FACULTY: ENGINEERING

FIRST SEMESTER EXAMINATIONS

2016/ 2017 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE CODE: MEE 405

COURSE TITLE: APPLIED FLUID MECHANICS II – 3 UNITS

DURATION: 2 HOURS 30 MINUTES

INSTRUCTIONS

1. ATTEMPT ANY **FOUR** QUESTIONS OF YOUR CHOICE
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM
3. YOU ARE NOT ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS

Question 1 (25 MARKS)

(a) Write short notes on the following:

(i) Steady uniform flow
(ii) Steady non-uniform flow
(iii) Unsteady uniform flow
(iv) Unsteady non-uniform flow

(b) In the figure below, a pipe of diameter 2.4 m carrying water has minor loss, $\frac{16v^2}{2g}$ and friction, f= 0.030. Assume head, H= 20 m. Determine the time taken after sudden opening of the valve for velocity to attain nine-tenths the final velocity.

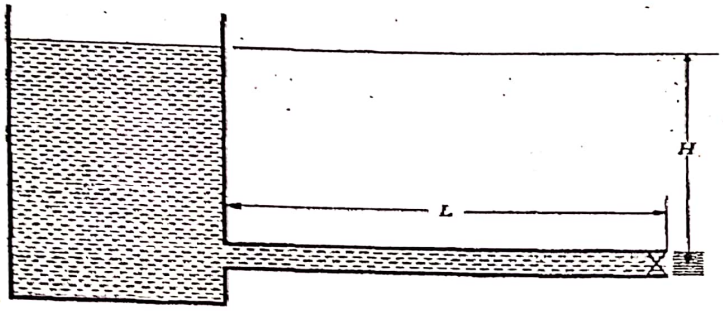

Fig. Q1b

(c) Determine the period of oscillation of a U-tube containing $3.33 \times 10^{-4}\ m^3$ of water. The cross-sectional area is $2.7 \times 10^{-4}\ m^2$. Neglect friction.

Question 2 (25 MARKS)

(a) Write short note on Water-hammer

(b) Water at a temperature of 20°C flows through a pipe system made up, over a considerable length, of a range of different pipe sizes and materials. For each of the sections detailed below calculate the appropriate wave propagation velocity. Assume that the effects of longitudinal strain, as represented by the inclusion of Poisson's ratio, may be neglected.

(i) 50 mm diameter steel, 5 mm wall, Young's modulus $E = 204 \times 10^9\ Nm^{-2}$
(ii) 50 mm diameter aluminium, 3 mm wall, $E = 70 \times 10^9\ Nm^{-2}$
(iii) 25 mm diameter glass, 5 mm wall, $E = 1 \times 10^9\ Nm^{-2}$
Assume density of water as 998 kgm^{-3} and bulk modulus as $2 \times 10^9\ Nm^{-2}$

(c) For the aluminium pipe in Question 2(b) above, assuming that the wave propagation velocity is 1500 m/s. What is the diameter of the pipe?

Question 3 (25 MARKS)

(a) What do you understand by Open channel flow?

(b) What are factors that can cause unsteadiness in open channel flow?

(c) An open channel has a cross-section in the form of a trapezium with a bottom width B of 4 m and side slopes of 1 vertical to 1.5 horizontal as shown in the figure Q3c below. Assuming that the roughness coefficient n is 0.025, the bed slope is 1 in 1800 and the depth of the water is 1.2 m. Find the volume rate of flow. Assume that the value of the coefficient C in the Chezy formula is 50 in SI units.

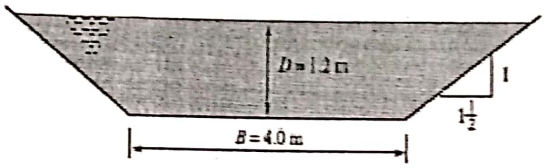

Fig. Q3c

Question 4 (25 MARKS)

(a) A 5 m deep, clean-earth river has a flow rate, $q =$ $10\ m^3 s^{-1}$ *per unit width. Calculate the Froude number of the river.*

(b) A wide rectangular channel has a flow rate, q of $1.8 m^3/s$ per unit width. Calculate
(i) the critical depth?
(ii)What type of flow exist, if D= $1\ m$?

(c) Determine the ratio of displacement thickness to the boundary layer thickness δ when the layer velocity profile is given by $\frac{u}{U_s} = Sin(\frac{\pi}{2}\frac{y}{\delta})$

Question 5 (25 MARKS)

(a) With the aid of diagram only, explain development of boundary layer along a flat plate.
(b) Derive Navier-Stoke's equation (3D) in Cartesian coordinate.

(c) List 3 applications of Navier-Stoke's equation in Engineering.