

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination

Summer Semester: A. Y. 2022-2023

Course No.: ME 4411

Time: 3.0 Hours

Course Title: Fluid Mechanics-I

Full Marks: 150

There are 06 (Six) Questions. Answer all of them. Marks in the margin indicate full marks. Do not write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are not allowed.

- Q1. (a) For watering the IUT football ground, you are asked to *design* a lawn sprinkler consists of two nozzles and rotates in the horizontal direction assuming all reasonable parameters. Will the design produce maximum power? To have the maximum power, *what* will be the expression of velocity? Also, *find* the value of efficiency at this condition. [25]
CO3, PO3
K5, P1, P2
- (b) *Design* a hydraulic energy transfer system using the concept of impact of jet having an area of 'A' which strikes a flat plate at an angle of θ normal to the plate with a velocity V. The plate is moving with a velocity u in the direction of normal to the plate surface. Will the system produce power in the direction of jet or not? *Find* the value of force exerted by the jet on the plate. [10]
CO3, PO3
K5, P1, P2
- Q2. *Design* an open channel for liquid flow of trapezoidal cross section of bottom width b, flow depth y, and trapezoid angle θ measured from the horizontal. Does the design will be the best hydraulic cross section? If yes, *determine* (i). Best hydraulic cross section, (ii) Hydraulic radius for the best cross section, (iii). Best trapezoid angle, (iv). Best flow depth for θ , and prove that the best cross section for trapezoidal channels is half of a hexagon. [25]
CO3, PO3
K5, P1, P2
- Q3. (a) In a jet-propelled boat water enters through orifices at right angles to the direction of motion of the ship. The water is discharged through two jets provided at the back of the ship. The diameter of each jet is 155 mm. If the total resistance offered to the motion of the boat is 5 kN, how much volume of water discharged through the back side and what will be the efficiency of jet propulsion? The velocity of the boat is 5.5 m/s. [15]
CO4, PO2
K3, P1
- (b) A 45 mm diameter jet of water having an absolute velocity of 50 m/s striking a curved vane at one end. The vane deflects the jet through an angle of 60° . As the surface of the vane provides frictional behavior, the outlet velocity of water is 45 m/s. Due to these frictional characteristics, formulate the effects of the force acting on the blade. [10]
CO4, PO2
K3, P1
- Q4. Consider a steady, laminar, incompressible flow of fluid with constant properties in the fully developed region of a straight circular pipe. By applying a momentum balance to a differential volume element, obtain the Darcy Weisbach Equation for fluid flow through a pipe. [25]
CO2, PO2
K3, P1
- Q5. (a) What is the purpose of Pitot static tube? Explain the construction and working principle of Pitot static tube. [10]
CO1, PO1
K1
- (b) What are the ways of calculating friction factor in pipe flow for different flow range. Explain in details. [10]
CO1, PO1
K1
- (c) A piping system involves two pipes of different diameters (but of identical length, material, and roughness) connected in series and parallel. How would you compare the (a) flow rates and (b) pressure drops in these two pipes? [10]
CO1, PO1
K1
- Q6. Water is flowing steadily in a 0.4-m-wide rectangular open channel at a rate of $0.2 \text{ m}^3/\text{s}$. If the flow depth is 0.15 m, determine the flow velocity and if the flow is subcritical or supercritical. Also determine the alternate flow depth if the character of flow were to change. [10]
CO4, PO2
K3, P1