L-3/T-1/CHE **Date : 16/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Heat Transfer Data booklet will be supplied.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

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

   (b) Steam flowing through a long, thin-walled pipe maintains the pipe wall at a uniform temperature of 500 °K. The pipe is covered with an insulation blanket comprised of two different materials, A and B as shown in figure. The interface between the two materials may be assumed to have an infinite contact resistance, and the entire outer surface is exposed to air at 300 °K and h = 25 W^2/m^2·K. Heat transfer resistance of the thin wall is negligible.

   (i) Draw the thermal resistance circuit for the system. **(5)**

   (ii) What is the total heat loss from the pipe? What are the insulation outer surface temperatures near A and B? **(15)**

2. (a) Derived the equation for critical radius of insulation in a cylindrical system. What would you do to reduce heat loss if the bare pipe radius is smaller than the critical radius of insulation? Explain your answer with a schematic of heat loss vs. radius. **(9+6=15)**

   (b) A hollow aluminium sphere, with an electrical heater in the center, is used in tests to determine the thermal conductivity of insulating materials. The inner and outer radii of the sphere are 0.15 and 0.18 m, respectively, and testing is done under steady-state conditions with the inner surface of the aluminium maintained at 250°C. A spherical shell of insulation is cast on the outer surface of the sphere to a thickness of 0.12 m. The outside air temperature is 20°C and the convection coefficient at the outer surface of the insulation is 30 W/m^2.K. If 80 W heat is dissipated during the test, what is the thermal; conductivity of the insulation? Conductivity of Aluminum at 250°C is 230 W/m.K. **(20)**

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3. (a) Consider a fluid flowing past a rough flat plate where the friction coefficient is C_f. The velocity distribution and the laminar boundary layer thickness for the fluid can be expressed by the following equations, respectively **(15)**

$$\frac{u}{u_\infty} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

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

where, u_∞ is the fluid velocity outside the boundary layer. Other symbols have their usual meanings. Derive a relation between fluid friction and heat transfer for laminar flow on a flat plate that is also known as Reynolds-Colburn analogy.

$$St_x Pr^{2/3} = \frac{C_{fx}}{2}$$

Where, St_x is the local Stanton number expressed as $St_x = \dfrac{h_x}{\rho C_p u_\infty}$

(b) Air at 27°C and 1 atm flows over a flat plate at a speed of 2 m/s. The plate is heated over its entire length to a temperature of 60°C. Calculate the heat transferred in the first 40 cm of the plate. Also compute the drag force exerted on the first 40 cm of the plate using the analogy between fluid friction and heat transfer. **(10+10=20)**

[**HINT**: Use average heat transfer coefficient to calculate the heat transfer Stanton number.]

4. (a) Define Nusselt number and Prandtl number? Explain their physical significance. What are the typical values of Prandtl number for gas and liquid metals? **(10)**

(b) Engine oil is heated by flowing through a circular tube of diameter, D = 50 mm and length, L = 25 m and whose surface is maintained at 150°C. If the flow rate and inlet temperature of the oil are 0.5 kg/s and 20°C, what is the outlet oil temperature? What is the total heat transfer rate for the tube? Assume that the thermal entrance region prevails in the entire tube length. **(25)**

[HINT: Assume an outlet temperature, evaluate the fluid properties at mean temperature and from heat balance calculate the outlet temperature. Iterate till you get a reasonable value for outlet temperature.]

SECTION – B

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

5. (a) Rayleigh number is important to characterize the laminar to turbulent transition of a free convection boundary layer flow. True/False. Explain your answer. **(5)**

(b) Write down the differences between forced convection and free convection. **(5)**

(c) Derive the expression for equivalent diameter for square pitch and triangular pitch tube arrangement of a shell and tube heat exchanger. **(10)**

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(d) Draw the temperature distribution profile for double pipe heat exchanger equipment (i) Boiling (ii) Condensing cases. **(5)**

(e) Why is a counterflow heat exchanger more effective than a parallel flow heat exchanger? **(5)**

(f) What are the criteria to know natural and forced convection? **(5)**

6. (a) A vertical plate of length L and width b is maintained at temperature T_s. The outside vapor temperature is T_{sat} where $T < T_{sat}$. **(25)**

(i) Find the mass flow rate of the condensate at a location x where the boundary layer thickness δ.

(ii) Derive the relationship of film thickness δ as a function of vertical distance x.

(iii) The average heat transfer coefficient for vertical film condensation can be expressed in terms of modified Nusselt number. Show that

$$\frac{\bar{h}\left(\upsilon^2/g\right)^{1/3}}{k} = 1.47\,Re_\delta^{-1/3} \qquad \text{for} \qquad Re_\delta \le 30$$

(b) A vertical plate (0.1 × 0.1 m) is exposed to steam at atmospheric pressure. The plate temperature is maintained at 98°C. Calculate the mass of steam condensed per hour. Fluid properties at the film temperature are evaluated **(10)**

$\rho_f = 960\ kg/m^3$ $\mu_f = 2.82 \times 10^{-4}\ kg/m.s$

$k_f = 0.68\ W/m.K$

7. (a) A vertical cylinder having a length of 0.3 m is maintained at 100°C and exposed to indoor air at 15°C. Calculate the minimum diameter the cylinder can have in order to behave as a vertical plate. **(10)**

(b) A polished stainless steel bar of 50 mm diameter and an emissivity of 0.1 is maintained at surface temperature of 250°C, while horizontally submerged in water at 25°C under atmospheric pressure. Estimate the heat transfer rate per unit length of bar. The convection heat transfer co-efficient can be evaluated from **(25)**

$$Nu_d = 0.62\left[\frac{g(\rho_l - \rho_v)\lambda d^3}{\upsilon_v k_v (T_s - T_{sat})}\right]^{1/4}$$

The total heat transfer co-efficient $\bar{h}$ is expressed as

$$\bar{h}^{4/3} = \bar{h}_{conv}^{4/3} + \bar{h}_{rad}\,\bar{h}^{1/3}$$

Fluid properties:

$\rho_l = 958\ kg/m^3$ $\rho_v = 0.5\ kg/m^3$

$K_v = 0.03\ W/m.K$ $\mu_v = 15 \times 10^{-6}\ N.s/m^2$

$\lambda = 2258.5 \times 10^3\ J/kg$

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8. 175,000 lb/hr of distilled water enters an 1 : 2 shell and tube heat exchanger at 93°F and leaves at 85°F. The heat will be transferred to raw water coming from supply at 75°F and leaving the exchanger at 80°F. A 10 psi pressure drop may be expended on both streams while providing a fouling factor of 0.005 for shell side and 0.0015 for tube side. **(35)**

1 : 2 shell and tube heat exchanger available for this service having,

Shell side	Tube side
ID = $15\frac{1}{4}$ in	Number = 160
Baffle space = 12 in	Length = 16 ft
	$\frac{3}{4}$ in OD, 18 BWG
	$\frac{15}{16}$ in triangular pitch

Will the exchanger be suitable?

