L-3/T-1/CHE **Date : 28/06/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHE 303** (Mass Transfer I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. A vent gas stream from a chemical plant is 15 wt% Z; the rest is air. The local pollution authorities feel that Z is a minor pollutant and require a maximum concentration of 4 wt%. The plant owner decided to build an absorption tower using water as the absorbent. The inlet water is pure and at 30°C. The operation is essentially isothermal. At 30°C the equilibrium data can be approximated by y = 0.5x (where y and x are weight fractions of Z in vapor and liquid, respectively). **(35)**

   (a) Find the minimum ratio of water to air (L/G) min.

   (b) Find the total number of equilibrium stages using $\frac{L}{G} = 1.22 \left(\frac{L}{G}\right)_{min}$

   Assuming that air is not soluble in water and that water is nonvolatile.

2. The system shown in the Fig. for Q. No. 2 is extracting acetic acid from water using benzene as the solvent. The temperature shift is used to regenerate the solvent and return the acid to the water phase. **(35)**

   (a) Determine y_1 and y_{N+1} (Units are in wt.fraction) for the column at 40°C.

   (b) Determine R' and x'_N for the column at 25°C.

3. (a) Discuss the advantages and disadvantages of batch distillation compared to continuous distillation. Would you expect to see batch or continuous distillation in the following industries? Why? **(15)**

   (i) Large basic chemical plant

   (ii) Pharmaceutical plant

   (iii) Still for solvent recovery in a painting operation

   (iv) Crude oil refinery

   (v) Condensate refinery

   (b) The McCabe-Thiele diagram is most useful when the operating line is straight. How can you achieve this in absorption process? **(10)**

   (c) In chemical engineering washing is treated as an equilibrium staged separation process – Explain. How do you reach equilibrium in washing? **(10)**

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4. Pure isopropyl ether is being used to extract an aqueous solution of 150 kg/h with 30 wt% acetic acid and 70 wt% water by countercurrent multi-stage extraction. The exit concentration in the aqueous phase is 10 wt%. **(35)**

   (a) Find the minimum isopropyl ether rate for this separation.

   (b) If 450 kg/h isopropyl ether is used

      (i) Calculate the number of stages required.

      (ii) Find the exit extract concentration

   The equilibrium data and right triangular diagram for water-aceticacid-isopropyl ether at 20°C and 1 atm are attached.

   [Note: Please attach the right triangular diagram with your answer script)

SECTION – B

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

If you answer Q. 7(a), you must attach the Fig. for Q. 7(a) with the answer script.

5. The equilibrium data for benzene-toluene system is given below for a system at 1 atm pressure. (The liquid composition of benzene in the mixture is denoted by χ_B; the enthalpies of saturated liquid and saturated vapor at the corresponding composition is denoted by **h** and **H**, respectively). The reference for enthalpies is taken as pure benzene at its boiling point.

χ_B	T(°C)	h (kJ/kmol)	H (kJ/kmol)
0	110.6057	5121.594	38451.43
0.1	105.837	4247.225	36821.79
0.2	101.6467	3494.285	35552.68
0.3	97.9292	2840.94	34539.77
0.4	94.60248	2270.257	33714.01
0.5	91.60229	1768.977	33028.35
0.6	88.87775	1326.605	32449.87
0.7	86.38817	934.735	31955
0.8	84.10065	586.5622	31526.47
0.9	81.98831	276.5179	31151.4
1	80.029	0	30820

A mixture of benzene and toluene containing 40 mole percent benzene is to be separated in a distillation column to give a product containing 90 mole percent benzene at the top and a bottom product containing not more than 10 mole percent benzene. The feed enters the column at its boiling point and the vapor leaving the column is condensed fully, provides reflux and product. The unit operates at 1 atm and a reflux ratio of 3 kmol/kmol product. The relative volatility is taken to be 2.5.

(a) Given the above data can you make the assumption of constant molal overflow for this unit? Give your reasoning. **(5)**

(b) Assuming constant molal overflow find the equation for top operating line, bottom operating line, equilibrium line. **(12)**

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Contd ... Q. No. 5

(c) What is the equation for the feed line? Explain your reasoning. **(3)**

(d) Using the equations above and using the Lewis method, determine the optimum stage for the feed to enter when the feed is at boiling point temperature. Find the theoretical number of stages for the system. **(15)**

6. (a) What are the reasons for reusing old distillation equipment? What conditions must be fulfilled to reuse an existing flash drum. List some steps you can take to reuse an existing flash drum if the above condition is not fulfilled? **(10)**

(b) A mixture of methanol and water in a flash drum is at 1 atm pressure. Equilibrium data at this pressure are listed as follows. (The data are in mole percentages) **(25)**

Methanol vapor	Methanol liquid	Temperature °C
0	0	100
13.4	2	96.4
23.0	4	93.5
30.4	6	91.2
36.5	8	89.3
41.8	10	87.7
51.7	15	84.4
57.9	20	81.7
66.5	30	78.0
72.9	40	75.3
77.9	50	72.1
82.5	60	71.2
87.0	70	69.3
91.5	80	67.6
95.8	90	66.0
97.9	95	65.0
100	100	54.6

If the feed is 30 mol% methanol and we desire a liquid product that is 20 mol% methanol, what V/F must be used? For a feed rate of 1000 lbmol/h, find product flow rates and compositions. Find the dimensions of a vertical drum. Use $h_{total}/D = 4.0$.

Assume vapors are ideal gases and the symbols have their usual meaning.

Data and formulae:

Specific gravity of water $\rho_w = 1.00$;

Specific gravity of liquid methanol $\rho_{m,L} = 0.7914$;

$MW_w = 18.01$, $MW_m = 32.04$

Permissible velocity $u_{perm} = K_{drum}\sqrt{\frac{\rho_l - \rho_v}{\rho_v}}$

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Contd ... Q. No. 6(b)

$$K_{drum} = \exp\left[A + B(\ln F_{lv}) + C(\ln F_{lv})^2 + D(\ln F_{lv})^3 + E(\ln F_{lv})^4\right]$$

where $F_{lv} = \frac{W_L}{W_V}\sqrt{\frac{\rho_V}{\rho_L}}$

W_L and W_V are liquid and vapor flow rates in lb/hr, K_{drum} is in ft/sec

A = –1.877478097; B = –0.8145804597; C = –0.1879744085

D = –0.0145228667; E = –0.0010148518

7. (a) A laboratory fractionating column is to be designed to operate at atmospheric pressure. We desire to separate a mixture containing 15.67% carbon disulphide mixed with carbon tetrachloride into an overhead product containing 91% carbon disulphide and a waste of 97.3% carbon tetrachloride (these percentages are weight percentages). A reflux ratio of 3.16 mol/mol of product is proposed. Determine the theoretical number of plates. **(20)**

We wish to use a feed entering at 290K having a specific heat of 1.7 kJ/kg K and a boiling point of 336 K. The latent heat of both carbon disulphide and carbon tetrachloride is assumed to be 25,900 kJ/mol.

Find the mean molecular mass of the feed stream given that the molecular weight of CS_2 is 76 g/mol and of CCl_4 is 72.6 g/mol.

The final design had 14 plates. What was the efficiency of the column? Use the Fig. for Q. 7(a) supplied for this question and attach it with your answer sheet.

