L-3/T-1/IPE

Date: 30/08/2025

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2023-2024

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. **Question No. 1 is COMPULSORY.**

Answer any **TWO** from the rest.

Symbols have their usual meaning and interpretation.

Assume reasonable values for missing data.

1. (a) Classify turbines with examples. **(10)**

(b) With suitable schematic diagram and assumptions, derive the expression of actual flow rate measured by an orifice meter for flow through a horizontal pipe. **(2+4+7=13)**

(c) An orifice with a 2-in-diameter opening is used to measure the mass flow rate of water at 60°F ($\rho = 62.36$ lbm/ft^3 and $\mu = 7.536 \times 10^{-4}$ lbm/f.s) through a horizontal 4-in-diameter pipe as shown in Fig. for Q. No. 1(c). A mercury manometer is used to measure the pressure difference across the orifice. If the differential height of the manometer is read to be 6 in, determine the volume flow rate of water through the pipe, and the average velocity. **(10)**

(d) With proper assumptions and diagram, derive the expression of force and workdone exerted by a fluid jet on a stationary flat plate normal to the jet. **(12)**

2. (a) With appropriate schematic and velocity diagrams, derive the expression of the maximum efficiency that can be developed in a Pelton turbine. **(12)**

(b) The water surface in a reservoir supplying water to a Pelton wheel is 400 m above the centre of the nozzle. The pipeline supplying the water to the wheel is 60 cm in diameter and 4 km long with $f = 0.03$. The buckets deflect the jets of 8 cm diameter through an angle of 165°. The bucket friction reduces the relative velocity by 15% and 8% of the power developed by the wheel is lost in mechanical friction. Assuming the coefficient of velocity of the nozzle as 0.98, speed ratio as 0.45 and jet ratio 12; determine **(18)**

(i) the quantity of water striking the bucket,

(ii) power developed at the shaft,

(iii) hydraulic efficiency,

(iv) speed of the wheel, and

(v) number of buckets.

Contd P/2

ME 223/IPE

3. (a) What is an indicator diagram of a reciprocating pump? With the help of indicator diagram, explain clearly the effect of acceleration and friction on workdone for a single acting reciprocating pump. **(10)**

(b) For a single acting reciprocating pump, stroke length = 0.2 m, piston diameter = 0.1 m, suction head = 5 m, delivery head = 32 m, diameter of suction and delivery pipes = 50 mm, length of suction pipe = 6 m; length of delivery pipe = 35 m. Darcy's friction factor f for both pipes = 0.02. If the pump is working at 30 r.p.m., find the pressure head (both gauge and absolute) in metres of water on the piston at the beginning, middle and end of both suction and delivery strokes. Also find the power required to drive the pump. State if separation may take place at any point. **(20)**

4. (a) Is there any limit to the suction lift of a centrifugal pump? If yes, what is the limit? Explain the reason(s) behind it. **(10)**

(b) A centrifugal pump impeller has an external diameter of 50 cm and discharge area of 0.15 m^2. The vanes are bent backwards so that the direction of the relative velocity at the outlet makes an angle of 150° with the tangent to the outer periphery, drawn in the direction of the impeller rotation. The diameters of the suction and delivery pipes are 30 cm and 25 cm respectively. Pressure gauges are at points on the suction and delivery pipes close to the pump, and each gauge 1.75 m above the level in the supply sump showed gauge pressure heads of 3.60 meters below and 20 meters above atmosphere head respectively, when the pump was delivering 225 litres per second of water at 820 rpm. It requires 100 horses power to drive the pump. Find **(20)**

(i) The loss of head in the suction pipe

(ii) The manometric efficiency

(iii) The overall efficiency.

SECTION – B

There are **FOUR** questions in this section. **Question No. 5 is COMPULSORY.**

Answer any **TWO** from the rest.

Moody diagram is attached.

5. (a) From the fundamental understanding of intermolecular actions, explain how the fluid viscosity changes with temperature. **(10)**

A hydraulic lift consists of a 25 cm diameter ram which slides in a 25.015 cm diameter cylinder, the annular space being filled with oil having a kinematic viscosity of 0.025 cm^2/sec and specific gravity of 0.85. If the ram travels 9.15 m per min., find the frictional resistance when 3.05 m of the ram is engaged in the cylinder.

(b) A small pressure differential is needed to be measured in an industrial flow system. What instrument will you recommend for this purpose? Briefly explain its working principle. **(15)**

Contd P/3

ME 223/IPE

Contd.... for Q. No. 5(b)

A closed tank contains compressed air and oil (SG_{oil} = 0.9) as is shown in Fig. for Q. 5(b). A U-tube manometer using mercury (SG_{Hg} = 13.6) is connected to the tank as shown. The column heights are h_1 = 0.91 m, h_2 = 0.15 m, and h_3 = 0.23 m. Determine the pressure reading (in psi) of the gage.