Fluid properties:

Distilled water	Raw water
C_p = 1 Btu/lb.°F	C_p = 1 Btu/lb.°F
μ = 1.96 lb/ft.hr	μ = 2.23 lb/ft.hr

K = 0.36 Btu/hr.ft^2 (°F/ft) for both stream

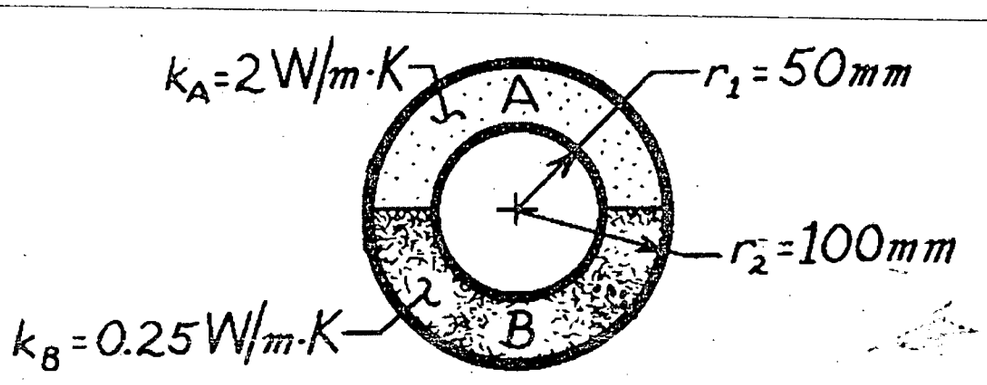

Figure for question No. 1(a)

Table: Summary of equations for flow over flat plates

Flow regime	Restrictions	Equation
		Heat transfer
Laminar, local	$T_w = \text{const}$, $\text{Re}_x < 5 \times 10^5$, $0.6 < \text{Pr} < 50$	$\text{Nu}_x = 0.332\ \text{Pr}^{1/3}\text{Re}_x^{1/2}$
Laminar, local	$T_w = \text{const}$, $\text{Re}_x < 5 \times 10^5$, $\text{Re}_x\ \text{Pr} > 100$	$\text{Nu}_x = \dfrac{0.3387\ \text{Re}_x^{1/2}\ \text{Pr}^{1/3}}{\left[1 + \left(\dfrac{0.0468}{\text{Pr}}\right)^{2/3}\right]^{1/4}}$
Laminar, local	$q_w = \text{const}$, $\text{Re}_x < 5 \times 10^5$, $0.6 < \text{Pr} < 50$	$\text{Nu}_x = 0.453\ \text{Re}_x^{1/2}\ \text{Pr}^{1/3}$
Laminar, local	$q_w = \text{const}$, $\text{Re}_x < 5 \times 10^5$	$\text{Nu}_x = \dfrac{0.4637\ \text{Re}_x^{1/2}\ \text{Pr}^{1/3}}{\left[1 + \left(\dfrac{0.0207}{\text{Pr}}\right)^{2/3}\right]^{1/4}}$
Laminar, average	$\text{Re}_L < 5 \times 10^5$, $T_w = \text{const}$	$\overline{\text{Nu}}_L = 2\ \text{Nu}_{x=L} = 0.664\ \text{Re}_L^{1/2}\ \text{Pr}^{1/3}$
Laminar, local	$T_w = \text{const}$, $\text{Re}_x < 5 \times 10^5$, $\text{Pr} \ll 1$ (liquid metals)	$\text{Nu}_x = 0.564(\text{Re}_x\ \text{Pr})^{1/2}$
Laminar, local	$T_w = \text{const}$, starting at $x = x_0$, $\text{Re}_x < 5 \times 10^5$, $0.6 < \text{Pr} < 50$	$\text{Nu}_x = 0.332\ \text{Pr}^{1/3}\ \text{Re}_x^{1/2}\left[1 - \left(\dfrac{x_0}{x}\right)^{3/4}\right]^{-1/3}$

Table: Summary of forced-convection relations

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

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

L-3/T-1/CHE **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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**.

Symbols indicate their usual meanings.

Assume reasonable value if additional data is required.

1. (a) In the context of staged distillation columns, describe briefly the function of: **(2.5×3=7.5)**

(i) Trays (ii) Downcomers (iii) Weirs

(b) Show and explain how the efficiency of a tray staged distillation columns varies with vapor velocity. **(7.5)**

(c) We wish to wash a solid stream. A countercurrent washing system with seven stages is used. The inlet solid flow is 10,000 kg/hr of dry solid. Each kilogram of dry solid also entrains 4 liters of solution. Thus, total inlet feed is 10,000 kg solid plus 40,000 liters of solution. The inlet concentration of this entrained solution is 2 wt% NaOH and 98 wt% water. Pure water at a flow rate of 25,000 kg/hr is used for washing. Assume that the liquid density is constant at 1 kg/liter. What is the outlet concentration of the NaOH in the overflow liquid? **(20)**

2. (a) Make a comparison between absorption and stripping with respect to purpose of use, gas-liquid equilibrium relationship, direction of mass transfer, position of operating line relative to that of equilibrium line in McCabe-Thiele diagram, and flow-basis for column diameter estimation. **(17)**

(b) A plate tower providing six equilibrium stages is employed for stripping ammonia from a waste water stream by means of countercurrent air at atmospheric pressure and 80°F. Calculate the concentration of ammonia in the exit water if the inlet liquid concentration is 0.1 mole% ammonia in water. The inlet air is free of ammonia, and 0.08 lb mole of air is fed to the tower per pound (lb) of waste water. The equilibrium relationship can be assumed to be $y_{NH_3} = 1.414\ x_{NH_3}$ at atmospheric pressure and 80°F. **(18)**

3. (a) A 11.5 wt% aqueous solution of acetic acid is to be treated in a four-stage cross-flow extraction system. A regenerated solvent (99.5 wt% 1-butanol and 0.5 wt% acetic acid) is fed continuously to each stage maintaining a fixed water (diluent) to 1-butanol (solvent) mass flow rate ratio of 3.40. The distribution coefficient (k_d) of acetic acid in this system is 1.613. Find the outlet concentration of all streams. **(20)**

(b) For a partially miscible countercurrent liquid-liquid extraction, consider that the inlet composition and mass flow rate of feed or raffinate and solvent or extract are completely known. The solute concentration in raffinate is required to be reduced to a desired low value. All the necessary equilibrium data at the operational temperature and pressure are also available. With the aid of a clear hand-drawing, demonstrate the determination of equilibrium stages required for this separation. **(15)**

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CHE 303

4. (a) McCabe-Thiele analysis of leaching requires a number of assumptions of which two are practically not valid. Write down these two assumptions. What is consequently done for these two assumptions in carrying out the analysis? **(8)**

(b) Write down the crucial additional assumption, condition of application, advantages and disadvantages of analytical Kremser equation. **(9)**

(c) A gas stream is 90 mole% N_2 and 10 mole% CO_2. It is required to absorb the CO_2 into water. The inlet water is pure and is at 5°C. Because of cooling coils, operation can be assumed to be isothermal. The operation is at 10 atm. Choose a basis of 1 mole/hr of entering gas. Determine the minimum amount of pure water, which is required to absorb 92% of the CO_2 using a very large number of equilibrium stages. **(18)**

[Given: Henry's law constant, H at 5°C is 876 atm]

Equation for Section A are as follows:

$$\frac{x_N - x_N^*}{x_0 - x_N^*} = \frac{1 - \frac{mV}{L}}{1 - \left(\frac{mV}{L}\right)^{N+1}}; \qquad x_N^* = \frac{y_{n+1} - b}{m}$$

$$\frac{y_{n+1} - y_1^*}{y_1 - y_1^*} = \frac{1 - \left(\frac{L}{mV}\right)^{N+1}}{1 - \frac{L}{mV}}; \qquad y_{n+1}^* = mx_N + b$$

SECTION – B

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

Assume reasonable value if additional data is required.

