L-3/T-1/IPE

Date : ~~25/04/2024~~ 26/5/24

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **IPE 305** (Manufacturing Process II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Derive an expression for MRR in machining ductile and brittle materials by AJM Find out the conditions for which AJM will produce equal material removed both for ductile and brittle materials. **(15)**

   (b) With suitable sketches, explain the reasons for development of modern machining processes. Explain the effects of SOD on machining accuracy in AJM process. **(10)**

   (c) Briefly explain the working principle of a WJM showing important elements. Give the practical application of WJM. **(10)**

2. (a) With the help of suitable sketch, describe the working principle of ECM. What are the materials commonly used for making a tool for use in this method? **(15)**

   (b) What are the functions of an electrolyte? What factors need to be considered while selecting it? Discuss the advantages and limitations of some electrolysis. **(10)**

   (c) Briefly explain the working principle of conventional EDM showing important elements. What are functions served by the dielectric fluid in EDM? **(10)**

3. (a) With the help of Earnest and Merchant model. She that $P_z = 2\tau_s S_o t \cot \beta$, where the notations indicate their usual meaning. **(15)**

   (b) Draw a single point turning tool and visualize its different rake angles, clearance angles and cutting edge angles. Also state why those angles are provided. **(10)**

   (c) A ductile metal rod of 200 mm diameter is turned at a speed of 320 rpm. feed of 0.24 mm/rev. and 3.00 mm depth of cut by a tool having rake angle 10° and principal cutting edge angle 70°. The following observations were made. P_z = 750 N, P_y = 200 N, Chip thickness = 0.65 mm. Using MCD, determine the values of μ, P_s, P_n, and τ_s. **(10)**

4. (a) With the help of neat sketches, describe the principles of operation of the following plastic molding processes: (i) Compression molding and (ii) Rotational molding. **(15)**

   (b) What are some of the attractive features of the transfer molding process? Using sketches, explain the injection molding process. **(10)**

   (c) With the help of diagram, discuss some of the defects that occur in plastic injection molding and methods to eliminate them. **(10)**

Contd P/2

IPE 305

SECTION – B

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

5. (a) What are the purposes of change gearbox in tuning and threading operation? Explain in detail. **(9)**

   (b) What do you mean by 14inch Lathe and a 24 inch shaper? **(9)**

   (c) Explain the differences between Turning and Threading, considering the amount of feed in Lathe operation. Also mention which connecting element (feed rod/lead screw) is generally responsible for Turning operation and for threading operation in general purpose Lathe machine? **(9)**

   (d) Write short note on Duplicating lathe and Gap lathe. **(8)**

6. (a) Discuss the following lathe operations with necessary sketches. **(9)**

   (i) Internal threading (ii) internal forming (iii) Shoulder facing.

   (b) What are purposes of Fly cutting? Explain the process in detail. **(9)**

   (c) What do you understand by Strain back effect? Explain the role of Clapper box to address the Strain back effect. **(9)**

   (d) Define Pressure angle, Module and Diametral pitch of gear. **(8)**

7. (a) Explain the following processes with necessary sketches. **(9)**

   i) Core drilling ii) Step drilling iii) Counter boring

   (b) Briefly discuss relative advantages of Dense spacing. Medium spacing and Open spacing of abrasive particle in grinding wheel. **(9)**

   (c) Explain briefly the Centerless grinding process with necessary sketch(es) and its application. **(9)**

   (d) Define Pitch, Lead and Pitch diameter of screw threads. **(8)**

8. (a) Briefly explain the functions of a transducer and tool horn in USM. Explain how material is removed in USM. **(10)**

   (b) With the help of diagram, explain the working principle of wire EDM. List the advantages of wire EDM. What are the characteristics required for a good electrode material in EDM? **(15)**

   (c) Show schematically the general pattern of wear that develops at the rake surface and the clearance surfaces of cutting tool. State the difference among abrasion wear, adhesion wear and diffusion wear in respect of cutting wear. **(10)**

