MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 205 FLUID MECHANICS II

DATE: 24/3/2021 **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 (COMPULSORY QUESTION) (30 MARKS)

a) A water wheel consists of a series of flat vanes, mounted radially on a wheel of large diameter which are struck normally by a jet of water q m^2 in cross section. The velocity of water leaving the nozzle is v m/s and velocity of vanes is u m/s

Derive an expression for the;

i) Force exerted by the jet on the vane (4 marks)

ii) Water flow/sec (4 marks)

iii) Efficiency of the arrangement (5 marks)

b) A jet of water of diameter 50mm and moving at a velocity of 15 m/s strikes a series of plates normally. If the plates are moving in the same direction as the jet at a velocity of 8.5m/s, calculate the;

i) Thrust on each plate (3 marks)

ii) Work done/sec (4 marks)

iii) Efficiency of the arrangement (6 marks)

QUESTION TWO (20 MARKS)

a) Determine the condition for maximum transmission of flow through a pipe assuming loss of head due to friction (6 marks)

b) Water is to be supplied to a turbine 200m below the reservoir level through 1500m length of a penstock with f = 0.025. Determine the smallest diameter of the penstock which will produce 550kw of power with a turbine efficiency of 80% (14 marks)

QUESTION THREE (20 MARKS)

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

b) A bacterium propels itself by rotating its tail which is known as Flagellum. A flagellum is usually in the form of a spiral. The thrust F developed by the bacterium depends on the rotational speed N of the flagellum, mass density ρ, dynamic viscosity η of the flow and diameter of the coiled flagellum D. By means of dimensional analysis, express F in terms of D, N, ρ and η. (8 marks)

c) i) what do understand by the term "dynamic similarity"? (2 marks)

ii) A ball of diameter 250mm moving at 2.0m/s experiences a drag of 5.5N in water. Another ball of diameter 0.5m is placed in a wind tunnel.

Calculate the drag force in the wind tunnel. (4 marks)

Assume ρ air= 1.28kg/m^3

ρ water = 10^3 kg/m^3

$\upsilon_{air} = 13\ \upsilon_{water}$

the drag on the ball $= \rho v^2 d^2 f(\frac{vd}{v})$

QUESTION FOUR (20 MARKS)

a) Assuming that there are no other losses, show that the frictional loss Hf in a horizontal pipe of diameter d m, length Lm for a flow flowing at u m/s is given by;

$$Hf = \frac{4flu^2}{2gd}$$

Where f = friction coefficient

g= acceleration due to gravity

(8 marks)

b) Calculate the frictional head loss in a horizontal pipe 90m long, 300m diameter and volumetric flow rate of water is 0.00356 m3/s, assume f = 0.0075 (6 marks)

c) Air of kinematic velocity 14.5x10-6 m2/s flows through a pipe of diameter 75mm. Calculate the maximum velocity for a lamina flow assuming the critical Re = 2010 (6 marks)

QUESTION FIVE (20 MARKS)

Water is discharged from a tank into the atmosphere through a horizontal pipe 45m long. The diameter of the pipe is 50mm for the first 25m from the entrance. The pipe then suddenly enlarges to 75mm in diameter for the remaining 20m of the length. The discharge through the pipe is $3dm^3$/sec. Taking into account losses at entry, due to friction, sudden enlargement and at the exit, calculate the head causing the flow.

Assume f for the 50mm dimeter pipe is 0.0048 and f for the 75mm diameter pipe is 0.0058.