MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: FLUID FLOW II

CODE: CHEP 312

SESSIONAL EXAMINATIONS
DECEMBER 2022

DURATION: 3 HOURS

EXAMINER: MR W. CHIPANGURA

INSTRUCTIONS

1. *Answer **ALL** questions **in section A***
2. *Answer **ANY THREE** questions **in section B***
3. *Start a new question on a fresh page*
4. *Total marks 100*

***Additional material(s):** Calculator*

SECTION A

*(Answer **all** questions)*

QUESTION 1

a) Distinguish between *Laminar* and *Turbulent* Flow. [6]

b) What do you understand by the terms:

i) major energy losses? [3]

ii) minor energy losses? [4]

QUESTION 2

a) How will you determine the loss of head due to friction in pipes? [6]

b) Give an expression for loss of head due to sudden contraction. [3]

QUESTION 3

Derive the momentum equation with the aid of a fully labeled diagram.
[8]

QUESTION 4

With the aid of a fully labeled diagram describe the steps for the development of a fully developed pipe flow [10]

[TOTAL 40 MARKS]

SECTION B

(*Answer any **3** questions***)**

QUESTION 5

a) A 2 cm diameter pipe is 20 m long and delivers water at 8×10^{-4} m^3/s at 20 °C. What fraction of this pipe is taken as entrance region? [8]

[*For water at 20 °C, $\rho = 998\ kg/m^3$ and $\mu = 0.001\ kg/ms$]*

b) A pipe 100 feet long and 20 inches in diameter contains water at 200 °F flowing at a mass flow rate of 700 lbm/sec. The water has a density of 60 lbm/ft^3 and a viscosity of 1.978 x 10^{-7} $lbf\text{-}sec/ft^2$. The relative roughness of the pipe is 0.00008. Calculate the head loss for the pipe. [12]

[*From the Moody Chart for a Reynolds number of 8.4 x 10^7 and a relative roughness of 0.00008, f is 0.012*].

QUESTION 6

a. A 600 mm diameter pipe reduces to 300 mm diameter. The pipe carries a 0.9 m^3/s flow of oil (relative density 0.85) and the inlet pressure is 275 kPa. Calculate the force of the oil on the reduced diameter, neglecting loss [12]

b. Water flows through a 10 mm jet at 0.8 litres per second and strikes a vertical plate. If the plate does not move, calculate the force applied by the jet. [8]

QUESTION 7

a. A horizontal venturi-meter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the throat and inlet is 20 cm of mercury. Determine the rate of flow. [12]

[*Cd=0.98*]

b. Water flows from a reservoir through a series of pipes into an outdoor dam 120 m below the surface of the reservoir. If the discharge pipe is 50 mm diameter and the total system losses are equivalent to five times the discharge velocity head, calculate the rate of discharge. [8]

QUESTION 8

a. A pipe through which the water is flowing, is having diameters 20 cm and 10 cm at the cross sections 1 and 2 respectively. The velocity of water at section 1 is given 40 m/s as shown in Figure 1. Find,

   i) velocity head for sections 1 and 2

   ii) rate of discharge [10]

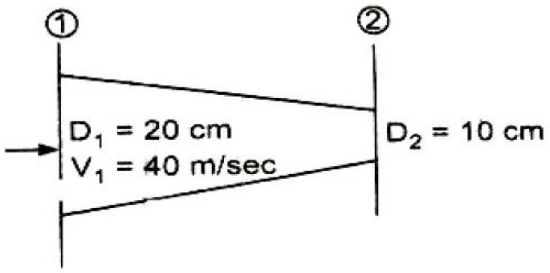

Figure 1

b. In a pipe of diameter 350 mm and length 75 m water is flowing at a velocity of 2.8 m/s. Find the head lost due to friction using:

   i) Darcy-Weisbach formula;

   ii) Chezy's formula for which C = 55 [10]

Assume kinematic viscosity of water as 0.012 stoke.

[TOTAL 60 MARKS]

END OF EXAMINATION

LIST OF FORMULAE

1. The Darcy-Weisbach equation $h_f = \frac{4fLV^2}{2gD}$
2. Chezy's formula $Q = C\sqrt{(mi)}$
3. $h_{L,major} = \frac{l}{D}\frac{V^2}{2g} f\left(\mathrm{Re}, \frac{\varepsilon}{D}\right)$
4. $h_{L,min} = K_L \frac{V^2}{2g}$