5. (a) Draw the schematic diagram of a flash distillation system. **(5)**

(b) A flash distillation chamber operating at 101.3 kPa is separating hexane-octane mixture. The feed mixture is 40 mole % hexane. (i) What is minimum liquid composition that can be obtained if V/F is allowed to vary? (ii) If V/F = 0.4, what are the liquid and vapor compositions? Equilibrium data for hexane-octane system; **(12)**

x_h	1	0.69	0.40	0.192	0.045	0
y_h	1	0.932	0.78	0.538	0.1775	0

(c) A tray tower is to be designed to continuously distill 204 kmol/h of a binary mixture of 60 mole % benzene and 40% toluene. A liquid distillate and a liquid bottom product of 95 mole % and 5 mole % benzene, respectively are to be produced. The feed is preheated so that it enters the column with 60% vapor. Calculate (i) Minimum number of theoretical stages and (ii) Minimum reflux ratio. Assume a constant relative volatility of 2.41 at a pressure of 101.3 kPa. **(18)**

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CHE 303

6. (a) What is Murphree efficiency? **(5)**

(b) We wish to separate ethanol from water in a distillation column with a total condenser and a partial reboiler. We have 200 kmoles/hr of feed-1, which is 30 mole % ethanol and is a saturated vapor. We also have 300 kmoles/hr of feed-2, which is 40% ethanol. Feed 2 is a subcooled liquid. One mole of vapor must condense inside the column to heat up 4 moles of feed to its boiling point. We desire a bottoms product that is 2 mole % ethanol and a distillate product that is 72 mole % ethanol. External reflux ratio is $L_0/D = 1$. The reflux is a saturated liquid. Column pressure is 101.3 kPa, and the column is well insulated. The feeds are to input at their optimum feed locations. Find the optimal feed locations and the total number of equilibrium stages required. Equilibrium data for ethanol-water system. **(30)**

x_E	0.02	0.1	0.24	0.33	0.4	0.51	0.57	0.74	0.89
y_E	0.17	0.44	0.55	0.58	0.6	0.66	0.68	0.78	0.89

7. (a) Discuss the differences between batch and continuous distillation column. **(10)**

(b) We wish to batch distill 50 kmoles of a 32 mole% ethanol, 68 mole % water feed. The system has a still pot plus two equilibrium stages and a total condenser. Reflux is returned as a saturated liquid, and we use L/D = 2/3. We desire a final still pot composition of 4.5 mole % ethanol. Find the average distillate composition, the final charge in the still pot, and the amount of distillate collected. Pressure is 1 atm. Equilibrium data for ethanol-water system. **(25)**

x_E	0.02	0.1	0.24	0.33	0.4	0.51	0.57	0.74	0.89
y_E	0.17	0.44	0.55	0.58	0.6	0.66	0.68	0.78	0.89

8. (a) Write the mass and energy balances and equilibrium expressions for any stage in a distillation column. **(5)**

(b) Draw and explain composition, temperature, and flow profiles of a distillation column. **(10)**

(c) What do you understand by open steam distillation? Why would you use open steam in a distillation column? **(5)**

(d) Distinguish between froth and spray regimes. **(5)**

(e) Write short notes on **(10)**

(i) Stripping distillation column

(ii) Inverted batch distillation.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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**.

Data booklet for CHE 307 to be supplied.

1. (a) Explain the term Retrograde condensation using P-T diagram in the critical region. **(10)**

(b) A liquid mixture of cyclohexanone (1)/Phenol (2) for which $x_1 = 0.6$ is in equilibrium with its vapor at 144°C. Determine the equilibrium pressure P and vapor composition y_1 from the following information: **(15)**

$$\ln \gamma_1 = Ax_2^2 \qquad \ln\gamma_2 = Ax_1^2$$

At 144°C, $P_1^{Sat} = 80$ kPa $\qquad P_2^{Sat} = 40$ kPa

The system forms an azeotrope at 144°C for which $x_1^{az} = 0.3$.

(c) Prove that an equilibrium liquid/vapor system described by Raoult's law cannot exhibit an axeotrope. **(10)**

2. (a) Define Partial Molar Properties and show that for a binary system **(10)**

$$\overline{M}_1 = M + x_2 \frac{dM}{dx_1}$$

where M is solution properties

$\overline{M}_i$ is partial properties.

(b) The molar volume of a binary liquid mixture at T and P is given by **(25)**

$$V = 120\, x_1 + 70\, x_2 + (15\, x_1 + 8x_2)\, x_1 x_2$$

(i) Find the expression for the partial molar volume of species 1 and 2 at T and P.

(ii) Show that $V = \sum_i x_i \overline{V}_i$.

(iii) Show that the expressions of partial molar properties satisfy the Gibbs/Duhem equation.

(iv) Show that $\left(\frac{d\overline{V}_1}{dx_1}\right)_{x_1=1} = \left(\frac{d\overline{V}_2}{dx_1}\right)_{x_1=0} = 0.$

(v) Plot values of V, $\overline{V}_1$ and $\overline{V}_2$ versus x_1 and label points $\overline{V}_1^{\infty}$ and $\overline{V}_2^{\infty}$ and show their values.

Contd P/2

CHE 307

3. (a) The excess Gibbs energy of a particular ternary liquid mixture is represented by empirical expression **(20)**

$$\frac{G^E}{RT} = A_{12}x_1x_2 + A_{13}x_1x_3 + A_{23}x_2x_3$$

(i) Determine the expression for the activity coefficient of species 1, 2 and 3.

(ii) How do you calculate limiting value of activity coefficient of species 1?

(iii) What does the limiting case represent?

(b) Show that fugacity co-efficient for a binary mixture, **(15)**

$$\hat{\phi}_1 = \exp\left[\frac{P}{RT}\left(B_{11} + y_2^2\delta_{12}\right)\right]$$

where, $$\ln \hat{\phi}_i = \int_0^P \left(\bar{z}_i - 1\right)\frac{dP}{P}$$

$$z = 1 + \frac{BP}{RT}$$

and $$B = \sum_i \sum_j y_i y_j B_{ij}$$

$$\delta_{12} = 2B_{12} - B_{11} - B_{22}$$

4. (a) Draw the schematic diagram of an adsorption refrigeration unit. Discuss the working principle and find the expression for $\left(Q_H/Q_C\right)_{min}$. Estimate $\left(Q_H/Q_C\right)_{min}$ if the surrounding temperature is 30°C and $T_C = -10°C$ and $T_H = 100°C$. **(15)**

(b) A refrigerator with tetrafluoroethane as refrigerant operates with an evaporation temperature of –15°F and a condensation temperature of 80°F. Saturated liquid refrigerant from the condenser flows through an expression valve into the evaporator from which it emerges as saturated vapor. **(20)**

(i) Estimate the circulation rate of the refrigerant for a cooling rate of 5 Btu/s.

(ii) By how much would the circulation rate be reduced if the throttle valve were replaced by a turbine in which refrigerant expands isentropically.

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

SECTION – B

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

5. The following is a set of VLE data for the system methanol (1)/water (2) at 60°C.

P/kPa	x_1	y_1	P/kPa	x_1	y_1
19.95	0.00	0.00	60.61	0.53	0.81
39.22	0.17	0.57	63.99	0.60	0.84
42.98	0.22	0.63	67.92	0.68	0.87
48.85	0.30	0.70	70.23	0.73	0.89
52.78	0.37	0.73	72.83	0.78	0.91
56.65	0.45	0.77	84.56	1.0	1.0

Contd P/3

CHE 307

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(a) Find parameter values for the Margules equation that provide the best fit of G^E/RT to the data. **(20)**

(b) Prepare a P_{xy} diagram that compares the experimental points with curves determined from the correlation. **(15)**

6. (a) Prove that Henry's law is related to the Lewis/Randall rule through the Gibbs-Duhen equation. **(10)**

(b) For liquid-phase reactions, find the relation of equilibrium constants to composition. **(10)**

(c) For the ammonia synthesis reaction written as **(15)**

$$\frac{1}{2}N_2\,(g)+\frac{3}{2}H_2\,(g)\rightarrow NH_3\,(g)$$

with 0.5 mol N_2 and 1.5 mol H_2 as the initial amounts of reactants and with the assumption that the equilibrium mixture is an ideal gas, show that

$$\varepsilon_e = 1-\left(1+1.299\,K\,\frac{P}{P_0}\right)^{-1/2}$$

7. Hydrogen gas is produced by the reaction of steam with 'water gas', an equimolar mixture of H_2 and CO obtained by the reaction of steam with coal. A stream of 'water gas' mixed with steam is passed over a catalyst to convert CO to CO_2 by reaction:

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

Subsequently unreacted water is condensed and carbon dioxide is absorbed, leaving a product that is mostly hydrogen. The equilibrium conditions are 1 bar and 800°K.