13\05\2024

L-3/T-1/IPE Date : ~~31/03/2024~~

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **IPE 307** (Operations Research)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A company is planning to spend \$10,000 on advertising. It costs \$3,000 per minute to advertise on television and \$1,000 per minute to advertise on radio. If the firm buys x minutes of television advertising and y minutes of radio advertising, then its revenue in thousands of dollars is given by $f(x, y) = -2x^2 - y^2 + xy + 8x + 3y$. How can the firm maximize its revenue? **(20 2/3)**

(b) Compute the gradient $\nabla f(x)$ and Hessian $\nabla^2 f(x)$ of the Rosenbrock function **(13)**

$$f(x) = 100\left(x_2 - x_1^2\right)^2 + \left(1 - x_1\right)^2$$

Show that $x^* = (1, 1)^T$ is the only local minimizer of this function, and that the Hessian matrix at that point is positive definite.

(c) Consider the problem **(13)**

$$\min_{x \in R^2} f(x) = -2x_1 + x_2 \qquad \text{subject to } \begin{cases} (1 - x_1)^3 - x_2 \geq 0 \\ x_2 + 0.25x_1^2 - 1 \geq 0 \end{cases}$$

The optimal solution is $x^* = (0, 1)^T$, where both constraints are active. Does the LICQ holds at this point? Are the KKT conditions satisfied?

2. (a) Giapetteo's Woodcarving, Inc., manufactures two types of wooden toys: soldiers and trains. They formulated the following LP to maximize weekly profit. **(36 2/3)**

$$\max z = 3x_1 + 2x_2$$

s.t. $2x_1 + x_2 \leq 100$ (Finishing constraint))

$x_1 + x_2 \leq 80$ (Carpentry constraint)

$x_1 \leq 40$ (Limited demand for soldiers)

x_1 = soldiers and x_2 = trains. After adding slack variables s_1, s_2 and s_3, the optimal tableau is as shown in the table below.

z	x_1	x_2	s_1	s_2	s_3	rhs	Basic Variable
1	0	0	1	1	0	180	$z = 180$
0	1	0	1	−1	0	20	$x_1 = 20$
0	0	1	−1	2	0	60	$x_2 = 60$
0	0	0	−1	1	1	20	$s_3 = 20$

Contd P/2

IPE 307

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

Use this optimal tableau to answer the following questions:

(i) Show that as long as soldiers (x_1) contribute between \$2 and \$4 to profit, the current basis remains optimal, If soldiers contribute \$3.50 to profit, find the new optimal solution to the Giapetto problem.

(ii) Show that as long as trains (x_2) contribute between \$1.50 and \$3.00 to profit, the current basis remains optimal.

(iii) Show that if between 80 and 120 finishing hours are available, the current basis remains optimal. Find the new optimal solution to the Giapetto problem if 90 finishing hours are available,

(iv) Show that as long as the demand for soldiers is at least 20, the current basis remains optimal.

(v) Giapetto is considering manufacturing toy boats. A toy boat uses 2 carpentry hours and 1 finishing hour. Demand for toy boats is unlimited. If a toy boat contributes \$3.50 to profit, should Giapetto manufacture any toy boats?

(b) Use the weak duality property to prove that if both the primal and the dual problem have feasible solutions, then both must have an optimal solution. **(10)**

3. (a) Derive the expressions for the expected number of customers in queuing system for the M/M/s model. **(12 2/3)**

(b) Consider an inventory system in which the sequence of events during each period is as follows. (1) We observe the inventory level (call it i) at the beginning of the period. (2) if $i \leq 1$, $4 - i$ units are ordered. If $i \geq 2$, 0 units are ordered. Delivery of all ordered units is immediate. (3) With probability 1, 0 units are demanded during the period; with probability 1/3, 1 unit is demanded during the period; and with probability 1/3, 2 units are demanded during the period. (4) We observe the inventory level at the beginning of the next period. **(12)**

Define a period's state to be the period's beginning inventory level. Determine the transition matrix that could be used to model this inventory system as a Markov chain.

(c) Suppose that all car owners fill up when their tanks are exactly half full. At the present time, an average of 7.5 customers per hour arrive at a single-pump gas station. It takes an average of 4 minutes to service a car. Assume that interarrival times and service times are both exponential. **(22)**

(i) For the present situation compute L and W.

