UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: March 2021

Module Number: ME3302 **Module Name: Fluid Mechanics**

[Three Hours]

[Answer **all questions**, each question carries **12** marks]

Q1 a) Mention **two** examples for free vortex flow.

[1 Mark]

b) A uniform flow with a velocity of y m/s is flowing over a plane source of strength z m^2/s. The uniform flow and source flow are in the same plane. Plot the expected flow pattern.

[2 Marks]

c) Prove that the maximum velocity is twice the average velocity of a laminar flow through a horizontal circular pipe.

[5 Marks]

d) A pipeline AB of diameter 300 mm and length 400 m carries water at a rate of 50 l/s. The flow takes place from A to B where point B is 30 m above point A. Find the pressure at point A in N/cm^2 , if the pressure at B is 19.62 N/cm^2. Take the friction factor as 0.008.

[4 Marks]

Q2 a) Equation Q2 (a) represents the displacement thickness of a flow over a plate. Derive the equation using usual notations.

$$\delta^* = \int_0^{\delta} \left(1-\frac{u}{U}\right) dy \quad \text{---------- (Q2(a))}$$

Here,

u= velocity at a distance y from the plate.

U= free stream velocity.

δ = boundary layer thickness.

[4 Marks]

Q2 continue to page 3

b) The velocity distribution in a boundary layer is given by $u = 0.05Uy$. Find the displacement thickness.

[2 Marks]

c) Use the Hardy Cross method to obtain the flow rates in each section of the pipe network shown in Figure Q2(c). Assume that discharges from D to A and C to B are 4 m^3/s for the first trail. Properties of each pipe section are given in Table Q2(c).

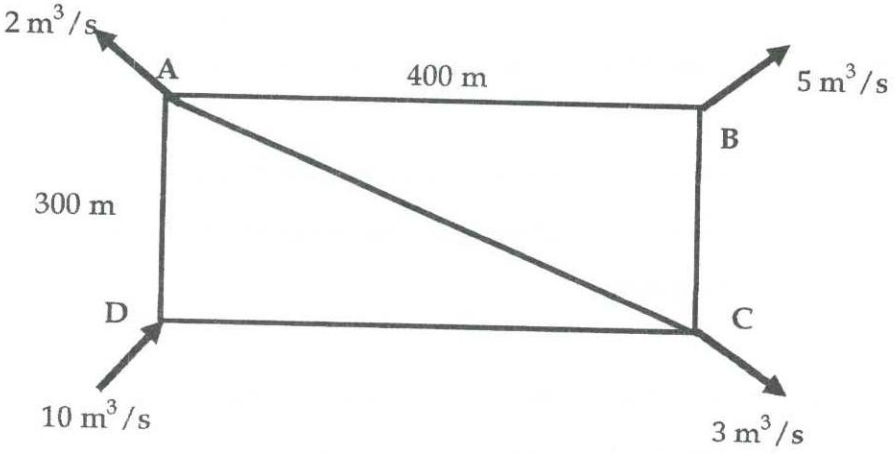

Figure Q2(c). Pipe network

Table Q2 (c). Properties of pipe sections

Pipe	Diameter (cm)	Friction Factor
AB	50	0.020
AC	45	0.030
BC	45	0.025
CD	50	0.020
DA	55	0.250

[6 Marks]

Q3 a) Explain the dimensionless number or the model law that can be used for model testing of pipe flow and fully immersed bodies.

[2 Marks]

b) Explain the Buckingham's π-theorem and selection of repeating variables in π – terms.

[2 Marks]

Q3 continue to page 3

c) The velocity of a circular orifice depends upon the head causing the flow *(H)*, the diameter of the orifice *(D)*, the co-efficient of viscosity (μ) , the mass density (ρ) and the acceleration due to gravity *(g)*. Using the Buckingham's π-theorem show that the velocity through the orifice (V) can be expressed using the following equation.

$$V = \sqrt{2gH}\, \emptyset \left(\frac{D}{H}, \frac{\mu}{\rho V H}\right)$$

[8 Marks]

Q4 a) Why is it necessary to do priming after installation of a centrifugal pump?

[2 Marks]

b) Derive an expression for the work done by impellor of a centrifugal pump on water per second per unit weight of water.

[2 Marks]

c) A centrifugal pump is running at 900 rpm and is working against a total head of 15 m. The outer diameter and outlet width of the impeller of the pump are 420 mm and 50 mm, respectively. The vane angles at outlet is 40° and manommetric efficiency is 78%. Determine the following.

i) The velocity of flow at the outlet.

ii) The velocity of water leaving the vane.

iii) The angle made by absolute velocity at the outlet.

iv) The discharge.

[8 Marks]

Q5 a) Discuss advantages and disadvantages of using a centrifugal pump instead of a positive displacement pump in an industrial application.

[3 Marks]

b) Explain applications of series and parallel arrangements of centrifugal pumps.

[3 Marks]

c) What is cavitation in a centrifugal pump? Explain causes of cavitation and how to eliminate the phenomena.

[3 Marks]

d) What is the basis of selection of a turbine for a hydro-power plant?

[3 Marks]