(a) Determine the molar ratio of steam to 'water gas' (H_2 + CO) required to produce a product gas containing only 2 mole % CO after cooling to 20°C, where the unreacted H_2O has been virtually all condensed. **(22)**

(b) What happens if solid carbon will form at the equilibrium conditions by the reaction: **(13)**

$$2\,CO\,(g) \rightarrow CO_2\,(g) + C\,(s)$$

8. (a) By using Gamma/Phi formulation of VLE, derive necessary equations for Dew Point and Bubble Point calculations. **(10)**

(b) Write a block diagram for the calculation of Dew P. **(15)**

(c) If pure liquid H_2SO_4 at 27°C is added adiabatically to pure liquid water at 27°C to form a 40 mass % solution, what is the final temperature of the solution? **(10)**

Table 9.1: Thermodynamic Properties of Saturated Tetrafluoroethane†

		Volume		Enthalpy		Entropy	
		$(ft)^3(lb_m)^{-1}$		$(Btu)(lb_m)^{-1}$		$(Btu)(lb_m)^{-1}(R)^{-1}$	
t(°F)	P(psia)	V^l	V^v	H^l	H^v	S^l	S^v
−40	7.429	0.01132	5.782	0.000	97.050	0.00000	0.23125
−35	8.577	0.01139	5.053	1.489	97.804	0.00352	0.23032
−30	9.862	0.01145	4.432	2.984	98.556	0.00701	0.22945
−25	11.297	0.01152	3.901	4.484	99.306	0.01048	0.22863
−20	12.895	0.01158	3.445	5.991	100.054	0.01392	0.22786
−15	14.667	0.01165	3.052	7.505	100.799	0.01733	0.22714
−10	16.626	0.01172	2.712	9.026	101.542	0.02073	0.22647
−5	18.787	0.01180	2.416	10.554	102.280	0.02409	0.22584
0	21.162	0.01187	2.159	12.090	103.015	0.02744	0.22525
5	23.767	0.01194	1.934	13.634	103.745	0.03077	0.22470
10	26.617	0.01202	1.736	15.187	104.471	0.03408	0.22418
15	29.726	0.01210	1.563	16.748	105.192	0.03737	0.22370
20	33.110	0.01218	1.410	18.318	105.907	0.04065	0.22325
25	36.785	0.01226	1.275	19.897	106.617	0.04391	0.22283
30	40.768	0.01235	1.155	21.486	107.320	0.04715	0.22244
35	45.075	0.01243	1.048	23.085	108.016	0.05018	0.22207
40	49.724	0.01252	0.953	24.694	108.705	0.05359	0.22172
45	54.732	0.01262	0.868	26.314	109.386	0.05679	0.22140
50	60.116	0.01271	0.792	27.944	110.058	0.05998	0.22110
55	65.895	0.01281	0.724	29.586	110.722	0.06316	0.22081
60	72.087	0.01291	0.663	31.239	111.376	0.06633	0.22054
65	78.712	0.01301	0.608	32.905	112.019	0.06949	0.22028
70	85.787	0.01312	0.558	34.583	112.652	0.07264	0.22003
75	93.333	0.01323	0.512	36.274	113.272	0.07578	0.21979
80	101.37	0.01335	0.472	37.978	113.880	0.07892	0.21957
85	109.92	0.01347	0.434	39.697	114.475	0.08205	0.21934
90	119.00	0.01359	0.400	41.430	115.055	0.08518	0.21912
95	128.63	0.01372	0.369	43.179	115.619	0.08830	0.21890
100	138.83	0.01386	0.341	44.943	116.166	0.09142	0.21868
105	149.63	0.01400	0.315	46.725	116.694	0.09454	0.21845
110	161.05	0.01415	0.292	48.524	117.203	0.09766	0.21822
115	173.11	0.01430	0.270	50.343	117.690	0.10078	0.21797
120	185.84	0.01447	0.250	52.181	118.153	0.10391	0.21772
125	199.25	0.01464	0.231	54.040	118.591	0.10704	0.21744
130	213.38	0.01482	0.214	55.923	119.000	0.11018	0.21715
135	228.25	0.01502	0.198	57.830	119.377	0.11333	0.21683
140	243.88	0.01522	0.184	59.764	119.720	0.11650	0.21648
150	277.57	0.01567	0.157	63.722	120.284	0.12288	0.21566
160	314.69	0.01620	0.134	67.823	120.650	0.12938	0.21463
170	355.51	0.01683	0.114	72.106	120.753	0.13603	0.21329

†Adapted by permission from *ASHRAE Handbook: Fundamentals*, p. 17.29, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, 1993.

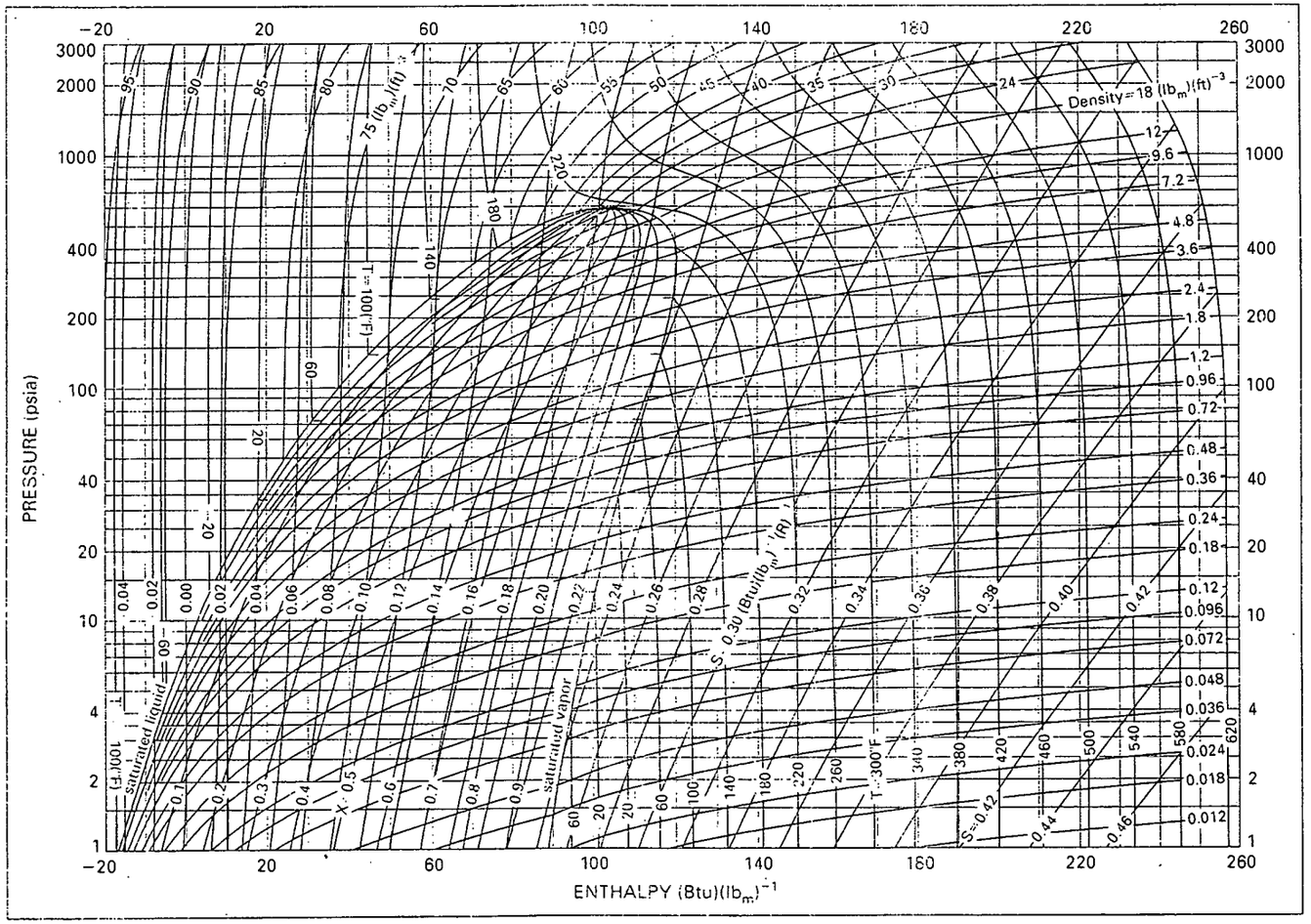

Figure G.2: *P H* diagram for tetrafluoroethane (HFC-134a). (*Reproduced by permission. ASHRAE Handbook: Fundamentals*, p. 17.28, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, 1993.)

