FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

DEPARTMENT OF METALLURGICAL ENGINEERING

FLUID MECHANICS EMI 2105

Final Examination Paper - January 2021

This examination paper consists of 3 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: **Miss M. Kanganga**

INSTRUCTIONS

1. This question paper consists of 5 questions
    1.1. Question 1 is compulsory
    1.2. Answer any other THREE (3)
2. Each question carries 25 marks
3. Answer each question on a new page and write as eligible as possible

Additional Requirements

1. calculator

Question 1

1.1. What is the relevance of fluid mechanics in mine drainage and dewatering? [4]

1.2. Giving examples, differentiate between compressible and incompressible fluids. [6]

1.3. The study of properties of fluids namely density, viscosity, surface tension, bulk modulus and vapour pressure is basic for the understanding of flow or static condition of fluids. Explain the implication of each property on either flow or static condition of a fluid. [10]

1.4. Explain the capillary-rise method for measuring surface tension [5]

Question 2

2.1. Determine the pressure at point *X* for the situation shown in Fig 2.1. [15]

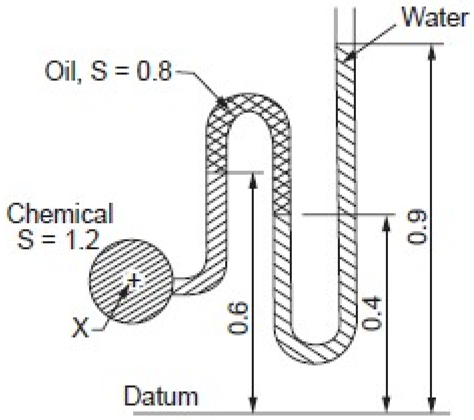

Figure 2.1

2.2. A manometer consists of a U-tube, 7 mm internal diameter, with vertical limbs each with an enlarged upper end of 44 mm diameter. The left-hand limb and the bottom of the tube are filled with water and the top of the right-hand limb is filled with oil of specific gravity 0.83. The free surfaces of the liquids are in the enlarged ends and the interface between the oil and water is in the tube below the enlarged end. What would be the difference in pressures applied to the free surfaces which would cause the oil-water interface to move 1 cm? [10]

Question 3

3.1. A cylinder of diameter 0.3 m and height 0.6 m stays afloat vertically in water at a depth of 1 m from the free surface to the top surface of the cylinder. Determine the buoyant force on the cylinder. [2]

3.2. A steel pipeline conveying gas has an internal diameter of 120cm and an external diameter of 125 cm. It is laid across the bed of a river, completely immersed in water and is anchored at intervals of 3 m along its length. Calculate the buoyancy force in newtons per metre and the upward force in newtons on each anchorage. Density of steel = 7900kgm^{-3}, density of water = 1000kgm^{-3}. [15]

3.3. A rectangular plane surface is 2m wide and 3m deep. It lies in a vertical plane in water. Determine the total pressure and position of centre of pressure when its upper edge is horizontal and

3.3.1. Coincides with water surface [4]

3.3.2. 2.5m below the free water surface [4]

Question 4

4.1. Water flows through a pipe AB 1.2 m in diameter at 3m s^{-1} and then passes through a pipe BC which is 1.5 m in diameter. At C the pipe forks. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The velocity in branch CE is 2.5ms^{-1}. Find

4.1.1. The volume rate of flow in AB [4]

4.1.2. The velocity in BC, [4]

4.1.3. The velocity in CD, [4]

4.1.4. The diameter of CE. [3]

4.2. A sharp-edged orifice, 5 cm in diameter, in the vertical side of a large tank discharges under a head of 5 m. If C_c = 0.62 and C_v = 0.98, determine

4.2.1. The diameter of the jet at the vena contracta, [4]

4.2.2. The velocity of the jet at the vena contracta and [3]

4.2.3. The discharge in cubic metres per second. [3]

Question 5

5.1. Oil with a free stream velocity of 2 m s−1 flows over a thin plate 2 m wide and 3 m long. Calculate the boundary layer thickness and the shear stress at the mid-length point and determine the total surface resistance of the plate. Take density as 860 kg m^{-3}, kinematic viscosity as 10^{-5} m2 s^{-1}. [10]

5.2. Show that the frictional torque T required to rotate a disc of diameter d at an angular velocity ω in a fluid of density ρ is given by

$$T = d^5\omega^2\rho\varphi\,(\rho d^2\omega/\mu),$$

and identify the Reynolds number group. [10]

5.3. With the aid of diagrams differentiate between laminar and turbulent flow. [5]

End of Exam