(ii) Suppose that a gas shortage occurs and panic buying takes place. To model this phenomenon, suppose that all car owners now purchase gas when their tanks are exactly three-quarters full. Since each car owner is now putting less gas into the tank during each visit to the station, we assume that the average service time has been reduced to $3\frac{1}{3}$ minutes. How has panic buying affected L and W?

Contd P/3

IPE 307

4. (a) Consider the game having the following payoff table. **(26 2/3)**

Strategy		Player 2	
		1	2
Player 1	1	3	–2
	2	–1	2

Use the graphical procedure to determine the value of the game and the optimal mixed strategy for each player according to the minimax criterion. Check your answer for player 2 by constructing his payoff table and applying the graphical procedure directly to this table.

(b) A zero-sum game has the following payoff table for player 1: **(20)**

Strategy		Player 2			
		1	2	3	4
Player 1	1	0	–2	2	1
	2	5	4	–3	5
	3	2	3	–4	3

(i) Use the dominated strategies technique to eliminate rows and/or columns, if possible.
(ii) Use maximin/minimax to find a saddle point of the game resulting from (i), if there is one.
(iii) Express the solution to the game of (i) as a linear programming problem (do not solve).

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Assume any appropriate value for missing data.

5. (a) Briefly discuss the impact of operations research on the following sectors: **(10)**
(i) transportation and (ii) healthcare.

(b) Summarize the usual phases of an operations research study. **(6)**

(c) EQA is a company that owns three farms in West Texas. Each farm has a limited area for growing crops and a limited amount of water for serving the crops. This information is given in Table 5.1. **(30 2/3)**

Farm	Area (Acres)	Water (Gal)
1	2,500	6,954,000
2	4,800	7,942,000
3	2,800	5,471,000

Table 5.1: Farm information

EQA is considering planting three varieties of crops that differ in yield (profit) per acre and in the water required for growing each crop. In addition to that, there is a maximum number of acres that can be planted for each crop variety. This information is summarized in Table 5.2.

Contd P/4

IPE 307

Contd ... Q. No. 5(c)

Crop	Maximum number of Acres	Water (Gal/Acre)	Yield ($/Acre)
Wheat	2,300	3,500	450
Potatoes	3,200	4,000	460
Corn	2,500	4,500	510

Table 5.2: Crop information

Write an explicit formulation for this problem. Make sure you describe all the elements of your formulation (i.e., decision variables, parameters, constraints, and objective function)

6. (a) Consider the following simplex tableaux that result from a maximization LP with decision variables x_1 and x_2, slack variable x_3, surplus variable x_4 and artificial variable x_5. **(20)**

(i)

Basic variables	Coefficient of:						RHS
	Z	x_1	x_2	x_3	x_4	x_5	
Z	1	0	1	–2	0	3	4
x_1	0	1	2	3	0	4	6
x_4	0	0	3	4	1	5	8

(ii)

Basic variables	Coefficient of:						RHS
	Z	x_1	x_2	x_3	x_4	x_5	
Z	1	0	1	2	3	0	4
x_1	0	1	–2	3	4	0	6
x_5	0	0	–3	4	5	1	8

(iii)

Basic variables	Coefficient of:						RHS
	Z	x_1	x_2	x_3	x_4	x_5	
Z	1	0	–1	–2	0	3	4
x_1	0	1	–2	3	0	4	6
x_4	0	0	–3	–4	1	5	8

(iv)

Basic variables	Coefficient of:						RHS
	Z	x_1	x_2	x_3	x_4	x_5	
Z	1	0	0	2	0	3	4
x_1	0	1	0	3	0	4	6
x_2	0	0	1	4	1	5	8

Contd P/5

IPE 307

Contd ... Q. No. 6(a)

For each of the above cases, determine whether the original LP is infeasible, or unbounded, or degenerate or has multiple optimal solutions, Briefly justify your answer.

(b) Consider the following problem. **(26 2/3)**

Maximize $Z = 2x_1 + 3x_2$,

subject to

$x_1 + 2x_2 \leq 4$

$x_1 + x_2 = 3$

and

$x_1 \geq 0, \quad x_2 \geq 0$

(i) Using the Big *M* method, construct the complete first simplex tableau for the simplex method and identify the corresponding initial (artificial) BF solution. Also, identify the initial entering basic variable and the leaving basic variable.

