L-3/T-1/CHE

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA


Sub: CHE 307 (Chemical Engineering Thermodynamics)

Full Marks: 210  Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Symbols have their usual meanings. A data booklet will be supplied.

1. (a) For a system that exhibits VLE, at least one of the k-values must be greater than 1.0 and at least one must be less than 1.0. True/False. Explain your answer.

(b) For a binary system that exhibits VLE, show that,

\[
\begin{align*}
\frac{v}{v^*} &= \frac{k_1}{k_2} - 1 \\
&= \frac{z_1 (k_1 - k_2) - (1 - k_2)}{(1 - k_1)(1 - k_2)}
\end{align*}
\]

(c) The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by the equation,

\[
H = 400x_1 + 600x_2 + x_1x_2 (40x_1 + 20x_2)
\]

where H is in J/mol.

(i) Show that

\[
\begin{align*}
\bar{H}_1 &= 420 - 60x_1^2 + 40x_1^3 \\
\bar{H}_2 &= 600 + 40x_1^3
\end{align*}
\]

(ii) Find the numerical values of pure species properties, and

(iii) Determine the numerical values for partial enthalpies at infinite dilution.

2. (a) 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 and vapor phase composition from the following information

\[
\begin{align*}
\ln \gamma_1 &= A x_2^2 \\
\ln \gamma_2 &= A x_1^2 \\
\frac{p_1}{p_{1,\text{Sat}}} |_{144^\circ C} &= 80 \text{ kPa} \\
\frac{p_2}{p_{2,\text{Sat}}} |_{144^\circ C} &= 40 \text{ kPa}
\end{align*}
\]

and \( x_{a1} |_{144^\circ C} = 0.304 \)

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

\[ V = 120x_1 + 70x_2 + (15x_1 + 8x_2) x_1x_2 \]

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

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

Contd .......... P/2
3. (a) The virial equation of state for a gas mixture is represented by
\[ nz = n + \frac{nBP}{RT} \]
where the second virial co-efficient
\[ B = \sum_i \sum_j y_i y_j B_{ij} \]
Show that for binary mixture, fugacity co-efficient of species 1,
\[ \ln \phi_1 = \frac{P}{RT} \left( B_{11} + y_2^2 \delta_{12} \right) \]
(b) Estimate \( z \) for an equimolar mixture of propane(1)/n-pentane(2) at 50°C and 2 bar.
Where,
\[ B_{11} = -331 \text{ cm}^3/\text{mol} \]
\[ B_{12} = -558 \text{ cm}^3/\text{mol} \]
\[ B_{22} = -980 \text{ cm}^3/\text{mol} \]

4. (a) A single effect evaporator operating at atmospheric pressure concentrates a 15% (by weight) LiCl solution to 40%. The feed enters the evaporator at the rate of 2 kg/s at 25°C. The normal boiling point of a 40% LiCl solution is about 132°C and its specific heat is estimated as 2.72 kJ/kg°C. What is the heat transfer rate in the evaporator? The change of enthalpy for water [from 25°C (l) to 132°C (g)] is 2635 kJ/kg.
(b) The excess Gibbs energy of a binary liquid mixture at T and P is given by
\[ G^E = A_{21} x_1 + A_{12} x_2 \]
Show that
\[ \frac{G^E}{x_1 x_2 RT} = \ln y_1^{\infty} = A_{12} \]

**SECTION – B**

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

5. (a) With a schematic diagram write the working principle of a Linde liquefaction process.
(b) Consider the vapor compression refrigeration cycle with tetrafluoroethane as refrigerant. If the evaporation temperature is -12°C, show the effect of condensation temperature on the coefficient of performance by making calculation for condensation temperatures of 38°C and 27°C.
   (i) Assume isentropic compression of vapor.
   (ii) Assume a compressor efficiency of 75%.
6. (a) Discuss on the choice of refrigerant.  
(b) Write different ways of cooling process on a T-S diagram.  
(c) A system formed initially of 2 mol CO\(_2\), 5 mol H\(_2\) and 1 mol CO undergoes the reactions:  
\[
\begin{align*}
\text{CO}_2 + 3 \text{H}_2 & \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O} \\
\text{CO}_2 + \text{H}_2 & \rightarrow \text{CO} + \text{H}_2\text{O}
\end{align*}
\]
Develop expressions for the mole fractions of the reacting species as function of the reaction coordinates for the two reactions.

7. The feed gas to a methanol synthesis reactor is composed of 75% mol 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:  
\[
\begin{align*}
2\text{H}_2 + \text{CO} & \rightarrow \text{CH}_3\text{OH} \\
\text{H}_2 + \text{CO}_2 & \rightarrow \text{CO} + \text{H}_2\text{O}
\end{align*}
\]
Assuming ideal gases, determine the composition of the equilibrium mixture.

8. (a) For calculating the effect of temperature on the equilibrium constant, derive the following equation:  
\[
\frac{\Delta G^\circ}{RT} = \frac{\Delta G_0^\circ - \Delta H_0^\circ}{RT_0} + \frac{\Delta H_0^\circ}{RT} + \frac{1}{T} \int_{T_0}^{T} \frac{\Delta C_p}{R} dT - \frac{1}{T_0} \frac{\Delta C_p}{R} \int_{T_0}^{T} dT
\]
(b) Oil refineries frequently have both H\(_2\)S and SO\(_2\) to dispose of. The following reactions suggests a means of getting rid of both at once:  
\[
2 \text{H}_2\text{S} + \text{SO}_2 \rightarrow 3 \text{S} + 2 \text{H}_2\text{O}
\]
For reactants in the stoichiometric proportion, estimate the percent conversion of each reactant if the reaction comes to equilibrium at 450\(^\circ\)C and 8 bar.

Fig.: for Q. 9(a)
SECTION - A

There are FOUR questions in this section. Q. No. 1 is Compulsory and carries 45 marks. Answer any TWO from the rest. Heat Transfer Data booklet will be supplied.

1. (a) Identify the following labeled sections of a shell and tube heat exchanger from Figure 1(a).

(b) What is the critical heat flux of a pool boiling curve? List the factors that can influence the critical heat flux.

(c) Calculate the equivalent diameter of a tube bundle (2" ID) arranged in a triangular pitch arrangement with 0.5" clearance.

