POLITEKNIK
Jabatan Pengajian Politeknik

EXAMINATION AND EVALUATION DIVISION
DEPARTMENT OF POLYTECHNIC EDUCATION
(MINISTRY OF HIGHER EDUCATION)

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

DECEMBER 2011 SESSION

J3008 : FLUID MECHANICS

DATE : 02 MAY 2012 (WEDNESDAY)
DURATION : 2 HOURS (2.30 PM - 4.30 PM)

This paper consists of **EIGHT (8)** pages including the front page.
Structured/Essay (6 questions – answer any **4 question**)

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STRUCTURED (100 marks)

Instruction: This section consists of 6 structured questions. Answer 4 questions only.

QUESTION 1

a) Convert the temperatures below according to the specified scales:

i. 300K to Rankine (°R) (3 marks)

ii. 300°F to Rankine (°R) (3 marks)

iii. 300°F to Kelvin (K) (3 marks)

b) If the volume of oil is 5.6 m^3 and weight is 46000 N, calculate:-

i. Mass density, ρ in unit kg/m^3 (3 marks)

ii. Specific weight, ω (3 marks)

iii. Specific gravity of oil, S (3 marks)

c) A Bourdon pressure gauge attached to a boiler located at sea level shows a reading pressure of 10 bars. If atmospheric pressure is 1.01 bars, determine :

i. The absolute pressure in kN/m^2 (4 marks)

ii. The pressure head of water, h (3 marks)

QUESTION 2

a) Define Pascal's Law. (4 marks)

b) A hydraulic jack consists of a small and a large cylinder with diameters of 7 cm and 20 cm respectively. The required force, F to lift up a load, W is 400 N. If the large piston is 15 cm higher than the small one, determine the weight, W that can be lifted if the specific weight of oil is 8730 N/m^3. (10 marks)

c) Figure 1 shows a differential manometer that is used to measure the difference of pressure between two pipelines. The U-tube contains water and mercury with specific weight of 9810 N/m^3 and 133416 N/m^3 respectively. The pressure difference between point A and point B is 48 kN/m^2. Given that $h_2 = 0.7$ m and $h_3 = 0.4$ m, determine the height of h_1. (11marks)

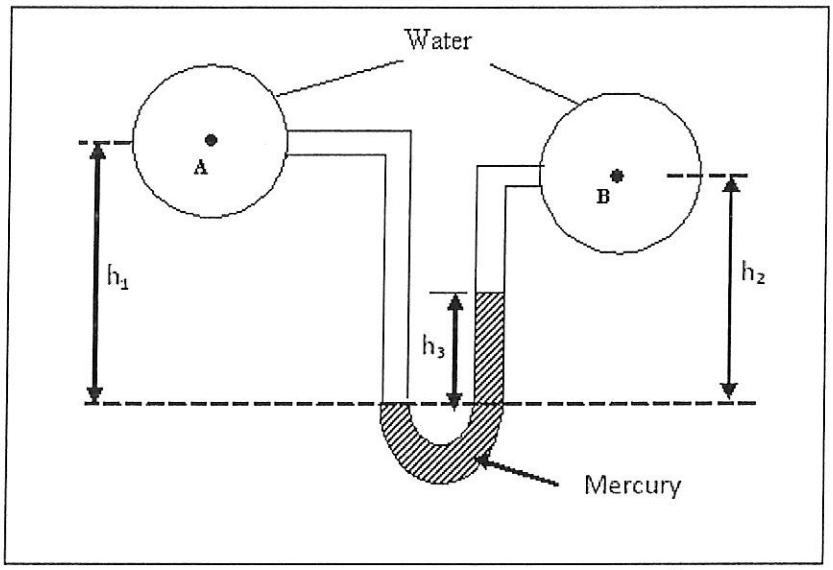

Figure 1

QUESTION 3

a) Define the following types of flow:

i. Steady flow (2 marks)

ii. Uniform flow (2 marks)

iii. Laminar flow (2 marks)

b) Oil flows in a circular pipe with a diameter of 30 mm with a velocity of 0.2 m/s. Then the pipe is split into two. One of the branches is 10 mm in diameter while the other branch has a diameter of 15 mm and flow velocity of 0.5 m/s. Determine the flow velocity in the pipe with the diameter of 10 mm. (8 marks)

c) A ventury meter is installed in the inclined pipe carrying oil having a relative density of 0.9, an entrance of 30 cm in diameter and a throat of 20 cm. The throat is 40 cm above the entrance. If the oil velocity in the ventury meter ,V_1 is 4 m/s, calculate:

i. The difference in pressure between the entrance and throat. (6 marks)

ii. The differences of mercury level in U-tube manometer. (5 marks)