(b) With appropriate diagrams describe the regimes that can be found in a typical distillation column **(15)**

8. (a) Describe the significance of the following when dealing with distillation columns. Use appropriate diagrams to clarify your statement: **(25)**

weir, downcomer, lever arm rule, pressure heads on sieve trays, minimum reflux ratio

(b) What do you understand by open steam distillation? Why would you use open steam in a distillation column? Show the schematic representation of such a distillation column. What is the equation for the bottom operating line for such a column? **(10)**

Figure for Question No. 2

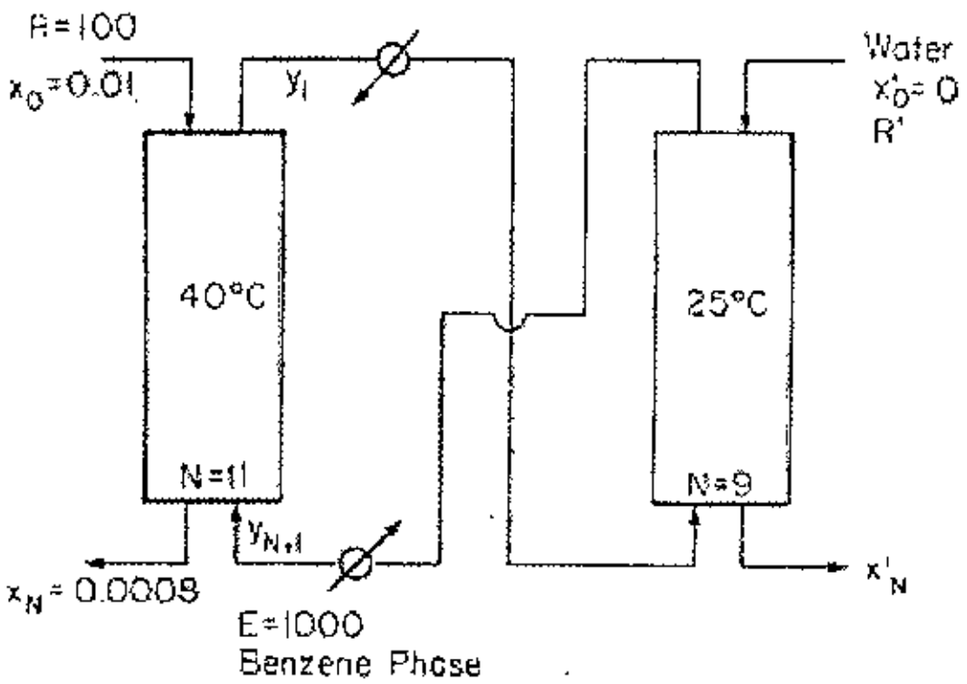


Table for Question No. 2: Distribution Coefficient for acetic acid in water and benzene

Solute (A)	*Solvent*	*Diluent*	*t, °C*	$K_d = y_A/x_A$
Equilibrium in Weight-Fraction Units (Perry and Green, 1984)				
Acetic acid	Benzene	Water	25	0.0328
Acetic acid	Benzene	Water	30	0.0984
Acetic acid	Benzene	Water	40	0.1822
Acetic acid	Benzene	Water	50	0.0588
Acetic acid	Benzene	Water	60	0.0637

[Type text] **For Question no. 34** [Type text]

Equilibrium data for water-acetic acid-isopropyl Ether at 20°C and 1 atm

Water Layer, wt %			*Isopropyl Ether Layer, wt %*		
Acetic Acid x_A	*Water* x_D	*Isopropyl Ether* x_S	*Acetic Acid* y_A	*Water* y_D	*Isopropyl Ether* y_S
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.30	84.4	2.3	4.82	1.9	93.3
25.50	71.1	3.4	11.40	3.9	84.7
36.70	58.9	4.4	21.60	6.9	71.5
44.30	45.1	10.6	31.10	10.8	58.1
46.40	37.1	16.5	36.20	15.1	48.7

Points on the same horizontal line are in equilibrium. *Source:* Treybal (1968)

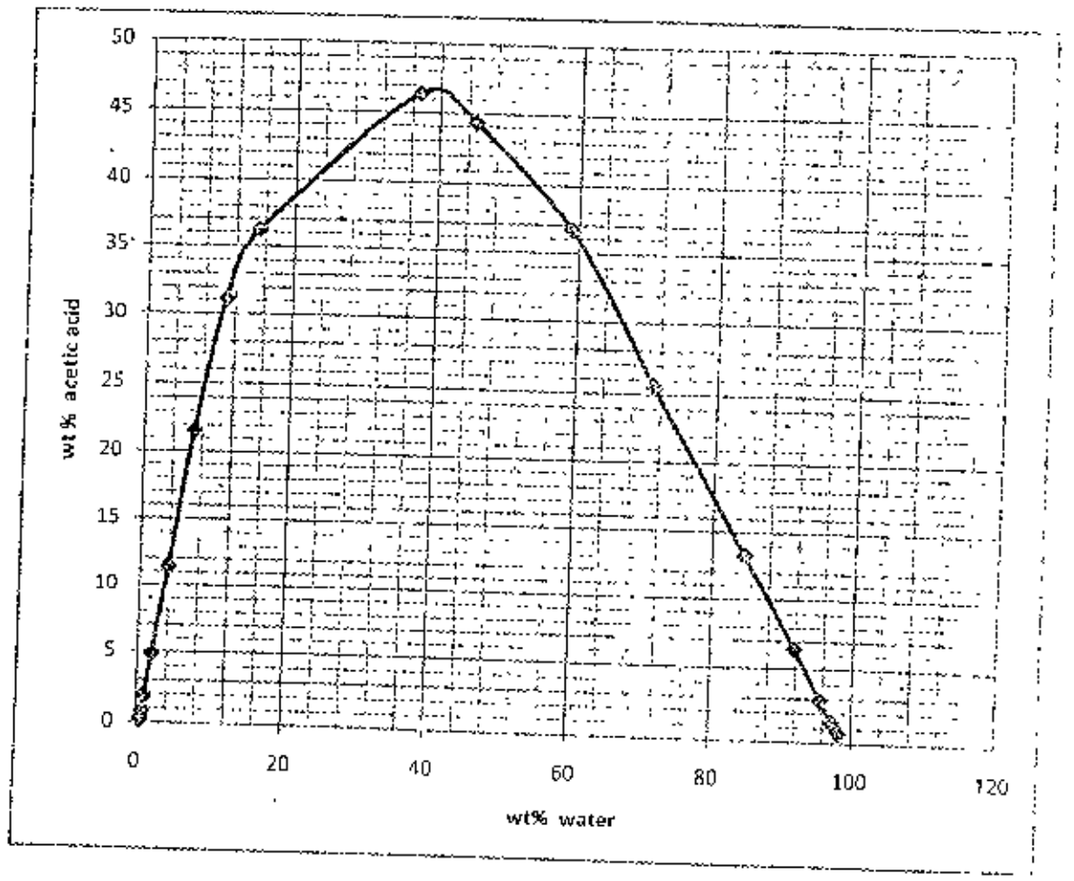
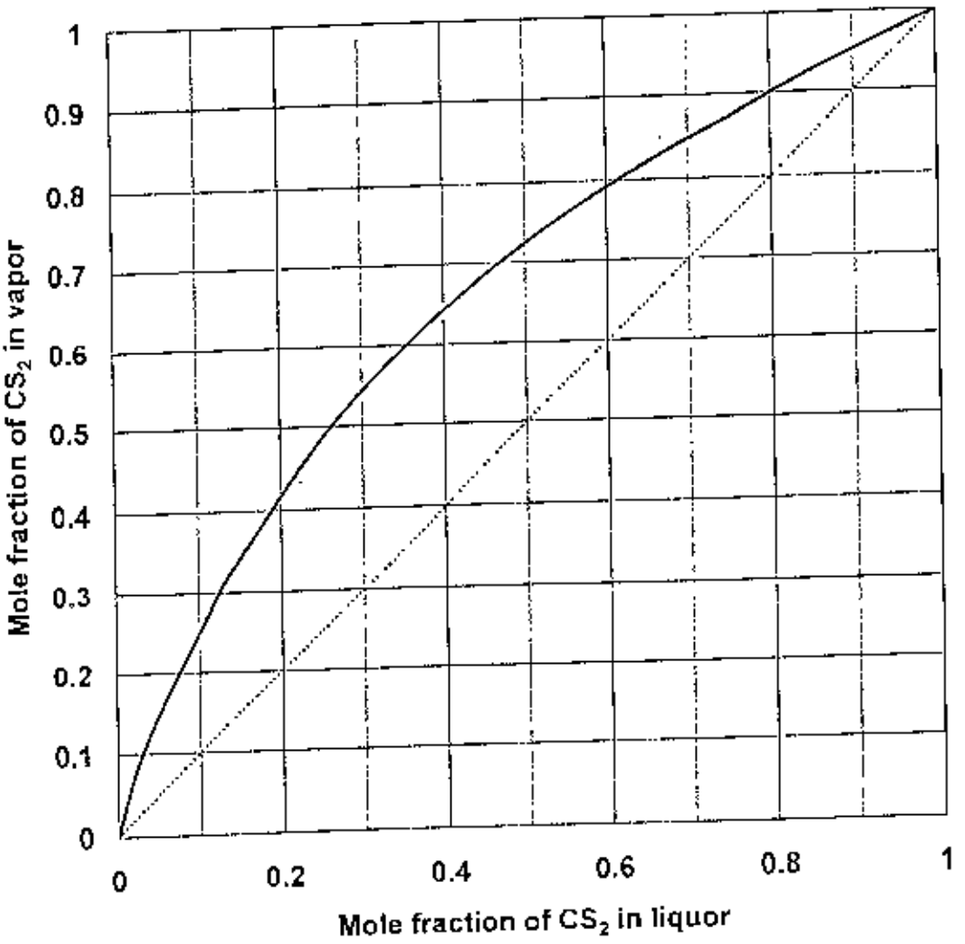


Figure for 7(a)



x-y diagram for $CS_2 - CCl_4$ system

L-3/T-1/CHE **Date : 05/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHE 301** (Heat Transfer)

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**.