(d) How the velocity profile of a fluid deviates from the isothermal condition during cooling and heating? Show the typical velocity profiles for liquid and gas for these conditions.

(e) What is the difference between Thermal resistance and R value? Explain with relevant equations.

(f) "Nusselt number is also considered as dimensionless heat transfer coefficient" – explain.

(g) Why does total heat transfer during film boiling consider only 75% of radiation heat transfer? Explain the reason for not considering total radiation heat transfer.

Contd .......... P/2
2. (a) With the help of schematics show the typical velocity and temperature profiles for a natural convection system where the vertical plate is (i) hotter and (ii) cooler than the ambient temperature. How do they differ from the forced convection system? Also explain the important dimensionless numbers involved in natural convection process.

(b) A spherical balloon gondola (2.4 m in diameter) rises to an altitude where the ambient pressure is 1.4 kPa and the ambient temperature is -50°C. The outside surface of the sphere is at approximately 0°C. Estimate the free-convection heat loss from the outside of the sphere. How does this compare with the forced-convection loss from such a sphere with a low free-stream velocity of approximately 30 cm/s?

3. (a) Using a neat schematic describe the working principle of plate and frame heat exchanger.

(b) Draw the temperature profiles of the hot and cold streams for the following situations:
   (i) cold fluid is evaporating and hot fluid is saturated steam
   (ii) cold fluid is gaining sensible heat and hot fluid is superheated steam that eventually condense.

(c) It is desired to heat 230 kg/h of water from 35 °C to 93°C with oil \( c_p = 2.1 \text{ kJ/kg.°C} \) having an initial temperature of 175°C. The mass flow of oil is also 230 kg/h. Two double-pipe heat exchanger are available:

| Exchanger 1: | \( U = 570 \text{ W/m}^2.\text{°C} \) | \( A = 0.47 \text{ m}^2 \) |
| Exchanger 2: | \( U = 370 \text{ W/m}^2.\text{°C} \) | \( A = 0.94 \text{ m}^2 \) |

Which exchanger should be used?

4. (a) A heat exchanger is to be designed to condense 600 kg/h of steam at atmospheric pressure. A square array of four hundred 1.0-cm-diameter tubes is available for the task, and the tube wall temperature is to be maintained at 97°C. Estimate the length of tubes required.

(b) In a gas-fired boiler, water is boiled at 150°C by hot gases flowing through 50-m-long, 5-cm-outter-diameter mechanically polished stainless steel pipes submerged in water. If the outer surface temperature of the pipes is 165°C, determine (i) the rate of heat transfer from the hot gases to water, and (ii) the rate of evaporation.

SECTION - B

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

5. (a) Starting from the Fourier's law of heat conduction, develop the general three dimensional heat-conduction equation.

(b) For a hollow cylinder exposed to a convection environment on its inner and outer surfaces, write down
   (i) Electric-resistance analogy and
   (ii) Overall heat transfer coefficient relationships based on outside and inside area of the tube.

Contd ............ P/3
(c) Consider a 0.8-m-high and 1.5-m-wide glass window with a thickness of 8 mm and a thermal conductivity of $k = 0.78 \text{ W/m.}^\circ\text{C}$. Determine the steady rate of heat transfer through this glass window and the temperature of its inner surface for a day during which the room is maintained at 20°C while the outdoor temperature is -10°C. Take the heat transfer coefficients on inner and outer surfaces of the window to be $h_1 = 10 \text{ W/m}^2.\circ\text{C}$ and $h_2 = 40 \text{ W/m}^2.\circ\text{C}$, which includes the effects of radiation.

6. (a) What is the significance of "critical thickness of insulation". Derive the equation for critical thickness of insulation for a cylindrical pipe.

(b) A 3-mm-diameter and 5-m-long electric wire is tightly wrapped with a 2-mm-thick plastic cover whose thermal conductivity is 0.15 $\text{ W/m.}^\circ\text{C}$. Electrical measurements indicate that a current of 10 A passes through the wire and there is a voltage drop of 8 V along the wire. If the insulated wire is exposed to a medium at 30°C with a heat transfer coefficient $12 \text{ W/m}^2.\circ\text{C}$, determine the temperature at the interface of the wire and the plastic cover in steady operation. Also determine whether doubling the thickness of the plastic cover will increase or decrease this interface temperature.

(c) It is common experience to feel "chilly" in winter and "warm" in summer in our homes even when the thermostat setting is kept the same. This is due to so called "radiation effect" resulting from radiation heat exchange between our bodies and the surrounding surfaces of the walls and the ceiling. Consider a person standing in a room maintained at 22°C at all time. The inner surfaces of the walls, floors and the ceiling of the house are observed to be at an average temperature of 10°C in winter and 25°C in summer. Now validate the "radiation effect" with these information. [See Fig. 6(c)].

7. (a) Write down Dittus-Boelter equation with its applicability ranges.

(b) Define Nusselt number and Prandtl number. Explain their physical significance.

(c) "Prandtl number for liquid metal is less than that of gas". – Do you agree with this statement? Justify to your answer.

(d) Atmospheric air at 300 K flows over a flat plate at a speed of 2 m/s. If the viscosity of air at 300 K is $1.85 \times 10^{-5} \text{ kg/m.s}$, calculate the boundary layer thickness at distance of 20 cm and 40 cm from the leading edge of the plate.
8. (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

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

$$\delta = 4.64 \sqrt{\frac{\nu_x}{u_\infty}}$$

where, $u_\infty$ is the fluid velocity outside the boundary layer and other symbols have their usual meanings. Derive Reynolds-Colburn analogy.

(b) Air at 2 atm and 473 K is heated as it flows through a tube with a diameter of 1 inch at a velocity of 10 m/s. Calculate the heat transfer per unit length of tube if a constant-heat-flux condition is maintained at the wall and the wall temperature is 20°C above the air temperature, all along the length of the tube.