(ii) Using the two-phase method, construct the complete first simplex tableau for phase 1 and identify the corresponding initial (artificial) BF solution. Also, identify the initial entering basic variable and the leaving basic variable.

7. (a) The board of directors of General Wheels Co. is considering six large capital investments. Each investment can be made only once. These investments differ in the estimated long-run profit that they will generate as well as in the amount of capital required, as shown by the following table (in units of millions of dollars): **(28 2/3)**

	Investment Opportunity					
	1	2	3	4	5	6
Estimated profit	15	12	16	18	9	11
Capital required	38	33	39	45	23	27

The total capital available for these investments is $100 million. Investment opportunities 1 and 2 are mutually exclusive, and so are 3 and 4. Furthermore, neither 3 nor 4 can be undertaken unless one of the first two opportunities is undertaken. There are no such restrictions on investment opportunities 5 and 6. The objective is to select the combination of capital investments to maximize the estimated long-run profit. Formulate a BIP model for this problem.

Contd P/6

IPE 307

Contd ... Q. No. 7

(b) Consider the following statements about any pure IP problem (in maximization form) and its LP relaxation. Label each of the statements as True or False, and then justify your answer. **(18)**

(i) The feasible region for the LP relaxation is a subset of the feasible region for the IP problem.

(ii) If an optimal solution for the LP relaxation is an integer solution, then the optimal value of the objective function is the same for both problems.

(iii) If a noninteger solution is feasible for the LP relaxation, then the nearest integer solution (rounding each variable to the nearest integer) is a feasible solution for the IP problem.

8. (a) The Versatech Corporation has decided to produce three new products. Five branch plants now have excess product capacity. The unit manufacturing cost of the first product would be \$41, \$39, \$42, \$38, and \$39 in Plants 1, 2, 3, 4, and 5, respectively. The unit manufacturing cost of the second product would be \$55, \$51, \$56, \$52, and \$53 in Plants 1, 2, 3, 4, and 5, respectively. The unit manufacturing cost of the third product would be \$48, \$45, and \$50 in Plants 1, 2, and 3, respectively, where Plants 4 and 5 do not have the capability to produce this product. Sales forecasts indicate that 700, 1,000, and 900 units of products 1, 2, and 3, respectively, should be produced per day. Plants 1, 2, 3, 4, and 5 have the capacity to produce 400, 600, 400, 600, and 1,000 units daily, respectively, regardless of the product or combination of products involved. Assume that any plant having the capability and capacity to produce them can produce any combination of the products in any quantity. Management wishes to know how to allocate the new products to the plants to minimize total manufacturing costs. **(18+10)**

(i) Formulate this problem as a transportation problem by constructing the appropriate parameter table.

(ii) Use the Northwest corner rule to obtain an initial BF solution.

(b) Reconsider Prob. 8(a). Suppose that the sales forecasts have been revised downward to 280, 400, and 350 units per day of products 1, 2, and 3, respectively, and that each plant now has the capacity to produce all that is required of any one product. Therefore, management has decided that each new product should be assigned to only one plant and that no plant should be assigned more that one product (so that three plants are each to be assigned one product, and two plants are to be assigned none). The objective is to make these assignments to minimize the total cost of producing these amounts of the three products. Formulate this problem as an assignment problem by constructing the appropriate cost table. **(18 2/3)**

L-3/T-1/IPE Date: ~~20/04/2024~~ 20/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **ME 223** (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 all.**

1. **Answer either (a) or (b)**

(a) Derive the general differential form of the continuity equation with necessary sketches and show the form of the continuity equation for the following cases. **(26¼)**

(i) Steady incompressible flow

(ii) 1D steady incompressible flow

(iii) The velocity of a fluid flow field is given by,

$$\vec{V} = x^3 y\hat{i} + y^2 z\hat{j} - \left(3x^2 yz + yz^2\right)\hat{k}$$

Show that it is a case of possible steady incompressible fluid flow. Calculate the velocity and acceleration at point (1, 2, 3).

