

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **ME 203** (Engineering Thermodynamics)

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meanings and interpretation.

Thermodynamic data tables will be supplied.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Distinguish between the following: (10)
 - (i) work and heat
 - (ii) classical thermodynamics and statistical thermodynamics.
- (b) Using 1st law of thermodynamics, Show that "energy" is a thermodynamic property. (10)
- (c) Air undergoes compression process in a piston-cylinder assembly from $P_1 = 1$ bar, $T_1 = 300$ K to $P_2 = 10$ bars. (15)
Employing 'ideal gas model', determine the work and heat transfer per unit mass; if
 - (i) isothermal process
 - (ii) isentropic process.
2. (a) Using 1st law of thermodynamics and suitable assumptions, derive Bernoulli's Equation. (10)
- (b) Water at atmospheric pressure and 100° is pumped/compressed to 5 atm pressure at a rate of 1.0 kg/s in isentropic process. Estimate the power required and exit temperature for the following 2 inlet state: (15)
 - (i) quality = 0
 - (ii) quality = 100

Discuss your findings.
- (c) A shell-and-tube condenser is used to condense steam leaving the steam-turbine at 10 kPa and 90% quality. Cooling water enters the condenser at 25°C and leaves at 35°C . Estimate the rate of cooling water per kg/s of steam condensation. (10)
3. (a) Mention two popular statements of 'second-law of thermodynamics'. Show that, these two statements are equivalent. (15)
- (b) With suitable assumptions, show that, for isentropic pressure (10)

$$PV^K = \text{constant.}$$

Discuss the limitations of the above equation.

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Contd.... for Q. No. 3

- (c) Centrifugal compressor of a gas turbine receives air from atmosphere at 1 bar and 300 K. At the discharge of the compressor, the pressure is 4 bar and 480 K, and the velocity is 200 m/s. The mass flow rate into the compressor is 10 kg/s. Estimate the power required to drive the compressor if the compression process is adiabatic. (10)
4. (a) Using Carnot principle, show that, $\eta_{rev} > \eta_{irr}$. (10)
- (b) In an air compressor, air is compressed from 1 bar, 300 K to 5 bar, 425 K. Estimate the entropy change of the system and entropy charge of the surroundings, if ambient condition is 1 bar and 25°C. Discuss the results. (15)
- (c) A steam turbine receives steam at 5 bar, 320°C. Steam leaves the turbine at 1 bar. If $\eta_t = 0.75$, $Q = 0$, $\Delta KE \approx 0$, $\Delta PE \approx 0$, estimate the work developed and entropy generation per unit mass of steam flow. (10)

SECTION – B

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

Assume reasonable values for missing data.

5. (a) What do you understand by "Regeneration" in steam power plant? With a block diagram show how regeneration is accomplished in steam power plants and draw corresponding T-s diagram. (10)
- (b) A steam power plant operates on an ideal reheat Rankine cycle between the pressure limits of 15 MPa and 10 kPa. The mass flow rate of steam through the cycle is 12 kg/s. Steam enters both stages of the turbine at 500°C. If the moisture content of the steam at the exit of the low-pressure turbine is not to exceed 10 percent, determine
- (i) the pressure at which reheating takes place,
 - (ii) the total rate of heat input in the boiler, and
 - (iii) the thermal efficiency of the cycle.
- Also, draw a block diagram and show the cycle on a T-s diagram with respect to the saturation lines. (25)
6. (a) The thermal efficiency of an ideal Brayton cycle increases with the pressure ratio of the gas turbine. For a fixed maximum temperature of the Brayton cycle, how does the pressure ratio affect the cycle? (5)
- (b) "In gas turbine power plants, intercooling and reheating are always used in conjunction with regeneration." Explain the statement showing all the processes in a block diagram and a T-s diagram. (10)

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Contd.... for Q. No. 6

(c) An ideal diesel engine has a compression ratio of 20 and uses air as the working fluid. The state of air at the beginning of the compression process is 95 kPa and 20°C. If the maximum temperature in the cycle is not to exceed 1927°C determine

(20)

- (i) the thermal efficiency and
- (ii) the mean effective pressure.

Assume constant specific heats for air at room temperature.

7. (a) If a refrigeration system produces 60 kW of refrigeration effect. Estimate: (i) Coefficient of performance, COP, (ii) Refrigeration mass flow rate, \dot{m} ; (Given, enthalpy change across evaporator is 145 kJ/kg and enthalpy change across compressor is 35 kJ/kg)

(5)

(b) A garment factory has a gas-based power plant. Managing director of the company would like to utilize exhaust heat of the plant. In what kind of refrigeration-based chiller, this exhaust heat can be used? Schematically show that refrigeration system.

(10)

(c) Cooling water leaves the condenser of a chiller and enters a cooling tower shown in Fig. for Q. No. 7(c). The cooling tower is to cool 60 kg/s of water from 40 to 33°C. Atmospheric air enters the tower at 1 atm with dry-and wet-bulb temperatures of 22 and 16°C, respectively, and leaves at 30°C with a relative humidity of 95 percent.

Using the psychrometric chart, determine

(20)

- (i) the volume flow rate of air into the cooling tower and
- (ii) the mass flow rate of the required makeup water.

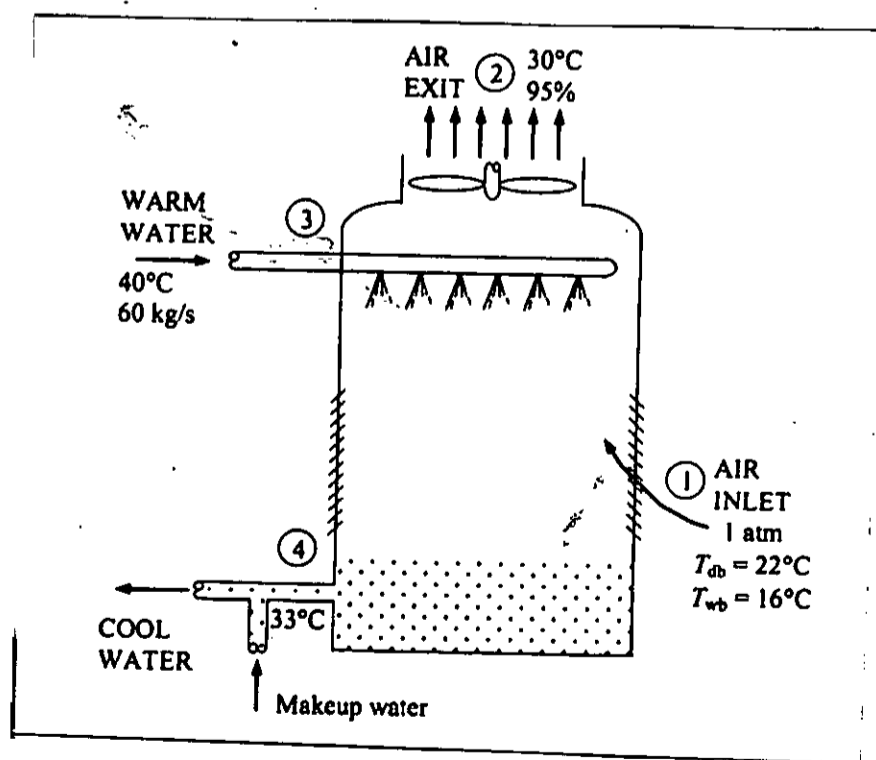


Fig. for Q. No. 7(c)

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8. (a) Explain the physical meaning of 'exergy'. Estimate the exergy of dry air at 200°C and 2 atm pressure. [Assume 25°C and 1 atm pressure as dead state] (10)

