MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 205: FLUID MECHANICS II

DATE: 17/5/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

This paper contains **FIVE** questions
Question **ONE** is compulsory and carries 30 marks
FOUR remaining questions carry 20 marks each.
Attempt question **ONE** and any other **TWO** questions.

QUESTION ONE (30 MARKS) (COMPULSORY)

a) Derive an expression for normal the force exerted by a jet of cross sectional area a m^2 which strikes at a plate inclined at plate an angle θ degrees to the normal to the plate with a velocity v m/sec if the plate is

i. Stationary (2 marks)

ii. Moving away in the direction of the jet at a velocity of u m/sec. (3 marks)

iii. Moving away in the direction normal to the plate at a velocity u m/sec. (4 marks)

b) A jet of water 62.5mm in diameter moving at a velocity of 17.5m/sec strikes a flat plate inclined at angle of 30^0 to the normal to the plate.

Calculate the normal force exerted on the plate when the plate is;

i. Stationary (3 marks)

ii. Moving at 5.0m/sec in the direction of the jet (4 marks)

iii. Moving at 8.0m/sec in the direction normal to the jet (5 marks)

c) i calculate the work done per second when plate is moving in the direction normal to the plate at 5.0m/sec (4 marks)

ii Calculate the efficiency of the arrangement (5 marks)

QUESTION TWO (MARKS)

a) Show that the head loss due to friction in a pipeline H_f is given by

$$H_f = \frac{4fLV^2}{2gd}$$

where f = friction coefficient which depends on the nature of pipe and fluid

L = length of the pipe (m)

V = mean velocity of flow (m/sec)

d = diameter of the pipe (m)

g = acceleration due to gravity (m/sec) (6 marks)

b) Two reservoirs are connected by a pipeline ABC. The water surface of a reservoirs at A is 15m above the reservoir at C. the first 90m of the pipe from A to B has a diameter of 300mm. At B the pipe suddenly enlarges to a diameter of 390mm and then runs for 60m to C.

Taking into account/losses, at entry, due to friction, due to sudden enlargement and exit Calculate the discharge in m^3/sec.

Assume: f = 0.0075 for both the 300mm and 390mm diameter portion of the pipe.

Loss of head at entry = $^1/_2\left(\frac{V_1{}^2}{2g}\right)$ where V_1 = velocity of flow in the small diameter pipe

(14 marks)

QUESTION THREE (20 MARKS)

a) Show that the loss of head due to sudden enlargement of a pipe diameter (H_L) is given by

$H_L = \frac{(V_1 - V_2)^2}{zg}$ where v_1= velocity in the smaller diameter pipe (m/s)

v_2= velocity in the larger diameter pipe (m/s)

g = acceleration due to gravity m/sec^2 (8 marks)

b) A pipe 350mm in diameter conveys water at the rate of $0.283\ m^3/sec$. the pipe suddenly enlarges to 700mm diameter. The pressure at the smaller section is $4.8\ kN/m^2$.

Calculate the

i head lost in meters (4 marks)

ii pressure at the larger section in kN/m^2 (4 marks)

iii power needed to push the water through the enlargement (4 marks)

QUESTION FOUR (20 MARKS)

a) What do you understand by the term "corresponding speed" in connection with the relationship between prototypes and models. (2 marks)

b) Show by dimensional analysis that the drag force F exerted on a sphere of diameter d, moving at a velocity v through a liquid of density ρ and of kinematic viscosity ϑ is given by

$F = ev^2d^2f\left(v\frac{d}{\vartheta}\right)$

Note that $\vartheta = \frac{\eta}{e}$

` (12 marks)

c) i) What do you understand by the term dynamic similarity? (2 marks)

ii) Water flows through a 25mm diameter pipe at a speed of 3m/sec. Air flows through a 75mm diameter pipe. If the two situations are dynamically similar, calculate the corresponding speed of air. (4 marks)

Assume: Density of water = 1000kg/m^3

Density of air = 1.23kg/m^3

Coefficient of dynamic viscosity of water = $1.14\text{x}10^{-3}\ \frac{KG}{m-sec}$

Coefficient of dynamic viscosity of air = $1.78\text{x}10^{-5}\frac{KG}{m-sec}$

QUESTION FIVE (20 MARKS)

a) A viscous flow takes place between two stationery parallel plates whose lengths in the direction of flow is L and whose distance apart is h. Show that if the width of the water is large compared with h so that end and side effects can be neglected, the pressure drop (P) in the direction of flow is given by

$$P = \frac{12\eta Lv}{h^2}$$

Where

η = coefficient of dynamic viscosity of the fluid

v = mean velocity of the fluid

b) The radial clearance between a player and the walls of a cylinder is 0.085mm, the length of the plunger is 300mm and the diameter is 110mm.

There is a difference in pressure of the water on the two ends of the plunger of 210km/m^2 and the coefficient of dynamic viscosity of water is $1.14x10^{-3}\,\frac{Ns}{m}$

Treating this as if it occurred between two parallel flat plates, calculate the leakage in litres/sec. (10 marks)