You can use the following correlation,

$$N_u = 0.023 Re^{0.8} Pr^{0.4}$$

Physical properties of air at a bulk temperature of 473 K,

- Viscosity, $\mu = 2.57 \times 10^{-5}$ kg/m.s
- Thermal conductivity, $K = 0.0386$ W/m.°C
- Heat capacity, $C_p = 1.025$ kJ/kg.°C

![Figure: 6(c)](image)
Table: Values of the coefficient $C_{sf}$ and $n$ for various fluid-surface combinations

<table>
<thead>
<tr>
<th>Fluid-Heating Surface Combination</th>
<th>$C_{sf}$</th>
<th>$n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water–copper (polished)</td>
<td>0.0130</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–copper (scored)</td>
<td>0.0068</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–stainless steel (mechanically polished)</td>
<td>0.0130</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–stainless steel (ground and polished)</td>
<td>0.0060</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–stainless steel (teflon pitted)</td>
<td>0.0058</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–stainless steel (chemically etched)</td>
<td>0.0130</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–brass</td>
<td>0.0060</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–nickel</td>
<td>0.0060</td>
<td>1.0</td>
</tr>
<tr>
<td>Water–platinum</td>
<td>0.0130</td>
<td>1.0</td>
</tr>
<tr>
<td>$n$-Pentane–copper (polished)</td>
<td>0.0154</td>
<td>1.7</td>
</tr>
<tr>
<td>$n$-Pentane–chromium</td>
<td>0.0150</td>
<td>1.7</td>
</tr>
<tr>
<td>Benzene–chromium</td>
<td>0.1010</td>
<td>1.7</td>
</tr>
<tr>
<td>Ethyl alcohol–chromium</td>
<td>0.0027</td>
<td>1.7</td>
</tr>
<tr>
<td>Carbon tetrachloride–copper</td>
<td>0.0130</td>
<td>1.7</td>
</tr>
<tr>
<td>Isopropanol–copper</td>
<td>0.0025</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Relevant Equations:

Free convection from sphere:

$$\frac{h_d}{k_f} = \frac{2 + 0.392 \text{Gr}_f^{1/4}}{k_f} \quad \text{for } 1 < \text{Gr}_f < 10^5$$

$$\text{Nu}_f = 2 + 0.43(\text{Gr}_f \text{Pr}_f)^{1/4} \quad \text{for } 3 \times 10^5 < \text{GrPr} < 8 \times 10^8$$

Forced convection from sphere:

$$\frac{h_d}{k_f} = 0.37 \left( \frac{\nu_{\infty} d}{v_f} \right)^{0.6} \quad \text{for } 17 < Re_d < 70,000$$

$$\text{Gr}_x = \frac{g\beta(T_w - T_\infty)x^3}{v^2}$$

Film condensation for horizontal tube banks:

$$\overline{h} = 0.725 \left( \frac{\rho(\rho - \rho_v)gh_f \sigma^2}{\mu_f d(T_s - T_w)} \right)^{1/4}$$

Pool boiling:

$$\dot{q}_{\text{nucleate}} = \mu_L \overline{h}_L \left[ \frac{g(\rho_L - \rho_v)}{\sigma} \right]^{1/2} \left[ \frac{C_p(T_s - T_{\text{sat}})}{C_{sf} h_f \text{Pr}_f} \right]^3$$

$$\dot{q}_{\text{film}} = C_{\text{film}} \left[ gk_f^3 \rho_v (\rho_L - \rho_v)[h_f \sigma + 0.4C_p(T_s - T_{\text{sat}})] \right]^{1/4} \mu_L D(T_s - T_{\text{sat}})$$

Where, $C_{\text{film}} = \begin{cases} 0.62 \text{ for horizontal cylinders} \\ 0.67 \text{ for spheres} \end{cases}$
SECTION – A

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

1. (a) Draw a graph of the function defined as

\[ f(x) = \begin{cases} 
1 - x & -1 \leq x \leq 0 \\
0 & 0 < x \leq 1 
\end{cases} \]

having period 2 on the interval \([-3, 3]\).

Find a Fourier series of \( f(x) \) and hence find the sum of the infinite series

\[ \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2} . \]

(b) Expand \( f(x) = x^2; 0 < x < 2\pi \) in a Fourier series and hence evaluate

\[ \sum_{n=1}^{\infty} \frac{1}{n^2} . \]

Sketch a graph of the function \( f(x) \) and show its periodic extension in graph.

2. (a) Graph the function \( f(x) \) defined below on the given interval and find the Fourier sine series of \( f(x) \):

\[ f(x) = \begin{cases} 
0 & 0 \leq x < \pi \\
\cos x & \pi \leq x \leq 2\pi 
\end{cases} \]

Also discuss the convergence of the series at \( x = \pi \).

(b) Find the Fourier integral of

\[ f(t) = \begin{cases} 
0 & |t| > 1 \\
1 + t & |t| < 1 
\end{cases} \]

and hence evaluate the integral

\[ \int_{0}^{\infty} \left( \frac{\sin \omega}{\omega} \right)^2 d\omega . \]

3. (a) Find the Fourier cosine integral of the function

\[ f(t) = \begin{cases} 
1 + \cos t & 0 \leq t \leq \pi \\
0 & t > \pi 
\end{cases} \]

and hence evaluate the integral

\[ \int_{0}^{\infty} \frac{\sin \omega}{\omega} \frac{\sin 3\omega}{1 - \omega^2} d\omega . \]

(b) Find the Fourier cosine transform of \( f(t) = e^{-at}; t > 0 \) and using the result find the Fourier transform of

\[ g(t) = \frac{\sin 3t}{4 + t^2} . \]

Contd ........... P/2
4. (a) Find the Fourier transform of
\[ f(t) = \begin{cases} 
1 - t^2; & |t| \leq 1 \\
0; & |t| > 1
\end{cases} \]
and hence evaluate the integral
\[ \int_{-\infty}^{\infty} \frac{\sin \omega - \omega \cos \omega}{\omega^3} \cos \omega \cos \omega \, d\omega. \]

(b) Use Fourier transform to solve the following boundary value problem:
\[ \frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}; \quad 0 < x < b, \quad t > 0 \]
\[ u_x(0, t) = u_x(b, t) = 0; \quad t > 0 \]
\[ u(x, 0) = 2x; \quad 0 < x < b \]

5. (a) Form a partial differential equation by eliminating the arbitrary function \( \varphi \) from
\[ \varphi(x^2 + y^2 + z^2 - 2xy) = 0 \]

(b) Solve the following PDEs
(i) \((mx - ny)p + (nx - lz)q = ly - mx\)
(ii) \(2xz - px^2 - 2qxy + pq = 0\)

6. (a) Solve the following PDEs
(i) \(\frac{\partial^2 z}{\partial x^2} \frac{\partial^2 z}{\partial x \partial y} - z \frac{\partial^2 z}{\partial y^2} = (y - 1) e^x\)
(ii) \(x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} - x \frac{\partial z}{\partial x} = \frac{x^3}{y^2}\)

(b) Find the integral surface of the linear PDE \(x(y^2 + z)p - y(x^2 + z)q = (x^2 - y^2)z\)
which contains the straight line \(x + y = 0, z = 1\).