(b) Air enters an insulated compressor at ambient conditions, 100 kPa and 25°C, at the rate of 0.1 kg/s and exits at 200°C. The isentropic efficiency of the compressor is 75%. Estimate the effectiveness of the compression process. (10)

(c) Using laws of thermodynamics and suitable assumptions, show that. (15)

$$C_p - C_v = -T \left(\frac{\partial P}{\partial v} \right)_T \left(\frac{\partial v}{\partial T} \right)_P^2 = \frac{\beta^2}{\kappa_T} v T$$

where, all the symbols have their usual meanings. Using this expression, show that for ideal gas,

$$C_p - C_v = R$$

SECTION – A

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

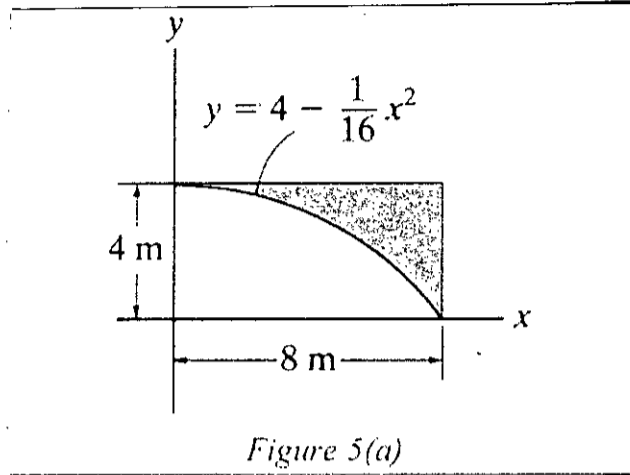
1. (a) Determine the maximum mass of the lamp (Fig. 1(a)) that the cord system can support so that no single cord develops a tension exceeding 400 N. (17)
- (b) In trying to move across a slippery icy surface as shown in Fig. 1(b), an 800-N man uses two ropes AB and AC . Knowing that the force exerted on the man by the icy surface is perpendicular to that surface, determine the tension in each rope. (18)
2. (a) The wire AE is stretched between the corners A and E of a bent plate as shown in Fig. 2(a). Knowing that the tension in the wire is 500 N, determine the moment of the force exerted by the wire on corner A (i) about the point B and (ii) about the line BE . (17)
- (b) Three children are standing on a 5×5 -m raft as shown in Fig. 2(b). If the weights of the children at points A , B , and C are 375 N, 260 N, and 400 N, respectively, determine (i) the magnitude and (ii) the point of application of the resultant of the three weights. (18)
3. (a) Determine the force in each member of the truss shown in Fig. 3(a). State whether each member is in tension or compression. (17)
- (b) The pin at B is attached to member ABC and can slide freely along the slot cut in the fixed plate as shown in Fig. 3(b). Neglecting the effect of friction, determine the couple M required to hold the system in equilibrium when $\theta = 30^\circ$. (18)
4. (a) Three blocks are piled up as shown in Fig 4(b). Determine the force P to move the block B . (10)
- (b) The square-threaded screw of the C-clamp as shown in Fig. 4(b) has a mean diameter of 9 mm and a pitch of 1.5 mm. The coefficient of static friction between the threads is 0.2. If the torque $T = 1.25$ N.m is used to tighten the clamp, determine the clamping force. (10)
- (c) The force P applied to the brake handle enables the band brake to reduce the angular speed of a rotating drum as shown in Fig. 4(c). If the tensile strength of the band is 3800 N, find the maximum safe value of P and the corresponding braking torque acting on the drum. Assume that the drum is rotating clockwise. (15)

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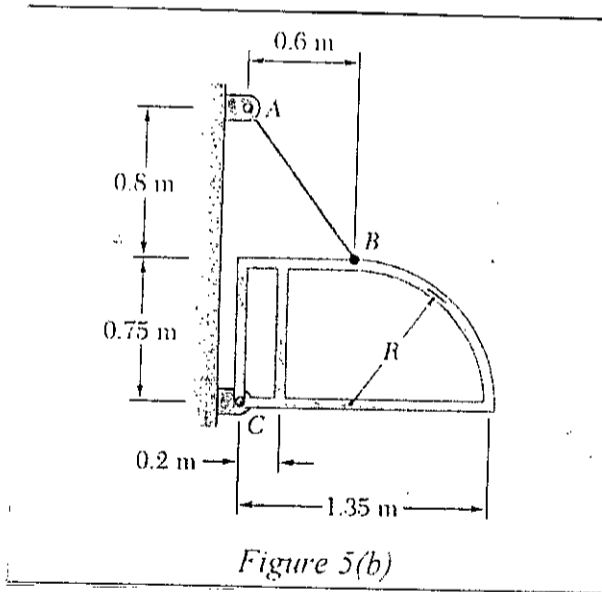
SECTION – B

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

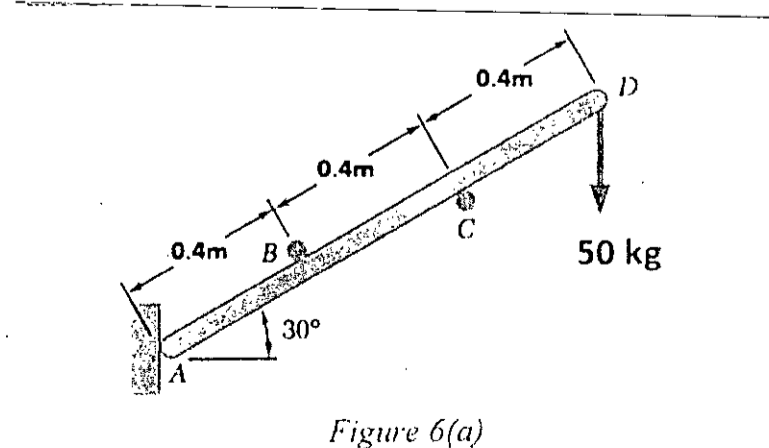
5. (a) Determine the centroid of the shaded area shown in Figure 5(a) by direct integration. (15)



- (b) The frame for a signboard is fabricated from a thin, flat steel bar as shown in Figure 5(b). The mass per unit length of the steel bar is 5.0 kg/m. The frame is supported by a pin at C and by a cable AB. Determine the tension in the cable AB. (20)



6. (a) A light rod AD is supported by frictionless pegs at B and C and rests against a frictionless wall at A as shown in Figure 6(a). A vertical 50 kg force is applied at D. Determine the reactions at A, B, and C. (15)



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Contd.... for Q. No. 6

(b) A 3 m pole is supported by a ball and socket joint at *A* and by the cables *CD* and *CE*. The line of action of the 5 kN force forms an angle of 90°, 150°, and 60° with the *x*, *y* and *z* axes respectively. Determine (i) the tension in cables *CD* and *CE*, (ii) the reaction at *A*.

