TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
Diploma in Mechanical Engineering (Y3S2)
EME 2305 : Fluid Mechanics II (Paper 2)
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: SEPTEMBER 2018
TIME: 2 HOURS
DATE: Sep 2018

Instruction to Candidates:

You should have the following for this examination

- *Examination Pass & Student ID Card*
- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

a) The pressure P, developed in a jet pump is found to depend on the jet diameter d, diffuser diameter D, the velocity u of the jet, the volume flow Q and the density and viscosity of the fluid. Using dimensional analysis, prove that the functional relationship between the variables can be given by: **(12 marks)**

$$\frac{P}{\rho u^2} = f\left[\frac{Q}{ud^2}, \frac{\mu}{\rho u D}, \frac{d}{D}\right]$$

b) Oil flows over a submerged body horizontally at a velocity 15 m/s. The property values for oil are: kinematic viscosity = 3.45×10^{-5} m^2/s, density = 833 kg/m^3. An enlarged model is used with 8:1 scale in a water towing tank. Determine: **(8 marks)**

i. The velocity of the model to achieve dynamic similarity.
ii. If drag force on the model is 3.5 N, predict the drag force on the prototype.

Take Kinematic viscosity of water as 1.14×10^{-6} m^2/s.

Question TWO

a) With reference to viscous flow through a circular pipe, prove that the velocity distribution u can be given by:

$$u = -\frac{1}{4\mu}\frac{\partial p}{\partial x}[R^2 - r^2]$$

Where: R is the radius of the pipe and the other symbols retain their usual meaning.

(10 marks)

b) A fluid of viscosity 10 poise and specific gravity 0.90 is flowing through a circular pipe of diameter 110 mm. the velocity at the center of the pipe is 2 m/s. Determine:

i. Pressure gradient.
ii. The shear stress at the pipe wall.
iii. The Reynolds number (Re) of the flow.
iv. The velocity at a distance of 30 mm from the wall.

(10 marks)

Question THREE

a) Prove that the Manometric head H_{mano} of a centrifugal pump can be given by:

$$H_{mano} = H_e + h_f$$

Where: H_e is the effective head and h_f is head loss in the system.

(8 marks)

b) The inlet and outlet diameters of a centrifugal impeller are 0.2 m and 0.4 m respectively. The vane angle at outlet is 45°. The pump speed is 1000 rpm. The flow velocity is constant at 3 m/s. The entry of the water is at radial direction. Determine:

i. The vane angle at inlet,
ii. The work done for 1 kg,
iii. The absolute velocity at outlet and its direction a_2.

(12 marks)

Question FOUR

a) Prove that the acceleration head h_a of a reciprocating pump can be given by:

$$h_a = \frac{l}{g}.\frac{A}{a}\omega^2 r\cos\theta$$

Where: l is the length of pipe, A is the cross-section area of pump cylinder, a is the cross-section area of pipe, r is the pump crank radius, ω is the angular speed of the pump and θ is crank angle. **(8 marks)**

b) A single acting reciprocating pump running at 20 rpm has a bore and stroke of 40 cm each. The suction and delivery heads are 4 and 20 m. The suction and delivery pipes of 20 cm diameter are 4 m and 20 m long. f = 0.02. Determine the power required if the efficiency is 80%. **(12 marks)**

Question FIVE

a) With reference to viscous flow between two parallel plates, prove that the loss of pressure head h_f can be given by:

$$h_f = \frac{12\mu\bar{u}L}{\rho g t^2}$$

Where: $\bar{u}$ is the average velocity, t is the thickness or distance between the plates, L is the length between two points under consideration along the plate, the rest of the symbols retaining their usual meaning.

(8 marks)

b) Oil is flowing between two parallel plates which are 80.0 mm apart at 1.5m/s, if the viscosity of the oil is 1.962 Ns/m^2. Determine:

i. The pressure gradient.
ii. The shear stress at the walls of the plate.
iii. The discharge per meter width for laminar flow.

Take viscosity of water as 0.01 poise (1 poise= 0.1 Ns/m^2).

(12 marks)