7. (a) Convert Laplace equation \(\nabla^2 v = 0\) from Cartesian co-ordinates into polar co-ordinates.
(b) Temperature distribution \(v\) inside a homogeneous solid satisfies the equation
\[ \frac{\partial v}{\partial t} = h^2 \nabla^2 v, \] \(h^2\) is the diffusivity of the substance and is a constant. Determine the
steady state temperature within the plate subject to the boundary conditions
\[ v(0, y) = 0, \quad v(x, 0) = 0, \quad v(x, \infty) = 0, \quad v(x, 0) = F(x) \]

8. (a) Suppose a very long circular cylinder is composed of two halves. The two halves of
the cylinder are thermally insulated from each other and the upper half of the cylinder is
kept at temperature \(v_1\), while the lower half is kept at temperature \(v_2\). Find the steady state
temperature in the region inside the cylinder.
(b) Find the potential of the region inside and outside a ring.
1. (a) Explain the following terms: 
   (i) international marine and aviation bunkers 
   (ii) non-energy uses of fuel 
   (iii) stock changes 
   (iv) energy self-sufficiency 
   
   (b) Proximate analysis of Kola Mouza peat is given below:  
   Moisture 8.75%  
   Ash 25.43%  
   Volatile Matter 46.46%  
   Fixed carbon 19.36%  
   How would you interpret this proximate analysis data to find probable uses of this peat? Explain your answer. 
   
   (c) Examine the potential of wind power in Bangladesh based on the wind map provided in the figure [for Q. No 1c]. 

2. (a) A coal has the following ultimate analysis:  
   C 83.39  
   H 4.56  
   O 5.05  
   N 1.03  
   S 0.64  
   Ash 5.33  
   Determine the mass of air required per kg of coal for theoretically perfect combustion, the mass of gas formed per kg of coal burned, the volume of flue gas at the boiler exit temperature of 316°C per kg of coal burned, and CO₂ percentage in the flue gas on a dry and wet basis. Molar volume of any gas at 273 k and 101.3 kPa is 22.41 m³/kmol.  
   
   (b) List the effect of volatile matter and ash on the combustion of coal and biomass. 
   
   (c) What do you understand by rank and grade of coal?
3. (a) Differentiate between NGL, NGC and LNG. (5)
(b) What is the typical composition of landfill gas? What are the benefits of extracting landfill gas from a landfill site? (5)
(c) Explain the terms flash point and flammability limit. How are they linked to transportation and storage safety of fuels? (10)
(d) Discuss the effects of sulphur content of furnace oil on its combustion and use. (10)
(e) Why do we need a vacuum distillation unit in a crude oil refinery? (5)

4. (a) Compare and contrast the combustion of coal using grate and suspension firing. Use schematics, if necessary. You should use three T's of combustion in your answer. (20)
(b) Explain the importance of excess air in combustion. (10)
(c) How can you find the % excess air from the given figure [for Q. No. 4c]? (5)

SECTION - B
There are FOUR questions in this section. Answer any THREE.

5. (a) What are the advantages of gas-turbine co-generation system? Discuss the differences between open cycle and closed cycle gas turbine cogeneration systems with diagrams. (4+6=10)
(b) Show Brayton and Rankine cycle in a T-S diagram. What are the benefits of combining these two cycles? If a plant consumes 100 MW thermal energy to produce 35 MW electricity, determine the efficiency increase for this plant for combining Brayton and Rankine cycle (with bottoming cycle efficiency of 25%)? State any assumption you make. (12)
(c) In tri-generation, how is the waste heat used for HVAC systems? (5)
(d) What is a heat pump? When is it most promising? Discuss its working principle with neat sketch. (8)

6. (a) What is maximum experimental safe gap (MESG)? Why is it necessary? (5)
(b) Boiler efficiency is an important parameter for power plant engineers. In case of a pulverized coal fired boiler, energy loss happens in many ways (i.e., heating gases, evaporation of moisture, radiation loss etc.). Consider a plant burning a high ash coal for a boiler producing saturated steam at 10 bar pressure (665 k cal/kg of enthalpy, Hs). (25)
The ultimate analysis of the coal and other measured data are given below:

Coal ultimate analysis: C - 77%; H - 5%; N - 1.7%; S - 2.5%; O - 4.8%; Ash - 9%

Calorific value (GCV): 7650 k cal/kg; Moisture: 5%

Flue gas temperature: 220°C

Ambient temperature: 25°C

Percentage of oxygen: 5% (in flue gas)

C_p of dry flue gas: 0.23 k cal/kg °C

C_p of air: 0.45 k cal/kg °C

Humidity of air: 0.016 kg/ kg of dry air

GCV of ash+unburnt fuel: 2000 k cal/kg

Assume amount of (ash + unburnt) ≡ ash content

Enthalpy of feed water: 60 k cal/kg

Assuming 3% radiation loss, determine the boiler efficiency by indirect method. Also find out the evaporation ratio.