(20)

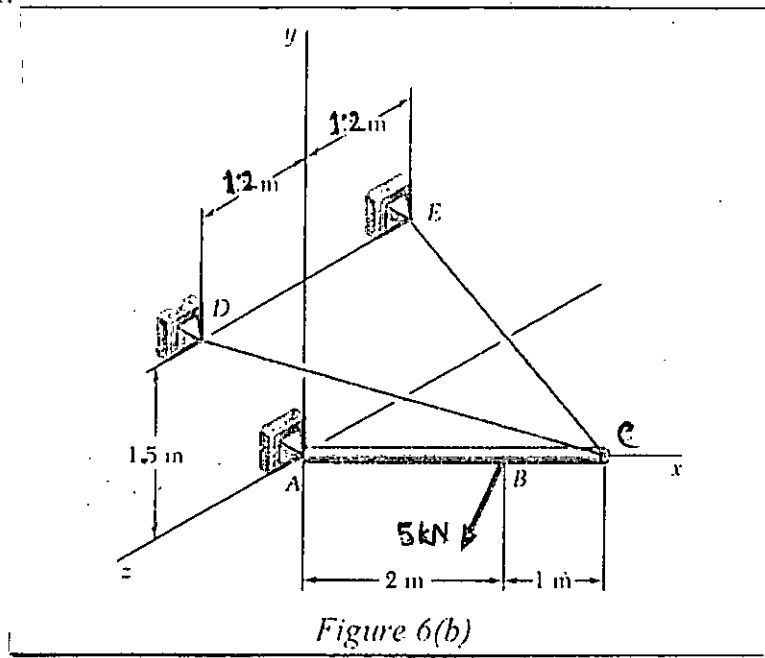


Figure 6(b)

7. (a) The pendulum shown in Figure 7(a) consists of two thin rods each having a weight of 10 lb. Determine the pendulum's mass moment of inertia and radius of gyration about an axis passing through the pin at *O* into the page. *G* denotes the center of gravity of the pendulum.

(15)

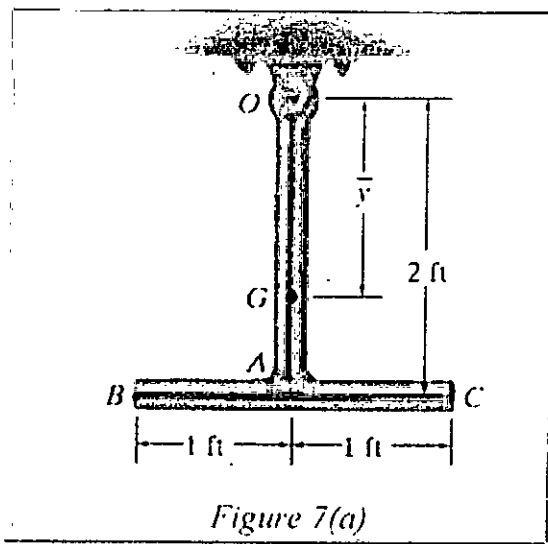


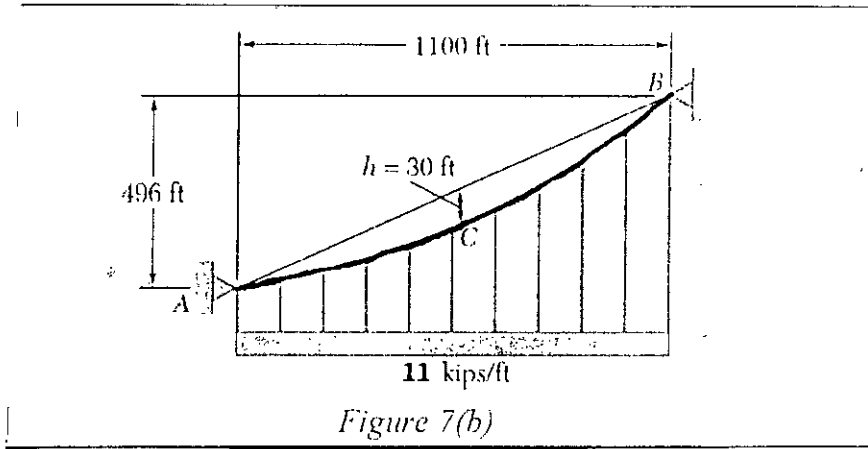
Figure 7(a)

(b) A cable from the side spans of a suspension bridge is shown in Figure 7(b) and it supports a load $w = 11$ kips/ft along the horizontal. The maximum vertical distance *h* from the cable to the chord *AB* is 30 ft and occurs at mid-span. Determine (i) the maximum tension in the cable, (ii) the slope at *B*.

(20)

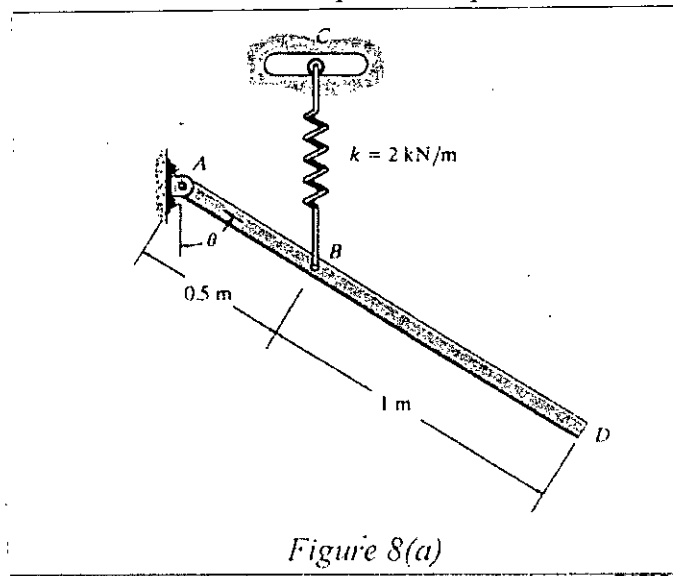
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Contd.... for Q. No. 7(b)



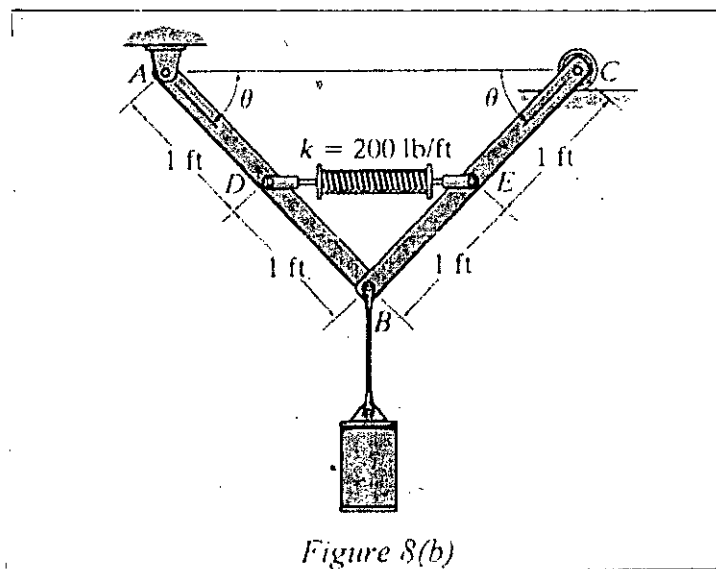
8. (a) The uniform bar AD as shown in Figure 8(a) has a mass of 20 kg. If the attached spring is unstretched when $\theta = 90^\circ$, determine the angle θ for equilibrium. Note that the spring always remains in the vertical position due to the roller guide. Investigate the stability of the bar when it is in the equilibrium position.

(15)



- (b) The mechanism shown in Figure 8(b) supports the 50 lb cylinder. Determine the angle θ for equilibrium if the spring has an unstretched length of 2 ft when $\theta = 0^\circ$. Neglect the mass of the members.

