L-2/T-2/MME **Date : 01/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **ME 221** (Elements of Fluid Mechanics and Machinery)

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 is continuum hypothesis in context to fluid mechanics? When does the continuum assumption fail? **(5)**

(b) State the "Newton's Law of Viscosity" explaining each term with a suitable diagram. Hence define the co-efficient of viscosity with unit. **(5)**

(c) Listing all necessary assumptions and diagrams explain the working principle of a two cylinder viscometer. It diameters of the cylinders are 30 cm and 30.3 cm and a torque of 0.18 Nm is required to rotate the inner cylinder at 500 rpm; calculate the fluid's viscosity. **(13)**

(d) What is the "No Slip Condition"? A flat plate is floating above a 0.05 cm thick film of lubricant and is being pulled to the right side at a speed of U = 1 m/s shown in fig. for Q 1(d). The viscosity of the lubricant is 0.4 Ns/m^2,

(i) Find the velocity distribution u(y) between the floor and the flat plate.

(ii) Calculate the velocity and shear force per unit area on the floor, on the flat plate and at the center of the lubricant film. **(12)**

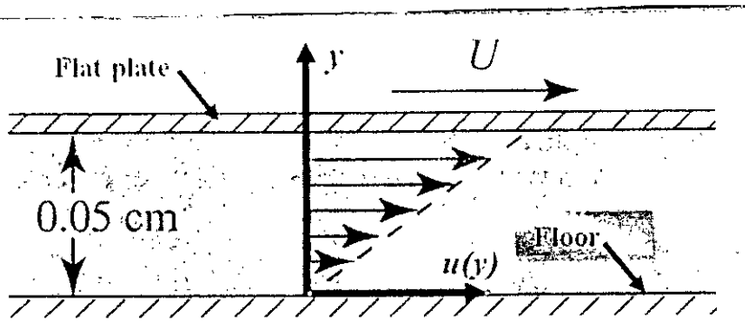
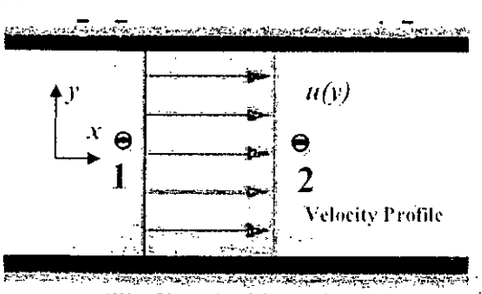


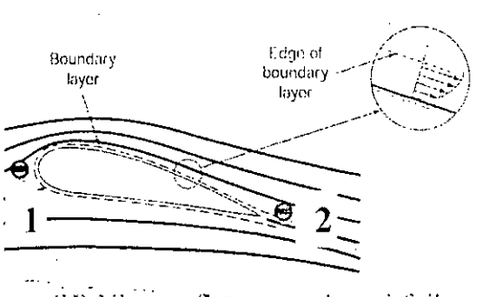
Fig. for Q 1(d).

2. (a) Write down the general vector form of incompressible "Navier-Stokes Equation" and explain each term. Listing all the necessary assumptions derive "Bernoulli's Equation" from it. **(18)**

(b) Write down Bernoulli's Equation between point 1 and 2 for the following flow situations: **(6)**



(iii) Flow inside a pipe



(iv) Viscous flow around an airfoil

Contd. P/2

MME 221

Contd ... Q. No. 2

(c) A stream of refreshing beverage of diameter d = 0.01 m flows steadily from the cooler of diameter D = 0.20 m as shown in Fig. for Q 2(c). Determine the flow rate, Q, from the bottle into the cooler if the depth of beverage in the cooler is to remain constant at h = 0.20 m. **(11)**

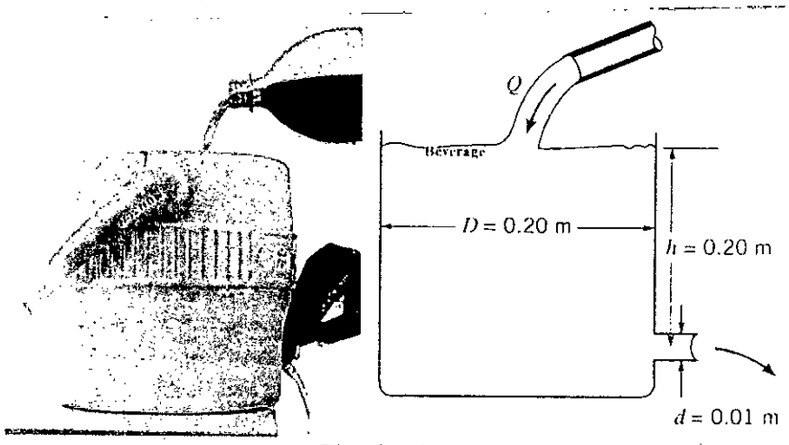


Fig. for Q 2(c).

3. (a) With practical examples and necessary diagrams explain the following:
(i) Laminar and (ii) turbulent flow **(8)**

(b) Derive the differential form of "Continuity Equation". Simply this equation for steady flows. **(12)**

(c) With suitable diagrams briefly explain "Static, Dynamic and Stagnation" pressure. Explain how the local flow velocity at a point in a flow field can be measured. **(15)**

4. (a) Define Reynolds Number for a pipe flow. What is major and minor loss? What are the main factors responsible for minor loss? **(7)**

(b) Write down "Darcy-Weisbach Equation" for a pipe flow explaining each term. Using Hagen-Poiseuille equation, show that friction factor for a laminar flow is 64/Re. **(11)**

(c) A piping system is shown in Fig. for Q 4(c). It is to transport water ($\upsilon = 1.14\times10^{-6}$ m^2/s) from tank A to B under the action of a pump developing 57.1 kW on the flow. If 152 mm diameter galvanized iron pipe is to be used, determine the flow rate Q for the system. **(17)**

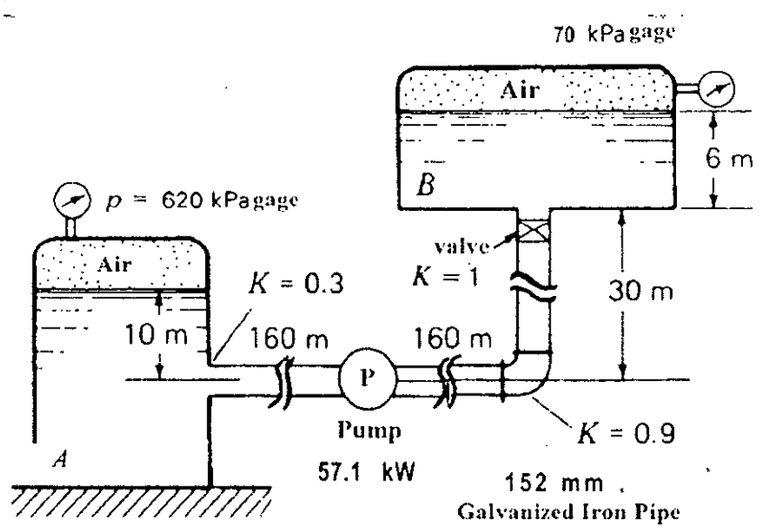


Fig. for Q 4(c).

Contd. P/3

MME 221

SECTION – B

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

5. (a) Prove that, pressure in a fluid element varies along the vertical direction only. What will be the head in water for the pressure of 25 mm mercury? **(17+3=20)**

(b) Gate ABC is a circular are, sometimes called a Tainter gate, which can be raised and lowered by pivoting about point O, as shown in Fig. for Q5(b). For the position shown, determine the magnitude and direction of hydrostatic force of the water on the gate. Assume unit depth into the paper. **(15)**

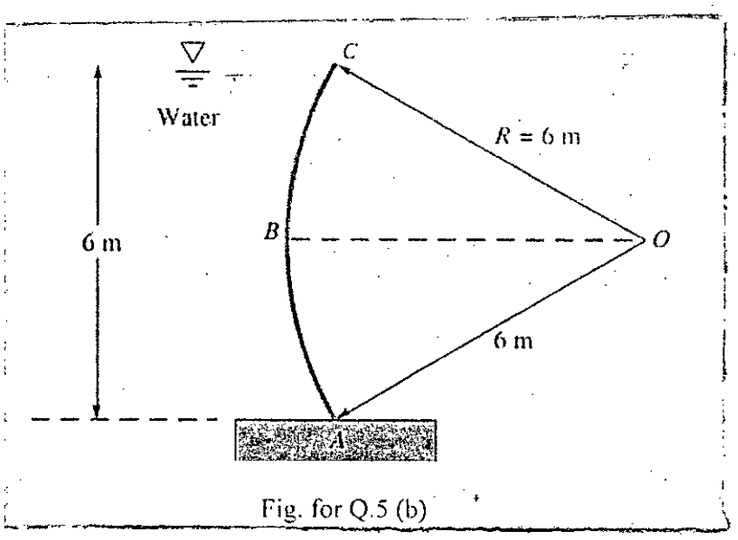


Fig. for Q.5 (b)

