# MACHAKOS UNIVERSITY

**University Examinations for 2019/2020Academic Year**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING**

**SECOND YEAR SECOND SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING**

**EMM205: FLUID MECHANICS II**

**DATE: 10/12/2020** **TIME: 8:30 – 10:30 AM**

**INSTRUCTIONS**

This paper contains FIVE questions.

Question ONE is compulsory and carries 30 marks

The remaining FOUR questions carry 20 marks each.

Attempt question ONE and any two of the remaining FOUR questions.

**QUESTION ONE(COMPULSORY) (30 MARKS**

a) A jet of water of density kg/$m^3$, cross sectional area $m^2$ impinges tangentially to a stationary vane with a section in the form of a circular arc with a subtended angle of 2**θ**. The velocity of the jet =u m/sec

Derive an expression for the

i. Magnitude of the resultant force on the valve (3 marks)

ii. Direction of the force (3 marks)

b) If the jet velocity is 16m/sec the subtended angle is 130 degrees and the diameter of the jet is 25mm. Calculate the magnitude and the direction of the resultant force on the vane. (6 marks)

c) The vane now moves at 11 m/sec in the direction of the jet.

Derive an expression for the:

i. Force on the vane in the direction of the jet (3 marks)

ii. Work done per second (3 marks)

d) If the vane moves at 6.5m/sec in the direction of the jet, Calculate the

i. Force exerted on the vane in the direction of the jet (4 marks)

ii. Work done per second (2 marks)

e) A jet of water 60mm in diameter moving at a velocity of 12.0m/sec strikes a smooth flat plate inclined at 60 degrees to the normal to the plate. The plate is moving away from the jet at a velocity of 3m/sec parallel to itself and in the direction normal to its surface.

Calculate the

i. Work done per second (3 marks)

ii. Efficiency of the arrangement (3 marks)

**QUESTION TWO (20 MARKS)**

a) A viscous flow occurs between two stationary parallel plates whose length in the direction of flow is L m and distance apart in h m

Show that if the width of the plate is large compared with h so that end and side are negligible, the viscous shear stress at the wall is given by

$$\tau = \frac{6v}{\square}\eta L$$

where η=the coefficient of dynamic viscosity. V=mean velocity of the fluid (12 marks)

b) The radial clearance between the plunger and cylinder walls is 0.1mm.The length of the plunger is 300mm and the diameter is 100mm.The difference of pressure between the ends of the plunger is 9m of water.

Calculate the

i. velocity of leakage in m/sec (4 marks)

ii. rate of leakage past the plunger in $m^3$/sec (4 marks)

Assume: $\eta_{water}$=1.14kg/m- sec

**QUESTION THREE (20 MARKS)**

a) Oil of specific gravity 0.91 with a coefficient of dynamic viscosity 0.21 $\frac{\text{N}-\text{sec}}{m^2}$ flows through a pipe of 250mm diameter at the rate of (1000 $\times 10^3$)kg/hr

i. Determine the Reynolds number (2 marks)

ii. State whether the flow is laminar or turbulent (2 marks)

b) Derive an expression for the head lost due to friction for liquid flowing through a horizontal pipe working from first principles and explaining the meaning of all symbols used.

(8 marks)

c) A pipe 60m long and running full is discharging water at the rate of 90dm$^3$/min. The head lost due to friction is 2.86mm and f=0.008. Calculate the diameter of the pipe. (8 marks)

**QUESTION FOUR (20 MARKS)**

a) What is the basic principle in the method of dimensional analysis? (2 marks)

b) i) A sphere of diameter d metres experiences a drag of F Newtons when moving at a velocity of u m/sec, through a fluid of $\rho$ kg/m$^3$density and coefficient of dynamic velocity of hg/m-sec

By means of dimensional analysis express F in terms of d u, $\ell$ and $\eta$ (12 marks)

ii) Loss of head in a pipe 25mm in diameter and 30m long through which water is flowing at 3m/sec was found to be 21 metres of water

Calculate the loss of head in a 75mm diameter pipe and 18m long through which water is flowing at the corresponding speed.

Assume: $\rho_{water}=10^3$ kg/m$^3$. $\eta_{water}=1.14\times10^{-3}$ kg/m-sec

$\rho_{air}=1.23$ kg/m$^3$ $\eta_{air}=1.78$kg/m-sec (6 marks)

**QUESTION FIVE (20 MARKS)**

a) Determine the condition for maximum transmission of power through a pipe assuming loss of head due to friction (8 marks)

b) A hydraulic machine is supplied with water through a horizontal pipe 900 m long. The power of the machine is 37.5kw and its mechanical efficiency is 80/100. Gauges fitted to the supply pipe show that the pressure at the power station is 5153kN/m$^2$ and at machine is 4672kN/m$^2$.

Calculate the:

i. diameter of supply pipe (6 marks)

ii. velocity of flow (6 marks)

Assume f =0.008