QUESTION 4

a) State **THREE (3)** limitations of Bernoulli's equation. (6 marks)

b) A sharp-edged orifice meter with a 80 mm diameter hole is installed to a pipeline of 210 mm diameter. The pipeline supplies oil of specific gravity, $s_{oil} = 0.9$. The pressure difference measured by mercury manometer is 690 mm (where mercury specific gravity, s_{Hg}= 13.6). Determine the actual discharge if the coefficient of discharge is 0.62. (Given $\rho_{water} = 1000$ kg/m^3) (11 marks)

c) An inclined pipe is used to supply water as shown in Figure 2. The cross-sectional areas of the pipe at entrance and exit are 0.05 m^2 and 0.005 m^2 respectively. The water pressure at entrance is 686.7 kN/m^2. If the velocity at the entrance is 1.5 m/s, determine the pressure at exit. (8 marks)

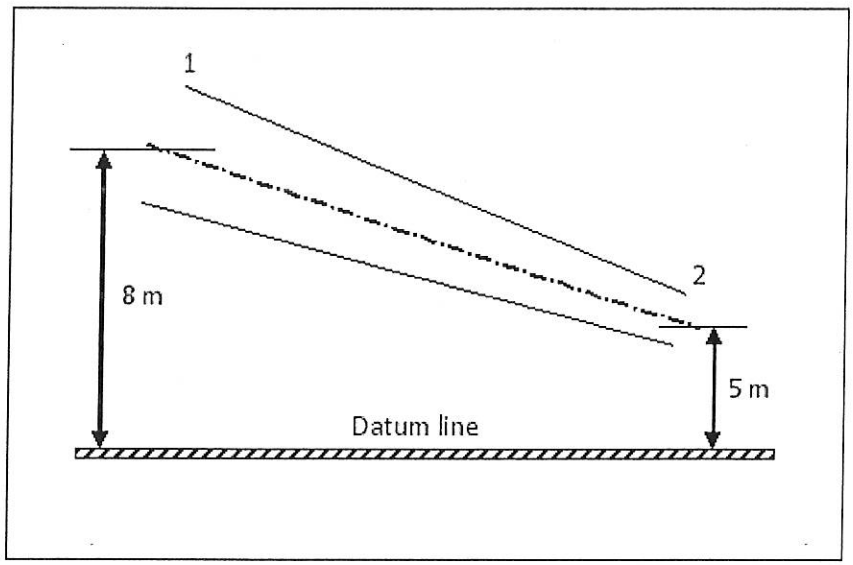

Figure 2

QUESTION 5

a) State **THREE (3)** types of losses in a pipe line. (3 marks)

b) Water flows vertically downwards through a 100 *mm* diameter pipe with a velocity of 5.4 *m/s*. The pipe suddenly enlarges to 300 *mm* in diameter. Determine:

i. The loss of head for the flow. (8 marks)

ii. The loss of head if the flow is reversed, assuming the coefficient of contraction, C_c is 0.62. (3 marks)

c) Water is discharged from a reservoir into the atmosphere through a pipe 80 *m* long. There is a sharp entrance to the pipe and the diameter is 250 *mm* for the first 50 *m*. The pipe then enlarges suddenly to 450 *mm* in diameter for the reminder of its length. The outlet is 35 *m* below the water surface level in the reservoir. Take $f = 0.004$ for both pipes. Calculate the discharge. (11 marks)

QUESTION 6

a) A nozzle is a device used to increase the velocity of a fluid.

i. Sketch and name TWO (2) types of nozzle. (6 marks)

ii. List **SIX (6)** engineering systems which use nozzles. (6 marks)

b) A fluid flows through a horizontal nozzle with enthalpy of 205 kJ/kg and 499 kJ/kg at the entrance and the exit of nozzle respectively. The velocity of the fluid is 77 m/s and the nozzle transfers heat at 0.035 kJ/kg. If the area at the entrance is 0.20 m^2 and the specific volume is 0.65 m^3/kg, determine :-

i. The velocity at the entrance. (8 marks)

ii. The mass flow rate of the fluid. (5 marks)

LIST OF FORMULA
J3008 – FLUID MECHANICS

Fluid Dynamics

$$\frac{P_1}{\omega}+\frac{v_1^2}{2g}+z_1=\frac{P_2}{\omega}+\frac{v_2^2}{2g}+z_2$$

$$Q_{actual}=C_d\times A_1\sqrt{\frac{2gH}{(m^2-1)}}$$

$$Q_{actual}=\frac{C_d\times A_1}{\sqrt{(m^2-1)}}\sqrt{2g\left[\frac{P_1-P_2}{\omega}+(z_1-z_2)\right]}$$

Energy Losses in Pipeline

$$h_C=\left[\frac{1}{Cc}-1\right]^2\times\frac{v_2^2}{2g}$$

$$h_i=0.5\frac{v_2^2}{2g}$$

$$h_F=\frac{4fl}{d}\frac{v^2}{2g}$$

$$h_L=\frac{(V_1-V_2)^2}{2g}$$

Nozzle

$$\frac{P_c}{P_1}=\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma+1}}$$

$$\frac{T_C}{T_1}=\frac{2}{\gamma+1}$$

$$\frac{T_1}{T_2}=\left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

$$V_C=\frac{RT_C}{P_C}\qquad A_C=\frac{\dot{m}V_C}{C_C}$$