All notations have their usual meanings.

A photocopy booklet containing data tables is to be provided.

1. (a) Natural convection heat transfer from a vertical flat rectangular plate is given by **(14)**

$$Nu_x = 0.508\, Pr^{1/2}\, (0.952 + Pr)^{-1/4}\, Gr_x^{1/4}$$

where, $Gr_x = \dfrac{g\beta\,(T_w - T_\infty)\,x^3}{V^2}$

The above equation gives the local heat-transfer coefficient along the vertical direction. Show that the average heat-transfer coefficient is given by

$$\bar{h} = \frac{4}{3}\, h_{x=L}$$

(b) A 20-cm-square steel plate is maintained at 80°C. The plate is submerged vertically in a big pool of water at 30°C. Calculate heat transfer rate from both sides of the plate. Use the equation from part (a) of this question **(11)**

(c) Write a short note on heat pipe. **(10)**

2. (a) Show that $A_{1,2}\, F_{1,2\text{-}3} = A_1\, F_{1\text{-}3} + A_2\, F_{2\text{-}3}$ in the Figure for Q. No. 2(a). **(5)**

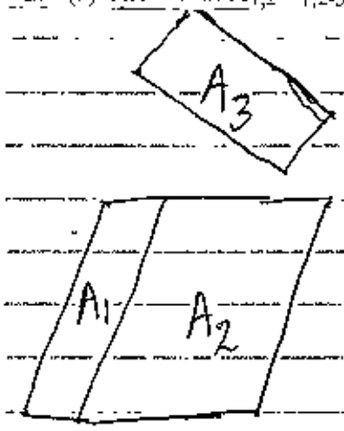


Figure for Question # 2(a)

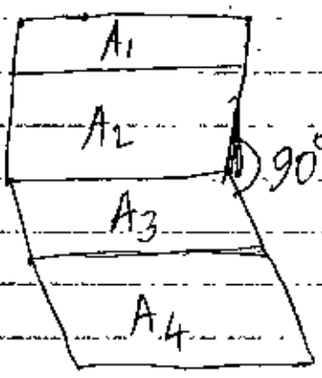


Figure for Question # 2(b)

(b) Determine the shape factor $F_{1\text{-}4}$ in the Figure for Q. No. 2(b) in terms of known shape factors for perpendicular rectangles with a common edge. **(12)**

(c) Show that a radiation shield placed between two parallel infinite planes will reduce the heat flow by one-half (assume all the surfaces have the same emissivity). **(12)**

(d) Write a few words on fouling factor and its use in heat exchange design. **(6)**

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3. (a) Analyze mathematically the film condensation on a vertical plate (condensate flow is laminar) and show that **(20)**

$$Nu_x = \left[\frac{\rho(\rho - \rho_v) g h_{f,g} x^3}{4\mu K (T_g - T_w)}\right]^{1/4}$$

(b) Draw the "Heat flux" vs "Temperature excess" curve and explain the different regimes of boiling. **(15)**

4. (a) Draw a simple diagram of a multipass shell-and-tube heat exchanger and label its different components. **(12)**

(b) In a double-pipe heat exchanger the temperature difference between hot fluid and cold fluid varies continuously along the length of the exchanger. Therefore, some kind of mean temperature difference is to be used for heat transfer calculations Show mathematically that log-mean temperature difference is appropriate for this. **(10)**

(c) Hot water at 90°C flows through the inside of a 2.5-cm-ID steel tube with 0.8-mm wall thickness at a velocity of 4 m/s. This tube forms the inside of a double-pipe heat exchanger. The outer pipe has a 3.75-cm ID and water at 20°C flows in the annular space at a velocity of 6 m/s. Calculate the overall heat transfer coefficient for this arrangement. The tube length is 6 0 m. **(13)**

SECTION – B

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

5. (a) Derive an expression for the heat flow rate through a hollow sphere with inside radius r_i, outside radius r_0 and constant thermal conductivity k. The inside and outside surfaces of the hollow sphere are held at constant temperature T_i and T_o, respectively. State the assumptions, if any. **(15)**

(b) A spherical vessel used as a reactor for producing pharmaceuticals has a 10 mm thick stainless steel wall (k = 17 W/m.K) and an inner diameter of 1 m. The exterior surface of the vessel is exposed to ambient air (T = 25°C) for which a convection coefficient of 6 $W/m^2.K$ may be assumed.

(i) During steady-state operation, an inner surface temperature of 50°C is maintained by energy generated within the reactor. What is the heat loss from the vessel? **(10)**

(ii) If a 2-mm-thick layer of fiberglass insulation (k = 0.040 W/m.K) is applied to the exterior of the vessel and the rate of thermal energy generation is unchanged, what is the inner surface temperature of the vessel? **(10)**

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6. (a) With the help of schematics, explain the differences between hydrodynamic and thermal boundary layers. **(7)**

(b) Starting from the given simplified continuity and momentum equations, derive the expression for the laminar boundary layer thickness for a fluid flowing past a flat plate. **(28)**

$$\delta = 4.64\sqrt{\frac{\nu x}{u_\infty}}$$

where, u_∞ is the fluid velocity outside the boundary layer. Other symbols have their usual meanings. Also state the assumptions you make to derive the equation.

Continuity equation: $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial x} = 0$

Momentum equation: $\rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial x}\right) = u\frac{\partial^2 u}{\partial y^2} - \frac{\partial p}{\partial x}$

7. (a) It is suggested that eddy diffusivity plays a significant role during turbulent fluid flow inside a tube. For a scenario where heat and momentum transport rates are same and Pr = 1.0, derive the Reynolds analogy: **(20)**

$$st = \frac{f}{8}$$

HINT: Assume no slip condition at the wall and maximum fluid velocity at the tube center is u_m. Also given,

$$q_w = hA_w\left(T_w - T_b\right)$$

$$\tau_w = \frac{f}{8}\rho u_m^2$$

(b) Water is heated from 15°C to 60°C by passing it through a 1.91 cm-diameter thin-walled copper tube at 121°C. For a water flow rate of 0.181 Kg/s, determine the tube length required to achieve the desired heat transfer. Assume fully developed turbulent flow inside the tube and use LMTD for convective heat transfer calculation. At bulk mean temperature water properties: **(15)**

$\rho = 993.2$ Kg/m^3 $\qquad$ $k = 0.628$ W/m.K

$\nu = 0.686 \times 10^{-6}$ m^2/s $\qquad$ $c_p = 4183$ J/Kg.K

8. (a) In a food industry, sugar slurry flows through a 25-mm-diameter tube at a rate of 0.5 kg/s. The slurry enters the tube at a temperature of 25°C, while the tube surface temperature is maintained at 100°C. Determine the slurry outlet temperature for a 5-m long tube. Assume that the entrance region prevails in the entire tube length. **(15)**

Sugar slurry properties at average temperature:

$c_p = 2035$ J/Kg.K

$\mu = 0.0836$ N.s/m^2

$k = 0.141$ W/m.K

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Contd ... Q. No. 8

(b) A concentric pipe heat exchanger is used to cool lubricating oil for a large diesel engine. The inner pipe is of radius 3 cm and has water flowing through it at a rate of 0.3 Kg/s. The hot oil is flowing at a rate of 0.15 Kg/s through the annular region. The outer pipe radius is 5 cm. Assuming fully developed flow in both pipes, calculate the heat transfer coefficients for water and oil sides. For the calculation purpose, consider that the average temperatures of oil and water were 80°C and 35°C, respectively. **(20)**

Oil properties at 80°C:

$c_p = 2131$ J/Kg.K, $\mu = 3.25 \times 10^{-2}$ N.s/m^2 $k = 0.138$ W/m.K

Water properties at 35°C:

