TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS FOR
THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING
(Y3 S1)
INSTITUTION BASED

EMG 2301 FLUID MECHANICS II

END OF SEMESTER EXAMINATIONS
SERIES: APRIL 2017
TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

This paper contains **FIVE** questions. Answer **ANY THREE** questions

---

Question 1

(a) (i) State Newton's second law of motion. **(2 mark)**

(ii) Write the momentum equation for steady one-dimensional flow for the case of no external forces and explain the physical significance of its terms. **(3 marks)**

(b) A 90^o elbow is used to direct water flow at a rate of 30 kg/s in a horizontal pipe upwards. The radius of the elbow is 40 cm. The elbow discharges water into the atmosphere, and thus pressure at the exit is the local atmospheric pressure. The weight of the elbow and the water in it is considered to be negligible. Calculate:

(i) The gauge pressure at the centre of the inlet of the elbow and

(ii) The magnitude and direction of the anchoring force needed to hold elbow in place.

(15 marks)

Question 2

(a) Show that for laminar flow in a tube the friction actor f is given by $f = 16/Re$ where Re is the flow Reynolds number. **(10 marks)**

(b) Through a short pipe which branches into two parallel pipes *A* and *B* each with a length of 50 m and with inside diameter of 25 mm and 50 mm, respectively as shown in Fig. Q2(b). The ends of the pipes are connected together by another short pipe. Determine the flow through each pipe if they have drop in elevation of 3 metres. Assume a constant friction factor in both pipes of 0.005. **(10 marks)**

Question 3

(a) Derive the Chezy formula for the uniform flow of a liquid along an open channel inclined at a slope *i*. **(10 marks)**

(b) A rectangular channel is to be designed for conveying 300 m^3 of water per minute. Determine the minimum cross-sectional area of the channel if the slope is 1 in 1600 and it can be assumed

$$V = 70\sqrt{mi}$$

where *V* is the velocity of water in the channel, *m* is the mean hydraulic depth and *i* is the inclination of the channel. **(10 marks)**

Question 4

Determine the theoretical depth of liquid in a closed circular channel or radius *R* for maximum velocity **(20 marks)**

Question 5

(a) Show by dimensional analysis that the power *P* required to operate a test tunnel is given by

$$P = \rho L^3 V^3 f\left(\frac{\mu}{\rho LV}\right)$$

where ρ is the density and μ the coefficient of dynamic viscosity of the fluid *V* the linear velocity of the fluid relative to the tunnel and *L* the characteristic linear dimension of the tunnel. **(10 marks)**

(b) A water tunnel was constructed for visual observation of the flow past models. It operates with the water flowing at a velocity of 3 m/s in the working section and absorbs 3.75 kW. If it is to operate as a wind tunnel under dynamically similar conditions, determine (a) the corresponding speed of air in the working section, and (b) the power required. Assume that for water ρ = 1000 kg/m^3 and kinematic viscosity $v = 1.14 \times 10^{-6}$ m^2/s, for air ρ = 1.28 kg/m^3, $v = 14.8 \times 10^{-6}$ m^2/s. **(10 marks)**