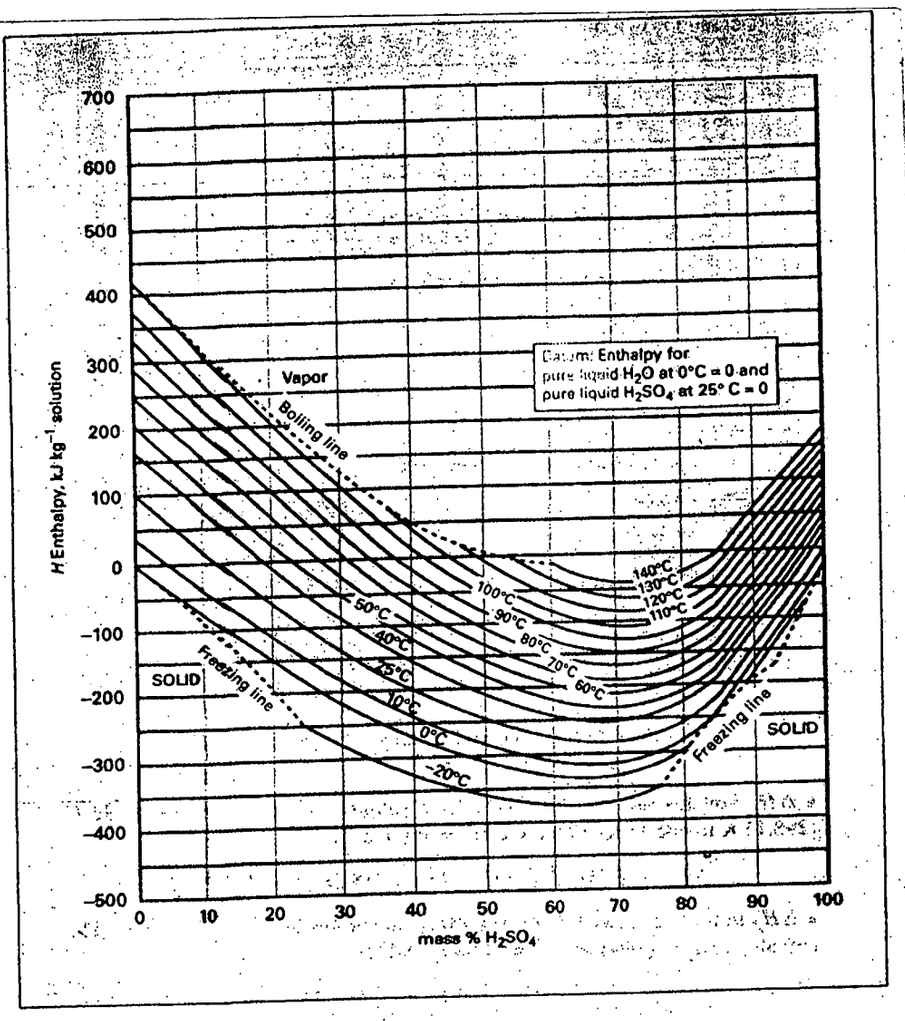

Figure 12.17: *H,x* diagram for H_2SO_4/H_2O

L-3/T-1/CHE Date : 30/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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. Analyze the differences between society and state. **(15)**

   (b) What is constitution? Discuss different types of constitution with examples. **(20)**

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

   (b) Discuss the importance of opposition party in a parliamentary democracy. **(20)**

3. (a) Make a comparative discussion between democracy and dictatorship. **(15)**

   (b) What are the different kinds of executive? Illustrate the functions of an executive in a state. **(20)**

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

   (a) Popular Sovereignty
   (b) Bicameral Legislature
   (c) Theory of Surplus Value
   (d) Independence of Judiciary

SECTION – B

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

5. (a) Discuss the significance of Language Movement of 1952. **(20)**

   (b) Describe the impact of 1970 election on the emergence of Bangladesh. **(15)**

6. (a) Define bureaucracy. Discuss the functions of bureaucracy in a state. **(20)**

   (b) Analyze the advantages and disadvantages of unitary form of government. **(15)**

7. (a) Make a brief discussion on the characteristics of the constitution of Bangladesh. **(10)**

   (b) Discuss the constraints of local government institutions in Bangladesh. **(10)**

   (c) Analyze the principles of the foreign policy of Bangladesh. **(15)**

8. (a) Write short notes on any three (03) of the following: **(35)**

   (a) UNO
   (b) Good Governance
   (c) Presidential Government
   (d) Great Mass Upsurge of 1969

L-3/T-1/CHE **Date : 30/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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) Define the terms 'Opportunity Cost' and 'Sunk cost' with examples. **(5)**

(b) The following information has been taken from the accounting records of Alif Corporation for last year, 2014. **(30)**

Selling expenses	Tk. 140000
Raw material Inventory, January 1	90000
Raw material Inventory, December 31	60000
Utilities, factory	36000
Direct labor cost	150000
Depreciation, factory	162000
Purchase of raw materials	750000
Sales	2500000
Insurance, factory	40000
Supplies, factory	15000
Administrative expenses	270000
Indirect labor	300000
Maintenance, factory	87000
Work-in-process Inventory, Beginning	180000
Work-in-process Inventory, Ending	100000
Finished goods Inventory, Beginning	260000
Finished goods Inventory, Ending	210000

Required:

(i) Prepare a schedule of cost of goods manufactured.

(ii) Compute the cost of goods sold as a statement

(iii) Prepare an Income statement.

2. (a) What are the differences between process costing and job-order costing? **(5)**

(b) Haxon corporation is a manufacturer that uses job-order costing. The company applies overhead cost to jobs on the basis of machine-hours worked. For the current year, the company estimated that it would work 75000 machine-hours and incur Tk. 450000 in manufacturing overhead cost. The following transactions were recorded for the year:

Contd P/2

HUM 303

Contd... Q. No. 2(b)

- Raw materials were purchased on account Tk. 410000.
- Raw materials were requisitioned for use in production Tk. 380000 (Tk. 360000 direct materials and Tk. 20000 indirect materials).
- The following costs were accrued for employee services: direct labor Tk. 75000; indirect labor Tk. 110000, sales commissions Tk. 90000 and administrative salaries Tk. 200000.
- Sales travel cost were Tk. 17000.
- Utility costs in the factory were Tk. 43000.
- Depreciation was recorded for the year Tk. 350000 (80% relates to factory operations and 20% relates to selling and administrative activities).
- Insurance expired during the year Tk. 10000 (70% relates to factory and 30% relates to administration).
- Manufacturing overhead was applied to production. The company worked 80000 machine-hours during the year.
- Goods costing Tk. 900000 to manufacturing according to the job cost sheets were completed.

Required:

(i) Prepare journal entries to record the preceding transactions.