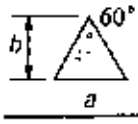
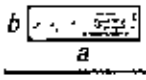
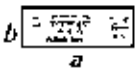
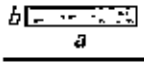
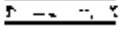
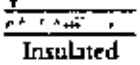
$c_p = 4178$ J/Kg.K, $\mu = 7.25 \times 10^{-4}$ N.s/m^2 $k = 0.625$ W/m.K

Table: Summary of forced-convection relations

Subscripts: b = bulk temperature, f = film temperature, ∞ = free stream temperature, w = wall temperature

Geometry	Equation	Restrictions
Tube flow	$\mathrm{Nu}_d = 0.023\,\mathrm{Re}_d^{0.8}\mathrm{Pr}^n$	Fully developed turbulent flow, $n = 0.4$ for heating, $n = 0.3$ for cooling, $0.6 < \mathrm{Pr} < 100$, $2500 < \mathrm{Re}_d < 1.25 \times 10^5$
Tube flow	$\mathrm{Nu}_d = 0.0214(\mathrm{Re}_d^{0.8} - 100)\mathrm{Pr}^{0.4}$ $\mathrm{Nu}_d = 0.012(\mathrm{Re}_d^{0.87} - 280)\mathrm{Pr}^{0.4}$	$0.5 < \mathrm{Pr} < 1.5$, $10^4 < \mathrm{Re}_d < 5 \times 10^6$ $1.5 < \mathrm{Pr} < 500$, $3000 < \mathrm{Re}_d < 10^6$
Tube flow	$\mathrm{Nu}_d = 0.027\,\mathrm{Re}_d^{0.8}\mathrm{Pr}^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$	Fully developed turbulent flow
Tube flow, entrance region	$\mathrm{Nu}_d = 0.036\,\mathrm{Re}_d^{0.8}\mathrm{Pr}^{1/3}\left(\frac{d}{L}\right)^{0.055}$ See also Figures G-5 and G-6	Turbulent flow $10 < \frac{L}{d} < 400$
Tube flow	Petukov relation	Fully developed turbulent flow, $0.5 < \mathrm{Pr} < 2000$, $10^4 < \mathrm{Re}_d < 5 \times 10^6$, $0 < \frac{\mu_b}{\mu_w} < 40$
Tube flow	$\mathrm{Nu}_d = 3.66 + \frac{0.0668(d/L)\,\mathrm{Re}_d\mathrm{Pr}}{1 + 0.04[(d/L)\,\mathrm{Re}_d\mathrm{Pr}]^{2/3}}$	Laminar, $T_w = \text{const.}$
Tube flow	$\mathrm{Nu}_d = 1.86(\mathrm{Re}_d\mathrm{Pr})^{1/3}\left(\frac{d}{L}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$	Fully developed laminar flow, $T_w = \text{const.}$ $\mathrm{Re}_d\mathrm{Pr}\frac{d}{L} > 10$
Rough tubes	$\mathrm{St}_b\mathrm{Pr}_f^{2/3} = \frac{f}{8}$ or Equation (G-7)	Fully developed turbulent flow
Noncircular ducts	Reynolds number evaluated on basis of hydraulic diameter $D_H = \frac{4A}{P}$ A = flow cross-section area, P = wetted perimeter	Same as particular equation for tube flow

Table: Heat transfer and fluid friction for fully developed laminar flow in ducts of various cross sections. Average Nusselt numbers based on hydraulic diameters of the cross sections

Geometry ($L/D_h > 100$)	Nu_H Constant axial wall heat flux	Nu_T Constant axial wall temperature	$f\,Re_{D_H}/4$
 $\frac{b}{a} = \frac{\sqrt{3}}{2}$	3.111	2.47	13.333
 $\frac{b}{a} = 1$	3 608	2.976	14.227
	4 002	3 34	15 054
 $\frac{b}{a} = \frac{1}{2}$	4.123	3.391	15.548
	4 364	3 657	16.000
 $\frac{b}{a} = \frac{1}{4}$	5.331	4.44	18.23
 $\frac{b}{a} = \frac{1}{3}$	4.79	3.96	17.25
 $\frac{b}{a} = \frac{1}{8}$	6.490	5.597	20.585
 $\frac{b}{a} = 0$	8 235	7.541	24 000
 $\frac{b}{a} = 0$	5 385	4.861	24.000

L-3/T-1/CHE **Date : 30/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc Engineering Examinations 2013-2014

Sub : **MME 391** (Fundamentals of Metallurgy)

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) Show that total ideal work done in a typical rolling process can be expressed as $\frac{2}{\sqrt{3}}\sigma_0\left(\epsilon_1^2+\epsilon_1\epsilon_2+\epsilon_2^2\right)^{1/2}$, where, the symbols have their usual meanings. Make necessary assumptions. **(18)**

   (b) Explain with malleableizing cycle how ferritic malleable cast-iron is produced from white cast-iron. **(10)**

   (c) Show and explain the variation of tensile strength of gray cast-iron with carbon and silicon content. **(7)**

2. (a) Which aluminum alloy is most frequently used for aircraft structures and why? **(5)**

   (b) Draw a phase diagram of aluminium-copper alloy and show microstructural changes that occur in an Al-4%Cu alloy during slow cooling from 700°C to room temperature. **(20)**

   (c) Elucidate the relationship of conductivity, strength, and thermal transformation of a 2014 aluminium alloy. **(10)**

3. (a) What is stress corrosion cracking of yellow alpha brass and how it is prevented? **(10)**

   (b) With a neat sketch show all points, lines and phase field of the useful part of copper-zinc phase diagram. **(10)**

   (c) Describe microstructural changes of a yellow alpha brass containing 30% Zn while cooling it from 1000°C to room temperature. **(15)**

4. (a) Explain with necessary graphical representation a typical cold-work-anneal cycle. Strain hardening in an alloy due to cold-working is expressed as: **(5+10)**

   $$\sigma = 150.000\ \epsilon^{0.5}\ \text{MPa}$$

   Calculate true and engineering σ_{UTS}. Where, the symbols have their usual meanings.

   (b) Show the relationship between the reduction of area and the reduction in height or thickness in a typical metal-forming process. **(12)**

   (c) A strip of metal of 1.0 m long is stretched in three steps: to length of 1.5 m, then to 2.0 m, finally to 2.5 m. Calculate engineering and true strains. Comment on obtained results. **(8)**

Contd P/2

MME 391/CHE

SECTION – B

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

5. (a) Mention the composition of the hot metal obtained from blast furnace. **(5)**

   (b) Explain the principles of removing impurities from hot metal for steel making. **(15)**

   (c) Discuss the retaining stages of hot metal in a BOF steel making process with chemical reactions. **(15)**

6. (a) Draw the iron and iron carbide thermal equilibrium diagram labeling all points, lines and phase fields (use a graph paper and draw the diagram to scale). **(17)**

   (b) Describe briefly the microstructural changes that occur in a mild steel containing 0.20 percent carbon during slow cooling from austenite range to room temperature. **(18)**

7. (a) Distinguish between full annealing and spherodize annealing. Give the important advantages of each. **(10)**

   (b) (i) Draw the isothermal-transformation diagram for a eutectoid steel and label it. **(10)**

   (ii) What is bainitic structure? Is it possible to produce 100% bainitic structure by continuous cooling of a plain carbon steel? If possible, explain. If not possible describe how 100% bainitic structure could be produced. **(15)**

8. (a) Explain the limitations of plain carbon steels? **(10)**

   (b) Discuss the influence of alloying elements on the iron-iron carbide diagram. **(10)**

   (c) What are stainless steels? Mention different types of stainless steels with their composition, properties and uses **(15)**

L-3/T-1/CHE Date : 30/07/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **MATH 323** (Fourier Analysis, Harmonic Functions and Partial Differential Equations)

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 Fourier series for **(20)**

$$f(x)=\begin{cases}-\pi, & -\pi < x < 0\\ x, & 0 < x < \pi\end{cases}$$

Hence deduce $\frac{\pi^2}{8}=1+\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}+\ldots\ldots$

(b) Expand $f(x) = x$, $0 < x < 2$ in a half range sine series and cosine series. **(15)**

2. (a) Expand the function **(15)**

$$f(x)=\begin{cases}1, & 0 \le x \le 1\\ -1, & 1 < x \le 2\end{cases}$$

in a Fourier sine series and find the sum of the series at $x = 1$.

