ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATIONS

2018/2019 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: MEE 405 – Fluid Mechanics II (3 Units)

CLASS: 400 Level Mechanical & Automotive Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer any **FOUR** questions

Date: March, 2019

Question 1

(a) Differentiate between steady uniform flow and unsteady uniform flow.

(b) i. What do you understand by the term 'waterhammer'?

ii. Discuss four (4) factors that can reduce the effect of water hammer.

(c) A rectangular cross-section tank, 3 m by 4 m located in Elizade University Senate building is filled with water up to a depth of 3 m. Calculate the time to reduce the volume in the tank by 60% if the discharge is via a 40 mm diameter pipe, 8 m long, for which a friction factor of 0.005 may be assumed and the separation losses may be represented by a k value of 0.9 Assume final discharge of 3 m below tank base level.

Question 2

(a) A rectangular channel 8 m wide, carries 20 m^3/s when flowing 1 m deep. Calculate:
i. Specific energy. ii. Is the flow subcritical or supercritical?

(b) Determine the period of oscillation of a U-tube containing 5 litres of water. The cross-sectional area is 270 mm^2. Neglect friction.

(c) Water at a temperature of 20 ^{0}C flows through a pipe system 15 mm wall, E = 2.0 x 10^9 Nm^{-2}. Assume that the effects of longitudinal strain, as represented by the inclusion of Poisson's ratio may be neglected and wave propagation velocity is 181 ms^{-1}. Calculate the pipe diameter. Take Bulk modulus as 2 x 10^9 Nm^{-2}.

Question 3

(a) List 6 application areas of Navier-Stoke's equation.

(b) A globe valve (k=3) at the end of a pipe 732 m long is rapidly opened. Where D = 3.5 ft, f =0.019 and H= 85 ft. How long does it take for the discharge to attain 75% of its steady-state value?

(c) Derive Navier-Stoke's equation (2-D) in rectangular coordinates.

Question 4

(a) With the aid of diagram, describe the development of boundary layer along a flat plate.

(b) i. List and explain 4 factors affecting transition from laminar to turbulent flow regime.
ii. Briefly explain the effect of pressure gradient on boundary layer development

(c) Determine the ratio of momentum thickness to the boundary layer thickness when the layer velocity profile is given by:

i. $\frac{u}{U_s} = \left(\frac{y}{\delta}\right)^{\frac{1}{2}}$ ii. $\frac{u}{U_s} = Sin(\frac{\pi}{2}\frac{y}{\delta})$

Where u is the velocity at a height y above the surface and the flow free stream velocity is U_s

Question 5

(a) What do you understand by the term "Open Channel Flow"?

(b) Most flows rarely attain full uniform flow due to several factors. State and explain three (3) of these factors.

(c) An open channel has a cross-section in the form of a trapezium as shown in Fig. Q5b with a bottom width B of 4 m and side slopes of 1 vertical to 1.5 horizontal. Assuming the roughness coefficient n is 0.025, the bed slope is 1 in 1500 and the depth of the water is 1.2 m. Find the volume rate of flow Q using Kutter formula.

$$C = \frac{23 + 0.00155/s + 1/n}{1 + (23 + 0.00155/s)n/\sqrt{m}}$$

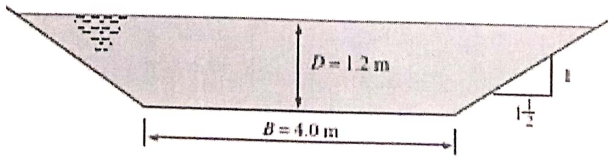

Fig. Q5b

Formulae

$$t = 2A_s \frac{(H_2^{1/2} - H_1^{1/2})}{C}$$

$$C = A_o \sqrt{\left[\frac{2g}{\left(\frac{4fl}{d}+k\right)}\right]}$$

Velocity of wave propagation, $c^2 = \frac{1}{\rho}\left(\frac{K}{1+DK/Ee}\right)$

$$t = 0.5l(v_0^2/gH)log_e\left[\frac{v_0 + v}{v_0 - v}\right]$$

$$Q = CA\sqrt{mi}$$

$$\theta = \int_0^\infty \frac{u}{U_s}\left(1 - \frac{u}{U_s}\right)dy$$