SECTION - A

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

1. (a) Deduce the differential continuity equation. Express it in vector notation. Then show that for the case of incompressible flow, the continuity equation may be written as,

\[ \nabla \cdot \mathbf{v} = 0 \]

(b) Calculate the force components of the water acting on the deflecting blade shown in the Fig. for Q. No. 1(b) in the blade:

(i) is stationary
(ii) moves to the right at 20 m/s
(iii) moves to the left at 20 m/s

List all assumptions. The nozzle diameter is 5 cm.

2. (a) Deduce the Bernoulli’s equation. List all assumptions made for the derivation of the equation.
(b) Define piezometric head, total head and total pressure.
(c) What is a venturi meter? A venturi meter reduces the pipe diameter from 20 cm to 8 cm. A manometer is connected as shown in the Fig. for Q. No. 2(c). Calculate the flow rate and the mass flux assuming ideal conditions.

**Figure for Q1(b)**

**Figure for Q2(c) Contd P/2**
3. (a) What is a Poiseuille flow? Derive an expression for the velocity distribution in a Poiseuille flow. 
(b) Show that in a Poiseuille flow the maximum velocity is twice of the average velocity. 
(c) A pressure drop of 400 Pa occurs over a section of 2-cm-diameter pipe transporting water at 20°C. Determine the length of the horizontal section if the Reynolds number is 1600. Also find the shear stress at the wall and the friction factor. 

4. (a) Distinguish among pumps, fans, blowers and compressors. 
(b) Water at 20° C is to be pumped through 300 m of cast iron pipe of 8 cm diameter from a reservoir to a device that is 10 m above the reservoir surface. It is to enter the device at 200 kPa. Screwed components include two elbows (loss coefficient = 0.64), a square-edged entrance (loss coefficient = 0.5) and an angle valve (loss coefficient = 1). If the flow rate is to be 0.02 m³/s, what pump power is needed (assume 80% efficiency)? Attach with your answer script the moody diagram marking the friction factor appropriate for this flow. 
(c) Draw the typical performance curves of a centrifugal pump and show the design points. Explain what happens to the performance curves when cavitation occurs. 

SECTION – B 
There are FOUR questions in this section. Answer any THREE. 
Assume reasonable value for missing data. 

5. (a) Define (i) Newtonian, and (ii) Non-Newtonian fluid and give four examples of each. Explain shear stress vs. rate of deformation diagram for different substances. 
(b) What is capillarity? Prove that the internal pressure of a droplet depends on the diameter of the droplet. 
(c) A shaft of 80 mm diameter rotates concentrically inside a fixed cylinder of 84 mm diameter as shown in Fig. for Q. No. 5(c). The length of the cylinder is 0.8 m. Find the rpm of the shaft if the space between the cylinder and shaft is filled with lubricating oil of viscosity 2.5 poise and a torque of 1.4 N-m is applied. Also find the power required to rotate shaft. 

6. (a) Find the difference in pressure between the chambers A and B shown in Fig. for Q. No. 6(a). 
(b) The rectangular gate as shown in Fig. for Q. No. 6(b) will open automatically when the depth of the water, d, becomes large enough. What is the minimum depth that will cause the gate to open? 

Contd ...........
7. (a) What is metacentric height? Discuss the stability of floating and submerged bodies.
(b) A block of wood having specific gravity of 0.8, floats in water as shown in Fig. for Q. No. 7(b). Find the metacentric height if the size of the block is 1.2 m x 0.6 m x 0.5 m.

(20)

8. (a) Derive the expression for critical depth for open channel flow and show that the critical depth of flow occurs when the Froude number is unity.
(b) A trapezoidal open channel is to be designed for minimum cross-sectional area and maximum flow rate. The flow rate of water is 150 m³/minute and the bed slope is 1 in 1500. The sides are inclined at 60° and the Chezy’s constant C = 90. Determine the cross-sectional dimensions of the channel.
Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)
Figure 7.13 Moody diagram. (From L. F. Moody, Trans. ASME, Vol. 66, 1944.)
SECTION - A

1. (a) Distinguish between thermal boundary layer and concentration boundary layer for a flow over a flat surface. Derive the expressions for local and mean heat transfer coefficients over a distance of \( x = 0 \) to \( x = L \) along the surface.

(b) The exact expression for the local drag coefficient \( C_x \) for laminar flow over a flat plate is given by
\[
C_x = 0.664 \left( \frac{Re_x}{L} \right)^{1/2}.
\]
Air at atmospheric pressure and at \( T_x = 350 \) K flows with a velocity of 30 m/s over a flat plate \( L = 0.2 \) m long. Determine the drag force acting per 1-m width of plate. The physical properties of air at 350 K are: \( \rho = 998 \) gm/m\(^3\), \( v = 20.76 \times 10^{-6} \) m\(^2\)/s.