(b) Find the Fourier transform of **(20)**

$$f(x)=\begin{cases}1-|x|, & |x|<1\\ 0, & |x|>1\end{cases}$$

and hence evaluate $\int_0^\infty \frac{\sin^4 x}{x^4}\,dx$.

3. (a) Find the Fourier sine integral of **(18)**

$$f(x)=\begin{cases}\sin x, & 0 \le x \le \pi\\ 0, & x > \pi\end{cases}$$

and then evaluate $\int_0^\infty \frac{\sin \pi\omega \sin x\omega}{1-\omega^2}\,d\omega$.

(b) Use finite Fourier transform to solve **(17)**

$$\frac{\partial u}{\partial t}=2\frac{\partial^2 u}{\partial x^2}, \qquad 0 < x < 4,\ t > 0,\ u(0, t) = u(4, t) = 0$$

$$u(x, 0) = 3\sin\pi x - 2\sin 5\pi x$$

Also give a physical interpretation of the solution.

Contd P/2

MATH 323/CHE

4. (a) Prove that $\int_0^\infty \frac{x \sin mx}{x^2+1}\,dx = \frac{\pi}{2}e^{-m}$, $m > 0$. **(10)**

(b) Find the solution of the boundary value problem **(25)**

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$

$u(0, t) = 1$, $u(\pi, t) = 3$, $u(x, 0) = 2$ where $0 < x < \pi$, $t > 0$

SECTION – B

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

Symbols used have their usual meaning.

5. (a) Apply Lagrange's auxiliary equation technique to solve: **(11)**

$(y - zx)\,p + (x + yz)\,q = x^2 + y^2$

(b) Solve the following PDE's by Charpit's method:

(i) $2xz - px^2 - 2qxy + pq = 0$ **(12)**

(ii) $px + qy = pq$ **(12)**

6. Solve the following higher order PDEs:

(a) $\left(D_x^3 - 4D_x^2 D_y + 4D_x D_y^2\right)z = 4\sin(2x + y)$ **(11)**

(b) $\left(3D_x^2 - 2D_y^2 + D_x - 1\right)z = 4e^{x+y}\cos(x + y)$ **(12)**

(c) $\left(x^2 D_x^2 - xyD_x D_y - 2y^2 D_y^2 + xD_x - 2yD_y\right)z = x^2 y^3$ **(12)**

7. (a) Write down the Laplace's equation in two dimension in polar co-ordinates and hence find its solution. **(20)**

(b) Find the steady temperature inside a solid sphere of unit radius if the temperature of its surface is given by $U_0 \cos\theta$. **(15)**

8. (a) Find the potential of the region inside and outside of a spherical surface. **(17)**

(b) Temperature distribution V inside a homogeneous solid satisfies the equation $\frac{\partial V}{\partial t} = h^2 \nabla^2 V$ where h^2 is the diffusivity of the substance and is a constant. Determine the steady state temperature within the plate subject to the boundary conditions **(18)**

$$\left.\begin{matrix} V = 0 \\ x = 0 \end{matrix}\right\} \quad \left.\begin{matrix} V = 0 \\ x = s \end{matrix}\right\} \quad \left.\begin{matrix} V = 0 \\ y = \infty \end{matrix}\right\} \quad \left.\begin{matrix} V = F(x) \\ y = 0 \end{matrix}\right\}$$

L-3/T-1/CHE **Date : 30/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHE 451** (Fuels and Combustion Science)

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 main sources of atmospheric Black Carbon and PM 2.5 in Dhaka city with respect to combustion process? Write down their relative contributions to total Black Carbon and PM 2.5 in Dhaka city. What are the possible soot formation pathway and its mitigation option in the combustion process? – State briefly. What are the reasons that can initiate dioxins formation in combustion process? How can one avoid dioxin formation in combustion process? – Write briefly. **(5+10+10+10)**

2. What are the criteria of a good burner? Discuss the codes for gas burner classification How many types of conventional gas burners are there? – Describe different types of gas burners along with their symbols, fluid mixing phenomena and velocity profile. **(5+5+25)**

3. (a) Show the classification of solid fuel firing systems on pressure drop-flow diagram What type of solid fuel firing system do you recommend for a 500 MW power plant? – Describe its working principle with a neat sketches. **(20)**

   (b) Briefly discuss the gasification steps of solid fuel (coal) in a fluidized bed gasifier along with its temperature profile. **(15)**

4. (a) What are different steam turbine cogeneration systems? – Show them with schematic diagram. **(10)**

   (b) A process industry has decided to install cogeneration plant. The process requirements are: **(25)**

   – The plant requires 4.5 MW of electrical power

   – The boiler has maximum steam generating capacity of 31.25 TPH at 63 kg/cm^2 pressure and a temperature of 486°C.

   – The table below gives the process steam requirements:

Process	Steam flow (TPH)	Pressure (kg/cm^2)	Temperature (°C)	Enthalpy (K cal/kg
Boiler	31.25	63	486	808
Process # 1	3.25	21	310	669
Process # 2	8.00	8.0	174	662
Process # 3	20.00	5.0	160	659

Contd P/2

CHE 451

Contd ... Q. No. 4(b)

(i) Determine the total power that could be generated by a single turbine that meets the process steam requirements.

(ii) Calculate the additional amount of power to be purchased from the grid.

(iii) Calculate the heat to power ratio of the cogeneration plant.

SECTION – B

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

5. (a) Draw and describe the Van Krevelen plot. **(10)**

(b) "Gaseous fuels are simpler to ignite, handle and control than liquid or solid fuels" – why? **(5)**

(c) What is the difference between external ignition and autoignition? What do you understand by ignition limits? **(5+5)**

(d) "Energy production by combustion must increase to meet the global energy demand" – what is your opinion in this matter? **(5)**

(e) What are the objectives of studying combustion science? **(5)**

6. (a) Describe the fire triangle and its significance in fire fighting. **(5)**

(b) A 6-year old pump motor is to be replaced. The new motor, just like the old one, would run 75% of the time. Both existing and replacement motors would operate at 100 OUTPUT HP (Brake HP). The existing motor efficiency is 86% while the replacement motor would be guaranteed at 94% efficiency. Electricity currently averages BDT 7.42 per kWH. Calculate the energy cost saving per year (assume 365 days/yr) if the existing motor is replaced with the new motor. **(10)**

(c) A refinery fuel gas has the composition: 75 (volume)% butane, 10% propane, 15% ethane. Determine the fuel gas temperature if the fuel is burned with 15% excess air. Given: **(20)**

LHV of ethane = -1.43×10^6 kJ/mol

LHV of propane = -2.04×10^6 kJ/mol

LHV of butane = -2.65×10^6 kJ/mol

(See attached specific heat capacity data)

7 (a) The exhaust gases from a furnace are leaving at 900 °C at the rate of 2100 m^3/hour. The owner of the process wants to recover the waste heat and asked you the following questions:

(i) What will be the minimum temperature of the exhaust gas stream if you recover heat using a heat exchanger? What limits the minimum temperature? **(3+2)**

(ii) What is the maximum recoverable heat? **(5)**

(iii) If this heat is recovered by installing a recuperator, to preheat the combustion air, what is the fuel (NG) savings? Volume of combustion air = 200 m^3/hour. **(15)**

Contd P/3

CHE 451

Contd ... Q. No. 7(a)

You can use the following additional information to answer his query –

specific heat of the fuel gas = 0.24 K cal/kg.°C

calorific value of NG = 35 MJ/m^3

density of the flue gas = 1.19 kg/m^3

specific heat of air = 0.24 K cal/kg.°C

density of air = 1.22 kg/m^3

(b) Describe the working principle of **(5+5)**

(i) a heat wheel

(ii) a heat pipe

8. (a) What is a Brayton cycle? What is a Rankine cycle? What advantages can you gain from combining these two cycles? **(15)**

(b) Very often, the power engineer is required to perform some basic calculations regarding the key parameters of a power plant. Most important is the quantity and cost of fuel that is required. Make an estimate of the coal required for running a power plant of 100 MW capacity. **(20)**

Additional information:

Gross colorific value (GCV) of coal = 20,000 kJ/kg

Efficiency of the boiler and combustion = 88% on GCV basis

Steam cycle efficiency = 42%

Turbine efficiency = 97%

Cost of coal = $ 65/tonne

For Question 6 (c)

Specific Heat Capacities at High Temperatures

$\hat{c}_p = \alpha + \beta T + \gamma T^{-2}$ T in K.

