MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING

MED-PR 208 FLUID MECHANICS III

DATE: 31/7/2019 **TIME:8.30-10.30 AM**

INSTRUCTIONS:

Answer Question One (Compulsory) and Any Other Two Questions

1. a) i) Explain the **THREE** laws of similitude used in modeling

ii) Show from first principles the requirement for the dynamic similarity between two fluid motions when considering;

I. viscous resistance

II. Wave resistance (10 marks)

b) Show that the loss of head, H_L when a pipe undergoes a sudden increase in diameter is given by;

$$H_L = \frac{(v_1 - v_2)^2}{2g}$$

Where v_1 and v_2 are velocities at sections while g is the gravitational acceleration.

(10 marks)

c) I) Show from basic principles that for a steady fluid flow under lamina condition, the pressure gradient equals the shear gradient.

II) Name three areas in engineering where lamina flow occurs (10 marks)

2 a) i) The variables controlling the discharge, Q, of a centrifugal pump depends on the Mass density (**ϱ**), the speed of the pump (**N**), the diameter of the impeller (**D**), the Manometric head ($\mathbf{H_m}$), the dynamic viscosity (**μ**) and the gravitational acceleration (**g**).

Using Buckingham's pie- theorem, show that the discharge is given by;

$$Q = N D^3 \phi \left\{ \frac{gH_m}{N^2D^2}, \frac{\mu}{\varrho ND^2} \right\}$$ (15 marks)

ii) A 1/6 model of the above phenomena is to be tested to study the performance of a new design of the pump. The pump is to run at 1500rpm.If the model delivers a discharge of $3m^3/s$ of water under a total head of 2.5m with an efficiency of 70% when running at 1800rpm.Determine for the prototype;

(I) The discharge

(II) The head

(III) The power (5 marks)

3. a) Stating the assumptions made, show from basic principles that Frictional head loss h_f of a fluid flowing at a mean velocity, $\bar{v}$, in a horizontal Pipe of length L and diameter D is given by;

$$h_f = 4f\frac{L\bar{v}^2}{D2g}.$$

Where g is gravitational acceleration and f is the friction factor. (14 marks)

b) Water of dynamic viscosity $0.00114Ns/m^2$ is pumped at a rate of 4 litres per minute through a circular pipe of diameter 40mm diameter and 750m long. Determine the power required (6 marks)

4 a) Show from the first principles that the pressure drop Δp, in the direction of flow in a steady laminar flow between stationary parallel flat plates is given by;

$$\Delta p = \frac{12\mu L\bar{v}}{h2}$$

Where μ=coefficient of dynamic viscosity, L=length of plates, $\bar{v}$=mean velocity of fluid, h=distance between plates and b= width of plate. (15 marks)

b) Oil having viscosity of 0.079kg/ms flows between two parallel flats plates 22mm apart. If the mean velocity of oil is 0.18m/s, calculate the shear Stress at 5mm from the lower plate (5 marks)

5 Two reservoirs are connected by a horizontal pipeline consisting of two pipes joined together. The entrance and exit are sharp and the change in section is sudden. One of the pipe is 15cm diameter and 6 meter long and the other of diameter 22.5cm and 16mlong empties water to the second reservoir. if the difference in the water level in the two reservoir is 6m and the friction coefficient is 0.04 determine the;

a) Velocity of water at entry to the second reservoir (16 marks)

b) Discharge (2 marks)

c) Power output as water enters the second reservoir (2 marks)