2. (a) Illustrate with sketches the temperature profiles for hot and cold fluids as a function of the distance along the flow for (i) parallel flow heat exchanger, (ii) Counter flow heat exchanger.

(b) Derive an expression for overall heat transfer coefficient of heat exchanger tube based on both inside surface and outside surface of the tube.

(c) Derive Kirchhoff's law of radiation.

3. (a) Fused quartz transmits 80 percent of the thermal radiation at \( T_x \) K in the wavelength band \( \lambda_1 = 0.3 \) to \( \lambda_2 = 5 \) \( \mu m \) and is opaque to radiation outside this range. If a blackbody radiation source at \( T_x = 1700 \) K is placed in front of this fused quartz sheet, what is the rate of energy transmitted through a 0.5 m\(^2\) area of the quartz sheet?

(b) A surface is subjected to irradiation of spectral distribution given by
\[
\begin{array}{c|c|c}
\lambda & I_\lambda & W/m^2 \\
\hline
0 < \lambda \leq 1 \text{ \( \mu m \)} & I_\lambda = 0 & W/m^2 \text{ \( \mu m \)} \\
1 < \lambda \leq 5 \text{ \( \mu m \)} & I_\lambda = 3000 & W/m^2 \text{ \( \mu m \)} \\
5 < \lambda \leq 10 \text{ \( \mu m \)} & I_\lambda = 8000 & W/m^2 \text{ \( \mu m \)} \\
10 < \lambda \leq 1000 \text{ \( \mu m \)} & I_\lambda = 0 & W/m^2 \text{ \( \mu m \)} \\
\end{array}
\]
Calculate the radiation energy incident on the surface per unit area over a solid angle subtended by \( 0 \leq \phi \leq 2\pi \) and \( 0 \leq \theta \leq \pi/3 \).
4. (a) Two parallel circular disks of equal diameter $D = 1$ m separated by 0.5 m have a common central normal, as illustrated in the accompanying figure 1. One disk is maintained at $T_1 = 800$ K and has an emissivity $\varepsilon_1 = 0.9$. The other is at $T_2 = 600$ K and has an emissivity $\varepsilon_2 = 0.7$. The disks are exposed through the opening between them into an ambient environment which can be regarded as a black medium at $T_w = 300$ K. Sketch the radiation network. Calculate the radiation heat transfer between the two disks and the total heat loss into the ambient. (20)

(b) Determine the view factor $F_{1-2}$ for the configuration of two offset sequences of area $A$, as shown in figure-2. (15)

SECTION – B

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

5. (a) Consider the two-dimensional, steady-state conduction problem for a rectangular region $0 \leq x \leq a$, $0 \leq y \leq b$ for the following boundary conditions:

(i) The boundary surface at $x = 0$ is electrically heated at a rate of $q_o \text{ W/m}^2$.
(ii) The boundary surface at $x = a$ is kept at constant temperature $T_o$.
(iii) The boundary surface at $y = 0$ is insulated.
(iv) The boundary surface at $y = b$ dissipates heat by convection into a medium at temperature $T_w$ with a heat transfer coefficient $h$.

The thermal conductivity of the solid is constant, and there is no heat generation in the medium. Write the mathematical formulation of this problem for the determination of two-dimensional, steady-state temperature distribution $T(x,y)$ within this region. (17)

(b) A copper bar of radius $b$ is initially at a uniform temperature $T_o$. The heating of the rod begins at time $t = 0$ by the passage of electric current which generates heat through out the rod at a constant rate $q_o \text{ W/m}^3$. The rod dissipates heat by convection from its surface at $r = b$, with a heat transfer coefficient $h$, into the ambient air at temperature $T_\infty$. Assuming that the thermal conductivity $k$ of the rod is constant and that the problem can be treated as one-dimensional transient heat conduction in the $r$ variable, write the mathematical formulation for the determination of the one-dimensional, time-dependent temperature distribution $T(r,t)$ within the solid for $t > 0$. (18)

6. (a) A steel plate of thickness $L = 5$ cm and thermal conductivity $k = 20 \text{ W/(m.}^\circ\text{C)}$ is subjected to a uniform heat flux $q = 600 \text{ W/m}^2$ on one of its surfaces and dissipates heat by convection with a heat transfer coefficient $h = 80 \text{ W/(m.}^2.\circ\text{C)}$ from the other surface into the ambient air at $T_\infty = 25^\circ\text{C}$. What are the temperatures of the surfaces of steel plate at steady-state condition? (15)
MME 235

Contd ... Q. No. 6

(b) The wall of an industrial furnace is made of fireclay brick of thickness 0.20 m having an average thermal conductivity of 1.2 W/(m·°C). The outside surface is to be insulated with material having thermal conductivity of 0.05 W/(m·°C) to limit the heat loss of 300 W/m² through the wall. The inside flame temperature of the furnace is 1300°C and the ambient air temperature is 25°C. The heat transfer coefficients on both sides of the wall are 200 W/(m²·°C). Calculate (i) the thickness of the insulation layer requirement and (ii) the inside surface temperature of the wall.

