MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 205: FLUID MECHANICS II

DATE: 20/6/2017 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS

Answer all questions in Section A and choose any other TWO in Section B

SECTION A: (COMPULSORY)

QUESTION ONE (30 MARKS)

a) i. Distinguish between Laminar and turbulent flow (2 marks)

ii. What is the physical meaning of Reynolds Number? (2 marks)

iii. Water flows through a horizontal pipe of diameter 75mm at the rate of 8.836×10^{-3} m^3/sec. Assuming that the density of water is 100 kg/m^3 and its kinematic viscosity is 1.14×10^{-6} m^2/sec, calculate the Reynold's Number (3 marks)

iv. Is the flow laminar or turbulent (2 marks)

b) A pressure difference of 32.5 KN/m^2 causes water to flow through a horizontal pipe of length 65 meters at 1.75 m/sec. Determine the increase in pressure difference required to make the water accelerate at 1.5m/sec^2 (3 marks)

c) Derive an expression for the force exerted on a flat vertical plate by a horizontal jet of water of cross-sectional area, A m^2 moving at a velocity of V m/sec; when the plate is moving in the direction of the jet at **u** m/sec. (4 marks)

d) Show that the maximum efficiency for this arrangement is 29.6% (4 marks)

e) A horizontal jet of water 60mm in diameter moving at a velocity of 10.5 m/sec strikes a smooth vertical flat plate. The plate is moving away from the jet in the direction of the jet at a velocity of 4.5 m/sec.

Calculate the

i. The work done per sec (5 marks)

ii. The efficiency of the arrangement (5 marks)

QUESTION TWO (20 MARKS)

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

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

Where η *= coefficient of dynamic viscosity*

v *= mean velocity of the fluid*

b) The radial clearance between a plunger and the walls of a cylinder is 0.095 mm, the length of the plunger is 310 mm and the diameter 112 mm. the pressure difference between the two ends of the plunger is 210 KN/m^2 and the coefficient of dynamic viscosity of water= 1.14 x 10^{-3} $\left(\frac{N-sec}{m^2}\right)$

Treating this as if it occurred between two parallel flat plates, estimate the leakage in Litres per Sec. (20 marks)

QUESTION THREE (20 MARKS)

a) Concisely, explain the meaning of the following terms

i. Dimensional analysis

ii. Geometric similarity

iii. Dynamic similarity

b) Show that the wave making resistance of a ship's hull R is given by

$R = \rho v^2 L^2 f(\frac{v}{\sqrt{gl}})$

Where ρ *= density of water*

v = mean velocity of the ship

L = characteristic length of the ship

g = acceleration due to gravity. (8 marks)

c) A ship is designed to cruise at 12.5 m/sec. At the 'corresponding speed' the wave making component of resistance of a model to $\frac{1}{40}$ scale is found to be 16 N when tested in fresh water. Calculate;

i. The model speed (4 marks)

ii. The wave making resistance of the prototype in sea water. (4 marks)

Assume: density of sea water = 1025 kg/m^3

Acceleration due to gravity = 9.81 m/sec^2

QUESTION FOUR (20 MARKS)

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

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

Where V_1 *= the velocity in the smaller pipe upstream of the enlargement*

V_2 *= the velocity in the larger pipe*

g = acceleration due to gravity (8 marks)

b) A pipe 350 mm in diameter, conveys 0.283 m^3/sec of water. It enlarges suddenly to 750mm. the pressure in the smaller pipe is 4.8 KN/m^2. Calculate;

i. Head lost (4 marks)

ii. Pressure in the larger part (4 marks)

iii. Power needed to force the water through the enlargement. (4 marks)

QUESTION FIVE (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 frictional resistance per unit area of pipe wall is proportional to the square of the mean velocity of flow. (8 marks)

b) Determine the conditions for maximum transmission of power through a pipe assuming loss of head by friction only. (6 marks)

c) A horizontal pipeline 300m long, and 150mm in diameter is supplied with water at 8300KN/m^2 pressure. Calculate the maximum power which can be transmitted through the pipe. (6 marks)