ρ (g/cm^3) as a function of P(N/m^2).

(b) A published study of a chemical reaction, A→ P, indicates that if the reactor initially contains A at a concentration C_{Ao} (g/L) and the reaction temperature, T is kept constant, then the concentration of P in the reactor increase with time according to the formula -

$$C_p(g/L) = C_{Ao}(1 - e^{-kt})$$

The rate constant, k (s^{-1}), is reportedly a function only of the reaction temperature. What plot would yield a straight line if the given equation is correct? **(15)**

2. (a) A mercury column is open to the atmosphere on a day when atmospheric pressure is 29.9 in.Hg. What is the gauge pressure 4 in. below the surface? The absolute pressure? (Give the answers in in.Hg.) **(10)**

(b) A mixture of ethanol (ethyl alcohol) and water contains 60% water by mass. **(25)**

(i) Assuming volume additivity of the components, estimate the specific gravity of the mixture at 20°C. What volume (in liters) of this mixture is required to provide 150 mol of ethanol?

(ii) Repeat part (i) with the additional information that the specific gravity of the mixture at 20°C is 0.93518 (making it unnecessary to assume volume additivity).

3. (a) The standard heat of the reaction $CaC_2(s) + 5\ H_2O\ (l) \rightarrow CaO\ (s) + 2CO_2(g) + 5\ H_2(g)$ is $\Delta \hat{H}^\circ_r = +69.36$ kJ/mol. Calculate $\Delta \hat{U}^\circ_r$ for this reaction. **(8)**

(b) The natural gas supplied by Titas (Bangladesh) contains 70% CH_4 and 30% C_2H_6 by mass. The standard heats of combustion of CH_4 and C_2H_6 are given below.

$CH_4(g) + 2O_2\ (g) \rightarrow CO_2\ (s) + 2HO_2(l)$; $\Delta \hat{H}^\circ_c = -700$ kJ/mol

$C_2H_6(g) + \frac{7}{2} O_2\ (g) \rightarrow 2CO_2(g) + 3\ H_2O(v)$; $\Delta \hat{H}^\circ_c = -1500$ kJ/mol

Contd P/2

ChE 111

Contd ... Q. No. 3(b)

Calculate the lower heating value (kJ/g) of the natural gas supplied by Titas (Bangladesh). **(20)**

(c) Briefly discuss the importance of adiabatic flame temperature. **(7)**

4. Ethanol is produced commercially by the hydration of ethylene: **(35)**

$$C_2H_4(g) + H_2O(v) \rightleftharpoons C_2H_5OH\ (v);$$

Some of the product is converted to diethyl ether in the undesired side reaction

$$2\ C_2H_5OH\ (v) \rightleftharpoons (C_2H_5)_2O(v) + H_2O(v)$$

The combined feel to the reactor contains 53.7 mole% C_2H_4, 36.7% H_2O and the balance nitrogen which enters the reactor at 310°C. The reactor operates isothermally at 310°C. An ethylene conversion of 5% is achieved, and the yield of ethanol (moles ethanol produced/mole ethylene consumed) is 0.900.

Data for Diethyl Ether:

$\Delta \hat{H}_f^{\circ} = -272.8$ kJ/mol for the liquid

$\Delta \hat{H}_v = 26.05$ kJ/mol (assume independent of T)

$C_P[\ kJ/(mol).°C\ ] = 0.08945 + 40.33 \times 10^{-5}\ T\ (°C)$

(a) Calculate the reactor heating or cooling requirement in kJ/mol feed.

(b) Why would the reactor be designed to yield such a low conversion of ethylene?

SECTION – B

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

5. (a) Explain the following terms with examples **(5×4=20)**

(i) Extent of reaction

(ii) Yield and selectivity

(iii) Recycle and purge

(iv) Degree of freedom analysis

(b) The following reaction is the oxidation of propylene, **(15)**

$$C_3H_6 + NH_3 + \frac{3}{2}O_2 \rightarrow C_3H_5N + 3\ H_2O$$

The feed contains 10% mole propylene, 12% mole NH_3 and 78% air. Determine which reactant is limiting and the percentage by which each of other reactant is in excess.

Contd P/3

ChE 111

6. A feel contains 80 wt% propane, 15 wt % butane and the balance water.

   (a) Calculate the molar composition of the fuel **(10)**

   (b) Calculate the ratio of moles water to moles of dry gas. **(5)**

   (c) If 100 kg/h of this fuel is used to be burned with 30% excess air, what is the required feed rate (kmol/h)? **(10)**

   (d) How would the answer of part (c) change if the combustion were only 75% complete? **(10)**

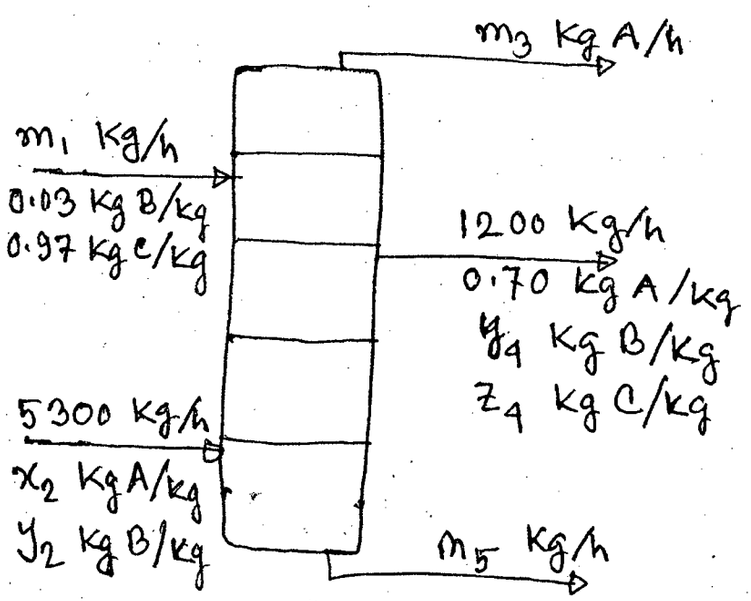
7. (a) What is the law of conservation of mass? Write down the general form of mass balance equation. **(10)**

   (b) How do you classify the chemical process? Describe different types of chemical process with examples. **(10)**

   (c) What are the differences between differential and integral mass balance? **(5)**

   (d) What are the reasons for using recycle in a chemical process? **(10)**

8. The following figure shows a distillation column with two feed streams and three product streams.



   (a) How many independent material balances may be written for this system. **(10)**

   (b) How many unknown flow rates and /or mole fractions must be specified before others may be calculated? Briefly explain your answer. **(10)**

   (c) For m_1 = 2000 kg/h and y_2 = 0.40 kg B/kg. Write down the series of equation and find the unknown variables. **(15)**