OR

(b) Derive the Bernoulli equation in pressure form, head form and energy form with necessary sketches and assumptions and show the modification of the Bernoulli equation for the following cases: **(26¼)**

(i) Real fluid flow system:

(ii) Real fluid flow system with a pump

(iii) Real fluid flow system with a turbine:

The electrical power input to the pump shown in Fig. 1(b) is 10 kW. If the pump has an efficiency of 80%, and the increase in pressure from A to B is 100 kPa, determine and compare the volumetric flow rate of water through the pump in cases of

(i) No head loss between A to B

(ii) Head loss between A to B is 1.25 m.

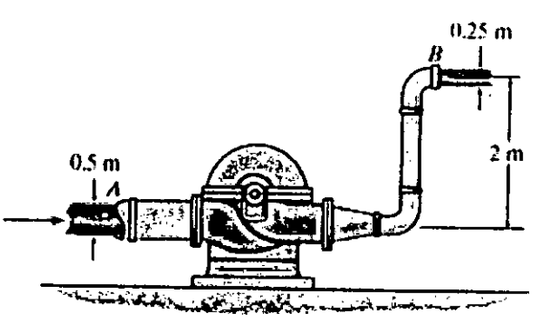


Fig.1(b)

Contd P/2

ME 223

2. **Answer either (a) or (b)**

(a) With suitable sketches, derive the following for viscous laminar flow through circular pipes: **(26¼)**

(i) Equation of shear stress

(ii) Equation of Local velocity, average velocity and location of maximum velocity

(iii) Hagen Poiseullie equation

(iv) A certain oil is flowing from a tank as shown in Fig. 2(a) through a 10 mm diameter and 20 m long pipe. The top surface of the oil is at a distance of 2.5 m above the exit end of the pipe. The absolute viscosity of oil is 0.01 Ns/m^2, and its specific weight is 8.5 kN/m^3. Considering laminar flow and neglecting minor losses, find the flow rate of oil.

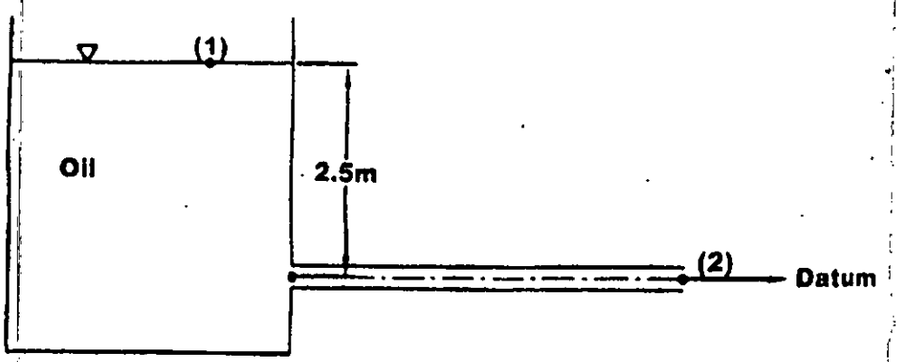


Fig.2(a)

OR

(b) (i) Derive the Darcy-Weisbach equation with suitable sketches and assumptions. **(26¼)**

(ii) Water at 10°C ($\mu = 1.307 \times 10^{-3}\ Ns/m^2$) flows from a large reservoir to a smaller one as shown in Fig. 2(b) through a 5-cm diameter cast iron piping system (Roughness height = 0.26 mm), as shown in Fig below. Determine the elevation Z_1 (point-1) for a flow rate of 8 L/s.

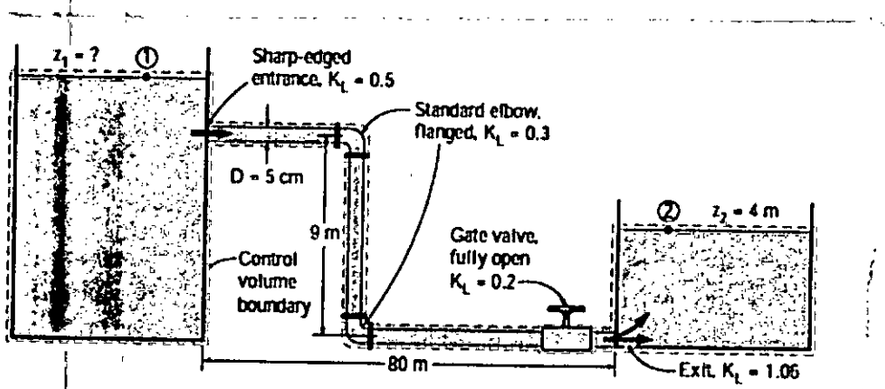


Fig.2(b)