(c) What is boiler blow down? How is it controlled? (5)

7. (a) What type of flame is a candle flame? Describe the steps involved in producing the candle flame? (7)

(b) Write briefly on the following: (i) Auto ignition; (ii) Induced ignition; (iii) Quenching; (iv) Minimum ignition energy. (4x2.5=10)

(c) Find out the critical heat flux for ignition if a 10 mm thick plywood is cooled by natural convection (10 W/m²K) in an environment at T_a = 20°C. Assume the emissivity = 0.95. The ignition temperature of plywood is 390°C. Also determine how long it will take to catch fire when subjected to a heat flux of 50 kW/m² \((C_S = 2500 \text{ J/kg K and } \rho_S = 540 \text{ kg/m}^3)\). (10) 

(d) What are low pressure, best pressure and high pressure for gas turbine cycles? Discuss with the help of Brayton cycle diagram. (8)

8. (a) What do you understand by sub critical, super critical and ultra-super critical pulverized coal power plant? (6) 

(b) What are the advantages of gasification over combustion of solid fuels? Discuss the economic benefits of gasification. (5+6=11)

(c) Discuss co-production in a IGCC with the help of a block diagram. Mention the possible production from this process. (10)

(d) What is Carnot efficiency? Is it possible to attain Carnot efficiency for a power plant? Give reasons to your answer. (8)
Fig. 1. Wind map of Bangladesh at 30-m elevation.
Figure for Question 4 (c)

![Graph showing carbon dioxide or oxygen, % by volume, vs. excess air, % for different fuels: CO₂ wood, CO₂ bituminous coal, CO₂ fuel oil, CO₂ natural gas, O₂ natural gas, O₂ fuel oil, O₂ coal, and O₂ wood.](image)
Percentage heat loss due to dry flue gas

\[ = m \times C_p \times (T_f - T_a) \times 100 \]

GCV of fuel

Percentage heat loss due to evaporation of water formed due to H₂ in fuel

\[ = 9 \times H_2 \{584 + C_p (T_f - T_a)\} \times 100 \]

GCV of fuel

Percentage heat loss due to evaporation of moisture present in fuel

\[ = M\{584 + C_p (T_f - T_a)\} \times 100 \]

GCV of fuel

Percentage heat loss due to moisture present in air

\[ = AAS \times \text{humidity factor} \times C_p (T_f - T_a) \times 100 \]

GCV of fuel

Percentage heat loss due to unburnt fuel in fly ash

\[ = \text{Total ash collected/kg of fuel burnt} \times \text{GCV of fly ash} \times 100 \]

GCV of fuel

Percentage heat loss due to unburnt fuel in bottom ash

\[ = \text{Total ash collected per Kg of fuel burnt} \times \text{G.C.V of bottom ash} \times 100 \]

GCV of fuel

\[ t_{ig} = \frac{\rho_s c_s d (T_{ig} - T_\infty)}{\dot{q}''_s} \]

\[ = \frac{\rho_s c_s d (T_{ig} - T_\infty)}{\alpha \dot{q}''_{ext}} \]

\[ \dot{q}''_{conv} = \bar{h} (T_{ig} - T_\infty) \]

\[ \dot{q}''_{rad} = \varepsilon \sigma \left( T_{ig}^4 - T_\infty^4 \right) \]
SECTION – A

There are FOUR questions in this section. Answer any THREE.
Symbols have their usual meanings.

1. (a) Using appropriate diagrams differentiate between configuration and conformation of biological molecules.
(b) Write down in detail four major ways that eukaryotes are different from prokaryotes.
(c) With the help of a properly labelled titration curve for a weak acid having pK_a=6.86, calculate the pH range within which this acid shows optimum buffering capacity (show your working). Explain in your own words why this is the optimum pH range for buffering.

2. (a) What are motifs, domains and ribbon diagrams?
(b) What are the properties of the enzyme DNA polymerase?
(c) Comparing the two amino acids, aspartic acid and phenylalanine, answer the following:
   (i) which would be very soluble in water and why?
   (ii) which would show absorbance in UV spectra and why?
   (iii) which would show positive hydropathic index and why?
   (iv) which is more likely to be present in a structural protein like α-keratin and why?

3. (a) Explain ANY TWO rules of DNA replication with appropriate diagrams.
(b) A Ramachandran plot is given in Figure 3.
   (i) Sketch a similar Ramachandran plot in your answer script with the axes labelled correctly (Label ψ, φ, axes and corresponding values eg. 180°, 0°, -180° etc.)
   (ii) Why is the middle of the graph empty? Why is the graph not symmetrical?
(iii) Marked in Figure 3 are four regions. With the help of the information below, state which regions A, B, C or D corresponds to the secondary structures: Right handed α-helices, antiparallel β-sheets, collagen and left handed α-helices.

<table>
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<th>Secondary Structure</th>
<th>φ</th>
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<tr>
<td>Right handed α-helices</td>
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<td>−45°</td>
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<tr>
<td>Antiparallel β-sheets</td>
<td>−139°</td>
<td>135°</td>
</tr>
<tr>
<td>Collagen</td>
<td>−51°</td>
<td>153°</td>
</tr>
<tr>
<td>Left handed α-helices</td>
<td>45°</td>
<td>45°</td>
</tr>
</tbody>
</table>

The DNA sequence is given as follows:

5' ATGTGGCACAGAGAATAA 3'

(a) The above DNA sequence is a part of the DNA coding sequence, what is the corresponding mRNA sequence?

(b) Use the codon chart and the correct reading frame to write down the correct peptide sequence in three letter code and one letter code.

(c) For the peptide obtained in part (b), draw the fully protonated structure and the titration curve. Using schematic diagrams show the net charge on the peptide at various pHs. What is the pI and the molecular weight of this peptide?

SECTION-B

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

5. (a) Write short notes on enzyme complementary to substrate and enzyme complementary to transition state hypothesis. Justify which one is more credible.

(b) Derive Lineweaver-Burk equation from Michaelis-Menten equation.

(c) What are the differences between uncompetitive and mixed inhibition?
6. (a) What are the rules of Fischer-Projection drawing? (10)
   (b) The structure of D-galactose is attached below. Transform it into its cyclic form. (5)

   ![Fischer-Projection Drawing of D-galactose](image)

   (c) What are the functions of glycogen? (10)
   (d) Write a short note on different blood types in the context of glycoproteins. (10)

7. (a) Discuss the importance of fatty acids. (7)
   (b) Draw the schematic representation of a phospholipid. (3)
   (c) Suppose we want to use an artificial carrier for a molecule inside a living body. Which type of fatty acid structure shall we use as the carrier? Justify your answer. (10)
   (d) Describe the three basic properties of biological membrane. (6)
   (e) Draw six types of integral membrane proteins. (9)

8. (a) Based on structure and functions, classify fatty acids. (10)
   (b) Suppose we have 1 (one) copy of an original template strand of DNA. We want to produce 32 (thirty-two) identical copies of this strand. Which laboratory technique shall we use for this operation and why? (10)
   (c) What are the differences between primary and derived databases? Why were derived databases developed even though there were primary databases? (15)
### Amino Acid Properties

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<th>Amino acid name</th>
<th>Molecular weight of amino acid</th>
<th>Molecular weight of residue</th>
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<th>pK₂</th>
<th>pK₃</th>
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### Codon Chart

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SECTION – A

There are FOUR questions in this section. Answer Q. No. 1 (Compulsory) and any TWO from the rest. Assume reasonably if additional data/information is required. Notations indicate their usual meanings.

