MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING

MED – PR 208: FLUID MECHANICS II

DATE: 20/01/2021 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE

a) The discharge, **Q** over a spill way is controlled by the velocity of flow, **V** the head causing flow, **H** the throat diameter, **D** and the gravitational acceleration, **g.** Show using Buckingham's pie-Theorem that the discharge is given by the expression;

$$Q=VD^2\,\phi\left\{\frac{V}{\sqrt{gD}},\frac{H}{D}\right\}$$

(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 laminar condition, The pressure gradient equals the shear gradient.

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

SECTION B: (ATTEMPT ANY TWO QUESTIONS IN THIS SECTION)

QUESTION TWO

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 at1500rpm.If the model delivers a discharge of $3m^3/s$ of water under a total head of 2.5m when running at 1800 rpm. Determine for the prototype;

I. The discharge

II. The head

III. The power (5 marks)

QUESTION THREE

a) i Explain the **THREE** laws of similitude used in model testing.

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

I. viscous resistance

II. Wave resistance (14 marks)

b) The thrust (P) on a sphere is expressed as;

$$p = \varrho V^2 D^2 \phi \left\{ \frac{VD}{\vartheta} \right\}$$

Where ρ=density, V=velocity of flow, D=diameter of sphere and ϑ =kinematic viscosity.

A sphere of certain dimensions obeys the above phenomenon and when placed in water moving with a velocity of 1.5m/s experiences a drag of 4.5N. Another sphere of twice the diameter is placed in a wind tunnel. The kinematic viscosity of air is 13 times that of water and the density of air is $1.28kg/m^3$.Determine the velocity of air for dynamical similarity and the drag at this velocity. (6 marks)

QUESTION FOUR

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 coefficient. (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 40mm diameter and 750m long. Determine the pump power required. (6 marks)

QUESTION FIVE

a) Show that the flow rate (Q),of a fluid of dynamic viscosity (μ), flowing under laminar conditions through a horizontal circular pipe of diameter (D),length(L),with mean velocity(v) and pressure difference between the ends(p) is given by;

$$Q = \frac{\prod PD^4}{128\mu L}$$

Hence show that the pressure difference can be expressed as;

$$P = \frac{32\mu\, LV}{D^2}$$

(12 marks)

b) Oil is pumped a pipe 100 mm diameter and 10m long. The pressure difference between the ends is 14.715KN/m^2,dymamic viscosity is 0.97Ns/m^2 and relative density is 0.90.Determine the;

i. Sheer stress at the pipe wall

ii. Power required to maintain flow (8 marks)