Contd P/3

ME 223

3. **Answer all the following questions**

(a) What is center of pressure? Where is it located relative to the centroid of a submerged surface? **(6¼)**

(b) Gate *AB* in Fig. 3(b) is a homogeneous mass of 180 kg, 1.2 m wide into the paper, hinged at *A*, and resting on a smooth bottom at *B*. For what water depth *h* will the force at point *B* be zero? Specific weight, γ = 12360 N/m^3 for glycerin and 9790 N/m^3 for water. **(10)**

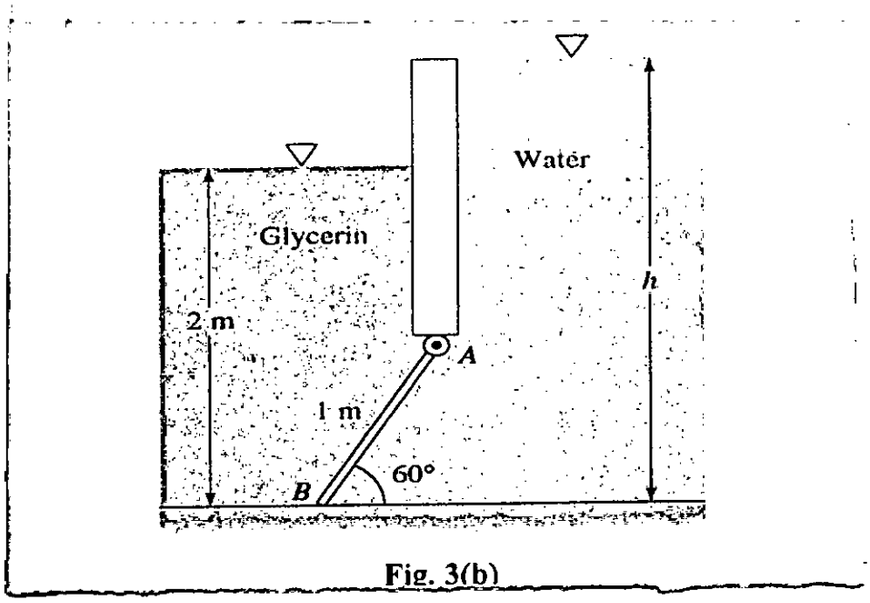


Fig. 3(b)

(c) For the inclined manometer containing mercury, shown in Fig. 3(c), determine the pressure in pipe *B* if the pressure in pipe *A* is 10 kPa. Pipe *A* has water flowing through it, and oil is flowing in pipe *B*. Given the specific gravity of Mercury is 13.6. **(10)**

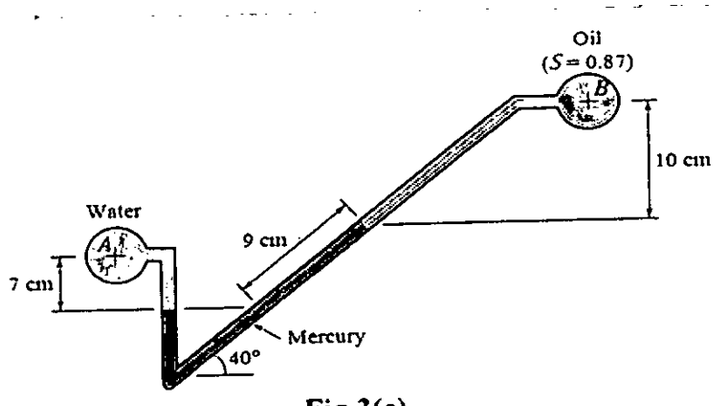


Fig.3(c)

Contd P/4

ME 223

4 **Answer all the following questions.**

(a) Derive the formula for measuring local velocity using a pitot static tube with necessary sketches **(10)**