6. (a) Show that, the magnitude of the force on a submerged plane surface is $F = p_c A$, where the symbols have their usual meaning. Hence, find the location of x an y coordinates of the resultant force. **(25)**

(b) Consider a wooden cylinder (Specific Gravity = 0.6) 1 m in diameter and 0.8 m long. Would this cylinder be stable if placed to float with its axis vertical in oil (Specific Gravity = 0.8). **(10)**

7. (a) For both the single and double acting reciprocating pump, mathematically show how much work can be saved by using air vessels in both suction and delivery side. Assume air vessels are fitted close to the cylinder. **(15)**

(b) A centrifugal pump running at 1200 rpm has the following variation of its prime variables. **(20)**

Discharge, Q(L/min)	0	1200	2400	3600	4200	4800	5500	6000	6600	7200
Head, H(m)	30.0	29.0	27.0	24.0	22.5	20.5	18.0	16.0	12.0	8.0
Power input, P_{in}(KW)	15	16.2	17.6	17.6	18.4	19.0	19.6	20.1	19.9	20.9

Contd. P/4

MME 221

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

Determine the efficiencies of this pump for each point. Hence, draw the pump characteristics (H-Q) curve and the efficiency-head curve on the same H and Q axes. Indicate the BEP clearly in the graph and determine the specific speed of the pump.

8. (a) Why is priming necessary for a centrifugal pump? **(5)**

(b) Differentiate among pumps, fans, blowers and compressors. **(8)**

(c) A 90° V-notch is used for measuring a discharge of 34 l/s. An error of 2mm was made while measuring the head over the notch. Calculate the % error in the discharge. Take C_d = 0.6. Symbols have their usual meaning. **(12)**

(d) For a centrifugal pump, which material is most suitable between the following two: i) Cast iron, ii) Stainless steel.

Discuss in the context of different losses and cavitation problem. **(10)**

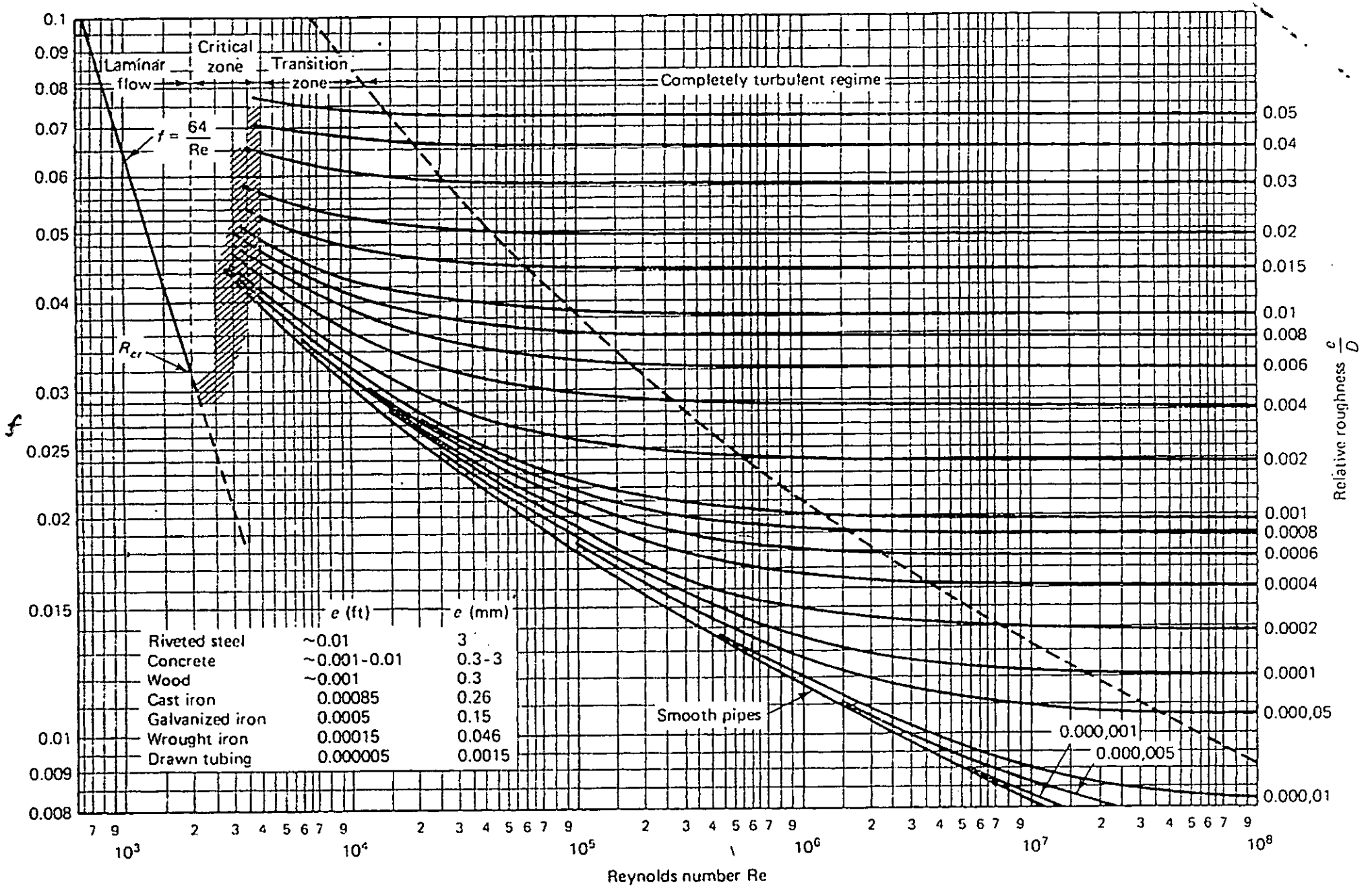


Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **MME 213** (Phase Diagrams and Transformation)

Full Marks : 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The figures in the margin indicate full marks.

1. (a) Both of LI_o and LI_2 order structures possess the same crystal structure and lattice type in disorder state, but different crystal structure with same lattice type in order state - explain. **(12⅔)**

   (b) Calculate lattice parameters a, b and c of LI_o and LI_2 order structures for Cu-Au binary alloy system given radius of Cu and Au are 140 pm and 166 pm respectively. Consider, Cu atom always hold the coordinate (0, 0, 0). **(17)**

   (c) For Fe_3Al DO_3 order crystal structure, how many atoms of Fe needs to be misplaced by Al to result in long range order parameter equals zero - calculate. **(17)**

2. A diffusion couple is made of 100 percent pure copper and 100 percent pure gold. Length of each rectangular bar is 500 cm with a cross-sectional area of 100 cm^2. The diffusion couple is annealed at 700 C for 8 weeks. Assume one dimensional diffusion only.

   (a) Provide the solution to determine the concentration profile of copper in gold bar which is valid for all time. **(12)**

   (b) When the expression is valid only for long time? **(8)**

   (c) Calculate the value of inter diffusivity if after the annealing cycle copper concentration at gold bar end is found to be 98 percent. **(20)**

   (d) If the all-time solution expression is used to determine long time concentration, will it differ from the solution found from only long time solution expression? Why? **(6⅔)**

3. (a) Define geometrical degree of freedom for interface. List the geometrical degree of freedom for solid – solid crystal interface. Which ones are eliminated for solid (crystal) – gas interface? **(14⅔)**

   (b) Only with neat sketch differentiate between coherent and incoherent interface. **(12)**

   (c) List the major types of VEC Hume-Rothery phases with examples. **(10)**

   (d) Write a short note on grain boundary grooving with necessary mathematical expression. **(10)**

Contd P/2

MME 213

4. (a) Is it possible to study cooling of a ternary alloy with only help of isothermal sections? How? **(10)**

   (b) For mixing any two ternary alloys prove the law of straight combining lines. **(12)**

   (c) For a typical ternary alloy system A-B-C exhibiting partial solid solubility and complete liquid miscibility, draw three vertical sections for A-(90B:10C), A-(80B:20C) and A-(70B:30C). Given both of ternary eutectic composition and binary B-C eutectic composition lies on the vertical section A(70B:30C). Also, melting temperature of A is maximum and melting temperature of C is minimum. **(24⅔)**

SECTION – B

There are **EIGHT** questions in this section. Answer any **SIX**.