(20)



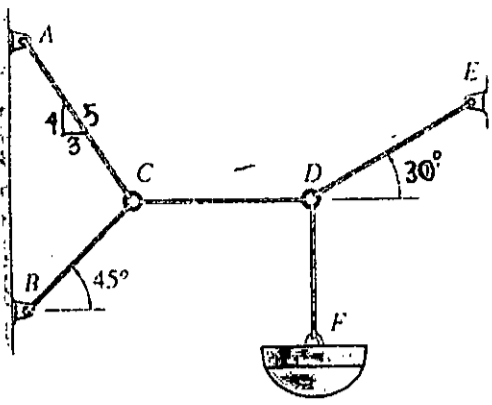


Fig. 1(a)

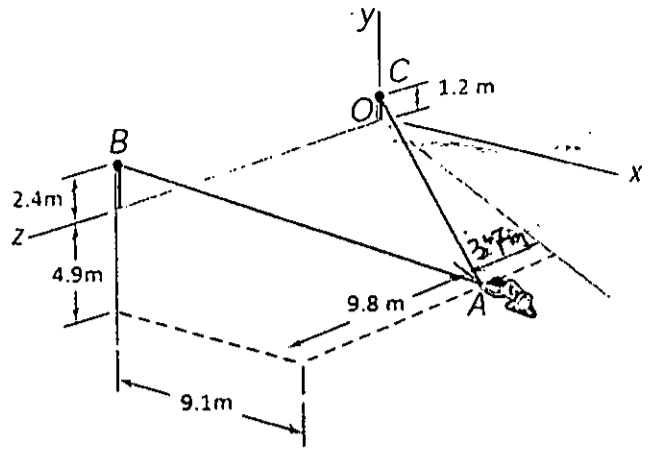


Fig. 1(b)

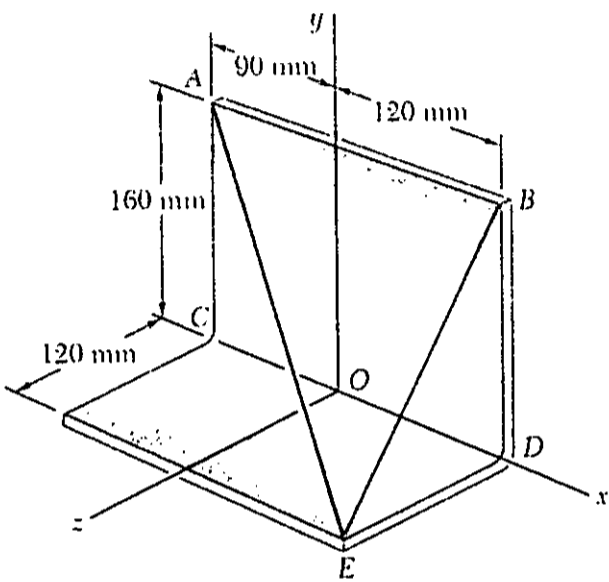


Fig. 2(a)

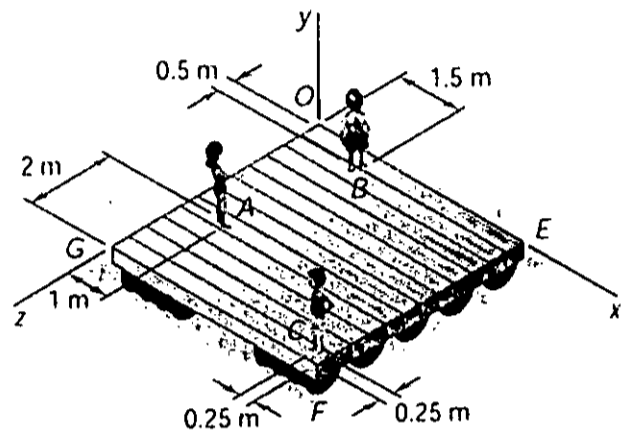


Fig. 2(b)

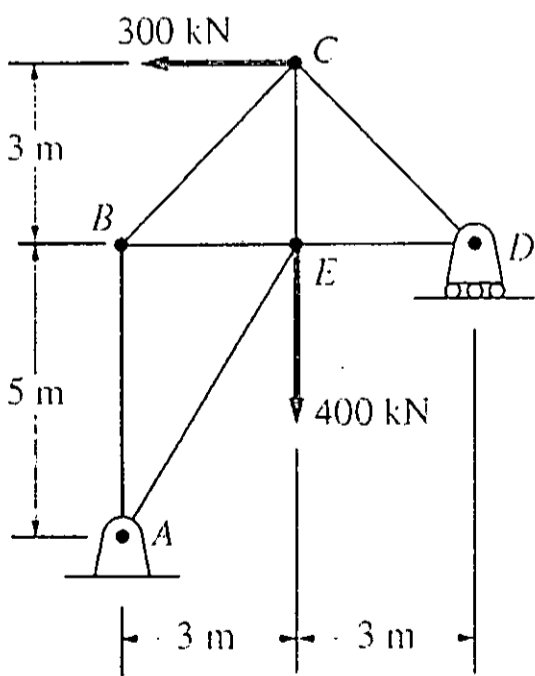


Fig. 3(a)

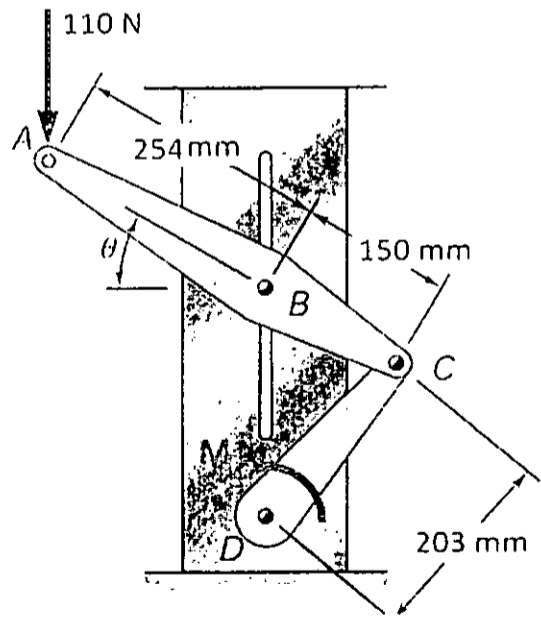


Fig. 3(b)

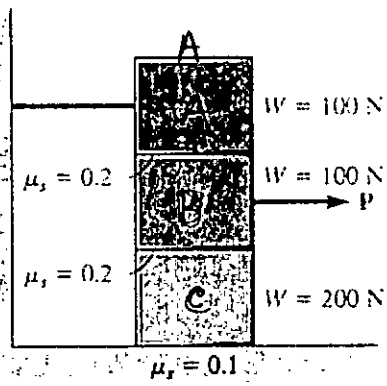


Fig. 4(a)

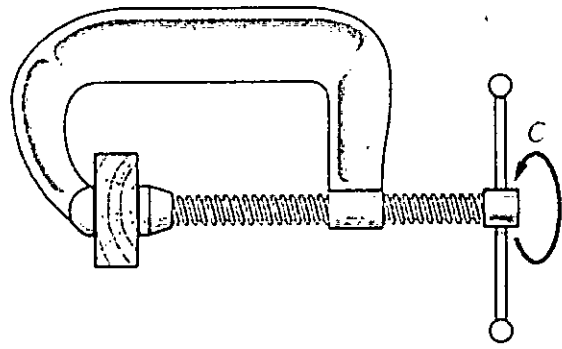


Fig. 4(b)