Component	Formula	Temperature Range K.	$\hat{c}_p$ J (mol)$^{-1}$ (K)$^{-1}$		
			α	$\beta \times 10^3$	$\gamma \times 10^{-5}$
oxygen	(O_2)	298 - 3000	29.97	4.19	- 1.67
Nitrogen	(N_2)	298 - 3000	28.59	3.77	- 0.50
Hydrogen	(H_2)	298 - 3000	27.29	3.27	0.50
Argon	(Ar)	298 - 8000	20.80	0.0	0.0
Carbon monoxide	(CO)	298 - 2500	28.42	4.10	- 0.46
Carbon dioxide	(CO_2)	298 - 2500	44.25	8.79	- 8.62
Water	(H_2O)	298 - 373	75.52	0.0	0.0
Steam	(H_2O)	298 - 2750	30.56	10.30	0.0
Sulphur dioxide	(SO_2)	298 - 2000	46.21	7.87	- 7.70
Sulphur trioxide	(SO_3)	298 - 1500	58.19	25.53 -	- 13.48
Sulphur	(S)	298 - 2400	22.02	- 0.42	1.51
Mercury vapour	(Hg)	298 - 6000	20.80	0.0	0.0
Methane	(CH_4)	298 - 1500	23.65	47.89	- 1.93
Acetylene	(C_2H_2)	298 - 2000	50.78	16.07	- 10.30
Iron	< Fe >$_\alpha$	298 - 1033	12.73	31.73	2.51
Carbon (graphite)	< C >	298 - 2500	16.87	4.77	- 8.54
Carbon (diamond)	< C >	298 - 1200	9.50	12.81	- 6.45
Ferrous oxide	< $Fe_{0.95}$ O>	298 - 1650	48.81	8.37	- 2.80
Ferric oxide	< Fe_2O_3 >	298 - 950	98.33	77.86	- 14.86
Magnetite	< Fe_3O_4 >	298 - 900	91.59	201.76	0.0

Data taken from K.K. Kelley, U.S. Bur. Mines Bull 584,

L-3/T-1/CHE **Date : 04/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B Sc Engineering Examinations 2013-2014

Sub : **HUM 201** (Sociology)

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 major environmental problems now challenge the ecosystems of modern industrial societies? **(10)**

   (b) Why can't technology solve all the problems of diminishing resources and environmental pollution? **(15)**

   (c) How does the "Tragedy of the Commons" help explain environmental destruction? **(10)**

2. (a) How would a Malthusian theorist's view of current world population patterns differ from that of a demographic transitionist? **(15)**

   (b) What is the demographic "fallout" of explosion? **(10)**

   (c) What social factors influence our health? **(10)**

3. (a) According to symbolic interactionism, how does social change influence our personal life? **(15)**

   (b) How is technology changing our society? **(10)**

   (c) What impact did the industrial revolution have on societies? **(10)**

4. Write short notes on any THREE of the following: **(35)**

   (a) Green house gases and global warming

   (b) Orange category A industry and Green category industry

   (c) Impacts of capitalism on a society

   (d) The functions of a family.

SECTION – B

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

5 (a) Illustrate the cultural impact of globalization on developing nations. **(10)**

(b) Critically discuss the argument of Immanuel Wallerstein on 'World System Theory'. **(10)**

(c) Describe the causes of poverty in Bangladesh by citing examples from our society. **(15)**

Contd P/2

HUM 201/CHE

6. (a) Explain different types of crime with suitable examples. **(10)**

   (b) Make a comparison between crime and deviance? **(10)**

   (c) Illustrate the social factors associated with deviant behaviour. **(15)**

7. (a) Explain the major forces of international migration in Bangladesh. **(10)**

   (b) Briefly discuss the functions of family in society. **(10)**

   (c) Who are juveniles? Discuss the causes of juvenile delinquency in our society. **(15)**

8. Write short notes on any THREE of the following: **(35)**

   (a) Uses of sociology for chemical engineering students,

   (b) Characteristics of culture,

   (c) Interactionist perspective,

   (d) Steps of social research.

L-3/T-1/CHE Date : 04/08/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **HUM 203** (Government)

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 state. Discuss the essential elements of a modern state. **(15)**

   (b) How do you define a constitution? Describe various types of constitution with examples. **(20)**

2. (a) Discuss the rights and duties of a citizen in a state. **(15)**

   (b) Define foreign policy. Analyze the principles of Bangladesh foreign policy. **(20)**

3. (a) Discuss the reasons and consequences of mass upsurge of 1969. **(15)**

   (b) 'Crisis of national integration was the main reason behind the emergence of Bangladesh' – discuss this statement. **(20)**

4. Write short notes on any three (3) of the following: **(35)**

   (a) Internationalism

   (b) Good Governance

   (c) Popular Sovereignty

   (d) Independence of Judiciary

SECTION – B

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

5. (a) Analyze the merits and demerits of democracy. **(15)**

   (b) Make a comparative discussion on parliamentary and presidential forms of government. **(20)**

6. (a) Define political party. Discuss the functions of the political parties in a democracy country. **(15)**

   (b) Discuss the salient features of the constitution of Bangladesh. **(20)**

Contd P/2

HUM 203/CHE

7. (a) Write short notes on the following topics: **(15)**

   (i) Unitary form of Government

   (ii) Socialism

   (b) Describe the rule making process in Bangladesh **(20)**

8. (a) What do you know about the United Nations Organization (UNO)? Discuss the achievements and failures of it. **(15)**

   (b) Define electoral college. Discuss about the political system of USA. **(20)**

L-3/T-1/CHE **Date : 04/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **HUM 303** (Principles of Accounting)

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) What is meant by product's CM ratio? How is this ratio useful in planning business operations? **(5)**

(b) Crown Creative inc. makes high quality Personal Digital Assistant (PDA). Sales and production data relating to the most recent year are given below: **(30)**

Sales (in unit)	2800
Selling price per unit	Tk 265
Contribution Margin Ratio	60%
Annual fixed expenses	Tk 111300

Management is anxious to improve the company's profit performance and has asked for several items of information.

Required:

(i) Compute break-even point in units and sales Taka.

(ii) Assume that sales increases by Tk. 60,000 next year. If cost behavior patterns remain unchanged, by how much will the company's net income increase?

(iii) Refer to the original data. Assume that next year management wants to earn a Tk.182,850 profit. How many units will have to be sold to meet this target profit?

(iv) Refer to the original data. Compute margin of safety both in Taka and percentage form.

(v) Refer to the original data. The sales manager is convinced that a 15% reduction in the selling price combined with a Tk. 56100 increase in advertising cost would cause annual sales in units to increase by 40%. Would you recommend that the company should do as the sales manager suggests?

(vi) * Compute degree of operating leverage at the present level of sales.

* Assume that the company likes to increase its net profit by 90% next year. By what percentage would you expect sales to increase? Use degree of operating leverage (DOV) to answer.

* Verify your answer by preparing income statement.

Contd P/2

HUM 303/CHE

2. (a) What is the basic difference between absorption costing and variable costing? **(5)**

(b) Chuck Wagon Grills manufacturing company makes a single product — a hand made specially barbecue gril that it sells for Tk. 210. Data for least year's operations follow: **(30)**

Units in beginning inventory	- 0 -
Units produced	20,000
Units in ending inventory	1000
Unit sold	19,000
Variable cost per units:	
Direct Materials	Tk. 50
Direct Labour	80
Variable manufacturing overhead	20
Variable selling and administrative overhead	10
Fixed cost:	
Fixed manufacturing overhead	Tk. 700,000
Fixed selling and administrative overhead	285,000

Required:

(i) Compute unit production cost under both absorption costing and variable costing method;

(ii) Prepare income statement under both of the methods;

(iii) Explain the reason for any difference between the net income under the both methods.

3. (a) Discuss the concepts - costs, expenses, losses and assets from cost accounting point of view. Give one example illustrating the relationship between them. **(5)**

(b) The data below have been taken from the cost records of Beverles Hospital. A careful study by the company's cost analyst has determined that if the number of X-rays taken is 7000, the average operating cost is Tk. 4.14 per X-ray. If the number of X-rays taken is 3000, the average cost is Tk. 5.65 per X-ray. **(15)**

Required:

(i) Using high-low point method, determine the variable cost per X-ray taken and the fixed cost in total.

