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December 2024

B.Tech. (ME) (Third Semester)

Fluid Mechanics and Machines

(PCC-ME-303/21)

Time : 3 Hours] [*Maximum Marks : 75*

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other. Assume suitable missing data.

Part A

1. (a) Define specific gravity of a liquid and a gas. **1.5**

   (b) Write the stability conditions of a floating body. **1.5**

   (c) Write impulse momentum relation. Write any one application of momentum equation. **1.5**

(d) Define momentum thickness of a boundary layer. 1.5

(e) Write two formulas to determine head loss due to friction in a flow through a pipe. 1.5

(f) Define similitude. What are different types of similitude ? 1.5

(g) What are the advantages of using a draft tube in a reaction turbine ? 1.5

(h) Draw a neat sketch of a Kaplan turbine. 1.5

(i) Define manometric head of a centrifugal pump. 1.5

(j) Draw the ideal indicator diagram for a single acting reciprocating pumps ? 1.5

Part B

2. (a) Classify different types of fluids. 7

(b) Find out the shear stress created by a fluid having dynamic viscosity of 10 poise and flowing over a flat plate at a distance of 0.2 m. If the velocity of the fluid is represented by v (m/sec) at a distance of y (m) from the plate. The velocity distribution is given as $v = 0.5y - y^2$ at a distance in which u is the velocity in metre per second at a distance y metre above the plate. 8

3. (a) Derive a general form of continuity equation. 7

(b) Determine the resultant force experienced by a right-angle bend fitted with a pipe having a diameter of 250 mm in horizontal plane. The total discharge flowing through the pipe and bend is 0.250 m^3/sec. Consider the pressures at the inlet and outlet of the bend as 24 N/cm^2 and 23 N/cm^2, respectively. 8

4. (a) Derive Hagen-Poiseuille equation for laminar flow in the circular pipe. 7

(b) A laminar flow of oil occurs between two parallel plates that are kept 0.15 m apart at a maximum velocity of 3 m/s. Estimate the flow rate per metre width, the shear stress on plate, the pressure difference between two points 15 m apart, the velocity gradient on the plate, and the velocity at 0.01 meters from the plates. Assume μ as 2.5 N. s/m^2. 8

5. (a) Derive Von-Karman Integral momentum equation for boundary layer. 8

(b) The power of a pump (P) is the function of discharge (Q), specific weight of fluid and head (H). Derive the expression of power. 7

6. (a) Discuss a constant efficiency curves for a Francis turbine. 7

(b) Design a Francis turbine runner with the following data :

Net head H = 70 m, speed N = 760 rpm, output power P = 320 kW, Hydraulic efficiency = 95%, overall efficiency = 87%, flow ratio = 0.16, width to outer diameter of runner ratio = 0.1, inner diameter is 1/2 of outer diameter. Also assume 5% of circumferential area of the runner to be occupied by the thickness of the vanes. Velocity of flow remains constant throughout and flow is radial at exit. 8

7. (a) With the help of a neat sketch discuss the principle and working of a double acting reciprocating pump. 7