7. (a) (i) Derive an expression for the heat transfer rate through a hollow spherical shell of inside radius r₁ maintained at uniform temperature T₁ and outside radius r₂ maintained at uniform temperature T₂ having a thermal conductivity k.

(ii) Develop an expression for the steady-state temperature distribution in the sphere.

(iii) Develop an expression for the thermal resistance of the hollow sphere.

(b) A spherical thin-walled metallic cylinder is used to store liquid nitrogen at 77 k (boiling point of nitrogen). The container has a diameter of 0.5 m and is covered with an insulating material having a thermal conductivity of 0.0017 W/(m·K). The insulation is 25 mm thick and its outer surface temperature is 300 K. The latent heat of vaporization of liquid nitrogen is 200 kJ/kg.

(i) What is the rate of heat transfer to liquid nitrogen?

(ii) Estimate the amount of nitrogen vaporized per day.

8. (a) A steel ball [ρ = 7850 kg/m³, cₚ = 0.5 kJ/(kg·°C), k = 50 W/(m·°C)] of diameter 2 cm is uniformly heated to a temperature of 900°C. It is to be hardened by suddenly dropping it into an oil bath at a temperature of 60°C. Quenching occurs when the ball reaches 200°C. The heat transfer coefficient between the oil and the sphere is 300 W/(m²·°C).

(i) How long should the ball be kept in the oil bath?

(ii) If 100 balls are to be quenched per minute, determine the rate of heat removal from the oil bath per minute needed to maintain its temperature at 60°C.

(b) Consider the following one-dimensional, steady-state heat conduction problem.

\[
\frac{d^2T(x)}{dx^2} + \frac{1}{k}g = 0 \quad \text{in} \quad 0 < x < L
\]

\[
\frac{dT(x)}{dx} = 0 \quad \text{at} \quad x = 0
\]

\[
k \frac{dT(x)}{dx} + hT(x) = 0 \quad \text{at} \quad x = L
\]

Write the finite-difference formulation of this heat conduction problem by dividing the region 0 < x < L into four equal parts.
Figure 1 for Question No. 4(a)

Figure 2 for Question No. 4(b)
<table>
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<tr>
<th>$\lambda T$ (μm · K)</th>
<th>$F_{0-\lambda}$</th>
<th>$I_{B,\lambda}(\lambda, T)/\sigma T^4$</th>
<th>$I_{B,\lambda}(\lambda, T)/I_{B,\lambda}(\lambda_{\max}, T)$</th>
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*The radiation constants used to generate these blackbody functions:

$G_1 = 3.7420 \times 10^4 \text{ μm}^2/m^2$

$G_2 = 1.4358 \times 10^4 \text{ μm} \cdot \text{K}$

$\sigma = 5.670 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$. 
View factor for coaxial parallel disks

View factor for perpendicular rectangles with a common edg
L-2/T-2/MME  

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA 
L-2/T-2  B.Sc. Engineering Examinations 2012-2013 
Sub: MME 213 (Phase Diagrams and Transformations) 
Full Marks: 280  Time: 3 Hours 
The figures in the margin indicate full marks. 
USE SEPARATE SCRIPTS FOR EACH SECTION 

SECTION – A 
There are EIGHT questions in this Section. Answer any SIX. 

1. What is a ternary phase diagram? Explain how Gibbs triangle guide to position composition of a ternary alloy system.  
(23 ½) 

2. (a) Draw a temperature-composition space diagram of a ternary isomorphous system and briefly discuss isothermal sections above liquidus line, in liquid-solid region and below solidus line.  
(15 ½) 
(b) Write a short note on production of VLS silicon nanowire.  
(8) 

3. (a) What is diffusion? Classify different types of diffusion and discuss the mechanisms of diffusion.  
(12) 
(b) Derive Fick’s first law for diffusion in an ideal solution.  
(11 ½) 

4. Briefly discuss the following instances where phase diagrams and phase relationships have proved invaluable in the efficient solving or practical metallurgical problems: (i) Permanent Magnets; (ii) Hacksaw Blades; (iii) Heating Elements and (iv) Austenitic Stainless Steel.  
(23 ½) 

5. (a) Draw a hypothetical binary phase diagram containing monotectic reaction. Explain with the help of microstructure, solidification of a hypomontectic alloy from liquid to room temperature.  
(15) 
(b) Using proper diagrams explain forming mechanism of the banded structure of copper-lead alloy in upward directional solidification, involving monotectic reaction.  
(8 ½) 

6. (a) Draw a hypothetical binary phase diagram containing peritectic reaction and explain with the help of lever rule how reactions occur to form new phases.  
(15 ½) 
(b) Describe the four rules giving a qualitative estimate of the ability of two metals to form substitutional solid solutions developed by Hume-Rothery.  
(8) 

7. Using free energy curves explain how minima and maxima are developed in phase diagrams for a binary alloy system.  
(23 ½) 

8. (a) Discuss the differences between congruently melting phase and incongruently melting phase.  
(b) Describe the basic rules for construction of a complex phase diagram.  
(12 ½) 
Contd .......... P/2
There are **FOUR** questions in this Section. Answer any **THREE**.
Graph paper is to be supplied.