1. (Compulsory)
   (a) Explain briefly the relationship among y-x, temperature-composition, and enthalpy-composition diagrams. Demonstrate how temperature-composition diagram can be generated from DePriester Chart.
   (b) Elaborate the purposes/functions of reflux and boilup in continuous distillation.
   (c) What is the quickest method to determine if Constant Molal Overflow (CMO) is valid in a given situation?
   (d) When would just a stripping or just an enriching distillation column be used?
   (e) Describe shortly when a continuous distillation column is required to operate at the limiting conditions.
   (f) What can be done if the existing continuous distillation column cannot produce the desired product purities?
   (g) Explain which type of distillation, batch or continuous, would use less energy.

2. (a) A mixture that is 40 mole% benzene and 60 mole% toluene is to be flashed in a flash distillation system. Feed is 100 kg moles/day. We desire a liquid product that is 30 mole% benzene. The relative volatility is $\alpha_{BT} = 2.4$.
   Find: (i) vapor composition, (ii) liquid flow rate.
   (b) A steady-state, countercurrent, staged distillation column is to be used to separate ethanol from water. The feed is a mixture of 40 wt% ethanol and 60 wt% water at 20°C. Flow rate of feed is 20,000 kg/hr. The column operates at a pressure of 1 kg/cm$^2$. The reflux is cooled to 40°C. A reflux ratio of $L/D = 3.5$ is being used. We desire a bottom composition of $x_B = 0.002$ (weight fraction ethanol) and a distillate composition of $x_D = 0.91$ (weight fraction ethanol). The system has a total condenser and a partial reboiler. Find D, B, Qc and $Q_R$. Use Figure 2(b) for data.
3. (a) Determine the number of stages and the base feed location for a column separating ethanol and propanol, \( \alpha = 2.1 \). Feed composition = 0.48, \( x_D = 0.96 \), \( x_B = 0.04 \). Constant molal overflow can be assumed, and reflux is a saturated liquid. Column has a total condenser and a partial reboiler. Pressure is 101.3 kPa. It is given that \( L/D = 3 \) and \( q = 0.4 \). (22) 
(b) What would be the number of stages for part (a), if you are required to consider a Murphree vapor efficiency of 75%? (8)

4. We wish to batch distill 50 kg moles 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. Determine the average distillate composition, the final charge in the still pot, and the amount of distillate collected. Pressure is 1 atm. Use Figure (4) for equilibrium data. (30)

SECTION – B
There are FOUR questions in this section. Answer any THREE. Assume reasonable value of additional data if required.

5. (a) Discuss the function of downcomers and weirs for staged distillation. Draw the downcomer and weir desire for (i) circular pipe, (ii) straight segmental, (iii) sloped and (iv) envelope. (12)
(b) What are the difficulties of using Murphree efficiencies for a multicomponent system? (3)
(c) Write the names of different types of trays for distillation in the order of their efficiencies from high to low. Draw the efficiency vs. vapor flow rate curve and identify the weeping, flooding and design point. (7)
(d) Why is it important to have a detailed pattern for sieve trays? Show equilateral triangular pitch by a diagram. (5)
(e) Discuss the advantages and disadvantages of sieve tray and valve tray in a distillation column. (8)

6. (a) What is absorption? Discuss different types of absorption. (3+6=9)
(b) It is desired to absorb 90% of the acetone in a gas containing 1.0 mole% acetone in air in a counter-current stage tower. The total inlet gas flow to the tower is 30 kmol/h and the total inlet pure water flow to be used to absorb acetone is 108 kmol H₂O/h. The process is to operate isothermally at 300 K and a total pressure of 101.3 kPa. The equilibrium relation for the acetone (A) in the gas-liquid is \( y_A = 2.53 x_A \). Determine the number of theoretical stages required for this separation graphically and repeat using Kremser (analytical) equation. (Graph papers to be supplied). (20)
(c) How do you know if the column is an absorber or a stripper? Why does the operating line for stripping stay below the equilibrium curve? (6)

Contd .......... P/3
7. (a) Discuss different types of extractors. For a process requiring high capacity and high stage efficiency, which type of extractor should be selected? (12)

(b) Define the following: (i) Extraction, (ii) Raffinate, (iii) Extract. (9)

(c) 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 clean hand drawing, demonstrate the determination of equilibrium stages required for this separation. (14)

8. (a) State the assumptions for McCabe-Thiele calculation method for washing. (5)

(b) During production of sodium hydroxide by the lime soda process, a slurry of CaCO₃ particles in a dilute sodium hydroxide solution emerges. A four-stage counter-current washing system is used. The underflow entrains approximately 4 kg liquid/kg calcium carbonate solids. The inlet water is pure water. If 10 kg wash water/kg calcium carbonate solids is used, predict the recovery of NaOH in the wash liquor. First determine with Kremser equation, then verify with McCabe-Thiele method. (Graph paper to be supplied). (18)

(c) Draw a countercurrent cascade for leaching and the McCabe-Thiele diagram for this system (by hand). Write the equation for operating line and state the assumption made in this case. (12)
Enthalpy-composition diagram for ethanol-water at a pressure of 1 kg/cm². (Bosn, Technische Thermodynamik, T. Steinkopff, Leipzig, 1935)

Figure for 8.2 (b)

$y$ versus $x$ diagram for ethanol-water.