(ii) Prepare the T-account of manufacturing overhead.

(iii) Is manufacturing overhead underapplied or overapplied for the year? Prepare a journal entry to close any balance in manufacturing overhead account to cost of goods sold.

3. (a) The admitting department's costs and the number of patients admitted for Nazia Hills Hospital during the immediately preceding eight months are given in the following table: **(15)**

Month	Number of patients Admitted	Admitting Department Costs
May	1800	Tk. 14700
June	1900	15200
July	1700	13700
August	1600	14000
September	1500	14300
October	1300	13100
November	1100	12800
December	1500	14600

Contd P/3

HUM 303

Contd... Q. No. 3(a)

Required:

(i) Use the high-low method to establish the fixed and variable components of admitting costs.

(ii) Express the fixed and variable components of admitting costs as a cost formula in the form $y = a + bx$.

(b) Tenor Company manufactures and sells a single product. The company's sale and expenses for last quarter are as follow: **(20)**

	Total	Per Unit
Sales	Tk. 450000	Tk. 30
Less: Variable expenses	180000	12
Contribution margin	270000	18
Less: Fixed expenses	216000	
Net Income	54000	

Required:

(i) What is the quarterly break-even-point in units sold and in sales amount?

(ii) Without restoring the computations, what is the total CM at the break-even point?

(iii) How many units would have to be sold each quarter to earn a target profit of Tk. 90000? Use the CM method.

(iv) Compute the company's margin of safety both in taka and percentage terms.

(v) What is the CM ratio? If sales increase by Tk. 50000 per quarter and there is no change in the fixed expenses, by how much would you expect net income to increase?

4. (a) Xavier Computer Company has two support departments and two operating departments. Relevant information is given below: **(15)**

	Support department		Operating Department		Total
	Legal Department	Personnel Department	Laptop Division	Work Station Division	
Budgeted manufacturing overhead cost	500000	100000	300000	200000	1100000
By legal Department Budgeted legal hours	—	1200	3200	4000	8400
By Personnel Department Budgeted personnel hours	400	—	1200	300	1900

Required: Allocate support departmental cost to operating departments by using:

(i) Direct method

(ii) Step-down method.

Contd P/4

HUM 303

Contd... Q. No. 4

(b)(i) Write down the importance of capital budgeting decision. **(4+16)**

(ii) A company is going to purchase a new machine. The related information of the machine is as follows:

Cost of the machine Tk. 75000	
Year	NPAT (Net profit after tax)
1	35000
2	12000
3	18000
4	10000
5	8000

Required:

Calculate:

(i) Payback period

(ii) Internal Rate of Return (IRR)

(iii) Net Present Value (NPV) at 10% cost of capital.

Should the company buy the machine?

SECTION – B

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

5. (a) What is matching principle and full disclosure principle according to Generally Accepted Accounting Principles (GAAP)? Explain with example. **(4)**

(b) Can a business enter into a transaction in which only the left side of the basic accounting equation is affected? If so, give an example. **(5)**

(c) "Aftab Automobile Agency" was opened at May 1, 2014. The following transactions occurred in the month of May– **(26)**

May 1: Mr. Aftab invested Tk. 700,000 cash in the business.

May 2: Hired a employee at a monthly salary of Tk. 10,000.

May 5: Paid advertising expense for the month in cash Tk. 5,000.

May 6: Borrowed Tk. 100,000 in cash from a bank by signing notes payable.

May 9: Earned revenue Tk. 50,000 by providing services, 50% of which received in cash and the remaining balance was on account.

May 11: Purchased office equipment for Tk. 50,000; Paid Tk. 15,000 in cash and the remaining amount will be paid in a later date.

May 14: Received Tk. 20,000 cash from the customers related to transaction May 9.

May 15: Paid to accounts payable Tk. 30,000 in cash.

Required:

(i) Give Journal entries in a good form for the month of May.

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

Contd P/5

HUM 303

6. (a) "Every debit must have its corresponding credit". Explain. **(5)**

(b) "Mr. X" started a business. During June 2013, the following transactions occurred: **(16)**

June 1: Service provided to a customer but not yet received Tk. 60,000.

June 3: Purchase supplies on account Tk. 30,000

June 7: Earned revenue Tk. 45,000 of which Tk. 10,000 is collected in cash and the balance was due in January.

June 9: Incurred utility expenses for the month on account Tk. 2,000.

June 11: Made an investment by "Mr. X" for Tk. 400,000 in cash.

June 13: Received Tk. 10,000 in cash from the customer.

June 15: Paid telephone bill for the month Tk. 5,000 in cash.

June 17: Paid Tk. 15,000 to account payable for supplies.

Required: Prepare a tabular summary for the month of June, 2013.

(c) Following information is available for "Bengal Plastic Ltd." **(14)**

"Bengal Plastic Ltd."

Income Statement

For the year ended December 31, 2014

	Amount (Tk.)
Sales	740,000
Less: Sales returns and allowances	40,000
Net sales	700,000
Less: Cost of goods sold	420,000
Gross profit	280,000
Less: operating expenses	232,000
Net income	**48,000**

"Bengal Plastic Ltd."

Balance Sheet

December 31, 2014

Asset	**Amount (Tk.)**	Liability and Equity	**Amount (Tk.)**
Cash	35,000	Accounts payable	60,000
Accounts receivable	50,000	Other current liability	25,000
Inventory	90,000	Long term debt	80,000
Investments (short term)	75,000	Common stock (Tk. 10 par)	340,000
Plant asset	400,000	Retained earnings	145,000
Total	**650,000**	**Total**	**650,000**

Contd P/6

HUM 303

Contd... Q. No. 6(c)

Other information: Common stock recently sold Tk. 9 per share at market.

Required: Calculate-

(i) Profit margin ratio.
(ii) Asset turnover or return on asset.
(iii) Return on equity (ROE).
(iv) Current ratio.
(v) Quick or acid test ratio.
(vi) Earnings per share (EPS).
(vii) Inventory turnover.

7. (a) Write down the two categories of adjusting entries and identify the types of adjustments applicable to each category. **(8)**

(b) The trial balance of "Sharp Company" is given below– **(27)**

"Sharp Company"
Trial Balance
December 31, 2014

Accounts title	Debit (Tk.)	Credit (Tk.)
Cash	8,000	
Accounts receivable	4,000	
Prepaid insurance	2,400	
Supplies	1,500	
Office equipment	12,000	
Accounts payable		3,800
Unearned service revenue		3,000
Salary expense	3,000	
Rent expense	1,900	
Capital		20,000
Service revenue		6,000
Total	**32,800**	**32,800**

Other Information:

- Unused supplies on hand at December 31, 2014 were Tk. 500.
- Travel expense incurred but not paid at December 31, 2014 were Tk. 350.
- Insurance policy was for 2 years.
- Rent is accrued but not paid Tk. 900 for the month.
- Invoice represented that services earned for Tk. 1,000 but not recorded.
- Office equipment is being depreciated at Tk. 250 per month.

Required:

(i) Prepare necessary adjusting entries.
(ii) Prepare an adjusted trial balance as at December 31, 2014.

Contd P/7

HUM 303

8. (a) What is ratio analysis? Why is it important for business decision? **(5)**

(b) Following balances are extracted from the ledger balances of "Danish Company". **(30)**

"Danish Company"

Trial Balance

31st December, 2011

Accounts title	Debit (Tk.)	Credit (Tk.)
Accounts receivable	12,000	
Accounts payable		6,000
Cash	30,500	
Trademark	20,000	
Capital		50,900
Supplies	900	
Salary expense	7,000	
Sale person salary	3,000	
Maintenance expense	4,000	
Rent expense	13,000	
Notes payable		5,000
Bond payable		20,000
Tax payable		20,000
Store equipment	25,000	
Machinery	2,500	
Unearned commission		3,000
Sales		98,000
Cost of goods sold	30,000	
Prepaid insurance	4,000	
Goodwill	51,000	
Total	**202,900**	**202,900**

Adjustments data:

(i) Two thirds of the supplies were used during the period.