(ii) Express the variable cost and fixed cost in the cost equation.

(iii) If the number of X-rays taken in a month is 4600, what total operating X-rays costs would you expect?

(iv) What is the major disadvantage of high-low point method?

Contd P/3

HUM 303/CHE

Contd... Q. No. 3

(c) The following information has been taken from the records of Blue-bird company: **(15)**

Particulars	Tk.
Raw materials purchased	100,000
Direct labour	200,000
Indirect labour	3,000
Salesman's salaries	25,000
Miscellaneous factory expenses	4,000
Fuel for the factory equipment	2,000
Factory insurance	8,000
Depreciation, factory plant	40,000
Depreciation, office equipment	12,000
Power and electricity	5,000
Sales	420,000
Advertisement	17,000
Office salaries	30,000
Office rent	20,000
Utilities (40% for factory, 60% for office)	15,000

Inventories	January 1	December 31
Raw materials	Tk 10,000	Tk 12,000
Work-in process	15,000	9,000
Finished goods	5,000	7,000

Requirements:

(i) Prepare a cost of goods sold statement and

(ii) An income statement for the year.

4. (a) Explain the purpose of cost allocation. **(5)**

(b) Phoenix consulting provides outsourcing services and advice to both government and corporate clients. For costing purposes, phoenix classifies its departments into two support departments (Human Resources and Information Systems) and two producing departments (Government Consulting and corporate consulting). For the first quarter of 2013, overhead costs across the departments and other data is given below: **(25)**

Contd P/4

IIUM 303/CHE

Contd... Q. No. 4(b)

	Support Department		Producing Department	
	Human Resources	Information System	Government Consulting	Corporate Consulting
	Tk.	Tk.	Tk.	Tk.
Overhead costs before allocation	600,000	24,00,000	87,56,000	124,52,000
Supported by (in percentage)				
Human Resources	–	25%	40%	35%
Information Systems	10%	–	30%	60%

Requirements:

You are asked to allocate the two support departments cost to the two producing departments using the following methods:

(i) Direct Method

(ii) Reciprocal Service Method.

(c) A production department of a manufacturing company has five different groups of machines. The machine hour rate of each of five machines are: **(5)**

Machine Group	I	II	III	IV	V
Machine Hour Rate (Tk.)	2.33	3.05	2.98	4.83	2.21

Requirements:

Calculate the overhead cost that will be absorbed by one unit of Product A and one unit of Product B on the manufacture of which the following time (in hours) are spent in the machine groups of this departments:

Machine Group	I	II	III	IV	V
Product A (each unit)	2	–	7	1	2
Product B each unit	4	1	–	6	1

SECTION – B

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

5. (a) What are the assumptions of Accounting according to Generally Accepted Accounting Principles (GAAP)? **(5)**

(b) Define gains and losses with example. **(5)**

Contd P/5

HUM 303/CHE

Contd... Q. No. 5

(c) "Unique Boutiques" was opened on June 1, 2014 by Mr. Y. The following transactions occurred in the month of June– **(25)**

June 1. Mr. Y invested Tk. 100,000 cash in the business.

June 2: Purchased a machine for Tk. 50,000 in cash.

June 5: Gave an advertisement to the news paper costing Tk. 7,000; the payment will be made on next month.

June 6: Borrowed Tk. 100,000 in cash from City Bank by signing notes payable.

June 10: Earned revenue Tk. 80,000 by delivering products, 50% of which received in cash and the remaining balance was on account.

June 13: Purchased office supplied for Tk. 10,000; Paid Tk 8,000 in cash and the remaining amount will be paid in a later date.

June 14: Received Tk. 20,000 cash from the customers related to transaction June 10.

June 16: Paid to accounts payable Tk. 2,000 in cash.

June 25: Paid office rent in cash Tk. 25,000 in cash.

June 28: Withdrew Tk. 5,000 cash from the business for personal use.

Required:

(i) Prepare a tabular summary for the month of June, 2014.

(ii) Prepare an Income Statement for the month of June.

6. (a) What is a trial balance and what is its purpose? **(5)**

(b) Mr. Mamun started a business on February 1, 2015. The following transactions took place during the month- **(30)**

February 1: Owner invested Tk. 800,000 cash in the business.

February 2: Service provided to a customer but not yet received Tk. 60,000.

February 3: Purchased equipment costing Tk. 70,000; A cash payment of Tk. 50,000 was made.

February 7: Paid the monthly salary of the two employees, totaling Tk. 20,000 in cash.

February 10: Incurred utility expenses for the month on account Tk. 2,000.

February 11: Made an investment by Mr. Mamun for Tk. 400,000 in cash

February 13: Received Tk. 10,000 in cash from the customer by providing services.

February 22: Paid telephone bill for the month Tk. 5,000 in cash.

February 25: Paid Tk. 15,000 to account payable for equipment.

February 25: Received Tk. 50,000 in cash from customers in payment of accounts receivables.

Required:

(i) Give journal entries for the month of January, 2012.

(ii) Prepare the ledger of "Cash Account".

Contd P/6

HUM 303/CHE

Contd... Q. No. 5

7. (a) What are the basic reasons of recording adjusting entries? Explain. **(5)**

(b) The Trial Balance of "Navana Builders" on May 31, 2014 is given below- **(30)**

"Navana Builders"

Trial Balance

May 31, 2014

Accounts Title	Debit (Tk.)	Credit (Tk.)
Cash	15,000	
Accounts receivable	7,000	
Prepaid insurance	2,400	
Supplies	1,500	
Office furniture	15,000	
Account payable		5,500
Unearned service revenue		6,000
Capital		27,500
Service revenue		7,900
Salary expense	2,000	
Rent expense	1,000	
Maintenance expense	2,000	
Drawings	1,000	
Total	**46,900**	**46,900**

Other Information:

* Supplies on hand Tk. 1000.
* Maintenance expense incurred but not paid on May 31, Tk. 8000.
* Tk. 3.000 of service perfonned during the month but has not been recorded as on May 31.
* Insurance policy is for two years.
* Interest accrued on May 3, is Tk. 1,000.
* Office equipment is being depreciated at Tk. 250 per month.
* Accrued salary is Tk. 1000.

Required:

(i) Prepare necessary adjusting entries.

(ii) Prepare an adjusted trial balance as on May 31, 2014.

Contd P/7

HUM 303/CHE

8. (a) What are the standards for comparison in the case of ratio analysis? **(5)**

(b) The following accounts are taken from the ledger balances of "P" Company Ltd on 31st December, 2014 **(30)**

"P" Company Ltd

Trial Balance

31st December, 2014

Accounts Title	Debit (Tk.)	Credit (Tk.)
Cash	60,800	
Accounts receivable	20,500	
Account payable		21.000
Capital		71,000
Land	25,000	
Sales revenue		30,200
Salary expense	12,000	
Prepaid rent	4,000	
Unity expense	1,000	
Commission expense	3,000	
Supplies	1,000	
Notes payable		7,100
Drawings	2,000	
Goodwill	20,000	
Machinery	100,000	
Long term investment	50,000	
Bond payable		155,000
Wage payable		15,000
Total	**299,300**	**299,300**

Adjustments data:

(i) Accrued salary is Tk. 500.

(ii) Tk. 5,000 of notes payable will be paid in the year 2016.

Required:

(i) Prepare a single step income statement for the year ended December, 2014,

(ii) Prepare an owners' equity statement and a classified balance sheet on 31st December, 2014.

L-3/T-1/CHE **Date : 08/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHE 307** (Chemical Engineering Thermodynamics II)

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) Show that the Linde process is a limiting case of the claude process with necessary diagram and equation. (15)

(b) A refrigerator with tetra fluoroethane as refrigerant operates with an evaporation temperature of -26°C and a condensation temperature of 27°C. Saturated liquid refrigerant from the condenser flows through an expansion valve into the evaporator, from which it emerges as saturated vapor. (20)

i) For cooling rate of 5.3 kW, what is the circulation rate of the refrigerant?

ii) Suppose the cycle of (i) is modified by the inclusion of a counter current heat exchanger between the condenser and the throttle valve in which heat is transferred to vapor returning from the evaporator. If liquid from the condenser enters the exchanger at 27°C and if vapor from the evaporator enters the exchanger at -26°C and leaves at 21°C, what is the circulation rate of the refrigerant?

iii) Determine COP for isentropic compression of the vapor for case (i) and (ii).

