BTS (C) 066(E)

B.Tech Degree III Semester Examination November 2002

ME/SE 305 FLUID MECHANICS AND MACHINERY

(1999 Admissions onwards)

Time: 3 Hours Max.Marks: 100

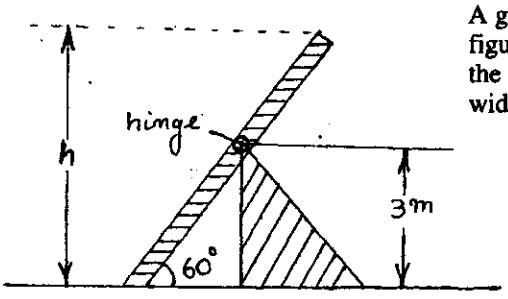
I. (a) Explain the variation of viscosity of liquids and gases with temperature. (6)

(b) What is the pressure with in a droplet of water 0.07mm in diameter if the pressure out side the droplet is 101 KN/m^2. Take surface tension of water as 72 x 10^{-3} N/m. (6)

(c) Lateral stability of a long shaft 12 cm in diameter is obtained by means of a 30 cm stationary bearing having an internal diameter of 12.025 cm. If the space between the bearing and the shaft is filled with a lubricating oil having viscosity 0.25 NS/m^2 what power will be required to overcome the resistance when the shaft is rotated at a constant speed of 200 rpm ? (8)

OR

II. (a) Explain the working of a micro manometer and derive an expression for the pressure difference measured by it. (6)

(b) 

A gate supporting water is shown in the figure. Find the height 'h' of water so that the gate tips about the hinge. Take the width of the gate as unity. (7)

(c) An empty tank with all sides closed is rectangular in plan, side elevation and end elevation with sides 12.5m long, 0.7 m broad and 0.6m high. If the sheet metal weigh 37 kg/m^2 of the surface and the tank is allowed to float in fresh water with 0.6m edge vertical, prove that the equilibrium is stable or otherwise. (7)

III. (a) Explain with respect to a fluid flow, steady and unsteady flow, uniform and non-uniform flow. (4)

(b) The velocity vector in a fluid flow is given by $V = 4x^3 i - 10x^2 yj + 2tk$.
Find the velocity and acceleration of a fluid particle at the point (2,1,3) at t = 1. (7)

(c) In a two dimensional incompressible flow $U = y^3/3 + 2x - x^2y^2$, $\vartheta = xy^2 - 2y - x^3/3$.
Show that the flow is steady and irrotational, also determine the expression for stream function ψ and potential function ϕ . (9)

OR

IV. (a) What is the percentage error on discharge due to 1 % error in the measurement of head for a rectangular notch. (5)

(b) Draw a venturymeter with all its necessary connections and explain the working.
What is the function of the converging and the diverging sections of a venturimeter ? (7)

(c) A venturimeter is installed in a pipe line of 30 cm in diameter. The throat-pipe diameter ratio is 1/3. Water flows through the installation. The pressure in the pipe is 137.7 KN/m^2 and the vacuum in the throat is 37.5 cms of mercury. If 4 % of the differential head is lost between the gauges, find the flow rate in the pipeline. (8)

V. (a) Derive the Hagen-Poisullie equation for steady laminar flow through circular pipe. (10)

(b) Crude oil (S = 0.95, μ = 2 poise) flows through a vertical pipe 15 m long and 3 cm in diameter. If the pressure at the lower end is 392.4 KN/m^2 (gauge) and that at the upper end is 147.15 KN/m^2 (gauge) find (i) the direction of flow and (ii) the rate of flow. (10)

OR

(Turn Over)

VI. (a) Using dimensional analysis derive the functional relationship $f = \phi\left[\frac{\rho VD}{\mu}, \frac{K}{D}\right]$ where

f - friction factor, D - Diameter of the pipe, ρ - density of liquid, μ - viscosity of liquid, V - velocity of liquid, K - height of roughness of pipe. (10)

(b) A spillway design is to be studied by means of a geometrically similar model of scale ratio 1:20. Neglecting viscous and surface tension force calculate :

(i) the discharge in the model corresponding to a discharge of 1500m^3/s in the prototype

(ii) the velocity in the prototype for a velocity of 2m/s in the model

(iii) The height of hydraulic jump in the prototype for a jump of 5 cm in the model

(iv) the energy dessipated in prototype for 0.184 KW in the model. (10)

VII. (a) A jet of water having a velocity 'V' strikes a single curved vane moving in the same direction as the jet with a velocity 'u'. The vane causes the jet to be reversed in direction. In flowing over the vane the relative velocity head of water is reduced by 17%. Show that the maximum efficiency is 56.6%. (8)

(b) Water impinges on a smooth moving curved vane under the following conditions. Velocity of vane = 15m/s, direction of jet at entry to vane = 30° to the direction of the vane, jet velocity = 30m/S. At the exit side the vane makes an angle of 170° with the direction of motion of the vane. Find :

(i) the vane angle at entry

(ii) the absolute velocity of water after leaving the vane and its direction

(iii) the work done. (12)

OR

VIII. (a) A pelton wheel is to develop 9196.875KW at the shaft when working under a head of 300m. Assuming the values of coefficient of velocity, speed ratio and jet ratio as 0.98, 0.45 and 12 respectively, determine:

(i) the number of jets (ii) the diameter of the wheel

(iii) the quantity of water required and (iv) the diameter of the jet.

Take the speed of wheel as 550 rpm and overall efficiency as 85%. (8)

(b) A Francis turbine runner is to be designed for the following data. Net head = 60m, Shaft power = 367.875 KW, speed = 600 rpm, hydraulic efficiency = 85 %, overall efficiency = 80 % flow ratio = 0.15, ratio of width to diameter = 0.1. Assume the inner diameter as half of the outer diameter. The velocity of flow is constant through out. The discharge is radial. Neglect vane thickness. (12)

IX. (a) Define the following terms with respect to a centrifugal pump

(i) static head (ii) Manometric head

(iii) Mechanical efficiency and (iv) Manometric efficiency. (4)

(b) Derive an expression for the specific speed for a centrifugal pump. (6)

(c) A centrifugal pump with radial inflow delivers 0.08m^3/s of water against a total head of 40m. If the outer diameter of the impeller is 30 cm and its width at the outer periphery is 1.25 cm, find the blade angle at outlet. The speed of the pump is 1500 rpm and its manometric efficiency is 80 %. (10)

OR

X. (a) Explain the need for an air vessel in a reciprocating pump and explain how it is working to serve the purpose. (8)

(b) A double acting reciprocating pump has a diameter of 18 cm and stroke 35 cm. The sump is 3m below the pump and the reservoir is 45m above the pump. The suction and delivery pipes are 6m and 80m long and 10 cm in diameter. The air vessels on the suction and discharge sides are 1.5m and 5m from the cylinder respectively. If the pump makes 45 double strokes per minute, find the pressure difference between the two sides of the piston at the beginning of the stroke. The friction factor f = 0.03. (12)

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