The questions are of equal value.

5. Define solid solution. With appropriate examples discuss how relative size factors of solvent and solute atoms control the solid solubility ranges in metallic alloys.

6. The cooling curve of any intermetallic compound is very similar to that of pure metal-why? Mention some special features of intermetallic compounds and explain how these features affect the service performances of metallic alloys.

7. What is degree of supercooling? Draw the Free Energy versus Temperature diagram and explain. Why supercooling is essential for solidification of any liquid metal.

8 Draw a typical binary equilibrium phase diagram where the two participating metals are partially soluble in each other, label its all lines and phases. With neat sketches show the development of the final microstructures if a binary alloy system cooled slowly from its liquid state to room temperature through a line that cuts solvus line at both above and below the eutectic temperature.

9. What do you understand by the term "monoeutectic reaction"? Draw the relevant phase diagram and discuss the microstructural changes if monoeutectic alloy system is further cooled to room termperature.

10 With necessary sketches discuss the underlying reasons of higher carbon solubility in more density packed austenite compared to that of the less density packed ferrite.

11. Draw the iron-carbon diagram and using this diagram calculate the percentages of total ferrite, pearlite and cementile in the microsturctures of a cost iron having 3.5% carbon which is slowly cooled from liquid state to room temperature.

12. What is martensite? Discuss the mechanism of martensite transformation in steel.

L-2/T-2/MME **Date: 11/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

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** questions.

1. (a) According to the revenue recognition principle, when should the revenue record? Explain with example. **(5)**

(b) Arismar started his manufacturing business on June 1, 2017. The following transaction took place during the month of operation. **(30)**

June 1: Invested Tk. 8,00,000 cash in the business.
June-6: Purchased office equipment cash in Tk. 1,20,000.
June-10: Hired a managing director and will be paid Tk. 30,000 per month.
June-12: Incurred advertising expense on account Tk. 10,000.
June-16: Paid office rent in advance Tk. 15,000.
June-17: Earned Tk. 80,000 for selling product, Tk. 45,000 is received in cash and remaining on account.
June-19: Withdrew Tk. 10,000 for personal use.
June-20: Paid due amount related to advertising.
June-29: Received cash from customers on credit sales.
June-30: Salary expense paid Tk. 8,000.

Required:

(i) Prepare journal entries for above transactions.
(ii) Prepare Asset accounts and liability account ledgers.

2. (a) Related information of Ham Kan Company is given below:

Ham Kan Company
Balance Sheet
December 31, 2017

Particulars	2017	2016
Cash	Tk. 5,200	Tk. 3,700
Accounts Receivable	21,000	23,400
Inventory	10,000	7,000
Land	20,000	26,000
Building	70,000	70,000
Accumulated depreciation	(15,000)	(10,000)
Total	1,11,200	1,20,100
Accounts Payable	13,070	31,100
Common stockholder equity	98,130	89,000
Total	1,11,200	1,20,000

Contd P/2

HUM 303

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

Ham Kan Company's 2017 Income Statement Includes net sale Tk. 1,00,000, cost of goods sold Tk. 60,000 and net income Tk. 15,000.

Required:

(a) Prepare a horizontal analysis and a vertical analysis for the balance sheet for the period 2017 (both in amount and in percentage). **(19)**

(b) Calculate the following ratios: **(16)**

(i) Current ratio

(ii) Quick ratio

(iii) Receivable turnover

(iv) Inventory turnover

(v) Profit margin

(vi) Return on stockholders' equity

(vii) Return on asset

(viii) Debt to asset ratio.

3. (a) What is the difference between revenue and gain? Illustrate your answer with example. **(5)**

(b) The trial balance of Lakecross Company is given below: **(30)**

Lakecross Company

Trial Balance

May 31, 2017

Particulars	Debit (Tk.)	Credit (Tk.)
Cash	3,500	–
Supplies	2,200	–
Prepaid Insurance	2,280	–
Land	12,000	–
Machinery	60,000	–
Furniture	15,000	–
Account payable	–	4,800
Unearned rent	–	3,300
Bank loan	–	35,000
Capital	–	46,380
Rent revenue	–	10,300
Advertising expense	600	–
Salary expense	3,300	–
Utility expense	900	–
Total	99,780	99,780

Contd P/3

HUM 303

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

Additional Information:

- Prepaid Insurance is for one year.
- Unused supplies balance of Tk. 750.
- Annual depreciation is Tk. 3,000 on machinery and Tk. 2,700 on furniture.
- The bank loan interest rate is 12% and accrued.
- Unearned rent Tk. 2,500 has been earned.
- Salaries of Tk. 750 are accrued.

Required:

(i) Journalize the adjusting entries for the month of May 31, 2017.

(ii) Prepare an adjusted trial balance as on May 31, 2017.

4. (a) What types of comparison can be done when financial statements are analysed? Explain with example. **(5)**

(b) Reboot Company has the following trial balance at December 31, 2017. **(30)**

Reboot Company

Trial Balance

As on December 31, 2017

Particulars	Debit (Tk.)	Credit (Tk.)
Cash	20,500	–
Account Receivable	15,000	–
Account Payable	–	12,000
Mortgage Payable	–	3,700
Inventory (01-01-2017)	5,800	–
Purchase	20,100	–
Sales	–	40,500
Sales Return	1,200	–
Purchase Return	–	500
Capital	–	36,200
Drawings	2,300	–
Salaries Expense	3,400	–
Prepaid Insurance	3,600	–
Machinery	16,000	–
Rent expense	5,000	–
Copyright	20,000	–
Bond payable (long term)	–	20,000
Total	1,12,900	1,12,900

Contd P/4

HUM 303

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

Other Information:

- Inventory (31-12-2017) Tk. 6700.
- Rent is 40% administrative and 60% selling.
- Salary of the sales person is payable Tk. 600.

Required:

(i) Prepare a multiple-Step Income Statement.

(ii) Prepare a Statement of Owner's Equity.

(iii) A classified balance sheet as on December 31st, 2017.

SECTION – B

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

5. (a) Differentiate between a product cost and period cost. **(6)**

(b) Why is manufacturing overhead considered an indirect cost of a unit of product? **(5)**

(c) Sunshine Company was organized on March 1, 2018. After five months of start-up losses, the income statement for August also showed a loss- **(24)**

Sunshine Company

Income Statement

For the month of August 31, 2018

	Amount (Tk.)	Amount (Tk.)
Sales		
Less:Operating expenses		
Direct labor cost	70,000	
Raw material purchased	165,000	
Manufacturing overhead	85,000	
Salaries (70% for factory and 30% for selling and administrative)	100,000	
Utility (40% for factory and 60% for selling and administrative)	42,000	462,000
Net operating loss		(12,000)

Inventory Balances

	August 1	August 31
Direct material	8,000	13,000
Work-in-process	16,000	21,000
Finished goods	40,000	60,000

Required:

(i) Prepare a cost of goods sold statement.

(ii) Prepare a new income statement for August.

Contd P/5

HUM 303

6. (a) What is meant by the term operating leverage? The degree of operating leverage for 'X' Company is 5 times where as it is 7 times for 'Z' Company. What does it imply? **(5)**

(b) Mr. D has prepared the following analysis for his new shop- **(30)**

	Tk.
Sales price per pair of sandals	40
Variable cost per pair of sandals	16
Contribution margin per pair of sandal	24
Fixed cost per year:	
Building rent	15,000
Equipment depreciation	7,000
Selling expense	20,000
Administrative expense	18,000
Total fixed costs	60,000

Required:

(i) Compute contribution margin ratio.

(ii) How many pairs of sandals must be sold each year to break-even? What does this represent in sales Taka?

(iii) Mr. D has decided that he must earn at least Tk. 18,000 in the first year to justify his time and effort. How many pairs of sandals must be sold to reach his target profit?

(iv) Mr. D now has two sales person working in the store, one full time and one part time. It will cost an additional Tk. 8,000 per year to convert the part time position to a full time position. Mr. D believes that the change would bring in an additional Tk. 25,000 in sales each year. Should he convert the position? (Assume number of unit sold is 5000 units)

(v) Assume that in next year company wants to sell 50,000 units; if selling price increased by Tk. 2 per unit and if fixed expenses increased by Tk. 20,000 then calculate profit or loss.

(vi) It is proposed to pay the store manager 50 paisa (Tk. 0.50) per pair as further commission. The selling price is also proposed to be increased by 5%. What would be the break even points in units?