(ii) Charge @10% depreciation on store equipment.

(iii) 60% rent relates to office and remaining to sales.

Required:

(i) Prepare a multiple step (classified) income statement for the year ended December, 2011.

(ii) Prepare an owners' equity statement and a classified balance sheet at 31st December, 2011.

L-3/T-1/CHE **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **CHE 471** (Biochemistry)

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 mathematically the value of pH of water at 25° C. **(7)**

   (b) Describe how a weak acid like acetic acid can act as a buffer? **(6)**

   (c) How many grams of acetic acid (MW = 60) and sodium acetate (MW = 82) must be added to 1 litre of water to make a buffer at pH = 5.0. The pKa of acetic acid = 4.75 **(10)**

   (d) How can water be a good solvent to both polar solutes and charged solutes? **(12)**

2. (a) Write down the amino acid structure at pH 7.0 and also write down their three letter and one letter code for **any five** of the following **(5×3=15)**

   (i) a polar amino acid
   (ii) an acidic amino acid
   (iii) a basic amino acid
   (iv) an amino acid which has a sulfur atom
   (v) an amino acid which has absorbance properties at 280 nm
   (vi) an amino acid which is neither acidic nor basic
   (vii) an imino acid

   (b) What do you understand by a Ramachandran plot? **(8)**

   (c) Draw the fully protonated tetrapeptide CYKE and show its titration curve. Mark on the titration curve the net charge on this tetrapeptide at various pHs. What is the pI and the molecular weight of this tetrapeptide? **(12)**

3. (a) Summarize with a diagram the central dogma of biology. What are the enzymes involved in DNA replication? **(10)**

   (b) Given the following DNA coding sequence write down the corresponding DNA template strand. Use the DNA template strand to complete the mRNA sequence and tRNA sequence. Finally write down the sequence of amino acids that are coded by the sequence given using the chart given below. Use the first 3 nucleic acids (5' ATG) as the starting codon (10). **(12)**

   DNA CODING sequence:

   5' ATGCCCCTTAAAGAGTTTACATATTGCTGGAGTA 3'

   (c) Describe any two laboratory techniques involving nucleic acids. **(8)**

   (d) How cam purity of DNA solutions be determined by use of Beer Lambert Law? **(5)**

Contd P/2

CHE 471

4. (a) Why are the pKa values for the ionizable groups in glycine lower than those for simple, methyl substituted amino and carboxyl groups? **(7)**

   (b) Write down the similarities and the differences between an α-helix and a DNA helix. **(8)**

   (c) What do you understand by supersecondary structures and motifs? Give an example of a motif. **(7)**

   (d) Write down any 4 factors that give stability to proteins. Explain why these factors confer stability to the proteins. **(8)**

   (e) Diagrammatically explain the difference between parallel and antiparallel β sheets. **(5)**

SECTION – B

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

5. (a) Write down the classification of microorganism belonging to the Kingdom of Protist. Give example of each class. **(5)**

   (b) Briefly discuss the endosymbiotic theory of evolution. **(10)**

   (c) Briefly discuss the differential centrifugation with appropriate diagram and examples. **(10)**

   (d) Write down the names of biological macromolecules and their constituent monomers. **(10)**

6. (a) Briefly discuss the methods for purifying proteins. **(10)**

   (b) Write down the differences between fibrous and globular proteins with appropriate images. **(10)**

   (c) Outline the strategy to determine the primary structure of peptides or proteins. **(10)**

   (d) Write a short note on mitochondria. **(5)**

7. (a) Write a short note on Protein Database. **(5)**

   (b) Briefly discuss genomics and proteomics, and their applications in biochemical engineering. **(10)**

   (c) Briefly discuss the steps of determine the composition of peptides or proteins using chemical methods. **(10)**

   (d) Describe the different types of isomers found among monosachharides with schematic diagrams. **(10)**

8. (a) What is fatty acid? Describe different categories of fatty acids with examples and schematic representations. **(10)**

   (b) What is lipid bilayer? Explain the properties of lipid bilayer membrane which help carry out its functions. **(10)**

   (c) Briefly describe with examples about Fisher projections and Haworth projections. **(10)**

   (d) Write a short note on cellulose. **(5)**

Table 1 : Amino acid properties

Amino acid name	Molecular weight of amino acid	Molecular weight of amino acid residue	pK of α-COOH group pK_1	pK of α-NH_3 group pK_2	pK of ionizing side chain pK_R
Alanine	89.10	71.08	2.34	9.69	--
Arginine	174.20	156.18	2.17	9.04	12.48
Asparagine	132.12	114.10	2.02	8.80	--
Aspartic Acid	133.11	115.09	1.88	9.60	3.65
Cysteine	121.16	103.14	1.96	10.28	8.18
Glutamic Acid	147.13	129.11	2.19	9.67	4.25
Glutamine	146.15	128.13	2.17	9.13	--
Glycine	75.07	57.05	2.34	9.60	--
Histidine	155.16	137.14	1.82	9.17	6.00
Hydroxyproline	131.13	113.11	1.82	9.65	--
Isoleucine	131.18	113.16	2.36	9.60	--
Leucine	131.18	113.16	2.36	9.60	--
Lysine	146.19	128.17	2.18	8.95	10.53
Methionine	149.21	131.19	2.28	9.21	--
Phenylalanine	165.19	147.17	1.83	9.13	--
Proline	115.13	97.11	1.99	10.60	--
Serine	105.09	87.07	2.21	9.15	--
Threonine	119.12	101.10	2.09	9.10	--
Tryptophan	204.23	186.21	2.83	9.39	--
Tyrosine	181.19	163.17	2.20	9.11	10.07
Valine	117.15	99.13	2.32	9.62	--

Table 2 : Codon chart

Second base in codon

First base in codon	U	C	A	G	Third base in codon
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

L-3/T-1/CHE **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Find the Fourier series for **(20)**

$$f(x)=\begin{cases} x+\dfrac{\pi}{2} & -\pi < x < 0 \\ \dfrac{\pi}{2}-x & 0 \le x < \pi \end{cases}$$

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

(b) Expand $f(x) = x(\pi - x)$ in Fourier sine series within $0 \le x \le \pi$. **(15)**

2. (a) Find the Fourier transformation of **(20)**

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

Using Parseval's Identity evaluate $\displaystyle\int_0^\infty \frac{(x\cos x-\sin x)^2}{x^6}\,dx$.

(b) Solve the integral equation $\displaystyle\int_0^\infty f(t)\cos ut\,dt=\begin{cases} 1-u, & 0\le u<1 \\ 0, & u>1 \end{cases}$. **(15)**

Hence show that $\displaystyle\int_0^\infty \frac{\sin^2 u}{u^2}\,du=\frac{\pi}{2}$.

3. (a) Use Fourier cosine integral formula to show that **(15)**

$$e^{-x}\cos x=\frac{2}{\pi}\int_0^\infty \frac{u^2+2}{u^4+4}\cos ux\,du, \quad x>0$$

(b) Use finite Fourier transformation to solve **(20)**

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}, \qquad 0<x<6, \quad t>0, \quad u(0,t)=u(6,t)=0$$

$$u(x,0)=\begin{cases} 1; & 0<x<3 \\ 0; & 3<x<6 \end{cases}$$

Also give a physical interpretation of the solution.

Contd P/2

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4. (a) Show that $\int_0^\infty \frac{\cos \lambda x}{\lambda^2 + 1} d\lambda = \frac{\pi}{2} e^{-x}, \quad x \geq 0.$ **(15)**

(b) Solve the boundary value problem using infinite Fourier transformation **(20)**

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2} \quad \text{where } x > 0, \ t > 0$$

$$u_x(0, t) = 0,$$

$$u(x, 0) = \begin{cases} x, & 0 < x \leq 1 \\ 0, & x > 1 \end{cases} \quad \text{and} \quad |u(x, t)| < M$$

Give a physical interpretation of the above problem.