(b) A venturi meter with a 90 mm throat is installed horizontally in a 180 mm diameter pipeline. A certain oil of specific gravity 0.84 flows at the rate of 0.05 m^3/s in the horizontal direction. Find the difference of pressure between the inlet and throat. If a manometer is connected at the inlet and throat, find the deflection of mercury in the manometer. Take $C_d = 0.97$ for the venturi meter. The specific gravity of manometric fluid is 13.6. **(16¼)**

SECTION – B

There are **FOUR** questions in this section. **Answer all.**

5. Answer either (a) or (b)

(a) Explain priming and cavitation with their causes and evaluate their effects on the performance of centrifugal pump. Also, show that, for a centrifugal pump with radial entry. **(26¼)**

$$H_m = \frac{(u_2^2 - v_{f2}^2 cosec^2\beta_2)}{2g}$$

OR

(b) Answer the following questions: **(26¼)**

(i) Draw and explain the characteristic curve for a centrifugal pump for forward curved blade. Also, write down the methods to calculate $(NPSH)_A$ and $(NPSH)_R$ in centrifugal pump.

(ii) A site requires a manometric head of 6 m and discharge of 10.3 m^3/hr. If the prime mover can provide 1400 rpm speed, find the spedific speed of the required pump and suggest at least two types of pumps that can be selected.

6. **Answer either (a) or (b)**

(a) In an inward flow reaction turbine, the diameter of the outer periphery is twice the diameter of the inner one, and the turbine operates under a head of 20 m. The turbine has radial tips at the outlet while at the exit blades make an angle of 30° with the forward tangent. Assuming a constant radial velocity of flow and that the blade friction accounts for a dissipation of energy equivalent to 10 percent of kinetic energy at the outlet, find (i) runner velocity at the rim, (ii) hydraulic efficiency of the turbine. Assume radial discharge at outlet. **(26¼)**

OR

(b) Answer the following questions: **(26¼)**

(i) Write down the key design considerations for a Pelton wheel.

(ii) What is role of draft tube and surge tank in hydro-electric powerplant? Explain with necessary diagrams.

Contd P/5

ME 223

7. (a) A jet impinging on a smooth curved vane moving at velocity u, as shown in Fig. for Ques. No. 7. The jet is striking at a velocity v_1, at an angle θ with the direction of blade motion and leaving at an angle φ with a velocity v_2. Consider the blade is axisymmetric with a vane angle α. Derive an equation of jet efficiency in terms of jet velocity, jet angle, and vane angle. If $v_1 = v_2 = 50$ m/s, $u = 20$ m/s, $\theta = \varphi = 15°$, $\alpha = 65°$, calculate the jet efficiency. **(26¼)**