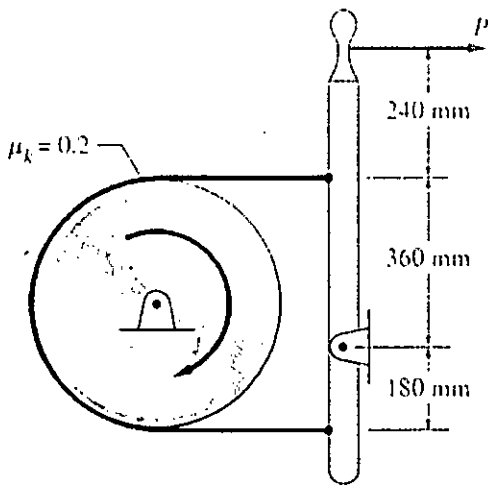


Fig. 4(c)

= 6 =

SECTION – A

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

1. (a) Why a synchronous motor cannot start by itself? Name three methods used to start a synchronous motor? (10)
 - (b) What is V-curve? Briefly describe how synchronous motor is used in power factor correction. (10)
 - (c) A 208 V, Y connected synchronous motor is drawing 50 A at unity pf from a 208 V power system. The field current flowing under these conditions is 2.7 A. Its synchronous reactance is 1.6 Ω. Friction and windage loss, core loss are negligible. Assume a linear open circuit characteristic. (26 2/3)
 - (i) Find V_{ϕ} and E_A for these conditions.
 - (ii) Find initial torque angle.
 - (iii) How much field current is required to make the motor operate at 0.8 pf leading?
 - (iv) What is new torque angle?
 - (v) How much power the motor is supplying?
 - (vi) Sketch the phasor diagram before and after changing the field current in the same axis.
 - (vii) After changing the field current now the load is increased by 35%. What will be the new power a factor and torque angle?
-
2. (a) The Fig 2(a) shows cross section of a stator of three phase induction motor. Describe how three phase set of currents produce rotating magnetic field in the stator. (16)

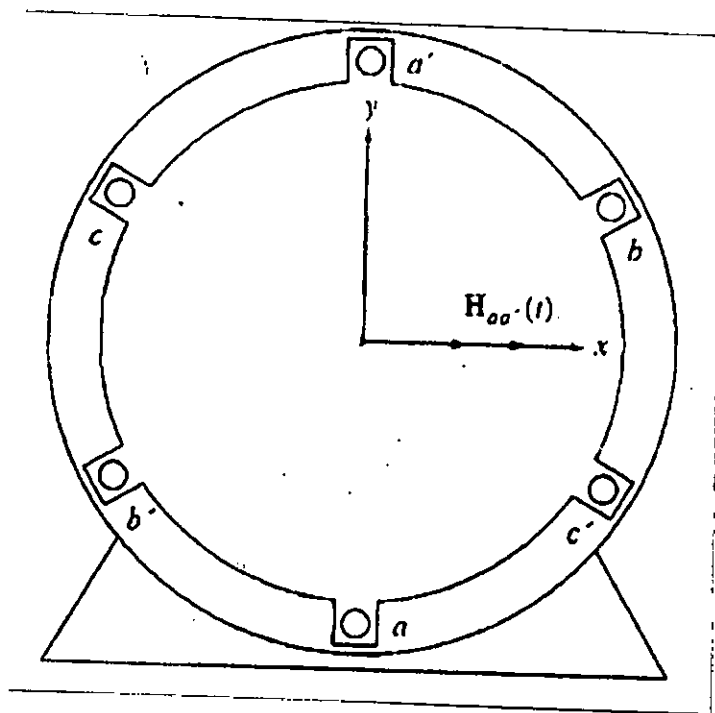


Fig 2(a)

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Contd.... for Q. No. 2

(b) A 208 V, four pole, 50 Hz, Y connected induction motor supplies 15 kW to a load at a speed of 1460 r/m. Its equivalent circuit components are

(30²/₃)

$$R_1 = 0.1 \Omega$$

$$X_M = 10 \Omega$$

$$X_1 = X_2 = 0.21 \Omega$$

All the mechanical losses are negligible.

- (i) What is the motor's slip?
- (ii) What is the induced torque in the motor in N.m under these conditions?
- (iii) What will be the operating speed of the motor if its torque is doubled?
- (iv) How much power will be supplied by the motor when the torque is doubled?
- (v) Find the value of rotor resistance R_2 .
- (vi) Find the speed at which maximum torque occurs.
- (vii) Find Air gap power and rotor copper loss at condition stated in Q2(b)(ii).

3. (a)The equivalent circuit impedances of a 20-kVA, 8000/240 V, 50-Hz Transformer referred to the primary side are

(36)

$$R_{eq} = 38.4 \Omega$$

$$X_{eq} = 192 \Omega$$

$$R_{htc} = 159 \text{ k}\Omega$$

$$X_M = 38.4 \text{ k}\Omega$$

- (i) Find the transformer's voltage regulation at rated load and 0.85 PF lagging
- (ii) Determine the transformer's efficiency at 85% of rated load and 0.8 PF leading
- (iii) The open circuit was performed at rated voltage in the low tension side. Find the Voltmeter (V_{OC}), ammeter (I_{OC}), and wattmeter (P_{OC}) reading during Open circuit test.
- (iv) Sketch the approximate per-unit equivalent circuit for the transformer. Use the transformer's ratings as the system base. Also draw the phasor diagram when a load described in Q3(a)(i) is connected.
- (v) Why open circuit test is performed in low tension side?

(b) What is core loss current? Explain why it is modeled as a resistor in the transformer equivalent circuit.

(10²/₃)

4. (a) A 480 V, 200 kVA, 0.8 pf lagging, 50 Hz, two pole delta connected synchronous generator has a synchronous reactance of 0.25Ω and armature resistance of 0.03Ω . At 50 Hz, its friction and windage losses are 6 kW and its core losses are 4 kW. The field circuit has a dc voltage of 200 V and maximum current I_F is 10 A. The resistance of the field circuit is adjustable for the range 20 to 200 Ω . The OCC of this generator is shown in Fig. 4(a).

(36)

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

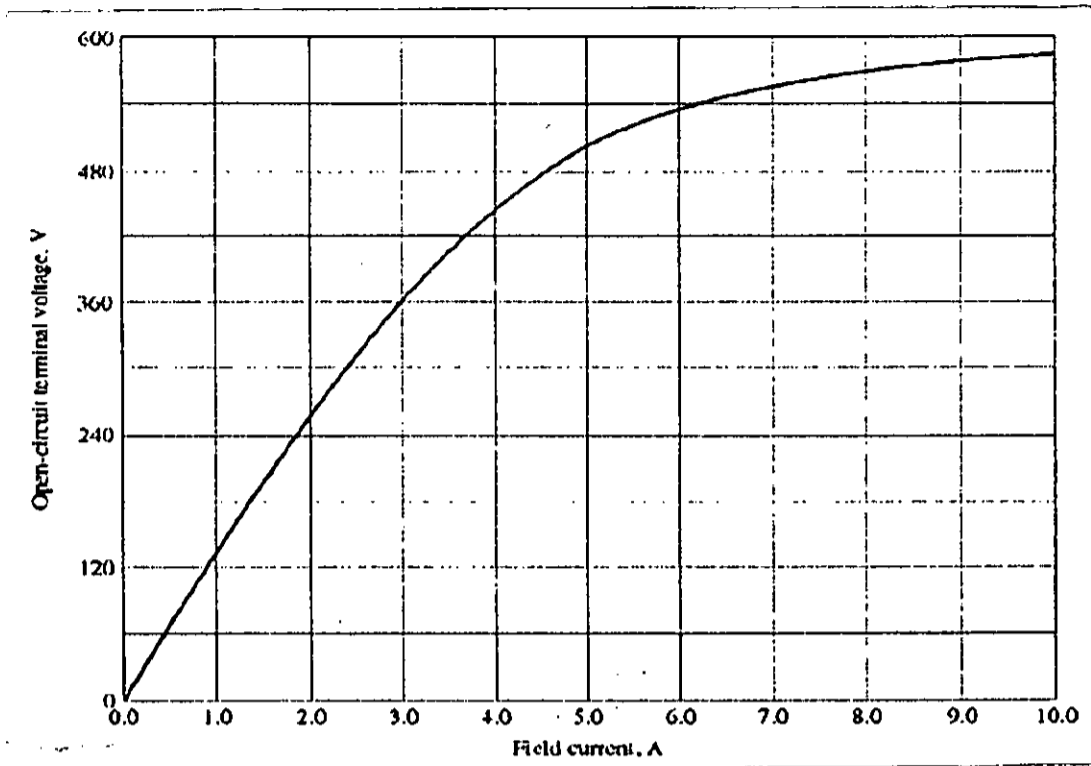


Fig. 4(a)