Contd P/6

HUM 303

7. (a) What do you understand by contribution margin? **(5)**

(b) Matador Ball pen has the following information given below- **(20)**

Units produced	25,000
Units sold	20,000
Selling price (per unit)	Tk. 50
Variable cost per unit:	
Direct material	Tk. 6
Direct labor	Tk. 9
Variable manufacturing overhead	Tk. 3
Variable selling and administrative overhead	Tk. 4
Fixed cost per year:	
Fixed manufacturing overhead	Tk. 300,000
Fixed selling and administrative overhead	Tk. 190,000

Required:

(i) Calculate the product cost per unit under absorption costing system and variable costing system.

(ii) Prepare income statement using under absorption costing system and variable costing system.

(iii) Reconcile the amount of profits under two costing systems.

(c) A number of costs typically found in an organization- **(10)**

(i) Boxes used for packing detergent produced by the company.

(ii) Lubricant for machine.

(iii) Advertising cost.

(iv) Power and electricity.

(v) Accountant's salary.

(vi) Sales person commission.

(vii) Wages of workers assembling computers.

(viii) Executive life insurance.

(ix) Shipping cost.

(x) Legal fees.

Required:

Classify above items into variable or fixed cost.

Contd P/7

HUM 303

8. (a) "Toshiba Company" provides outsourcing and consulting services to government and corporate clients. It has two supports departments- Human Resource (HR) and Information Technology (IT) – and two operating departments- Government Consulting (GOVT) and Corporate Consulting (CORP). For the year 2018, the following information were available- **(10)**

Budgeted overhead before Allocation (Tk.)	Support Dept.		Operating Dept.		Total
	HR	IT	GOVT	CORP	
	600,000	24,00,000	87,56,000	124,52,000	242,08,000
Support work by HR	–	25%	40%	35%	100%
Support work by IT	10%	–	30%	60%	100%

Required:

Allocate two supports departments cost to the two operating departments by using- Reciprocal method.

(b) What is the importance of Capital Budgeting decision? **(5)**

(c) A company wants to purchase a new equipment. The related information of the equipment is as follows: **(20)**

Cost of the equipment Tk. 75,000	
Year	Net Profit After Tax (NPAT)
1	Tk. 40000
2	13000
3	20000
4	10000
5	7000

Required:

(i) Pay-Back-Period (PBP).

(ii) Internal Rate of Return (IRR).

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

(iv) Profitability Index (PI) at @10% cost of capital.

Should the company buy the equipment?

L-2/T-2/MME **Date: 11/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **HUM 103** (Economics)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What are the assumptions of a perfectly competitive market? Explain. **(10)**

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

   (c) From the following revenue and cost functions, calculate profit maximizing level of output and maximum profit. **(10)**

$$R = 1200Q - 2Q^2$$

$$C = Q^3 - 61.25Q^2 + 1538.5Q + 2000$$

2. (a) Define fixed cost and variable cost. **(5)**

   (b) How would you derive the long run average cost (LAC) curve of a firm from its short run average cost curves? Explain graphically. **(10)**

   (c) A manufacturer has a fixed cost of $40,000 and a variable cost of $1.60 per unit made and sold. Selling price is $2 per unit. **(10)**

   (i) Find the revenue, cost and profit functions using q for the number of units.

   (ii) Compute profit if 150000 units are made and sold.

   (iii) Find the break-even quantity.

   (iv) Construct the break-even chart. Label the cost and revenue lines, the fixed cost line, and the break-even point.

   (d) What is the relation among various short run average cost curves? **(10)**

3. (a) When does a firm emerge as a monopolist? **(10)**

   (b) What are the relation among marginal revenue (MR), price (P) and price elasticity of demand (e) of a firm under monopoly? **(10)**

   (c)Explain the short run equilibrium of a firm under monopoly. **(10)**

   (d)What are the conditions for equilibrium of a firm? **(5)**

4. (a) Explain Vicious Circle of Poverty. **(10)**

   (b) What are the methods of measuring national income? Explain any two of them. **(10)**

   (c) What are the problems of measuring national income in a developing country like Bangladesh? **(15)**

Contd P/2

SECTION – B

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

5. (a) Clarify the concept of utility in economics and explain the law of diminishing marginal utility with numerical as well as graphical presentations. **(10)**

(b) What do you know about the demand function of a commodity? Describe the common factors that affect the demand for a commodity. **(15)**

(c) What do understand by 'change in quantity demanded', and 'change in demand'? Explain graphically. **(10)**

6. (a) Define different types of elasticity of demand and describe their importance in economics. **(10)**

(b) Let the demand function for Samsung mobile phone is **(15)**

$$Q_{ds} = 2475 - 2.8P_s + 0.07Y + 1.44P_d - 28.5P_{sb}$$

where, price of Samsung mobile, P_s = \$285, price of Apple mobile, P_a = \$460, price of battery, P_{sb} = \$75 and income level, Y = \$56,000. Find the cross-price elasticities and income elasticity of Samsung mobile phone. Explain why the sign of the coefficients of cross-price elasticities are different.

(c) What is an indifference curve? Illustrate the optimal consumption point of a consumer with the help of indifference curves and budget line. **(10)**

7. (a) What do you understand by localization of industries? What are the causes of localization of industries? **(10)**

(b) Explain the advantages and disadvantages of localization of industries. **(15)**

(c) What do you understand by division of labour? Explain different types of division of labour. **(10)**

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

(i) Marginal rate of substitution (MRS) and marginal utility (MU)

(ii) Fundamental economic problems

(iii) Substitution effect and income effect of a price change

(iv) Market demand and market supply curves and their interactions.

L-2/T-2/MME **Date: 27/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **EEE 267** (Electrical and Electronic Technology)

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** questions.

1. (a) Two balanced loads are connected to a 240 kV rms 60 Hz balanced line, as shown in Fig. for Q. 1(a). Load 1 consumes 50 kW at a power factor of 0.6 lagging, while load 2 consumes 60 kVAR at a power factor of 0.8 lagging. Assuming the *abc* sequence, determine: **(15)**

   (i) the complex, real and reactive powers consumed by the combined load

   (ii) the line currents

   (iii) the kVAR rating of the three capacitors Δ-connected in parallel with the load that will raise the overall power factor to 0.9 lagging

   (iv) the capacitance of each capacitor.

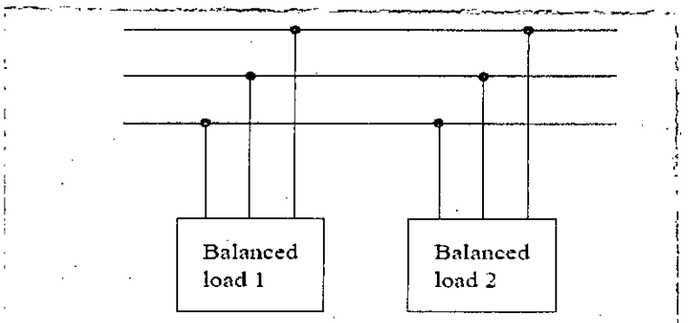


Fig. for Q. 1(a)

(b) Find the line currents in the unbalanced three-phase circuit of Fig. for Q. 1(b) and the real power absorbed by the load. **(14)**

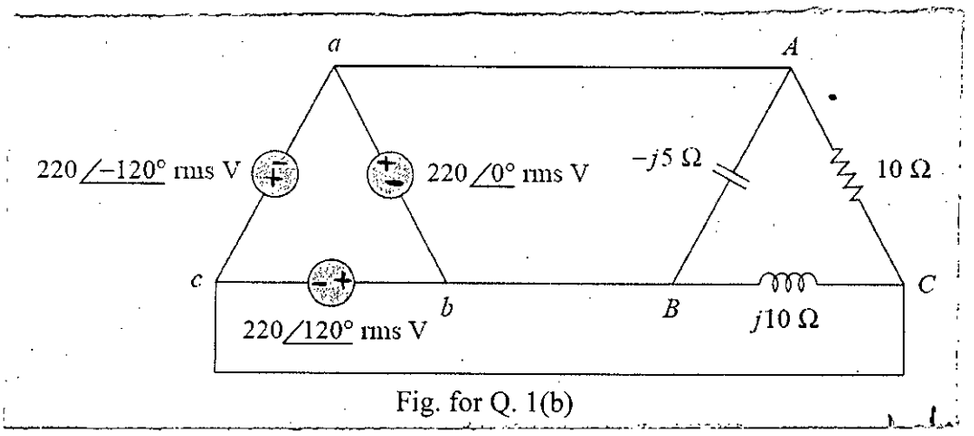


Fig. for Q. 1(b)

(c) Draw the phasor diagram for the line voltages and phase voltages in a Y connected balanced load assuming the *abc* sequence. Take V_{an} as the reference of the diagram. **(3)**

(d) Write down the characteristics of an ideal Op-amp. **(3)**

Contd P/2

EEE 267/MME

2. (a) Show that the diode small-signal resistance $r_d = nV_T / I_D$. **(10)**

(b) The 6.8 V Zener diode in the circuit of Fig. for Q. 2(b) is specified to have $V_Z = 6.8\ V$ at $I_Z = 5\ mA$, $V_{Z0} = 6.7\ V$ and $I_{Ze} \approx 0.2\ mA$. The supply voltage V^+ is nominally 10 V but can vary by $\pm 1\ V$. Find out: **(15)**

(i) V_0 with no load and with V^+ at its nominal value.