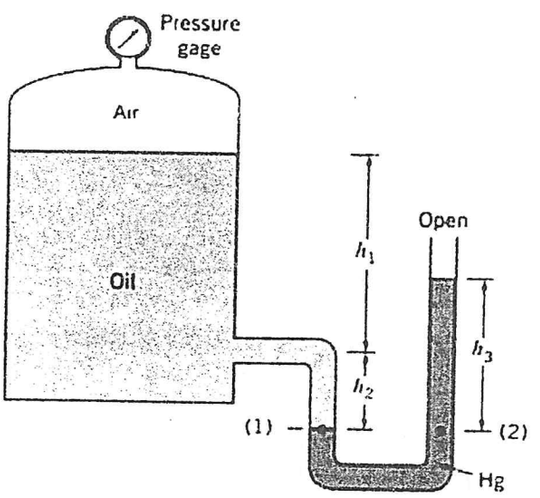

Fig. for Q. 5(b)

(c) If the flow rate through a 10-cm-diameter wrought iron pipe (e = 0.046 mm) is 40 lit/s (Fig. for Q. 5(c)), find the difference in elevation H of the two reservoirs. Loss coefficients for different fittings are given below: **(15)**

Type of Fittings	Loss coefficient
Entrance	0.5
Screwed globe valve (fully open)	5.7
Standard elbow	0.64
Exit	1.0

Water density and viscosity at 20°C are 998.2 kg/m^3 and 1.0 mPa.s, respectively.

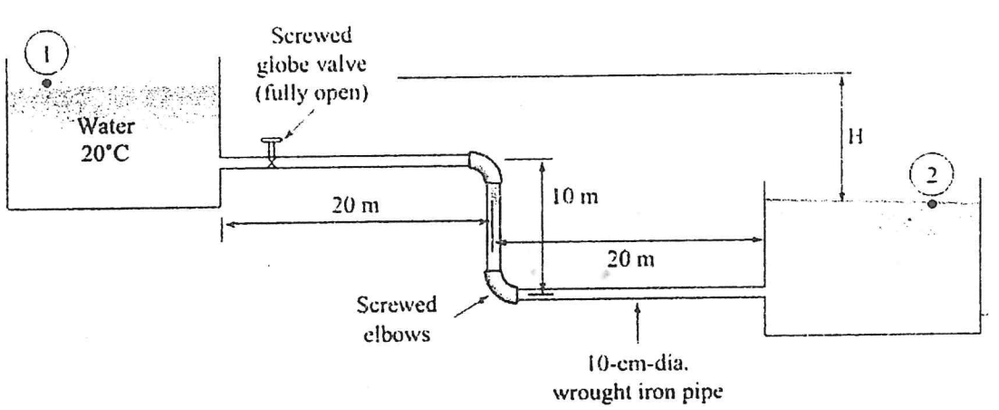

Fig. for Q. 5(c)

(d) What do you mean by streamline? Define HGL and EGL. **(5)**

Contd P/4

ME 223/IPE

6. (a) For fully developed laminar viscous flow through a circular pipe show that the velocity profile across any section is parabolic. **(15)**

(b) Differentiate between laminar and turbulent flows. **(5)**

(c) A 15 kW pump with 70% efficiency is discharging oil of specific gravity 0.85 to the overhead tank as shown in Fig. for Q. 6(c). If the losses in the whole system are 1.75 m of the flowing fluid, find the discharge. **(10)**

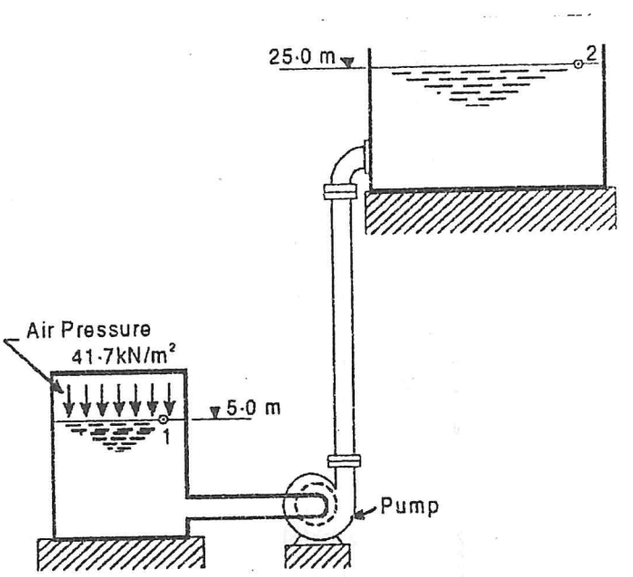

Fig. for Q. 6(c)

7. (a) What do you mean by particle acceleration in context of fluid flow? Derive the expressions of particle acceleration along x-, y- and z-coordinate system? **(15)**

(b) Differentiate among static, stagnation and dynamic pressure in context of fluid flow. **(5)**

(c) A pitot tube is inserted in an air flow (at STP) as shown in Fig. for Q. 7(c). If the manometric deflection is 30 mm of Mercury, determine the flow speed. **(10)**

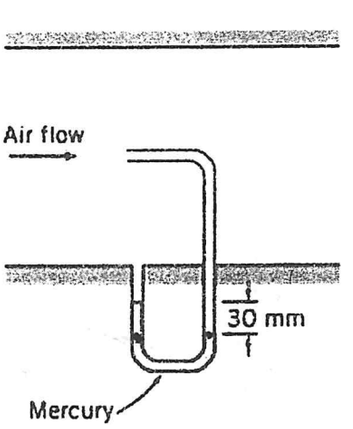

Fig. for Q. 7(c)

62