- (i) How much field current is required to make V_T equal to 480 V when generator is running at no load?
 - (ii) What is the internal generated voltage of this machine at rated condition?
 - (iii) How much power generator's prime mover is capable of supplying?
 - (iv) What is the voltage regulation if the generator is loaded with rated load at 0.8 pf leading?
 - (v) What will happen to terminal voltage of this generator if another load of same power factor is added to it? Sketch the before and after phasor diagram.
 - (vi) What should be done to restore the terminal voltage to previous value?
- (b) What is brushless excitation scheme? Draw the brushless exciter circuit of synchronous generator and explain its operation.

(10 2/3)

SECTION – B

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

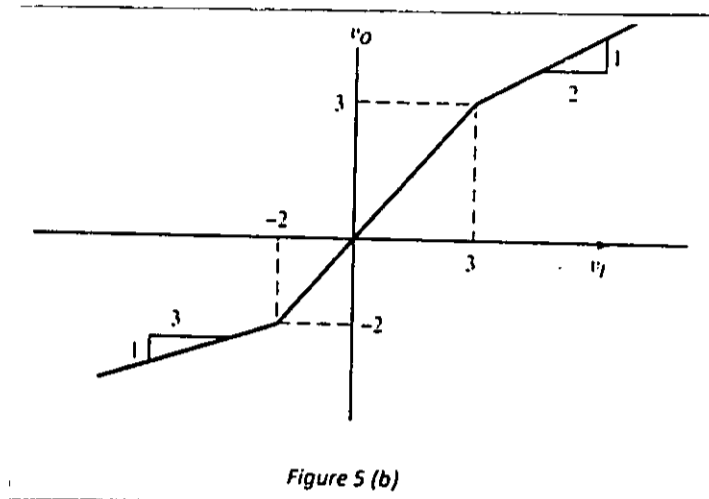
5. (a) A full-wave bridge rectifier circuit with a 1-kΩ load operates from a 120-V (rms) 60-Hz household supply through a 10-to-1 step-down transformer having a single secondary winding. It uses four diodes, each of which can be modeled to have a 0.7-V drop for any current.
- (i) What is the peak value of the current through the load and Peak Inverse Voltage of diode?
 - (ii) For what fraction of a cycle does each diode conduct?
 - (iii) What is the average voltage across the load?

(26 2/3)

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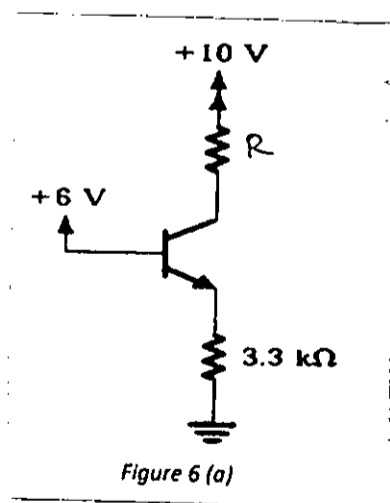
Contd.... for Q. No. 5

(b) Design a circuit which meets the input-output (V_o vs. V_i) characteristics shown in Figure 5 (b). You are allowed to use diode, resistors and DC voltage source. (20)



If $5\sin(100t)$ V is used as input in your designed circuit, what will be the peak voltage of output?

6. (a) (i) Find the unknown resistor shown in Figure 6 (a) such that transistor remains in deep saturation with $\beta = 1.5$. (26²/₃)
- (ii) Now you add a base resistor at the base to bring the transistor at the edge of saturation with $\beta = 100$. What is the value of base resistor?



(b) Define holding and latching current SCR. Draw a full-wave controlled rectifier and describe its operation with necessary plots. (20)

7. (a) Describe the speed control mechanism of a shunt DC motor above base speed. Explain with necessary equations. (14)

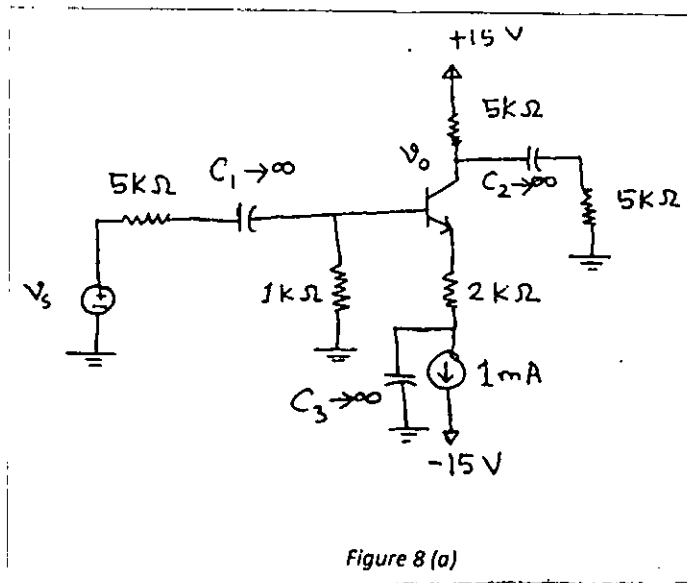
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(b) A 50-hp, 250-V, 1200 r/min dc shunt motor with compensating windings has an armature resistance (including the brushes, compensating windings, and interpoles) of 0.06Ω . Its field circuit has a total resistance of 50Ω , which produces a *no-load* speed of 1200 r/min. There are 1200 turns per pole on the shunt field winding. Find the speed of this motor when its input current is 100 A and determine induced torque also. (17)

(c) Derive the expression of terminal characteristics of a DC series motor and explain its behavior at no load. (You can derive the expression considering unsaturated field winding) (15 $\frac{2}{3}$)

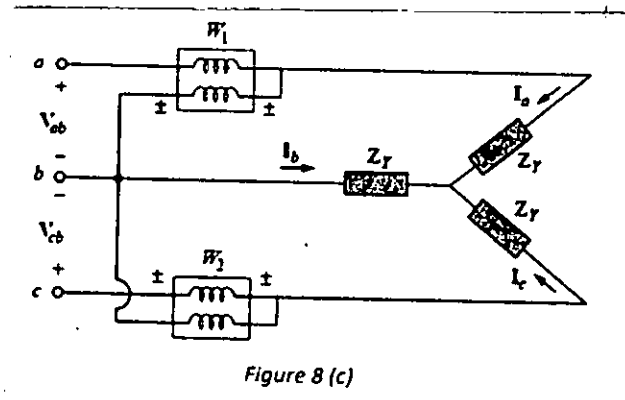
8. (a) A common emitter amplifier with $\beta = 100$ is shown in Figure 8 (a). (20)



- (i) What type of biasing is used in above circuit? Draw small signal equivalent circuit.
- (ii) Determine voltage gain of the amplifier.