(ii) Line regulation

(iii) Load regulation

(iv) Change in V_0 when $R_L = 2\ k\Omega$

(v) Change in V_0 when $R_L = 0.5\ k\Omega$

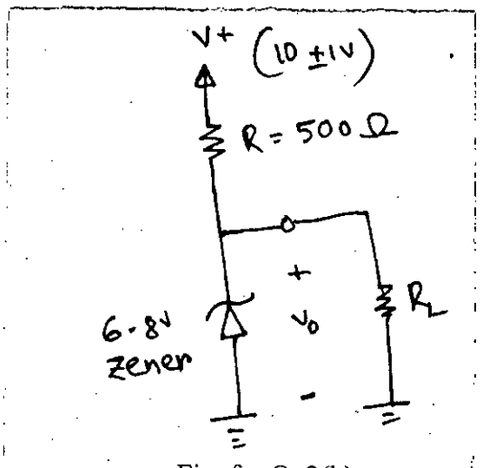


Fig. for Q. 2(b)

(c) Draw the full wave bridge rectifier arrangement and mention the states (forward or reverse biased) of the diodes during the positive and negative half cycle. **(5)**

(d) Draw the clipper circuit for which the input and output graphs follow Fig. for Q. 2(d). **(5)**

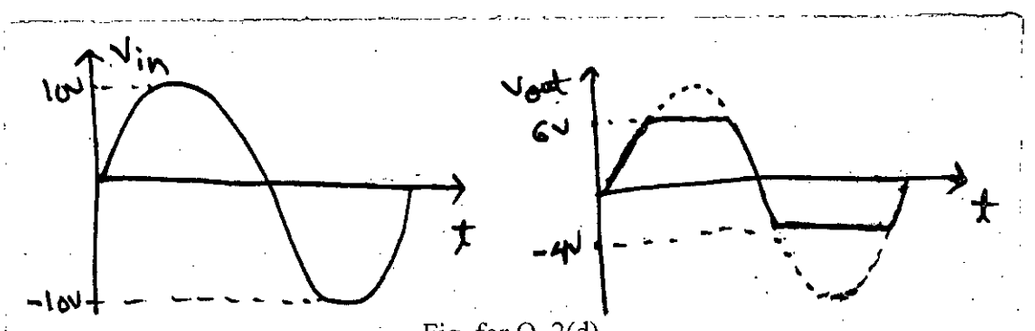


Fig. for Q. 2(d)

Contd P/3

EEE 267/MME

3. (a) Analyze the circuit shown in Fig. for Q. 3(a) to determine the voltages at all nodes and the currents through all branches. Given $V_t = 1V$ and $k_n'\left(\frac{W}{L}\right) = 1\,mA/V^2$. Neglect the channel-length modulation effect. **(15)**

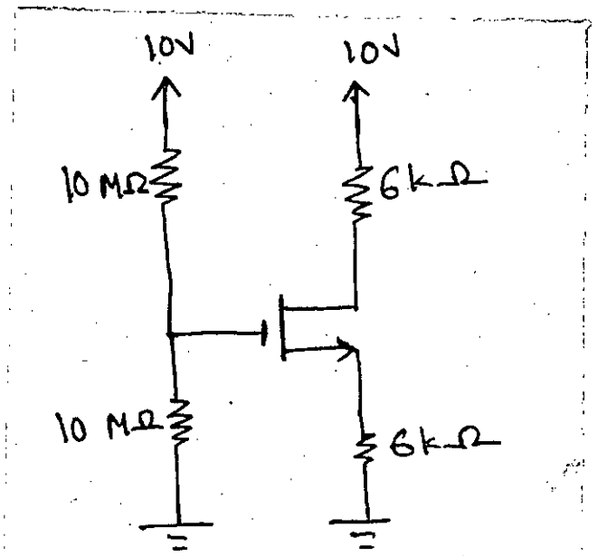


Fig. for Q. 3(a)

(b) The NMOS and PMOS transistors in the circuit of Fig. for Q. 3(b) are matched with $k_n'\left(\frac{W}{L}\right) = k_p'\left(\frac{W}{L}\right) = 1\,mA/V^2$ and $V_{tn} = -V_{tp} = 1V$. Assuming $\lambda = 0$ for both devices, find the drain currents I_{DN} and I_{DP}, as well as the voltage v_0 for $v_{in} = 0V, +2.5V$ $-2.5V$. **(16)**

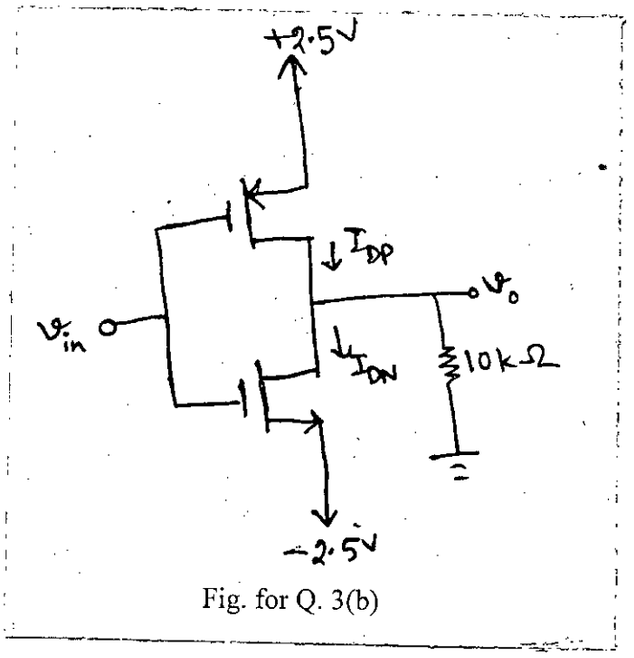


Fig. for Q. 3(b)

(c) What is transducer? Briefly discuss primary and secondary electrical transducers with example. **(4)**

Contd P/4

EEE 267/MME

4. (a) Analyze the circuit of Fig. for Q. 4(a) to determine the voltages at all nodes and the current through all branches. All find out the power dissipated at the 5 $k\Omega$ resistor. Assume $\beta = 100$. **(14)**

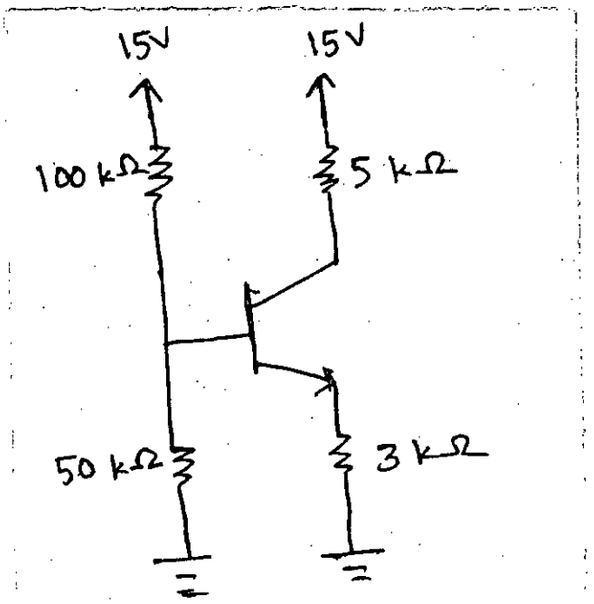


Fig. for Q. 4(a)

(b) Analyze the circuit of Fig. for Q. 4(b) to determine the voltages at all nodes and the current through all branches. Assume $\beta = 100$ for the active mode. The minimum value of β is specified to be 30. **(16)**