9. (a) Explain eutectic and eutectoid reactions with reference to typical thermal equilibrium diagrams.

(b) Bismuth and antimony are completely soluble in both the liquid and solid states. Bismuth melts at 520°F and antimony melts at 1170°F. An alloy containing 50 percent bismuth starts to solidify at 940°F by separating crystals of 90 percent antimony. An alloy containing 80 percent bismuth starts to solidify at 750°F by separating crystals of 75 percent antimony.

   (i) Draw the equilibrium diagram to scale on a piece of graph paper and label all points, lines and areas.

   (ii) For an alloy containing 40 percent antimony,
       (1) give the temperature of initial solidification;
       (2) give the temperature of final solidification;
       (3) give the chemical composition and relative amounts of phases present at 800°F;
       (4) sketch the microstructure at room temperature;
       (5) draw the cooling curve.

10. (a) What is meant by the term 'precipitation hardening'? Explain briefly the theory of precipitation hardening.

(b) With reference to a suitable phase diagram explain, the formation of cored structure due to nonequilibrium cooling. How can coring in a solidified alloy be eliminated?

11. (a) Draw the iron and iron-carbide thermal equilibrium diagram labeling all points, lines and phase fields. Define ferrite and austenite.

(b) Describe the microstructural changes that occur in a high carbon steel containing 1.0 percent carbon during slow cooling from austenite range to room temperature.

(c) Mention the effect of carbon content on the yield strength, hardness, toughness and percentage of elongation of a hot rolled steel bar.

12. Describe how an I.T. diagram is determined experimentally. How does it differ from C-C-T diagram?

(b) Explain 'Order-Disorder Transformation'.
There are FOUR questions in this Section. Answer any THREE.

1. (a) The input voltage \( v_i \) to the clamping circuit of Fig. for Q. No. 1(a)(i), is a rectangular wave as shown in Fig. for Q. No. 1(a)(ii). Draw the output voltage waveform \( V_{out} \) and input-output transfer characteristics for the following circuit (Fig. 1(a)).

(b) Design a diode circuit for the following input output characteristic. (See Fig. for Q. No. 1(b)).

(c) Design the diode circuit within the black box of Fig. for Q. No. 1(c).
2. (a) Design an OP-Amp circuit with inputs \( v_1 \) and \( v_2 \) such that output \( v_{out} = -5v_1 + 3v_2 \). 

(b) Design an analog computer circuit to solve the following differential equation:

\[
\frac{d^2v_o}{dt^2} + 2\frac{dv_o}{dt} + v_o = 4\sin 4t, \quad t > 0 \text{ subject to } v_o(0) = -2, \quad v'_o(0) = 1.
\]

3. (a) Define III-V material. Discuss why III-V material is considered as a potential replacement of silicon in the next generation high speed CMOS applications. Also discuss the limitation of III-V material when it is used as channel in MOS device. 

(b) Discuss the operating principle of LED. With detailed logical explanation, mention which material should be used in designing BLUE, RED and GREEN LED.

4. (a) Determine the voltage gain of the stage shown in Fig. for Q. No. 4(a)

(b) Determine the voltage gain and input impedance and output impedance for the circuit shown

**SECTION - B**

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

5. (a) Show that the total instantaneous power in a balanced three phase system does not change with time.

(b) Show that three-phase system uses only 75 percent of the material used in the equivalent single-phase system.

Contd ........ P/3
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Contd... Q. No. 5

(c) Given $V_{an} = 110 \angle \phi$, $V_{ab} = V_{bc} \angle 0^\circ$ and $\phi > 0^\circ$, determine all the phase voltages, line voltages, and the phase sequence.

6. (a) Draw the phasor diagram of a single-phase transformer for (i) lagging p.f. load; (ii) leading p.f. load; and (iii) unity p.f. load.

(b) A single phase 15-kVA, 2300/230 V transformer is to be tested to determine its excitation branch components, its series impedance and its voltage regulation. The following test data have been taken from the primary side of the transformer:

<table>
<thead>
<tr>
<th>Open-circuit test</th>
<th>Short-circuit test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{oc} = 2300$ V</td>
<td>$V_{sc} = 47$ V</td>
</tr>
<tr>
<td>$I_{oc} = 0.21$ A</td>
<td>$I_{sc} = 6.0$ A</td>
</tr>
<tr>
<td>$P_{oc} = 50$ W</td>
<td>$P_{sc} = 160$ W</td>
</tr>
</tbody>
</table>

(i) Find the equivalent circuit of this transformer referred to the low-voltage side.
(ii) Calculate the full-load voltage regulation at 0.8 lagging power factor.
(iii) What is the efficiency of the transformer at full load with a power factor of 0.8 lagging?