(b) Establish a relationship between phase and line current of a Δ connected load and show it using phasor diagram. (11)

(c) Let the line voltage $V_L = 208 \text{ V}$ and the wattmeter readings of the balanced system in the Figure 8 (c) be $W_1 = -560 \text{ W}$ and $W_2 = 800 \text{ W}$. Determine power factor and phase impedance. (15 $\frac{2}{3}$)



SECTION – A

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

1. (a) Reduce the matrix $A = \begin{pmatrix} 3 & 9 & 6 & 9 \\ 2 & 7 & 3 & 5 \\ 3 & 8 & 1 & -2 \\ 5 & 12 & 7 & 6 \end{pmatrix}$ to echelon form then to its canonical form

and write down the rank and nullity. (15)

- (b) Test whether the vectors $\underline{u} = (3, 2, -1, 1)$, $\underline{v} = (1, 1, -1, 2)$, $\underline{w} = (1, 2, 0, -1)$ and $\underline{x} = (5, 6, 2, -9)$ are linearly independent or not. If not then express \underline{x} as a linear combination of \underline{u} , \underline{v} and \underline{w} . (15)

- (c) Find non-singular matrices P and Q such that PAQ is in the normal form, where (16 $\frac{2}{3}$)

$$A = \begin{pmatrix} 3 & 2 & -1 & 5 \\ 5 & 1 & 4 & -2 \\ 1 & -4 & 11 & -19 \end{pmatrix}$$

2. (a) Determine whether the following matrix is diagonalizable. If so, find a nonsingular matrix P that diagonalizes A, and write down the diagonal matrix D so that $P^{-1}AP = D$. (23 $\frac{2}{3}$)

$$A = \begin{bmatrix} 5 & 4 & -1 \\ 4 & 5 & -1 \\ -4 & -4 & 2 \end{bmatrix}$$

- (b) For the symmetric matrix $A = \begin{pmatrix} 1 & -3 & 2 \\ -3 & 7 & -5 \\ 2 & -5 & 8 \end{pmatrix}$ find nonsingular matrix P (23)

such that $P^1AP = D$ (a diagonal matrix). Write down the rank, index and signature. Identify the geometrical object represented by $X'AX = \text{constant}$.

3. (a) (i) Write down the definitions of gradient, divergence and curl and their physical interpretations (ii) Prove that $\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2 \mathbf{A}$. (23)

- (b) If $A = (2y + 3)\mathbf{i} + xz\mathbf{j} + (yz - x)\mathbf{k}$, evaluate $\int_C A \cdot d\mathbf{r}$ along the following paths C: (23 $\frac{2}{3}$)

(i) $x = 2t^2, y = t, z = t^3$ from $t = 0$ to $t = 1$

(ii) the straight lines from $(0,0,0)$ to $(0,0,1)$, then to $(0,1,1)$ and then to $(2,1,1)$. 8

SECTION – A

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

1. (a) Xavier company makes a product that sells for Tk. 20 per unit. Variable costs are Tk. 11 per unit and fixed costs are total Tk. 1,16,000 annually. (35)

Required:

- (i) What is the product's CM ratio?
 (ii) Determine break-even point in units and in sales taka.
 (iii) The company estimates that sales will increase by Tk. 55,000 during the coming year due to increased demand. By how much should net income increase?
 (iv) Assume that the operating results for were as follows:

Sales	Tk. 4,80,000
Less: Variable cost of sales	2,64,000
Contribution margin	2,16,000
Less: Total fixed cost	1,60,000
Net Income/Profit	56,000

It is expected that sales will be increased by 15% next year. By how much should net income increase?

- (v) Refer to the original data mentioned at the beginning assume that the company sold 28,000 units last year. The sales manager is convinced that a 10% reduction in selling price combined with Tk. 70,000 increase in advertising expense, would cause annual sales in units to increase by 50%. Prepare two contribution margin income statements, one showing the results of last year operations and another showing what the results of operations would be if these changes were made. Would you recommend that the company do as the sales manager suggest?
 (vi) What is the operating leverage for the projected sales period according to requirement (v)?
2. (a) Herlington Company uses a job order cost system in each of its three manufacturing departments. Manufacturing overhead is applied to jobs based on direct labor cost in Department D, direct labor hours in Department E, and machine hours in Department K. In establishing the predetermined overhead rates for 2020, the following estimates were made for the year. (27)

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Contd.... for Q. No. 2(a)

	Department		
	D	E	K
Manufacturing overhead	Tk. 1,200,000	Tk. 1,500,000	Tk. 900,000
Direct labor costs	Tk. 1,500,000	Tk. 1,250,000	Tk. 450,000
Direct labor hours	100,000	125,000	40,000
Machine hours	400,000	500,000	120,000

During January, the job cost sheets showed the following costs and production data.

	Department		
	D	E	K
Direct materials used	Tk. 140,000	Tk. 126,000	Tk. 78,000
Direct labor costs	Tk. 120,000	Tk. 110,000	Tk. 37,500
Manufacturing overhead incurred	Tk. 99,000	Tk. 124,000	Tk. 79,000
Direct labor hours	8,000	11,000	3,500
Machine hours	34,000	45,000	10,400

Required:

- (i) Compare the predetermined overhead rate for each department.
- (ii) Compute the total manufacturing costs assigned to jobs in January in each department.
- (iii) Compute each department's underapplied or overapplied overhead for January 31.

(b) The Alpine House, Inc., is a large retailer of winter sports equipment. An income statement for the company's Ski Department for a recent quarter is presented below:

(8)

The Alpine House, Inc. Income Statement—Ski Department For the Quarter Ended March 31, 2022		
Particular	Amount (\$)	Amount (\$)
Sales		\$150,000
Cost of Goods Sold		(90,000)
Gross Margin		60,000
Operating expenses:		
Selling expenses	\$30,000	
Administrative expenses	10,000	
Total operating expenses		(40,000)
Net operating income		\$20,000

Skis sell, on the average, for \$750 per pair. Variable selling expenses are \$50 per pair of skis sold. The remaining selling expenses are fixed. The administrative expenses are 20% variable and 80% fixed. The company does not manufacture its own skis; it purchases them from a supplier for \$450 per pair.

Required:

- (i) Prepare a contribution format income statement for the quarter.
- (ii) For every pair of skis sold during the quarter, what was the contribution toward covering fixed expenses and toward earning profits?

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3. (a) Savoy Ltd. manufactures a variety of engines for use in heavy equipment. The company has always produced all the necessary parts for its engines, including all the carburetors. An outside supplier has offered to sell one type of carburetor to Savoy Ltd. for a cost of \$35 per unit. To evaluate this offer, Savoy Ltd. gathered the following information relating to its own cost of producing the carburetors intentionally.

(25)

Particulars	Per Unit(\$)	15,000 Units per Year
Direct Material	14	2,10,000
Direct Labor	10	1,50,000
Variable manufacturing overhead	3	45,000
Fixed manufacturing overhead, traceable	6*	90,000
Fixed manufacturing overhead, allocated	9	1,35,000
Total cost	42	
*One-third supervisory salaries; two-thirds depreciation of special equipment		

Required:

- (i) If the company has no alternative use for the facilities that are now being used to produce the carburetors, should the outside supplier's offer be accepted? Show all computations.
- (ii) Suppose that the carburetors were purchased, Savoy Ltd., could use the freed capacity to launch a new product. The segment margin of the new product would be \$1,50,000 per year. Should Savoy Ltd. accept the offer to buy the carburetors for \$35 per unit? Show all computations.