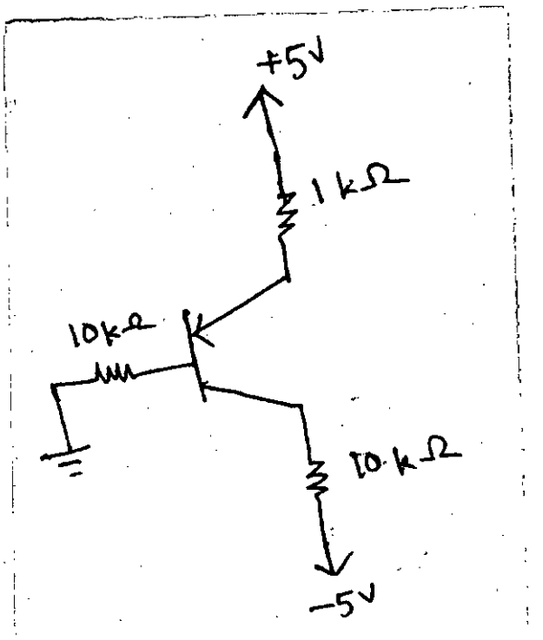


Fig. for Q. 4(b)

Contd P/5

EEE 267/MME

Contd... Q. No. 4

(c) Draw the arrangement for a non-inverting 2 *V* detector with an op-amp. The bias voltages are +15 *V* and –15 *V*. Draw the output if the input of this detector is shown in Fig. for Q. 4(c). **(5)**

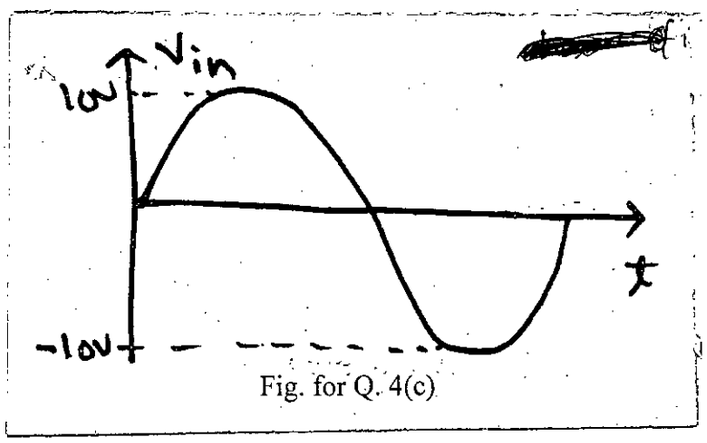


Fig. for Q. 4(c)

SECTION – B

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

5. (a) Describe the open circuit test technique of a single phase transformer. **(10)**

(b) A 1000-VA, 230/115 V single phase transformer has been tested to determine its equivalent circuit. The results of the tests are shown below– **(15)**

Open circuit test (on secondary side)	Short circuit test (on primary side)
V_{OC} = 115 V	V_{SC} = 17.1 V
I_{OC} = 0.11 A	I_{SC} = 8.7 A
P_{OC} = 3.9 W	P_{SC} = 38.1 W

(i) Find the equivalent circuit of this transformer referred to the low-votlage side of the transformer.

(ii) Find the transformer's voltage regulation at rated conditions at 0.8 PF lagging, and 0.8 PF leading.

(c) A 208-V, 45-hp, 0.85-PF-leading, Δ-connected, 50 Hz synchronous machine has a synchronous reactance of 2.5 Ω and a negligible armature resistance. Its friction and windage losses are 1.5 kW, and its core losses are 1.0 kW. The shaft is supplying a 15-hp load, and the motor's power factor is 0.85 leading. **(10)**

Sketch the phasor diagram of this motor, and find the values of I_A, I_L and E_A at this load.

Contd P/6

EEE 267/MME

6. (a) Describe the conditions of paralleling two synchronous generators. **(5)**

(b) Fig. for Q. 6(b) shows a generator supplying a load. A second load is to be connected in parallel with the first one. The generator has a no load frequency of 51.0 Hz and a slope of 1 MW/Hz. Load 1 consumes a real power of 1000 kW at 0.85 PF lagging while load 2 consumes a real power of 800 kW at 0.7 PF lagging. **(15)**

(i) Before the switch is closed, what is the operating frequency of the system?

(ii) After load 2 is connected, what is the operating frequency of the system?

(iii) After load 2 is connected, what action could an operator take to restore the system frequency to 50 Hz?

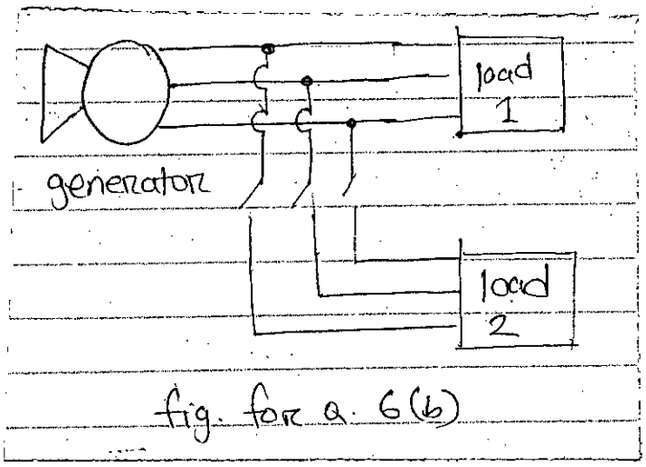


fig. for Q. 6(b)

(c) The infinite bus in Fig. for Q. 6(c) operates at 480 V. Load 1 is an induction motor consuming 100 kW at 0.78 PF lagging, and load 2 is an induction motor consuming 200 kW at 0.8 PF lagging. Load 3 is a synchronous motor whose real power consumption is 150 kW. Assume per phase line resistance 0.1 ohm. **(15)**

(i) If the synchronous motor is adjusted to operate at 0.85 PF lagging, what is the transmission line loss in the system?

(ii) If the synchronous motor is adjusted to operate at 0.85 PF leading, what is the transmission line loss in this system?

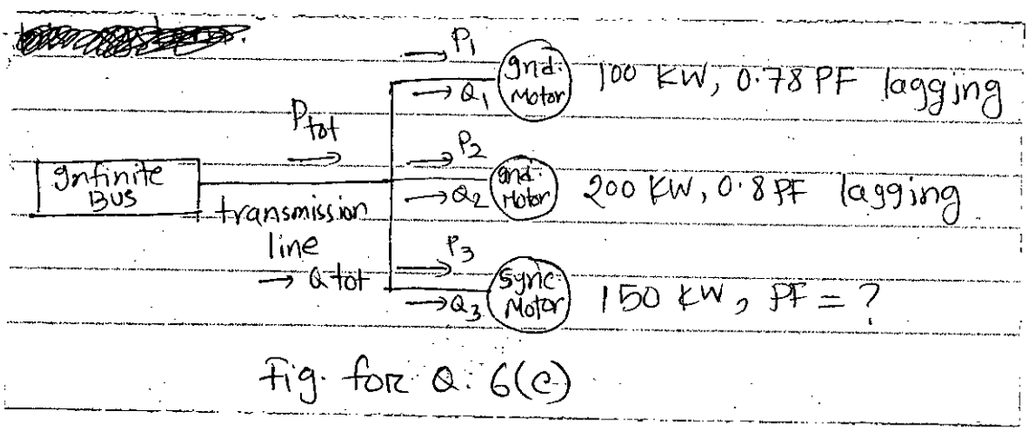


fig. for Q. 6(c)

EEE 267/MME

7. (a) Derive the expression of induce torque of a 3-ϕ induction motor. From the expression, define the condition of maximum torque and the expression of the maximum torque under that condition. **(15)**

(b) A 30 HP, 4-pole, 415 V, 50 Hz, 3-phase squirrel cage induction motor is supplied from a 50 Hz, 3-phase ac supply mains with line to line voltage of 415 V. The motor has following parameters for its per phase equivalent circuit. **(20)**

Stator leakage reactance = 2 jΩ

Rotor leakage reactance = 1 jΩ

Stator winding resistance = 0.5 Ω

Rotor winding resistance = 0.2 Ω

Stator magnetizing reactance = 100 jΩ

Stator core loss at rated voltage = 200 W

(i) Determine the steady state torque of the motor when it runs at 1450 rpm.

(ii) Determine the maximum developed torque of the motor.

8. (a) Describe the terminal voltage control strategies of a separately excited DC generator. **(15)**

(b) Derive the torque-speed characteristics of a series dc motor. **(20)**

L-2/T-2/MME **Date: 16/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **MME 235** (Heat and Mass Transfer)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Table for Blackbody Radiation function and Figure for View Factor are provided.

Symbols have their usual meaning. Assume reasonable values for any missing data.