(c) Show that a balanced three-phase set of currents flowing in a three-phase winding produces a rotating magnetic field of constant magnitude. How can the direction of rotation of the magnetic field be reversed?

7. (a) For a synchronous generator, show that the armature voltage can be modeled as an inductor in series with the internal generated voltage.

(b) Using phasor diagram, describe the effect of increasing load on a synchronous generator operating alone at leading p.f.

(c) A 480 V, 50 Hz, Y connected six pole synchronous generator has a per phase synchronous reactance of 1.0 $\Omega$. Its full-load armature current is 60 A. This generator has friction and windage losses of 1.5 kW and core losses of 1.0 kW at 60 Hz at full load. The field current has been adjusted so that the terminal voltage is 480 V at no load.

(i) What is the speed of rotation of this generator?
(ii) What is the terminal voltage of this generator if it is loaded with the rated current at 0.8 p.f. leading?
(iii) What is the efficiency of this generator when it is operating at the rated current and 0.8 p.f. leading?
(iv) How much shaft torque must be applied by the prime mover at full load? How large is the induced counter-torque?
(v) What is the voltage regulation of this generation at 0.8 p.f. leading?
8. (a) Write short notes on the following:
   (i) Neutral-plane shift
   (ii) Interpoles

(b) Draw the equivalent circuit of a series DC motor. Also, derive the torque speed relationship for it.

(c) A 250-V series DC motor with compensating windings has a total series resistance $R_A + R_s$ of 0.08 Ω. The series field consists of 25 turns per pole. The magnetization curve expressed in terms of $E_A$ vs. magnetomotive force at 1200 r/min is given by the following table.

<table>
<thead>
<tr>
<th>$F$, A-turns</th>
<th>1000</th>
<th>1250</th>
<th>1333</th>
<th>1667</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_A$, V</td>
<td>63</td>
<td>80</td>
<td>84</td>
<td>105.33</td>
<td>126.33</td>
</tr>
</tbody>
</table>

Find the speed and induced-torque of this motor when its armature current is 50A.
SECTION - A
There are FOUR questions in this Section. Answer any THREE.

1. (a) Explain graphically the 'Change in demand' and the 'Change in quantity demanded' with reference to the change in prices of substitute and complementary commodities. (15)

(b) Illustrate the concept of supply function. (5)

(c) Discuss the factors that affect the supply of a commodity. (15)

2. (a) Mathematically derive the cardinal theory of utility maximization. (10)

(b) Define market equilibrium. Explain graphically the price determination process of a commodity under competition. (10)

(c) (i) Calculate the equilibrium price and quantity from the following demand and supply functions and show the results in a graph.

\[ QD_x = 4000 - 400 P_x \]

\[ QS_x = -500 + 500 P_x \]

(ii) If a per unit tax of Tk. 0.90 is imposed, how will it affect the equilibrium price and quantity?

(i) If Government provides a subsidy of Tk. 2 per unit, what will happen to the equilibrium price and quantity? (15)

3. (a) Discuss in detail the income elasticity of demand and cross elasticity of demand. (15)

(b) Briefly explain the properties of indifference curve. (20)

4. (a) What is meant by production possibility frontier (PPF)? Explain how resources can allocated in a society with the help of PPF. (20)

(b) Describe three applications of production possibility frontier. (10)

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

5. (a) What are the assumptions of a perfectly competitive market? Explain them. (10)

(b) Explain the long-run equilibrium of a firm under perfect competition. (15)

(c) From the following total revenue (TR) and total cost (TC) functions, calculate the profit maximizing level of output and maximum profit.

\[ TR = 4350 Q - 13Q^2 \]

\[ TC = Q^3 - 5.5 Q^2 + 150Q + 845 \]

Contd ........... P/2
6. (a) Define fixed cost and variable cost. 
   (b) How would you derive the long run average cost (LAC) curve of a firm from it's 
       short-run average cost (SAC) curves? 
   (c) A manufacturer has a fixed cost of $75,000 and a variable cost of $7 per unit made 
       and sold. Selling price is $10 per unit. 
       (i) Find the revenue, cost and profit function using q for the number of units. 
       (ii) Compute profit if 40,000 units are made sold. 
       (iii) Find the break-even quantity. 
       (iii) Construct the break-even chart. Label the cost and revenue lines, the fixed cost 
            lines and the break-even point. 

