



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 $a \text{ m}^2$ which strikes at a plate inclined at plate an angle θ degrees to the normal to the plate with a velocity $v \text{ m/sec}$ if the plate is

- Stationary (2 marks)
- Moving away in the direction of the jet at a velocity of $u \text{ m/sec}$. (3 marks)
- Moving away in the direction normal to the plate at a velocity $u \text{ m/sec}$. (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° to the normal to the plate.

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

- Stationary (3 marks)
- Moving at 5.0m/sec in the direction of the jet (4 marks)
- 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 reservoir 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 m³/sec.

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

Loss of head at entry = $\frac{1}{2} \left(\frac{V_1^2}{2g} \right)$ 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

$$H_L = \frac{(v_1 - v_2)^2}{2g} \text{ where } v_1 = \text{velocity in the smaller diameter pipe (m/s)}$$

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

g = acceleration due to gravity m/sec² (8 marks)

- b) A pipe 350mm in diameter conveys water at the rate of $0.283 \text{ m}^3/\text{sec}$. 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

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

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

(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 = 1000 kg/m^3

Density of air = 1.23 kg/m^3

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

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

QUESTION FIVE (20 MARKS)

- a) A viscous flow takes place between two stationary 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 plunger 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 210 kN/m^2 and the coefficient of dynamic viscosity of water is $1.14 \times 10^{-3} \frac{\text{Ns}}{\text{m}}$

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