1. (a) Distinguish between thermal boundary layer and velocity boundary layer for a fluid flow over a flat surface. **(8)**

(b) Derive the expressions for local and mean mass transfer coefficients over a distance of x = 0 to x = L along the surface of flat plate. **(12)**

(c) The rate at which water is lost because of evaporation from the surface of a body of water may be determined by measuring the surface recession rate. Consider a summer day for which the temperature of both the water and the ambient air is 305 K and the relative humidity of the air is 30%. If the surface recession rate is known to be 0.2 mm/h, what is the rate at which mass is lost because of evaporation per unit surface area? **(15)**

What is the convection mass transfer coefficient? For Saturated water: Vapor at 305 K, $\rho_g = 0.0336$ kg/m^3; for liquid water at 305 K, $\rho_f = 995$ kg/m^3.

2. (a) Derive an expression for the log mean temperature difference (LMTD) for a counter flow heat exchanger. **(15)**

(b) Draw the temperature distribution curve for following cases: **(12)**

(i) parallel flow heat exchanger, (ii) counter flow heat exchanger (iii) parallel flow heat exchanger where hot fluid is a condensing vapor, (iv) counter flow heat exchanger where cold fluid is an evaporating liquid.

(c) Do we expect heat and mass transfer to change with transition from a laminar to a turbulent boundary layer? If so, how? **(8)**

3. (a) What is Wien's displacement law? **(4)**

(b) A surface emits as a blackbody at 1500 K. What is the rate per unit area (W/m^2) at which it emits radiation over all directions corresponding to $0° \le \theta \le 60°$ and over the wavelength interval $2\ \mu m \le \lambda \le 4\ \mu m$? **(14)**

Contd P/2

MME 235

Contd... Q. No. 3

(c) The spectral, hemispherical absorptivity of an opaque surface can be approximated as follows: α **(17)**

$\alpha_\lambda = 0$ for $0.3 < \lambda$ μm

$\alpha_\lambda = 0.9$ for $0.3 \leq \lambda \leq 1.5$ μm

$\alpha_\lambda = 0.1$ for $\lambda > 1.5$ μm

What is the solar absorptivity, α_S? If it is assumed that $\alpha_\lambda = \varepsilon_\lambda$, and that the surface is at a temperature of 340 K, what is its total, hemispherical emissivity?

4. (a) Determine the view factor F_{12} for the configuration shown in Figure for Question 4(a). **(17)**

(b) A long, hemi cylindrical (1-m radius) shaped furnace shown in Figure for Question 4(b) used to heat treat sheet metal products is comprised of three zones. The heating zone (1) is constructed from a ceramic plate of emissivity 0.85 and is operated at 1600 K by gas burners. The load zone (2) consists of sheet metal products, assumed to be black surfaces, that are to be maintained at 500 K. The refractory zone (3) is fabricated from insulating bricks having an emissivity of 0.6. Assume steady-state conditions, diffuse, gray surfaces, and negligible convection. **(18)**

(i) What is the heat rate per unit length of the furnace (normal to the pate) that must be supplied by the gas burners for the prescribed conditions?

(ii) What is the temperature of the insulating brick surface for the prescribed conditions?

SECTION – B

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

For mathematical problems, state the assumptions that you considered and also draw a schematic of the problem given.

5. (a) Beginning with a differential control volume in Cartesian coordinates, show that under steady-state, one-dimensional conditions with no energy generation, the heat flux is a constant in the direction of heat transfer. **(18)**

(b) A long copper bar of rectangular cross section, whose width w is much greater than its thickness L, is maintained in contact with a cold plate at its lower surface, and the temperature throughout the bar is approximately equal to that of the cold plate, T_o. Suddenly, an electric current is passed through the bar and an air stream of temperature T_∞ is passed over the top surface, while the bottom surface continues to be maintained at T_o. Obtain the differential equation and the boundary and initial conditions that could be solved to determine the temperature as a function of position and time in the bar. **(17)**

Contd P/3

MME 235

6. (a) A truncated solid cone is of circular cross section, and its diameter is related to the axial coordinate by an expression of the form $D = ax^{3/2}$, where a = 1.0 $m^{1/2}$. The sides are well insulated, while the top surface of the cone at x_1 is maintained at T_1 and the bottom surface at x_2 is maintained at T_2. [As shown in Fig. for question 6(a)] **(18)**

   (i) Obtained an expression for the temperature distribution T(x), assuming one dimensional steady-state conditions.

   (ii) What is the rate of heat transfer across the cone if it is constructed of pure aluminum ($k \approx$ 239 W/m.K at 60°C) with x_1 = 0.075 m, T_1 = 100°C, x_2 = 0.225 m, and T_2 = 20°C?

   (b) A very long rod 5 mm in diameter has one end maintained at 100°C. The surface of the rod is exposed to ambient air at 25°C with a convection heat transfer coefficient of 100 W/m^2.K. Determine the temperature distributions along rods constructed from 2024 aluminum alloy and type AISI 316 stainless steel and also draw a figure to show temperature distribution of both. What are the corresponding heat losses from the rods? For 2024 aluminum at 335 K: k = 180 W/m.K and for stainless steel, AISI 316 at 335 K: k=14 W/m.K. **(17)**

7. (a) Using the energy balance method, derive the finite-difference equation for the (m, n) nodal point located on a plane as shown in Fig. for question 7(a). Consider, T_c point as the desired (m, n) nodal point. The point is located on insulated surface of a medium with uniform heat generation. Also, calculate the heat generation rate if the temperatures have been measured at locations corresponding to the nodal points as following: **(18)**

$$T_a \approx T_{m,n+1} = 235.9^\circ C, T_b \approx T_{m-1,n} = 227.6^\circ C, T_c \approx T_{m,n} = 230.9^\circ C, T_d \approx T_{m-1,n-1} = 220.1^\circ C$$

$$T_e \approx T_{m,n-1} = 222.4^\circ C, T_\infty = 200.0^\circ C \text{ and } h = 50 \text{ W/m}^2\text{.K}, k = 1 \text{ W/m.K}, \Delta x = \Delta y = 10 \text{ mm}$$

   (b) A steady-state, finite-difference analysis has been performed on a cylindrical fin as shown in Fig. for question 7(b) with a diameter of 12 mm and a thermal conductivity of 15 W/m.K. The convection process is characterized by a fluid temperature of 25°C and a heat transfer coefficient of 25 W/m^2.K. **(17)**

   (i) The temperatures for the first three nodes, separated by a spatial increment of x = 10 mm, are given in the sketch. Determine the fin heat rate.

   (ii) Determine the temperature at node 3, T_3.

8. (a) Using lumped capacitance method, derive an expression for the temperature of a solid as a function of time. Mention the limitations of lumped capacitance method. **(20)**

   (b) A thermocouple junction, which may be approximated as a sphere, is to be used for temperature measurement in a gas stream. The convection coefficient between the junction surface and the gas is h = 400 W/m^2.K, and the junction thermo-physical properties are k = 20 W/m.K, c = 400 J/kg.K, and ρ = 8500 kg/m^3. **(15)**

   Determine the junction diameter needed for the thermocouple to have a time constant of 1 s. If the junction is at 25°C and is placed in a gas stream that is at 200°C, how long will it take for the junction to reach 199°C?

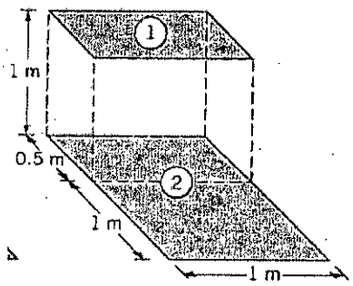


Figure for Question 4(a)

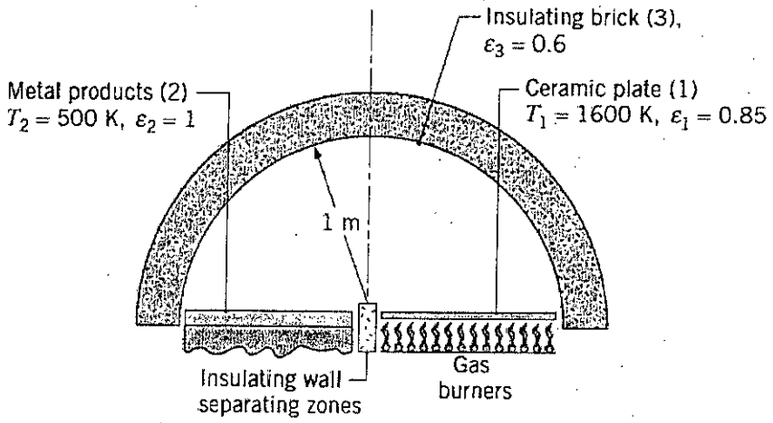


Figure for Question 4(b)