7. (a) What do you understand by division of labour? Explain different types of division of 
       labour. 
   (b) What are the advantages and disadvantages of division of labour? 

8. (a) What is meant by the concept of vicious circle of poverty? Discuss the demand side 
       and supply side of the vicious circle of poverty. 
   (b) Explain the various steps that can be taken to break the vicious circle of poverty in the 
       context of a least developed country like Bangladesh.
SECTION A

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

1. (a) Explain graphically the ‘Change in demand’ and the ‘Change in quantity demanded’ with reference to the change in prices of substitute and complementary commodities. (15)

(b) Illustrate the concept of supply function. (5)

(c) Discuss the factors that affect the supply of a commodity. (15)

2. (a) Mathematically derive the cardinal theory of utility maximization. (10)

(b) Define market equilibrium. Explain graphically the price determination process of a commodity under competition. (10)

(c) (i) Calculate the equilibrium price and quantity from the following demand and supply functions and show the results in a graph.

\[ Q_D = 4000 - 400 P_x \]
\[ Q_S = -500 + 500 P_x \]

(ii) If a per unit tax of Tk. 0.90 is imposed, how will it affect the equilibrium price and quantity?

(i) If Government provides a subsidy of Tk. 2 per unit, what will happen to the equilibrium price and quantity?

3. (a) Discuss in detail the income elasticity of demand and cross elasticity of demand. (15)

(b) Briefly explain the properties of indifference curve. (20)

4. (a) What is meant by production possibility frontier (PPF)? Explain how resources can allocated in a society with the help of PPF. (20)

(b) Describe three applications of production possibility frontier. (10)

SECTION B

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

5. (a) What are the assumptions of a perfectly competitive market? Explain them. (10)

(b) Explain the long-run equilibrium of a firm under perfect competition. (15)

(c) From the following total revenue (TR) and total cost (TC) functions, calculate the profit maximizing level of output and maximum profit.

\[ TR = 4350 Q - 13Q^2 \]
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(b) How would you derive the long run average cost (LAC) curve of a firm from its short-run average cost (SAC) curves? (10)
(c) A manufacturer has a fixed cost of $75,000 and a variable cost of $7 per unit made and sold. Selling price is $10 per unit. (15)
   (i) Find the revenue, cost and profit function using q for the number of units.
   (ii) Compute profit if 40,000 units are made sold.
   (iii) Find the break-even quantity.
   (iii) Construct the break-even chart. Label the cost and revenue lines, the fixed cost lines and the break-even point.

7. (a) What do you understand by division of labour? Explain different types of division of labour. (15)
(b) What are the advantages and disadvantages of division of labour? (20)

8. (a) What is meant by the concept of vicious circle of poverty? Discuss the demand side and supply side of the vicious circle of poverty. (15)
(b) Explain the various steps that can be taken to break the vicious circle of poverty in the context of a least developed country like Bangladesh. (20)
1. (a) What are the assumptions of Accounting according to Generally Accepted Accounting Principles (GAAP)?

(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.

(c) “Ratan Automobile Agency” was opened at May 1, 2011. The following transactions occurred in the month of May:

- May 1: Mr. Ratan 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. 20,000 in cash.
- May 20: Received Tk. 35,000 from a customer in advance, service to be performed in next month.
- May 22: Withdraw Tk. 5,000 cash from the business for personal use.

Required:

(i) Prepare a tabular summary for the month of May.
(ii) Prepare an owners' quality statement for the month of May.

2. (a) What is a trial balance and what is its purpose?

(b) Mr. Rubel started a business. During January 2012, the following transactions occurred:
HUM 303

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

January 1: Service provided to a customer but not yet received Tk. 60,000.
January 3: Purchase supplies on account Tk. 30,000
January 7: Earned revenue Tk. 45,000 of which Tk. 10,000 is collected in cash and the balance was due to January.
January 9: Incurred utility expense for the month on account Tk. 2,000.
January 11: Made an investment by Mr. Rubel for Tk. 400,000 in cash.
January 13: Received Tk. 10,000 in cash from the customer.
January 15: Paid telephone bill for the month Tk. 5,000 in cash.
January 17: Paid Tk. 15,000 to account payable for supplies.