(b) The Regal Cycle Company manufactures three types of bicycles- A dirt bike, a mountain bike and a racing bike. Data on sales and expenses for the past quarter follow:

(10)

	Total	Dirt Bikes	Mountain Bikes	Racing Bikes
Sales	\$3,00,000	\$90,000	\$1,50,000	\$60,000
Variable manufacturing and selling expenses	(1,20,000)	(27,000)	(60,000)	(33,000)
Contribution margin	1,80,000	63,000	90,000	27,000
Fixed Expenses:				
Advertising, traceable	30,000	10,000	14,000	6,000
Depreciation of special equipment	23,000	6,000	9,000	8,000
Salaries of product-line manager	35,000	12,000	13,000	10,000
Allocated common fixed expenses*	60,000	18,000	30,000	12,000
Total fixed expenses	1,48,000	46,000	66,000	36,000
Net operating income(loss)	32,000	17,000	24,000	(9,000)

* Allocated on the basis of sales dollars.

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

Management is concerned about the continued losses shown by the racing bikes and wants a recommendation as to whether or not the line should be discontinued. The special equipment used to produce racing bikes has no resale value and does not wear out.

Required: Should production and sale of the racing bikes be discontinued? Explain and show computations to support your answer.

4. (a) When and why is a flexible budget prepared? Discuss the frequency used techniques of capital budgeting with examples. (15)

(b) You have been asked to prepare a December cash budget for Keraniganj Company, a distributor of exercise equipment. The following information is available about the company's operations: (20)

- (i) The cash balance on December 1 is Tk. 40,000.
- (ii) Actual sales for October and November and expected sales for December are as follows:

	October	November	December
Cash sales	Tk. 65,000	Tk. 70,000	Tk. 83,000
Sales on account	Tk. 400,000	Tk. 525,000	Tk. 600,000

Sales on account are collected over a three-month period as follows: 20% collected in the month of sale, 60% collected in the month following sale, and 18% collected in the second month following sale. The remaining 2% is uncollectible.

- (iii) Purchases of inventory will total Tk. 280,000 for December. Thirty percent of a month's inventory purchases are paid during the month of purchase. The accounts payable remaining from November's inventory purchases total Tk. 161,000, all of which will be paid in December.
- (iv) Selling and administrative expenses are budgeted at Tk. 430,000 for December. Of this amount, Tk. 50,000 is for depreciation.
- (v) A new web server for the Marketing Department costing Tk. 76,000 will be purchased for cash during December, and dividends totaling Tk. 9,000 will be paid during the month.
- (vi) The company maintains a minimum cash balance of Tk. 20,000. An open line of credit is available from the company's bank to increase its cash balance as needed.

Required: Prepare a cash budget for December.

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SECTION – B

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

5. Define accounting. Discuss the accounting process and the users of accounting information. Tania Hamid started her own consulting firm, Tania Consulting, on May 1, 2022. The following transactions occurred during the month of May. (35)

May 1	Tania invested Tk. 700,000 cash in the business.
2	Paid Tk. 90,000 for office rent for the month.
3	Purchased Tk. 80,000 of supplies on account.
5	Paid Tk. 12,500 to advertise in the <i>County News</i> .
9	Received Tk. 400,000 cash for services performed.
12	Withdrew Tk. 100,000 cash for personal use.
15	Performed Tk. 640,000 of services on account.
17	Paid Tk. 250,000 for employee salaries.
20	Made a partial payment of Tk. 60,000 for the supplies purchased on account on May 3.
23	Received a cash payment of Tk. 400,000 for services performed on account on May 15.
26	Borrowed Tk. 500,000 from the bank on a note payable.
29	Purchased equipment for Tk. 420,000 on account.
30	Paid Tk. 27,500 for utilities.

Required: Prepare a tabular analysis of the above transactions.

6. What is meant by a journal? What benefits does a journal provide in the recording process? Presented below is information related to THT Real Estate Agency. (35)

Oct. 01	Tania Berge begins business as a real estate agent with a cash investment of Tk. 3,000,000
02	Paid rent, Tk. 70,000, on office space.
03	Purchases office equipment for Tk. 280,000, on account.
06	Sells a house and lot for Hal Smith; bills Hal Smith Tk. 440,000 for realty services performed.
27	Pays Tk. 110,000 on the balance related to the transaction of October 3.
30	Receives bill for October utilities, Tk. 13,000 (not paid at this time).

Required:

Journalize the above transactions, post to the ledger accounts, and prepare a trial balance as on 31 October.

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7. What do you mean by adjusting the accounts? Discuss the types of adjusting entries with examples. The trial balance of Keraniganj Fashion Center contained the following accounts at November 30, the end of the company's fiscal year.

(35)

Keraniganj Fashion Center		
Trial Balance		
November 30, 2022		
	Debit	Credit
Cash	Tk. 20,700	
Accounts Receivable	30,700	
Inventory	44,700	
Supplies	6,200	
Equipment	133,000	
Accumulated Depreciation—Equipment		Tk. 28,000
Notes Payable		60,000
Accounts Payable		48,500
Owner's Capital		93,000
Owner's Drawings	12,000	
Sales Revenue		755,200
Sales Returns and Allowances	8,800	
Cost of Goods Sold	497,400	
Salaries and Wages Expense	140,000	
Advertising Expense	24,400	
Utilities Expense	14,000	
Maintenance and Repairs Expense	12,100	
Freight-Out	16,700	
Rent Expense	24,000	
Totals	Tk. 984,700	Tk. 984,700

Adjustment data:

- (i) Supplies on hand totaled Tk. 2,600.
- (ii) Depreciation is Tk. 11,500 on the equipment.
- (iii) Interest of Tk. 3,800 is accrued on notes payable at November 30.
- (iv) Inventory actually on hand is Tk. 44,400.

Required:

Prepare a multiple-step income statement and an owner's equity statement for the year, and a classified balance sheet as of November 30, 2022. Notes payable of Tk. 20,000 are due in January 2023.

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8. What do you mean by financial statement analysis? Discuss the bases and tools for financial statement analysis. Kalatia Company has these comparative balance sheet data:

(35)

Kalatia Company		
Balance Sheets		
December 31		
	2022	2021
Cash	Tk. 15,000	Tk. 30,000
Accounts receivable (net)	70,000	60,000
Inventory	60,000	50,000
Plant assets (net)	200,000	180,000
	<u>Tk. 345,000</u>	<u>Tk. 320,000</u>
Accounts payable	Tk. 50,000	Tk. 60,000
Mortgage payable (15%)	100,000	100,000
Common stock, Tk. 10 par	140,000	120,000
Retained earnings	55,000	40,000
	<u>Tk. 345,000</u>	<u>Tk. 320,000</u>

Additional information for 2022:

- (i) Net income was Tk. 25,000.
- (ii) Sales on account were Tk. 375,000. Sales returns and allowances amounted to Tk. 25,000.
- (iii) Cost of goods sold was Tk. 198,000.
- (iv) Net cash provided by operating activities was Tk. 48,000.
- (v) Capital expenditures were Tk. 25,000, and cash dividends were Tk. 10,000.

Required:

Compute the following ratios at December 31, 2022.

- a) Current ratio
- b) Accounts receivable turnover
- c) Average collection period
- d) Inventory turnover
- e) Days in inventory
- f) Free cash flow.
