B. Tech Degree III Semester Examination, December 2006

SE/ME 305 FLUID MECHANICS & MACHINERY

(1999 Admissions Onwards)

Time : 3 Hours Maximum Marks : 100

I. (a) Explain the phenomenon of capillarity. Obtain an expression for capillary rise and capillary fall of a liquid. (8)

(b) A manometer containing mercury is connected to two points 15m apart, on a pipe line conveying water. The pipe line is straight and slopes at angle 15^0 with the horizontal. The manometer gives a reading of 150mm. Determine the pressure difference between the two points of the pipe line. (8)

(c) What is a differential manometer? How are they used for the measurement of pressure? (4)

OR

II. (a) Explain what is meant by metacentric height of a floating body. Derive an expression for it. (10)

(b) A trapezoidal channel, 2m wide at the bottom and 1m deep, has side slopes of 1:1. Determine

(i) the total pressure

(ii) the centre of pressure on the vertical gate closing the channel, when it is full of water (10)

III. (a) State the difference between

(i) Rotational and irrotational flow (ii) Laminar and turbulent flow

(iii) Stream lines and streak lines (6)

(b) Define the terms velocity potential function and stream function. (6)

(c) If stream function for steady flow is given by $\psi = \left(y^2 - x^2\right)$, determine whether the flow is rotational or irrotational. Then determine the velocity potential ϕ. (8)

OR

IV. (a) State and prove Bernoulli's equation. State the assumptions made. What are the limitations of Bernoulli's equation? (10)

(b) A 30cm x 15cm venturimeter is provided in a vertical pipe-line carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevations of the throat section and entrance section of the venturimeter is 30cm. The differential U-tube mercury manometer shows gauge deflection of 25cm.

Calculate (i) the dischargeof the oil

(ii) the pressure difference between the entrance and throat section (10)

V. (a) Derive Chezy's formula to determine loss of head due to friction in pipes. (6)

(b) Explain minor energy losses in pipes. (8)

(c) A tank of 100 square metres in area contains water 4m deep. Find the time taken to fall water level to 2m through a pipe 300m long and 150mm diameter connected to the bottom of the tank. Take $f = 0.01$. (6)

OR

VI. (a) State Buckingham's π theorem. What are repeating variables? How are the repeating variables selected in dimensional analysis? (8)

(b) Write short notes on:
(i) Reynold's number (ii) Froude's number (4)

(c) The pressure difference Δp in a pipe of diameter D and length l due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π Theorem, obtain an expression for Δp. (8)

VII. (a) Obtain an expression for the work done per second on a curved plate by a jet of water when the plate is moving in the direction of jet. (8)

(b) A jet of water 50mm diameter impinges on a curved vane and is deflected through an angle of 135^0. The vane moves in the same direction as that of the jet with a velocity of $5m/s$. If the rate of flow of the water is 30 litres/sec, determine neglection friction:
(i) Component of force on the vane in the direction of motion
(ii) Power developed by the vane
(iii) Efficiency (12)

OR

VIII. (a) Distinguish between impulse and reaction turbines. Explain the working of a radial flow reaction turbine. (8)

(b) Obtain an expression for the work done per second by water on the runner of a pelton wheel. Hence derive an expression for maximum efficiency of the pelton wheel giving the relationship between the jet speed and bucket speed. Draw inlet and outlet velocity triangles for a pelton turbine and indicate the direction of various velocities. (12)

IX. (a) Define a centrifugal pump. Explain the working of a single-stage centrifugal pump. (8)

(b) The internal and external diameter of an impeller of a centrifugal pump which is running at 1000rpm are 200mm and 400mm respectively. The discharge through pump is 0.04m3/s and velocity of flow is constant and equal to 2.0m/s. The diameters of the suction and delivery pipes are 150mm and 100mm respectively and suction and delivery heads are 6m (abs.) and 30m (abs.) of water respectively. If the outlet vane angle is 45^0 and power required to drive the pump is 16.18KW, determine :
(i) vane angle of the impeller at inlet
(ii) The overall efficiency of the pump
(iii) Manometric efficiency of the pump (12)

OR

X. (a) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. Find an expression for the work done per second in case of single-acting reciprocating pump. (8)

(b) A single acting reciprocating pump has a plunger 10cm diameter and a stroke length 200mm. The centre of the pump is 4m above the water level in the sump and 14m below the level of water in a tank to which water is delivered by the pump. The diameter and length of suction pipe are 40mm and 6m while the delivery pipe are 30mm and 18m respectively. Determine the maximum speed at which the pump may be run without separation, if separation occurs at $7.85N/cm^2$ below the atmospheric pressure. Take atmospheric pressure head = 10.3m of water. (12)

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