(c) Following information is available for “Walton Company” –

<table>
<thead>
<tr>
<th>Walton Company</th>
<th>Income Statement</th>
<th>For the year ended December 31, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net sales</td>
<td>Amount (Tk.)</td>
<td>600,000</td>
</tr>
<tr>
<td>Expenses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>415,000</td>
<td></td>
</tr>
<tr>
<td>Selling and administrative expense</td>
<td>120,800</td>
<td></td>
</tr>
<tr>
<td>Interest expense</td>
<td>7,800</td>
<td></td>
</tr>
<tr>
<td>Income tax expense</td>
<td>18,000</td>
<td></td>
</tr>
<tr>
<td>Total expense</td>
<td>561,600</td>
<td></td>
</tr>
<tr>
<td>Net income</td>
<td>38,400</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Walton Company</th>
<th>Balance Sheet</th>
<th>December 31, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset</td>
<td>Amount (Tk.)</td>
<td>Liabilities and Equity</td>
</tr>
<tr>
<td>Cash</td>
<td>21,000</td>
<td>Accounts payable 122,000</td>
</tr>
<tr>
<td>Investment (Short term)</td>
<td>18,000</td>
<td>Income tax payable 24,000</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>86,000</td>
<td>Bond payable 120,000</td>
</tr>
<tr>
<td>Inventory</td>
<td>90,000</td>
<td>Common stock (Tk. 5 par) 150,000</td>
</tr>
<tr>
<td>Plant asset</td>
<td>423,000</td>
<td>Retained earnings 233,000</td>
</tr>
<tr>
<td>Total asset</td>
<td>638,000</td>
<td>Total Liabilities and Equity 638,000</td>
</tr>
</tbody>
</table>

Other information: Common stock recently sold at Tk. 19.50 per share.

Required: Compute –

(i) Quick or acid test ratio.  ii) Receivable turnover. (iii) Return on equity (ROE).
(iv) Debt to total asset. (v) Earnings per share (EPS). (vi) Price earnings ratio.
(vii) Asset turnover or return on asset. (viii) Inventory turnover.

Contd ……….. P/3
3. (a) "Adjusting entries are required by the cost principles of accounting." Do you agree? Explain.

(b) The Trial Balance of "Al-Amin Company" on May 31, 2014 is given below –

<table>
<thead>
<tr>
<th>Accounts Title</th>
<th>Debit (Tk.)</th>
<th>Credit (Tk.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>Prepaid insurance</td>
<td>2,400</td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>Office furniture</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>Accounts payable</td>
<td></td>
<td>5,500</td>
</tr>
<tr>
<td>Unearned service revenue</td>
<td></td>
<td>6,000</td>
</tr>
<tr>
<td>Capital</td>
<td></td>
<td>22,500</td>
</tr>
<tr>
<td>Service revenue</td>
<td></td>
<td>5,900</td>
</tr>
<tr>
<td>Salary expense</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Rent expense</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Maintenance expense</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Drawings</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39,900</td>
<td>39,900</td>
</tr>
</tbody>
</table>

Other Information:

- Accrued rent is Tk. 600.
- Maintenance expense incurred but not paid on May 31, Tk. 8000.
- Tk. 3,000 of service performed during the month but has been recorded as of May 31.
- Unearned service revenue of Tk. 1,500 has been earned.
- Tk. 1000 of supplies has been used during the period.
- Office equipment is being depreciated at Tk. 250 per month.
- Accrued salary in Tk. 1000.

Required:

(i) Prepare necessary adjustment entries.
(ii) Prepare an adjusted trial balance as on May 31, 2014.

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

(b) The following accounts are taken from the ledger balances of "Z" Company Ltd at 31\textsuperscript{st}
December, 2011.

<table>
<thead>
<tr>
<th>Accounts Title</th>
<th>Debit (Tk.)</th>
<th>Credit (Tk.)</th>
</tr>
</thead>
</table>

"Z" Company Ltd
Trial Balance
31\textsuperscript{st} December, 2011.
Accounts Title | Debit (Tk.) | Credit (Tk.)
--- | --- | ---
Cash | 40,800 |  
Accounts receivable | 20,500 |  
Accounts payable | 21,000 | 
Capital | 51,000 | 
Land | 25,000 |  
Sales revenue | 30,200 |  
Salaries | 12,000 |  
Prepaid rent | 4,000 |  
Utility expense | 1,000 |  
Commission expense | 3,000 |  
Supplies | 1,000 |  
Notes payable | 7,100 |  
Drawings | 2,000 |  
Goodwill | 20,000 |  
Machinery | 100,000 |  
Long term investment | 50,000 |  
Bond payable | 155,000 |  
Wage payable | 15,000 |  
Total | 279,300 | 279,300

Adjustments data:
(i) Accrued salary is Tk. 500.
(ii) Commission expense is related to sales.
(iii) Tk. 5,000 of notes payable will be paid in 2013.

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 on 31st December, 2011.

SECTION – B
There are FOUR questions in this Section. Answer any THREE.

5. (a) Define the term Mixed Cost. Give general formula for a mixed cost.
What is the major disadvantage of High-Low Method?
HUM 303

Contd ... Q. No. 5

(b) Assume that the General Electrical Company would like to estimate the variable and fixed components of its electrical costs. It has complied the following data for the last five months of operations.