Figure for 8.4
SECTION – A

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

1. (a) How do you define physical environment and man-made environment? (5)
   (b) Define global warming. Briefly explain the potential consequences of global warming. (18)
   (c) Explain with examples orange category A industry and orange category B industry. (12)

2. (a) What is meant by a criminal, deviant, juvenile delinquent and white-collar criminal? (8)
   (b) Explain the causes of juvenile delinquency. (12)
   (c) Briefly discuss different types of crimes with example from each of them. (15)

3. (a) Write down the causes of development of cities. (10)
   (b) Classify different kinds of cities with example from each of them. What are the disadvantages of mega cities? (10)
   (c) What is meant by human migration? Briefly discuss the causes and effects of rural to urban migration. (15)

4. Write short notes on any THREE of the following: (35)
   (a) Sources of social change
   (b) Features of capitalism
   (c) Environmental justice
   (d) Types of pollution.
5. (a) How do social norms help to develop normative behavior pattern of a social group? (10)
(b) Does cultural lag resist social change? Show arguments in favor of your answer. (10)
(c) Write the differences between culture and civilization. (15)

6. (a) If you conduct a research on “Facebook and Social interactions” how will you design your research? Explain highlighting different steps of doing research in social sciences. (20)
(b) Critically discuss different indicators of Social Impact Assessment (SIA). (15)

7. (a) ‘Globalization is often used to refer to economic globalization: like integration of national economies into the international economy through trade, foreign direct investment, capital flows, migration, and the spread of technology’ - Explain. (20)
(b) Critically discuss various functions of mass media in our society. (15)

8. Write short notes on any three of the following: (35)
   (a) Different systems of social stratification.
   (b) Types of social mobility.
   (c) Karl Marx’s theory of social differences.
   (d) Social values.
L-3/T-1/ChE

Date: 02/08/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
Sub: HUM 303 (Principles of Accounting)

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 criteria of financial elements “Assets” and “Liabilities”? (5)
   (b) Alex started a firm on May 1, 2016. The following transactions occurred during the month of May:
   May 1: Invested cash Tk. 200000 in the business.
   May 2: Paid Tk. 10000 for office rent.
   May 3: Performed Tk. 3300 of service on account.
   May 9: Purchase office equipment for Tk. 20000, paying Tk. 5000 cash and remaining on account.
   May 12: Received Tk. 2000 for services provided on account on May 3.
   May 15: Withdrew Tk. 1000 for personal use.
   May 26: Paid advance for insurance expense Tk. 5,000.
   May 29: Paid dues on purchase of office equipment.
   May 30: Additional Investment Tk. 100000.

   Required: Prepare a tabular summary for the Month of May, 2016.

2. (a) What are the advantages of a journal book? (5)
   (b) Mr. Johnson opened a computer service organization. The transaction of January, 2016 are as follows:
   January-2: Invested Tk. 150000 in the business.
   January-3: Purchase equipment for Tk. 40000.
   January-9: Purchase supplies on account for Tk. 5000.
   January-11: Provide service on account Tk. 15000.
   January-16: Paid Tk. 5000 for advertising expense.
   January-21: Received Tk. 7010 from dues on January 11.
   January-25: Paid salary Tk. 20000.
   January 26: Paid dues on supplies purchase.
   January 27: Received Tk. 5000 for future service.
   January 30: Paid advance rent Tk. 40000.

   Required: (i) Prepare Journal entries.
     (ii) Prepare ledger for Asset accounts.
HUM 303 (CHE)

3. (a) What are the reasons of adjusting the account?
(b) 

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Other Information:
- Unused supplies on hand Tk. 500.
- Accrued travel expense Tk. 350.
- Insurance policy was for 2 years.
- Rent expense incurred but not paid Tk. 900.
- Invoice represented that service earned but not recorded Tk. 1000.
- Depreciation of office equipment Tk. 250 per month.

Required:
(i) Prepare necessary adjustment journal entries. (ii) Prepare an adjustment trial balance.

4. 

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<td>Trademark</td>
<td>20000</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>50900</td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>Salary expense</td>
<td>7000</td>
<td></td>
</tr>
<tr>
<td>Administrative expense</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>Maintenance expense</td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>Rent expense</td>
<td>13000</td>
<td></td>
</tr>
<tr>
<td>Note Payable</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>Bond Payable (long-term)</td>
<td>20000</td>
<td></td>
</tr>
<tr>
<td>Tax Payable</td>
<td>20000</td>
<td></td>
</tr>
<tr>
<td>Store equipment</td>
<td>25000</td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>Unearned commision</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>Sales</td>
<td>98000</td>
<td></td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>30000</td>
<td></td>
</tr>
<tr>
<td>Prepared Insurance</td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>Goodwill</td>
<td>51000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>202900</td>
<td>202900</td>
</tr>
</tbody>
</table>

Contd ........... P/3
HUM 303 (CHE)

Contd ... Q. No. 4

Adjustment data: Two thirds of the supplies were used during the period.

Charge @ 10% depreciation on store equipment.

60% rent relates to office and remaining to sales.

Required: (i) Prepare a multiple-step (classified) income statement for the year ended December, 2016.

(ii) Prepare an owner’s equity statement and a classified balance sheet at 31st December, 2016.

SECTION – B

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

5. (a) Only variable costs can be differential cost. Do you agree? Explain. 

(b) Define the following cost concepts with example:

(i) Opportunity cost. (ii) Conversion cost. (iii) Committed fixed cost.

(c) The following cost and inventory data are taken from the accounting records of Sunflower Construction Company for the year ended on 31st December, 2014.