SECTION – B

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

5. (a) Solve $(xy^3 - 2x^4)\, p + (2y^4 - x^3y)\, q = 9z\,((x^3 - y^3)$ by applying Lagrange's method. **(12)**

(b) Find the integral surface of the first order linear partial differential equation **(13)**

$$2y(z - 3)\, p + (2x - z)\, q = y(2x - 3)$$

containing the circle $z = 0$, $x^2 + y^2 = 2x$.

(c) Apply Charpit's method to solve the equation $(p^2 + q^2)\, x = pz$. **(10)**

6. Solve the following partial differential equations:

(i) $(D_x^2 - 4D_xD_y + 4D_y^2)\, z = e^{3x-y} + 24xy^2$ **(13)**

(ii) $(D_x^2 + D_xD_y + D_y - 1)\, z = \sin(x + 2y)$ **(12)**

(iii) $(x^2D_x^2 + 2xyD_xD_y - xD_x)\, z = x^3y^{-2}$ **(10)**

7. (a) Solve Laplace's equation $\nabla^2 u(x, y, z) = 0$ in spherical polar coordinates (r, θ, ϕ) when u is independent of θ and ϕ. **(20)**

(b) Find the steady temperature inside a solid sphere of unit radius if one hemisphere of its surface is kept at temperature zero and the other at temperature unity. **(15)**

8. (a) Find the potential of the region inside and outside a ring. **(15)**

(b) An infinitely long rectangular plate with insulated faces have temperature v(x, y) on the boundaries always and is given by **(20)**

$$v(0, y) = 0, \quad v(\pi, y) = 0, \quad v(x, \infty) = 0, \quad v(x, 0) = \begin{cases} x, & 0 < x \leq \frac{\pi}{2} \\ \pi - x, & \frac{\pi}{2} < x < \pi \end{cases}$$

Determine the steady-state temperature within the plate.

L-3/T-1/CHE **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

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) A person takes a shower for ten minutes. The water flow rate is 10 kg/min, and the temperature of the shower water is 45°C. Assuming that cold water is at 15°C, and that hot water from a 95% efficiency electric heater is at 60°C, how many cubic meter of natural gas (NG) does it use to provide the hot water for the shower? If the electric heater is replaced by a 70% efficient gas water heater, what would be the natural gas consumption? Given: **(22)**

   Calorific value of NG 35 MJ/m^3

   NG transmission efficiency 96%

   Efficiency of electricity generation from NG 42%

   Electricity transmission and distribution losses 6%

   Specific heat of water 4.18×10^{-3} MJ/kg.K

   (b) A waste heat audit survey indicates 4500 kg/hr of water at 90°C is discharge to the sewer. How much heat and money can be saved by utilizing this fluid as makeup to the boiler instead of the 20°C feedwater supply? Cost of coal is BDT 9000/ton. Calorific value of coal is 22 MJ/kg. Boiler efficiency is 80% and hours of operation is 4000/year. **(13)**

2. (a) "Depending on the gasifier system configuration, operating conditions, and gasification agents, four types of synthetic gas can be produced from carbonaceous solid or liquid materials". What are these four gaseous products? What are their applications? **(4×4=16)**

   (b) What are the advantages of gasification over direct combustion? **(14)**

   (c) Briefly mention different stages of coal gasification reaction. **(5)**

3. (a) What is the difference between combined cycle power plant and cogeneration plant? What are the typical efficiencies of these plants? What do you understand by topping and bottoming cycles? **(4+2+4)**

   (b) An industrial plant has 27,240 kg/h of superheat steam at 6890 kPa (abs) and 482.2°C available. Two options are being considered for use of this steam: **(25)**

   (1) expanding the steam in a turbine having 70% efficiency to 6.89 kPa (abs), and (2) expand the steam in a turbine to 1378 kPa (abs) generating electricity and utilizing the low-pressure exhaust steam for process heating. Evaluate the two schemes for energy efficiency when the boiler has an 82% efficiency on a HHV basis. Given:

Contd P/2

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

Steam enthalpy @ 6890 kPa and 482.2°C = 3368 kJ/kg

Steam enthalpy @ turbine exit (6.89 kPa) = 2124 kJ/kg

Steam enthalpy @ turbine exit (1378 kPa) = 3058 kJ/kg

Latent heat of condensation @ 1378 kPa = 1939.9 kJ/kg

$$\text{Boiler input} = \frac{\text{Steam generated (Steam enthalpy} - \text{feedwater enthalpy)}}{\text{boiler efficiency}}$$

Feedwater enthalpy = 465 kJ/kg

4. Bangladesh mostly depends on local NG, local and imported coal and imported crude oil for its energy need. The details (energy production, supply and consumption) are given below for 2008:

Crude oil produced : 78 ktoe; coal produced : 228 ktoe; Gas produced : 14079 ktoe

Crude oil imported : 1109 ktoe, coal imported : 400 ktoe

Import of petroleum products : 3623 ktoe

Export of petroleum products : 140 ktoe

The following are uses of petroleum products (ktoe) in the country:

Road transport : 1764

International transport (marine and aviation bunkers) : 254

Industry : 270

Residential and commercial : 1325

Non-energy use : 349

The following are uses of gas (ktoe) in the country:

Road transport : 535

Industry : 2161

Residential and commercial : 1789

Non-energy use : 1844

Electricity generation	Electricity consumption (ktoe)
Production 35 TWh (or 3006 ktoe)	Residential and commercial : 1193
Primary energy consumed	Industry : 1539
Coal 219 ktoe	
Oil 621 ktoe	
NG 7371 ktoe	
Hydro 127 ktoe	
Losses and own-use 274 ktoe	

(a) Based on the given information, prepare the overall energy balance for the year 2008. [Use the provided table; attach it with the answer script]. **(25)**

(b) What is the difference between industrial and non-energy consumption of gas? **(5)**

(c) What is the overall efficiency of power generation sector? **(5)**

Contd P/3

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SECTION – B

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

5. (a) Name and define the main properties of liquid fuels. Discuss their importance in different fuel related usages such as for heating, in internal combustion engines and for illumination. **(25)**

   (b) Write a short account on the two methods for expressing the composition/analysis of coal. **(10)**

6. (a) Coal of known ultimate analysis is burned in a furnace. Excess air for burning (more than the theoretical quantity) is used. Show that the percentage of excess air can be calculated only from the exhaust gas analysis data. **(22)**

   (b) Describe the combustion process of pulverized coal in a furnace. What happens to the ash when pulverized coal is burned in a furnace? **(8+5)**

7. (a) What are the different steps in the design process of a furnace? Briefly discuss each of these steps. **(20)**

   (b) Describe the burning of a fuel-gas in Bunsen burner (include primary and secondary air and flame structure in your answer). **(10)**

   (c) Write a few words on the importance of minimum ignition energy from safety viewpoint. **(5)**

8. (a) Write a short account on the spontaneous ignition of a decomposing haystack. **(12)**

   (b) Draw and explain the PT diagram for hydrogen in oxygen in a spherical vessel. **(8)**

   (c) Explain the formation of fine droplets of liquid fuel in a high pressure nozzle. **(8)**

   (d) Describe the structure of a candle flame. **(7)**

Table for Question 4 (a)

Supply and Consumption	Coal	Crude oil	Oil Products	Natural Gas	Hydro	Electricity	Total
Production							
Imports							
Exports							
International Bunkers							
TPES							
Electricity							
Oil Refineries							
Other transformation*							
TFC							
Industry							
Transport							
Residential & Commercial							
Non-energy use							

* Includes transfers, statistical differences, energy industry own use, and losses