2. (a) Derive a relation between standard Gibbs-energy change and the equilibrium constant. (10)

(b) Prove that for gas phase reaction: (10)

$$\prod (y_i)^{\nu_i} = \left(\frac{P}{P^o}\right)^{-\nu} K$$

(c) The feed gas to a methanol synthesis reactor is composed of 75 mole % H_2, 15 mole % CO, 5 mole % CO_2 and 5 mole % N_2. The system comes to equilibrium at 550 k and 100 bar with respect to the reactions: (15)

$$2H_2(g) + CO(g) \rightarrow CH_3OH(g)$$

$$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$$

Assuming ideal gases, determine the composition of the equilibrium mixtures.

3. Ethanol is produced from ethylene via the gas phase reaction

$$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$$

Reaction conditions are 400K and 2 bar.

a) Determine a numerical value for the equilibrium constant K for this reaction at 25°C. (15)

Contd P/2

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Contd ... Q. No. 3

(b) Determine the value of K at 400K. (5)

(c) Determine the composition of the equilibrium gas mixture for an equimolar feed containing only ethylene and H_2O. (10)

(d) For the same feed as in part (c), but for P = 1 bar, would the equilibrium mole fraction of ethanol be hither or lower? Explain. (5)

4 (a) By clearly showing all the necessary equations, write a block diagram for the calculation of Dew T. (15)

(b) With a neat sketch, write the working principle of an absorption refrigeration system. Derive necessary equations. (10)

(c) A system initially containing 2 mol C_2H_4 and 3 mol O_2 undergoing the reactions (10)

$$C_2H_4(g)+\frac{1}{2}O_2(g)\rightarrow((CH_2)_2O(g)$$

$$C_2H_4(g)+3O_2(g)\rightarrow 2CO_2(g)+2H_2O(g)$$

Develop expression for the mole fractions of the reacting species as function of the reaction coordinates.

SECTION-B

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

5. (a) Of the following fine binary liquid/vapor systems, which can be approximately modeled by Raoult's law? Explain your answer. (Hint: Table B.1 of App B may be useful) (15)

i) Benzene/toluene at 1 atm.

ii) n-Hexane/n-heptane at 25 bar

iii) Hydrogen/propane at 200K

iv) Iso-Octane/n-Octane at 373.15 K

v) Water/n-decane at 1 bar.

(b) A binary system of species 1 and 2 consists of vapor and liquid phase in equilibrium at temperature T, for which (20)

$$\ln\gamma_1 = 1.8\ x_2^2 \qquad \ln\gamma_2 = 1.8x_1^2$$

$$P_1^{sat} = 1.24 \text{ bar} \qquad P_2^{sat} = 0.89 \text{ bar}$$

(i) for what range of values of the overall mole fraction z_1 can this two-phase system exist with a liquid mole fraction $x_1 = 0.65$.

(ii) what is the pressure P and vapor mole fraction y_1 within this range?

(iii) What are the pressure and composition of the azeotrope at temperature T?

Contd P/3

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6. (a) Define fugacity. What is its physical significance? (8)

(b) The excess Gibbs energy of a binary liquid mixture at T and P is given by (27)

$$\frac{G^E}{RT} = \left(-2.6x_1 - 1.8x_2\right) x_1 x_2$$

(i) Find expressions for $\ln\gamma_1$ and $\ln\gamma_2$ at T and P

(ii) Show that these expressions satisfy the Gibbs/Duhem equation.

(iii) Plat $\ln\gamma_1$ and $\ln\gamma_2$ versus x_1, Label points $\ln\gamma_1^{\infty}$, $\ln\gamma_2^{\infty}$ and show their values.

7. (a) "Henry's law applies to a species as it approaches infinite dilution in a binary solution, and the Gibbs/Duhem equation insures validity of the Lewis/Randall rule for the other species at it approaches purity"-justify this statement with necessary equations. (18)

(b) Figure for Question No. 7(b) presents the plots of excess properties of two binary mixtures. Draw the corresponding plots of $\ln\gamma_1$ and $\ln\gamma_2$ vs x_1 qualitatively. (Hints: for $x_i \rightarrow 1$, $\ln\gamma_i \rightarrow 0$ and i generally have the same sign as G^E.) (10)

(c) What is the basic criterion to check whether the experimental values of activity coefficients contain systematic error? (07)

8. (a) A concentrated binary solution containing mostly species 2 (but $x_2 \neq 1$) is in equilibrium with a vapor phase containing both species 1 and 2. The pressure of this two-phase system is 1 bar; the temperature is 298.15 K. Determine from the following data good estimates of x_1 and y_1

$H_1 = 200$ bar $P_2^{Sat} = 0.10$ bar

State and justify all assumptions. (15)

(b) For SO_2 at 600K and 300bar, make good estimates of the fugacity and $\frac{G^R}{RT}$. (14)

(Hint: use the supplied data book and figure for Question No. 8(b))

(c) Distinguish between excess properties and residual properties. (6)

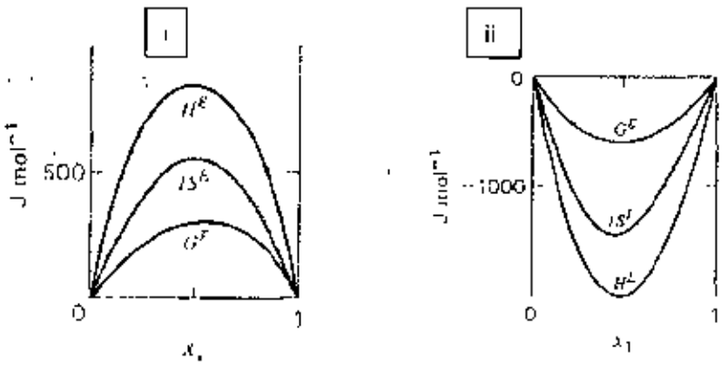
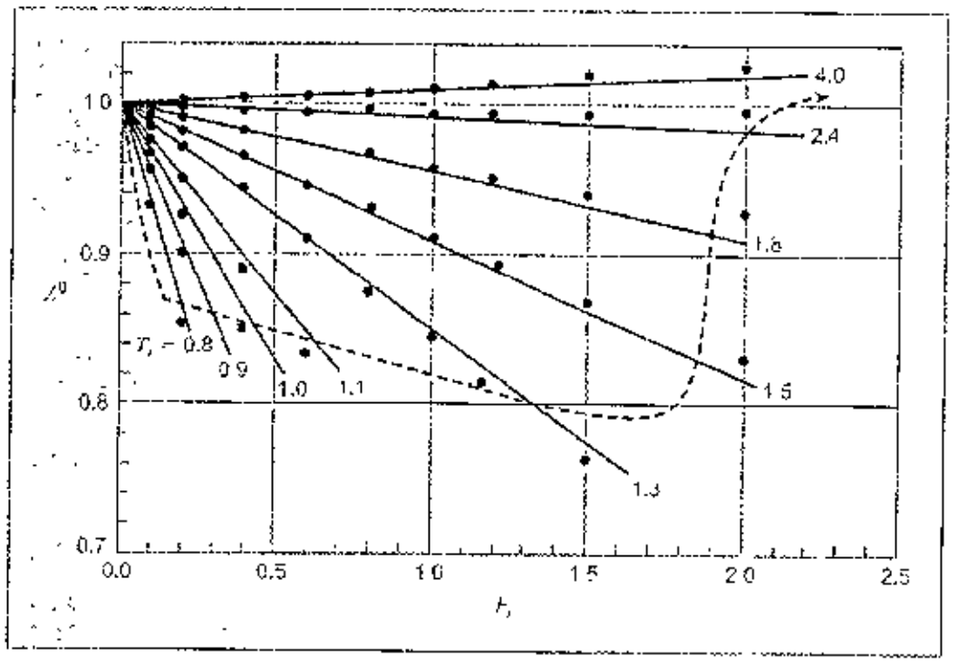


Figure for Question 7 b) excess properties at 323.15 K for i) chloroform(1)/n-heptane (2) and ii) acetone(1)/chloroform(2)



Comparison of correlations for Z^0. The virial-coefficient correlation is represented by the straight lines; the Leo/Kesler correlation, by the points.

Figure for Question No. 8 (b)