<table>
<thead>
<tr>
<th>Inventories</th>
<th>January 1,2014</th>
<th>31st December, 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct material</td>
<td>Tk. 7,000</td>
<td>Tk. 15,000</td>
</tr>
<tr>
<td>Work-in-process</td>
<td>10,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Finished goods</td>
<td>20,000</td>
<td>35,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Incurred</th>
<th>Amount (Tk.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct labor cost</td>
<td>70,000</td>
</tr>
<tr>
<td>Purchase of raw materials</td>
<td>118,500</td>
</tr>
<tr>
<td>Indirect-labor</td>
<td>30,000</td>
</tr>
<tr>
<td>Maintenance, factory equipment</td>
<td>6,000</td>
</tr>
<tr>
<td>Advertising expense</td>
<td>90,000</td>
</tr>
<tr>
<td>Insurance, factory</td>
<td>800</td>
</tr>
<tr>
<td>Sales commission</td>
<td>35,000</td>
</tr>
<tr>
<td>Administrative managers salary</td>
<td>55,000</td>
</tr>
<tr>
<td>Supervisors salary</td>
<td>12,000</td>
</tr>
<tr>
<td>Rent, factory</td>
<td>30,000</td>
</tr>
<tr>
<td>Rent, office</td>
<td>25,000</td>
</tr>
<tr>
<td>Rent for showroom</td>
<td>13,000</td>
</tr>
<tr>
<td>Utility (70% factory, 30% for office)</td>
<td>15,000</td>
</tr>
<tr>
<td>Supplies (60% factory, 40% for office)</td>
<td>3,000</td>
</tr>
<tr>
<td>Power and electricity</td>
<td>2,500</td>
</tr>
<tr>
<td>Fuel for factory equipment</td>
<td>700</td>
</tr>
<tr>
<td>Depreciation, factory equipment</td>
<td>30,000</td>
</tr>
<tr>
<td>Legal fees</td>
<td>15,000</td>
</tr>
</tbody>
</table>

Required: (i) Prepare a cost of goods sold statement in a good form.
HUM 303 (CHE)

6. (a) Nokia company manufactures and sales a specialized cordless telephone for the most electromagnetic radiation environments. The company’s contribution format income statement for recent year is given below:

<table>
<thead>
<tr>
<th></th>
<th>Total(Tk.)</th>
<th>Per unit(Tk.)</th>
<th>Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (20,000 units)</td>
<td>10,00,000</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Less:Variable expense</td>
<td>800,000</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Contribution margin</td>
<td>200,000</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Less: Fixed cost</td>
<td>150,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net profit</td>
<td>50,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The management is anxious to increase company’s profit and has asked for an analysis of a number of items.

Required:

(i) Compute the company’s CM ratio and variable expense ratio.
(ii) Compute company’s break-even-points in units and Tk.
(iii) Assume that sales increase by Tk. 400,000 next year. If cost behavior patterns remain unchanged, by how much will the company’s net operating income increase?
(iv) Refer the original data. Assume that next year management wants the company to earn a profit of at least Tk. 90,000. How many units will have to be sold to meet this target profit?
(v) Refer to the original data. Compute the company’s margin of safety.

(b) The Matador Company makes and sells pens. Some pertinent facts are as follows:

Present sales volume is 50,000 units per year at a selling price of Tk. 50 per unit. Fixed costs are Tk. 90,000 per year. Variable cost is Tk. 30 per unit.

Required:

(i) What is the present operating income for a year? (Make a contribution margin format income statement to compute your answer)
(ii) What is the present break-even-points in units and amounts?
(iii) What is the new BEP in units and amounts if the variable cost is increased by Tk. 4 per unit?
(iv) Compute the operating income if a 20% increase in fixed costs, a 10% decrease in variable costs per unit and a 40% increase in units sold occur. (Consider each case separately)

7. (a) Write down the methods of mixed cost analysis.

(b) Cape Air flies with medium sized passenger jet on a route between Washington D.C and Cape Cod. The manger of the airline would like to estimate the relationship between the planes pay load (i.e., total weight of passengers and cargo) and total fuel costs. On five recent flights, the payload varied between 22 tons and 35 tons.

Contd .......... P/5
HUM 303 (CHE)

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

<table>
<thead>
<tr>
<th>Flight</th>
<th>Payload (tons)</th>
<th>Fuel (Cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight 1</td>
<td>35</td>
<td>Tk. 780</td>
</tr>
<tr>
<td>Flight 2</td>
<td>26</td>
<td>720</td>
</tr>
<tr>
<td>Flight 3</td>
<td>33</td>
<td>765</td>
</tr>
<tr>
<td>Flight 4</td>
<td>28</td>
<td>735</td>
</tr>
<tr>
<td>Flight 5</td>
<td>22</td>
<td>700</td>
</tr>
</tbody>
</table>

Required:
Using the least squares regression method estimate the variable cost per ton and fixed cost per flight.

(c) What comparison can be done with ratio analysis?

(d) Rezayna Corporation
Income Statement
For the year ended December 31, 2016

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Amount (tk.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>740000</td>
</tr>
<tr>
<td>Less: Sales return</td>
<td>(40000)</td>
</tr>
<tr>
<td>Net Sales</td>
<td>700000</td>
</tr>
<tr>
<td>Less: Cost of goods sold</td>
<td>(420000)</td>
</tr>
<tr>
<td>Gross Profit</td>
<td>280000</td>
</tr>
<tr>
<td>Less: Operating expenses</td>
<td>(232000)</td>
</tr>
<tr>
<td>Net Income</td>
<td>48000</td>
</tr>
</tbody>
</table>

Rezayna Corporation
Balance Sheet
As on December 31, 2016

<table>
<thead>
<tr>
<th>Asset</th>
<th>Amount (tk.)</th>
<th>Liability and Equity</th>
<th>Amount (Tk.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>35000</td>
<td>Accounts Payable</td>
<td>60000</td>
</tr>
<tr>
<td>Account receivable</td>
<td>50000</td>
<td>Other current liability</td>
<td>25000</td>
</tr>
<tr>
<td>Inventory</td>
<td>90000</td>
<td>Long term liability</td>
<td>80000</td>
</tr>
<tr>
<td>Investment(short-term)</td>
<td>75000</td>
<td>Ending Equity</td>
<td>485000</td>
</tr>
<tr>
<td>Machinery</td>
<td>400000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>650000</td>
<td>Total</td>
<td>650000</td>
</tr>
</tbody>
</table>

Required:
(i) Profit margin ratio  (ii) Asset turnover ratio (iii) Return on Equity
(iv) Current ratio  (v) Quick ratio  (vi) Inventory turnover

Contd .......... P/6
HUM 303 (CHE)

8. (a) Write down the limitation of different types of Capital Budgeting Decision. (9)
(b) Describe the importance of Capital Budgeting Decision. (6)
(c) A company wants to purchase a new machine. The related information of the machine is as follows:

<table>
<thead>
<tr>
<th>Cost of the machine Tk. 75000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Required: Determine:
(i) Pay Back Period (PBP)
(ii) Internal Rate of Return (IRR)
(iii) Net Present Value at 10% cost of capital.

Should the company buy the machine?