MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 205: FLUID MECHANICS 11

DATE: **TIME: 2 HOURS**

INSTRUCTIONS

This paper contains FIVE questions
Question ONE is **compulsory** and carries 30 Marks.
Questions TWO – FIVE carries 20 Marks each. **Answer any Two.**

QUESTION ONE (COMPULSORY) (30 MARKS)

a) A horizontal jet of cross-sectional area a m^2 moving at u m/s strikes a plate at angle θ^0 to the normal of the plate. Derive an equation for the force exerted on the plate if the;

i) Plate is stationary (2 marks)

ii) Plate is moving away from jet at u m/s in the direction of the jet (3 marks)

b) Derive an expression for

i) Work done per second (2 marks)

ii) Efficiency of the arrangement (3 marks)

c) When the plate is now moving in the direction normal to itself, derive an expression for

i) Force exerted on the plate at θ^0 to the normal of the plate (3 marks)

ii) Work done per second (3 marks)

iii) Efficiency of the arrangement (4 marks)

d) A jet of oil 10 mm in diameter moving at 50 m/s impinges on a stationary sheet plate at an angle of 60^0 to the normal its surface. Calculate;

(i) Normal force on the plate when stationary (2 marks)

(ii) Normal force on the plate if it is moving at 10 m/s in the direction of the jet (2 marks)

(iii) Work done per second (2 marks)

(iv) Efficiency of the arrangement (4 marks)

QUESTION TWO (20 MARKS)

a) Derive an expression for the loss of head due to friction in a pipeline in terms of the velocity head, assuming that the frictional resistance per unit area of the pipe wall is proportional to the square of the mean velocity of flow. (10 marks)

b) Determine the;

i) loss of head due to friction in a pipeline 360 m long and 150 mm diameter which emerges at 42 dm^3/sec. Assume f = 0.005 (5 marks)

ii) power loss due to friction (5 marks)

QUESTION THREE (20 MARKS)

Water is discharged from a reservoir through a pipe 1200 m long which is 400 mm in diameter for 600 m and 250 mm diameter for the remaining length. Taking into account; entry losses, friction losses, sudden contraction loss and exit losses, determine the discharge in m^3/s. The end of the pipe is 35 m below the reservoir level.

C_c is 0.62

f for the 400 mm diameter pipe is 0.004

f for the 250 mm diameter pipe is 0.006 (20 marks)

QUESTION FOUR (20 MARKS)

a) Define the following terms;

i) Coefficient of dynamic viscosity (1 mark)

ii) Coefficient of kinematic viscosity (1 mark)

b) What is the physical meaning of Reynolds Number (2 marks)

c) Viscous flow takes place between two stationary parallel plates whose length in the direction of flow is L and distance apart is h. Show that if the width of the plate 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 = viscosity of the flow

v = mean velocity of the flow (10 marks)

d) The radial clearance between a plunger and the walls of a cylinder is 0.075 mm, the length of the plunger is 250 mm and its diameter is 100 mm. There is a difference in pressure of the water in the two sides of the plunger of 207 kN/m^2 and the viscosity of water is 1.31 x 10^{-3} kg/ms

Determine the discharge in m^3/s (6 marks)

QUESTION FIVE (20 MARKS)

a) By means of dimensional analysis, show that the force on a body of a given form placed in a steady stream of uniform viscous fluid and held in a fixed altitude is given by;

$$P = \rho v^2 l^2 f\left(\frac{\rho v l}{\eta}\right)\left(\frac{v^2}{lg}\right)$$

Where

P = component of rhe the dynamic force in a fixed direction

ρ = mass density of the fluid

v = undisturbed velocity of the stream relative …

l = the typical linear dimension of the body

g = acceleration due to gravity (14 marks)

b) A water tunnel was constructed for usual observation of the flow past models. It operates with water flowing at a velocity of 3 m/s in the walling section. If it is to operate as a wind tunnel under dynamically similarly conditions, determine the corresponding speed of air.

Assume; for water $\rho = 10^3$ kg/m^3 and kinematic viscosity = 1.14 x 10^{-6} m^2/s

for air ρ = 1.28 kg/m^3 and kinematic viscosity = 14.8 x 10^{-6} m^2/s (6 marks)