MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING AND MINING AND MINERAL PROCESSING ENGINEERING

MODULE: FLUID FLOW I/FLUD MECHANICS

CODE: CHEP 222/ENGT 225

SESSIONAL EXAMINATIONS
DECEMBER 2022

DURATION: 3 HOURS

EXAMINER: MR C.K. SIMENDE

INSTRUCTIONS

1. *Answer **any four** questions*
2. *Start a new question on a fresh page*
3. *Total marks 100*

Additional material(s): *Calculator*

QUESTION 1

a) A reservoir supplies fresh water through a pipe to a town 83 meters below the reservoir. Calculate the pressure in the town (assuming the water is static).[3]

b) Calculate the pressure and the force applied to a vertical wall of a dam that is 3 meters wide and 6 meters deep, if it has water to the top of one side of the wall. [6]

c) A plastic drum is used as a marker buoy. It has a mass of 5 kg and a volume of 30 litres. If the drum is held underwater (fresh water) by a rope, what is the tension in the rope? [5]

d) Three litres of petrol weighs 23.7 N. Calculate the:

i) mass density [2]

ii) specific weight [2]

iii) specific volume and [2]

iv) specific gravity of petrol [2]

e) A plate 0.05 mm distant from a fixed plate moves at 1.2 m/sec and requires a shear stress of 2.2 N/m^2 to maintain this velocity. Find the viscosity of the fluid between the plates. [3]

QUESTION 2

a) What is the pressure within a 1 mm diameter spherical droplet of water relative to the droplet of water relative to the atmospheric pressure outside? Assume surface tension for pure water to be 0.073 N/m. [3]

b) A nuclear submarine in **Fig.1** is rated to withstand a pressure difference of 70 atm before catastrophic failure. If the internal air pressure is maintained at 1 atm, what is the maximum permissible depth? [5]

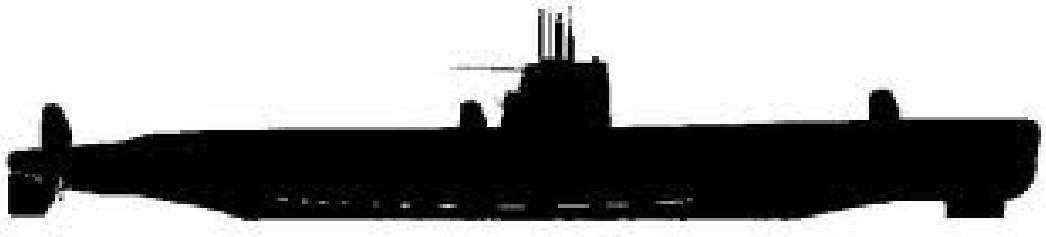

Fig. 1: Nuclear submarine

c) A large piston supports a car (**Fig. 2**). The total mass of the piston and car is 3200 kg. What force must be applied to the smaller piston? [4]

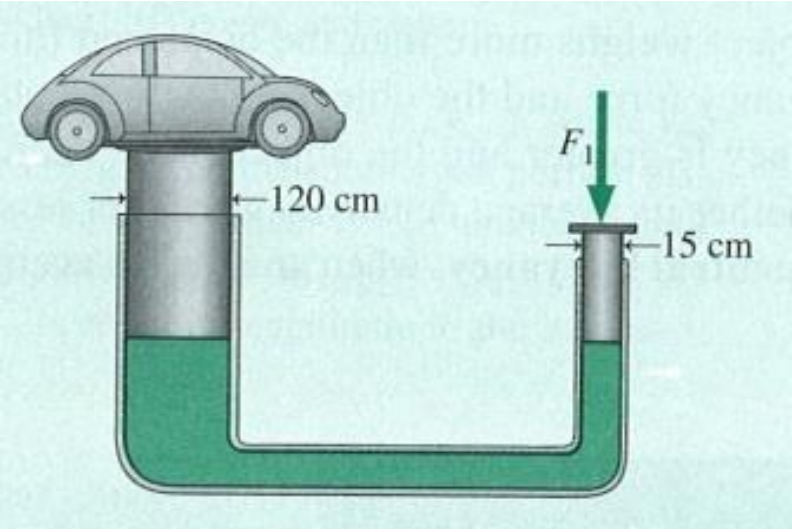

Fig. 2

d) Derive the continuity equation for one dimensional flow using the aid of a fully labeled diagram and state all the assumptions made during the derivation. [10]

e) A river is 40 m wide, 2.2 m deep and flows at 4.5 m/s. It passes through a 3.7 m wide gorge, where the flow rate increases to 6.0 m/s. How deep is the gorge? [3]

QUESTION 3

a) A 30 cm diameter pipe, conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively (**Fig. 3**). If the average velocity in the 30 cm diameter pipe is 2.5 m/s:

i) Find the discharge in this pipe [5]

ii) Also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s [8]

