MACHAKOS UNIVERSITY

UNIVERSITY EXAMINATIONS FOR 2019/2020 ACADEMIC YEAR

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

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

EMM 205 FLUID MECHANICS II

INSTRUCTIONS TO CANDIDATES

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: (Compulsory Question) (30 Marks)

a) Derive an expression for the time exerted by a jet of cross sectional area M2 which strikes at tat plate an angle 0 degrees to the normal to the plate with a velocity 15m/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)

(Total 30 Marks)

QUESTION 2 (MARKS)

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

$$Hf = \frac{4flu2}{zgd}$$ where f = friction coefficient which depends on the nature of pipe and fluid

e = length of the pipe (m)

u = mean velocity of flow (m/sec)

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/ 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 = ½ $\frac{(V1^2)}{zg}$ where V1 = velocity of flow in the small diameter pipe

(14 Marks)

(Total 20 Marks)

QUESTION 3 (20 MARKS)

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

$$HL = \frac{(V_1-V_2)2}{zg}$$ WHERE V1 = velocity in the smaller diameter pipe (m/s)

V2= velocity in the larger diameter pipe (m/s)

G = acceleration due to gravity (m/s) (8 Marks)

b) A pipe 350mm in diameter conveys water at the rate of 0.283 m3/sec. the pipe suddenly enlarges to 700mm diameter. The pressure at the smaller section is 4.8 hrs/m^2.

Calculate the (i) Head lost in meters (4 Marks)

(ii) Pressure at the larger section in km/m2 (4 Marks)

(iii) Power needed to push the water through the enlargement (4 Marks)

(Total 20 marks)

QUESTION 4 (20 MARKS)

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

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

F= eu2d2 $\frac{(vd)}{u}$

Note that u = $\frac{n}{e}$ **(12 marks)**

c) A 150mm diameter sphere is a model of a 400mm diameter sphere prototype. It is tested in a wind tunnel. The travels 96km/hr in standard air.

Calculate the (i) speed in the wind tunnel under dynamically similar conditions (3Marks)

(ii) Drag force on the prototype if the drag force on the wind tunnel/model was measured to the 15N. (3 Marks)

Assume: compressibility effects are negligible density of standard air = 1.2 kg/m3

(Total 20 Marks)

QUESTION 5 (20 MARKS)

a) A viscous flow takes place between two stationery parallel plates whose lengths in the direction of flow is L and whose diameter 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

$$P = \frac{12nlv}{h^2}$$ where n = coefficient of dynamic viscosity of the fluid

u = 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/m2 and the coefficient of dynamic viscosity of water is 1.14×10^{-3} $\frac{Ns}{m}$

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

(Total 20 Marks)