<table>
<thead>
<tr>
<th>Machine Hours</th>
<th>Electrical Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>1,000</td>
</tr>
<tr>
<td>September</td>
<td>900</td>
</tr>
<tr>
<td>October</td>
<td>1,500</td>
</tr>
<tr>
<td>November</td>
<td>2,000</td>
</tr>
<tr>
<td>December</td>
<td>1,300</td>
</tr>
</tbody>
</table>

Using the High-Low method of analysis, calculate the following:

(i) The estimated variable cost per machine hour for electricity.

(ii) The estimated fixed cost per month for electricity.

(iii) Using the result you have obtained, what will be the total estimated cost of electricity if 1,800 machine hours were required in any month?

(c) The following information summarizes the company's cost structure:

<table>
<thead>
<tr>
<th>Variable cost per unit</th>
<th>Tk. 1.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed cost per unit</td>
<td>4.50</td>
</tr>
<tr>
<td>Total cost per unit</td>
<td>Tk. 5.80</td>
</tr>
<tr>
<td>Total units produced and sold</td>
<td>48,000 units</td>
</tr>
</tbody>
</table>

Required: Calculate the amount for the following items at the 40,000 unit level of activity.

(i) Total variable cost

(ii) Total fixed cost

(iii) Variable cost per unit

(iv) Fixed cost per unit.

6. (a) What is meant by the term Operating Leverage and Margin of Safety?

(b) In two companies making the same product and with the same total sales and total expenses may not have same contribution margin – Do you agree with the statement? Why or why not? Explain with reason(s).

(c) The following is Alsatia Corporation’s contribution format income statement for July:

Sales: Tk. 1,400,000
Less: Variable Expenses: (900,000)
Contribution Margin: 500,000
Less: Fixed Expenses: (300,000)
Net Income: Tk. 200,000

The company has no beginning or ending inventories. It has produced and sold 10,000 units during the month.
HUM 303

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

Required:

(i) What is the company’s contribution margin ratio?
(ii) What is the company’s break-even in units?
(iii) If sales increase by 100 units, by how much should net income increase?
(iv) How many units would the company have to sell to attain target profits of $225,000?
(v) What is the company’s margin of safety in dollars?
(vi) What is the company’s degree of operating leverage (DOL)?
(vii) Prove DOL by assuming 10% increase in sales.

7. (a) Under absorption costing, how is it possible to increase net income without increasing sales?

(b) Lee Company, which has only one product, has provided the following data concerning its most recent month operations:

<table>
<thead>
<tr>
<th>Selling price</th>
<th>Tk. 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units produced</td>
<td>6,200 units</td>
</tr>
<tr>
<td>Units sold</td>
<td>5,900 units</td>
</tr>
<tr>
<td>Units in ending inventory</td>
<td>300 units</td>
</tr>
</tbody>
</table>

Variable costs per unit:

| Direct materials | Tk. 42 |
| Direct labor | 28 |
| Variable manufacturing overhead | 1 |
| Variable selling and administrative | 5 |

Fixed costs:

| Fixed manufacturing overload | Tk. 62,000 |
| Fixed selling and administrative | 35,400 |

The company produces the same number of units every month, although the sales in units vary from month to month. The company’s variable costs per unit and total fixed costs have been constant from month to month.

Required:

(i) What is the unit product cost for the month under variable costing?
(ii) What is the unit product cost for the month under absorption costing?
(iii) Prepare an income statement for the month using the variable costing method.
(iv) Prepare and income statement for the month using the absorption costing method.
(v) Reconcile the variable costing and absorption costing net income for the month.

8. (a) What is Capital Budgeting? Define different types of investment decision with example.

(b) A company is considering an investment proposal to install a new machine at a cost to Tk. 50,000. The estimated cash flows from the investment proposal are as follows:
Contd ... Q. No. 8(b)

<table>
<thead>
<tr>
<th>Year</th>
<th>CFAT (Cash Flow Adjustment Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10,000</td>
</tr>
<tr>
<td>2</td>
<td>10,450</td>
</tr>
<tr>
<td>3</td>
<td>11,800</td>
</tr>
<tr>
<td>4</td>
<td>12,250</td>
</tr>
<tr>
<td>5</td>
<td>16,750</td>
</tr>
</tbody>
</table>

Required: Determine

(i) Internal rate of return (IRR).

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

(iii) Profitability Index (PI) at 10% discount rate.

(c) The following data (in thousands of dollars) have been taken from the accounting records of Lamer Corporation for the just completed year.

- Purchases of raw materials: $110
- Direct labor: $130
- Manufacturing overhead: $200
- Administrative expenses: $160
- Selling expense: $140
- Raw materials inventory, beginning: $30
- Raw materials inventory, ending: $60
- Work in process inventory, beginning: $50
- Work in process inventory, ending: $10
- Finished goods inventory, beginning: $150
- Finished goods inventory, ending: $140

Required:

(i) Prepare a Schedule of Cost of Goods Manufacturing in good form.

(ii) Compute the Cost of Goods Sold.