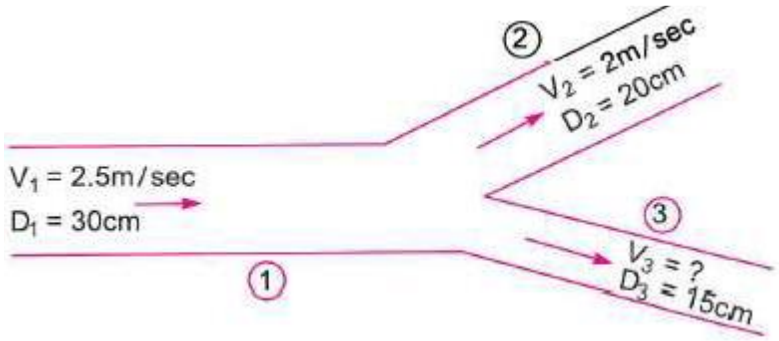

Fig. 3

b) Derive the Bernoulli's equation using the aid of a fully labeled diagram and state all the assumptions made during the derivation. [12]

QUESTION 4

a) At first thought it seems natural that fluids would show a smooth and regular pattern of movement, without all the irregularity of turbulence. Consider what it is that governs whether a given flow is laminar or turbulent in the first place, and what the transition from laminar to turbulent flow is like. Osborne Reynolds did the pioneering work on these questions in the 1880s in an experimental study of flow through tubes with circular cross section (Reynolds, 1883). Describe thoroughly the Reynolds experiment using a clearly labeled diagram and explain the results as obtained from his findings. [15]

b) **Fig. 4** shows a pump delivering water through as pipe 30 mm bore to a tank. Find the pressure at point (1) when the flow rate is 1.4 dm^3/s. The density of water is 1000 kg/m^3. The loss of pressure due to friction is 50 kPa.

[5]

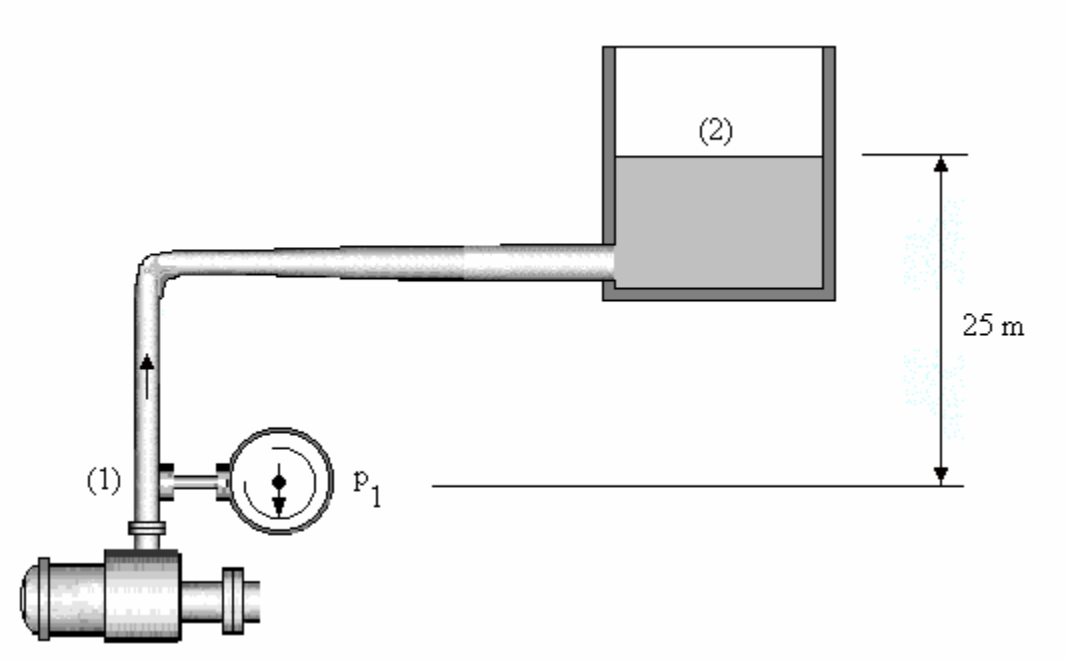

Fig. 4

c) Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2.0 m/s. Find the total head or total energy per unit weight of the water at a cross-section, which is 5 m above the datum line. Density of water is 1000 kg/m^3. [5]

QUESTION 5

a) Water is flowing through a pipe having diameters 300 mm and 200 mm at the bottom and upper respectively. The intensity of pressure at the bottom end is 24. 525 N/cm^2 and the pressure at the upper end is 9.81 N/cm^2. Determine the difference in datum head if the rate of flow through pipe is 40 litres/s. [10]

b) A pipe 1 m diameter and 15 km long transmit water of velocity of 1 m/sec. The friction coefficient of pipe is 0.005. Calculate the head loss due to friction? [3]

c) The discharge Q through an orifice depends on the pressure P, the density of fluid ρ and the diameter of the orifice d. Determine a general formula for the discharge? [12]

END OF EXAMINATION

LIST OF FORMULAE

$$\rho = \frac{m}{V}, \quad \frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

$$\gamma = \frac{W}{V} = \rho \times g, \quad \Delta H = h_f = f \frac{L}{D} \frac{V^2}{2g}$$

$$v = \frac{V}{m} = \frac{1}{\rho}, \quad \frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$\tau = \mu \frac{du}{dy}, \quad P = \frac{\sigma \times \pi d}{\frac{\pi}{4} d^2} = \frac{4\sigma}{d}$$

$$A_1 V_1 = A_2 V_2 = Q$$