Table: Blackbody Radiation Function

λT (μm · K)	$F_{(0\to\lambda)}$	$I_{\lambda,b}(\lambda,T)/\sigma T^5$ (μm · K · sr)$^{-1}$	$\dfrac{I_{\lambda,b}(\lambda,T)}{I_{\lambda,b}(\lambda_{max},T)}$
200	0.000000	0.375034×10^{-27}	0.000000
400	0.000000	0.490335×10^{-13}	0.000000
600	0.000000	0.104046×10^{-8}	0.000014
800	0.000016	0.991126×10^{-7}	0.001372
1,000	0.000321	0.118505×10^{-5}	0.016406
1,200	0.002134	0.523927×10^{-5}	0.072534
1,400	0.007790	0.134411×10^{-4}	0.186082
1,600	0.019718	0.249130	0.344904
1,800	0.039341	0.375568	0.519949
2,000	0.066728	0.493432	0.683123
2,200	0.100888	0.589649×10^{-4}	0.816329
2,400	0.140256	0.658866	0.912155
2,600	0.183120	0.701292	0.970891
2,800	0.227897	0.720239	0.997123
2,898	0.250108	0.722318×10^{-4}	1.000000

Table: Blackbody Radiation Function (Continued)

λT (μm · K)	$F_{(0\to\lambda)}$	$I_{\lambda,b}(\lambda,T)/\sigma T^5$ (μm · K · sr)$^{-1}$	$\dfrac{I_{\lambda,b}(\lambda,T)}{I_{\lambda,b}(\lambda_{max},T)}$
3,000	0.273232	0.720254×10^{-4}	0.997143
3,200	0.318102	0.705974	0.977373
3,400	0.361735	0.681544	0.943551
3,600	0.403607	0.650396	0.900429
3,800	0.443382	0.615225×10^{-4}	0.851737
4,000	0.480877	0.578064	0.800291
4,200	0.516014	0.540394	0.748139
4,400	0.548796	0.503253	0.696720
4,600	0.579280	0.467343	0.647004
4,800	0.607559	0.433109	0.599610
5,000	0.633747	0.400813	0.554898
5,200	0.658970	0.370580×10^{-4}	0.513043
5,400	0.680360	0.342445	0.474092
5,600	0.701046	0.316376	0.438002
5,800	0.720158	0.292301	0.404671
6,000	0.737818	0.270121	0.373965
6,200	0.754140	0.249723×10^{-4}	0.345724
6,400	0.769234	0.230985	0.319783
6,600	0.783199	0.213786	0.295973
6,800	0.796129	0.198008	0.274128
7,000	0.808109	0.183534	0.254090
7,200	0.819217	0.170256×10^{-4}	0.235708
7,400	0.829527	0.158073	0.218842
7,600	0.839102	0.146891	0.203360
7,800	0.848005	0.136621	0.189143
8,000	0.856288	0.127185	0.176079
8,500	0.874608	0.106772×10^{-4}	0.147819
9,000	0.890029	0.901463×10^{-5}	0.124801
9,500	0.903085	0.765338	0.105956
10,000	0.914199	0.653279×10^{-5}	0.090442

Table: Blackbody Radiation Function (Continued)

λT (μm · K)	$F_{(0\rightarrow\lambda)}$	$I_{\lambda,b}(\lambda,T)/\sigma T^5$ (μm · K · sr)$^{-1}$	$\dfrac{I_{\lambda,b}(\lambda,T)}{I_{\lambda,b}(\lambda_{max},T)}$
10,500	0.923710	0.560522	0.077600
11,000	0.931890	0.483321	0.066913
11,500	0.939959	0.418725	0.057970
12,000	0.945098	0.364394×10^{-5}	0.050448
13,000	0.955139	0.279457	0.038689
14,000	0.962898	0.217641	0.030131
15,000	0.969981	0.171866×10^{-5}	0.023794
16,000	0.973814	0.137429	0.019026
18,000	0.980860	0.908240×10^{-6}	0.012574
20,000	0.985602	0.623310	0.008629
25,000	0.992215	0.276474	0.003828
30,000	0.995340	0.140469×10^{-6}	0.001945
40,000	0.997967	0.473891×10^{-7}	0.000656
50,000	0.998953	0.201605	0.000279
75,000	0.999713	0.418597×10^{-8}	0.000058
100,000	0.999905	0.135752	0.000019

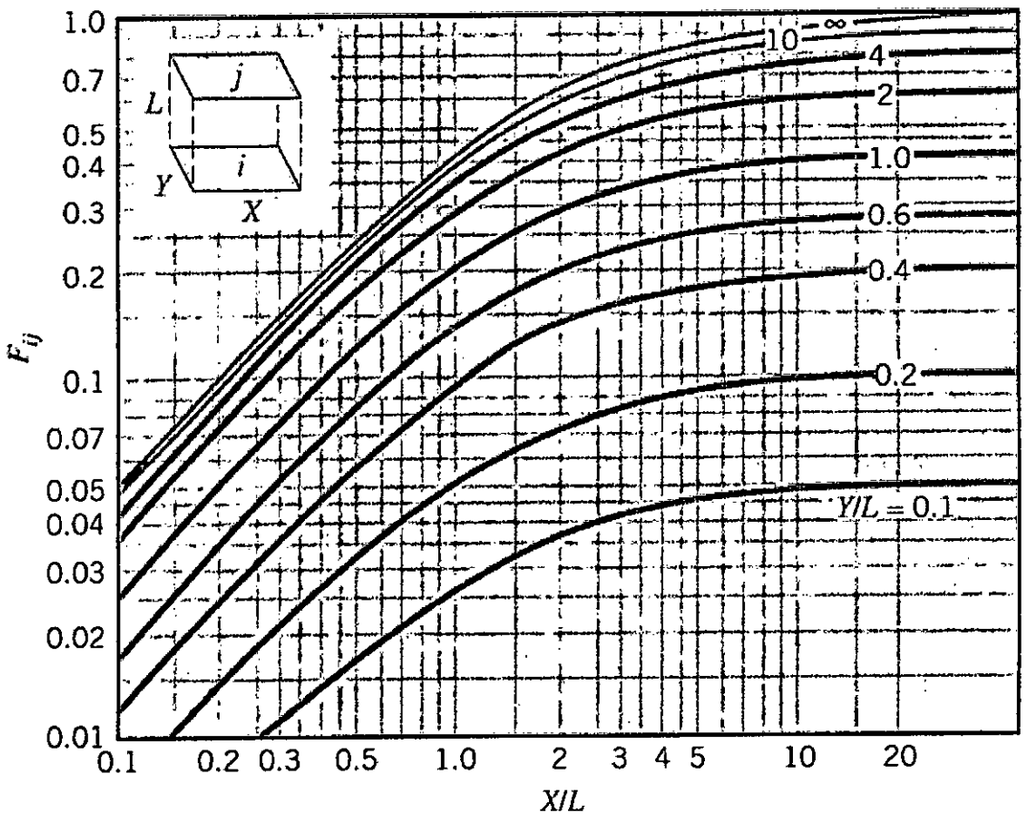


Figure: View factor for aligned parallel rectangles.

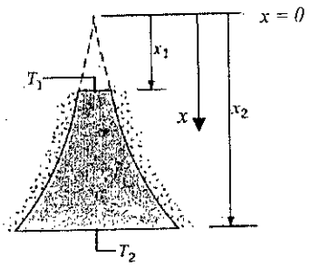


Fig. for question 6 (a)

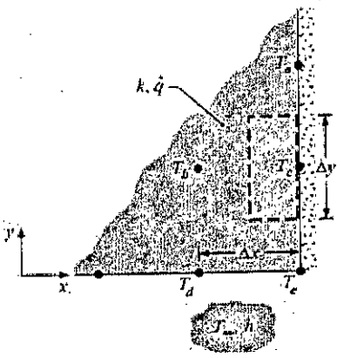


Fig. for question 7 (a)

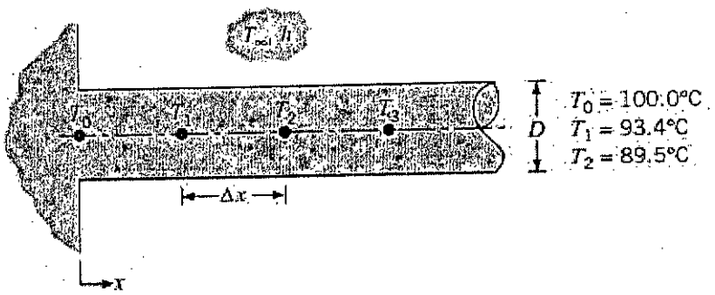


Fig. for question 7 (b)