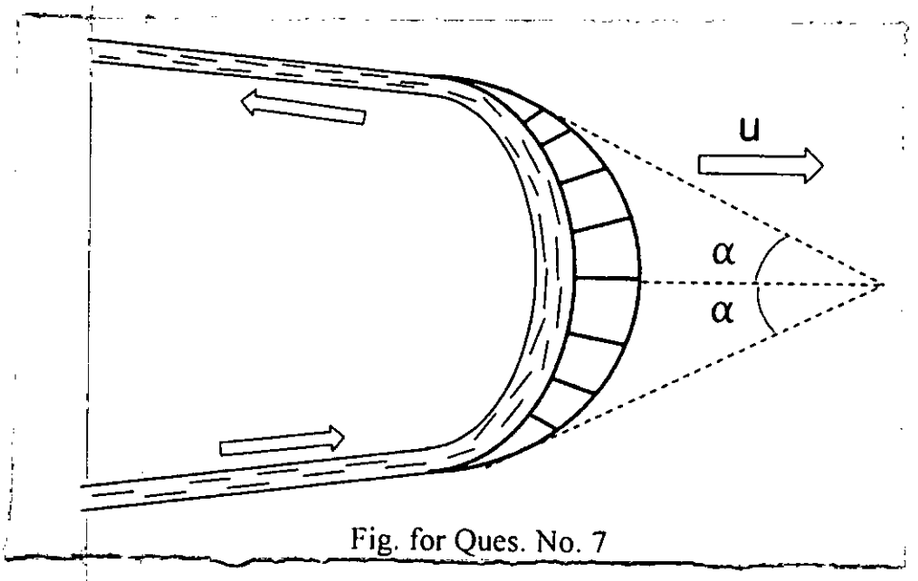
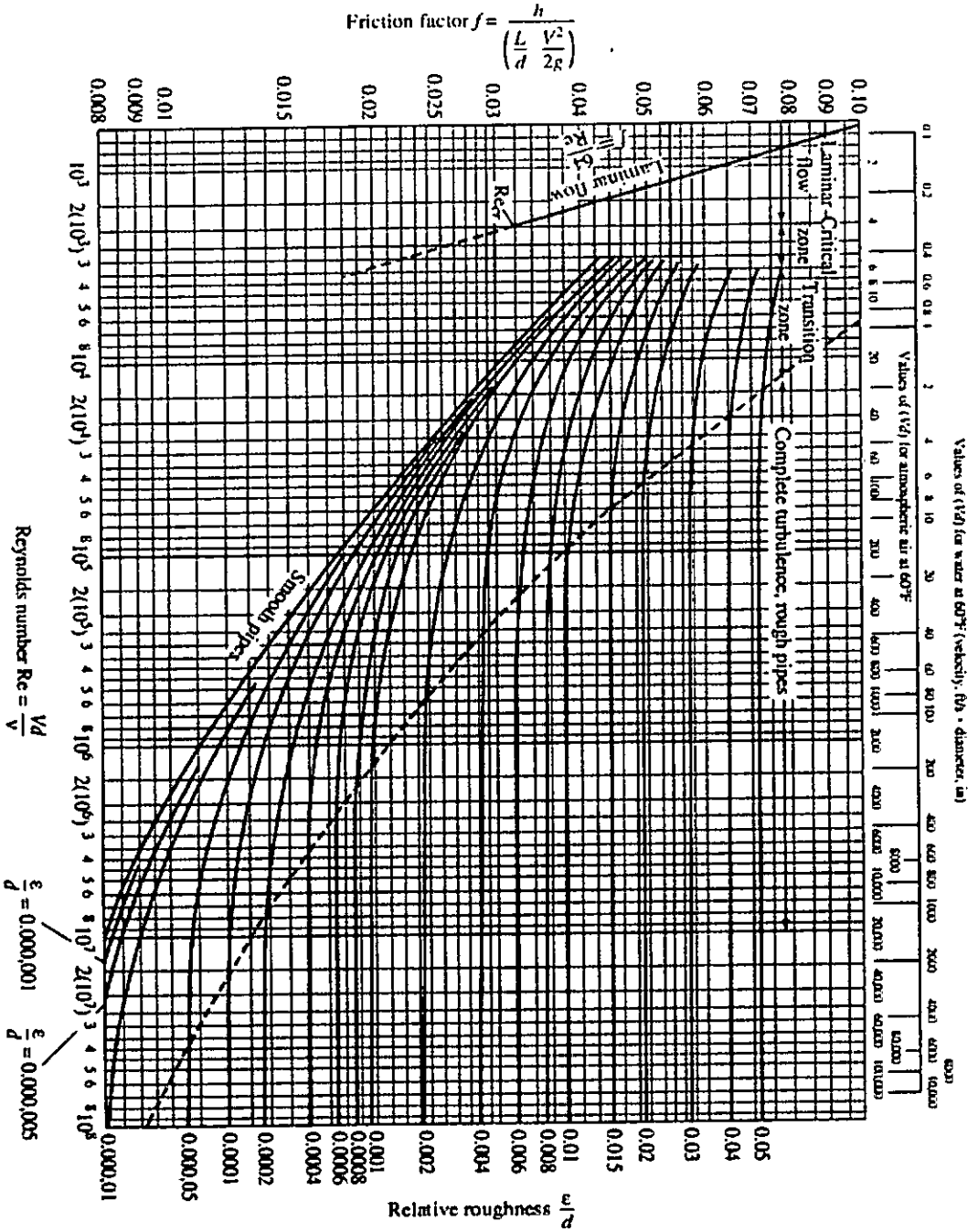


Fig. for Ques. No. 7

8. Answer the following questions:

(a) Classify fan, blower and compressors. Explain the working mechanism of a vane compressor with suitable diagram. **(16¼)**

(b) Mention different types of centrifugal fans and write down some key characteristics of the most efficient one. **(10)**



Moody chart for Ques. 2(b)