B. Tech Degree III Semester Examination in Marine Engineering, March 2008

MRE 305 FLUID MECHANICS AND MACHINERY

Time : 3 Hours Maximum Marks : 100

I. (a) Define the terms :

(i) Dynamic viscosity (ii) Surface tension
(iii) Metacentre (iv) Dynamic similarity (10)

(b) Using Buckingham's Π - theorem, show that the discharge Q consumed by an oil ring is given by

$$Q = Nd^3\phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{w}{\rho N^2 d}\right]$$

where d is the internal diameter of the ring, N is rotational speed, ρ is density, μ is viscosity, σ is surface tension and w is the specific weight of oil. (10)

OR

II. (a) The dynamic viscosity of an oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 r.p.m. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm. (7)

(b) What are the gauge pressure and absolute pressure at a point 3 m below the free surface of a liquid having a density of 1.53×10^3 Kg/m^3 if the atmospheric pressure is equivalent to 750 mm of mercury? The specific gravity of mercury is 13.6 and density of water = 1000 Kg/m^3. (7)

(c) A circular plate 3 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the centre of pressure. (6)

III. (a) Explain the principle of venturimeter with a neat sketch. Derive the expression for the rate of flow of fluid through it. (10)

(b) The stream function for a two-dimensional flow is given by $\psi = 2xy$, calculate the velocity at the point P(2, 3). Find the velocity potential function ϕ. (10)

OR

IV. (a) Obtain expression for head loss in a sudden expansion in the pipe. List all the assumptions made in the derivation. (6)

(b) A circular duct of 50 mm internal diameter is to convey water at the rate of 500 litres per minute. If the friction factor is 0.002, calculate the loss of head for a length of 60 m of this pipe. (6)

(c) Write short notes on the following :

(i) Velocity potential (ii) Stream line
(iii) Stream function (iv) Irrotational flow. (8)

V. (a) Find an expression for the loss of head of a viscous fluid flowing through a circular pipe. (10)

(b) Write short notes on the following :

(i) Steady and unsteady flow

(ii) Forced vortex flow

(iii) Compound vortex flow. (10)

OR

VI. (a) Derive an expression for the velocity distribution of viscous fluid flow through circular pipe and using that derive Hagen Poiseuille formula. (10)

(b) An oil of viscosity 0.1 Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5 litre/s. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. (10)

VII. (a) Show that efficiency of a free jet striking normally on a series of flat plates mounted on the periphery of a wheel can never exceed 50%, (8)

(b) A jet of water having a velocity of 22 m/s strikes a curved vane, which is moving with a velocity of 12 m/s. The jet makes an angle of 20° with the direction of motion of vane at inlet and leaves at an angle of 130° to the direction of motion of vane at outlet. Calculate :

(i) Vane angles, so that the water enters and leaves the vane without shock

(ii) Work done per second per unit weight of water striking the vane per second. (12)

OR

VIII. (a) What is the basis of selection of a turbine at a particular place? (6)

(b) Define the terms : speed ratio, flow ratio and jet ratio. (6)

(c) A pelton wheel has a mean bucket speed of 12 m/s with a jet of water flowing at the rate of 700 litre/s under a head of 30 meters. The buckets deflect the jet through an angle of 160°. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98. (8)

IX. (a) Define the terms : suction head, delivery head, static head and manometric head. (6)

(b) What is priming? Why is it necessary? (6)

(c) A centrifugal pump is to discharge 0.116 m^3/s at a speed of 1500 rpm against a head of 30 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 70%. Determine the vane angle at the outer periphery of the impeller. (8)

OR

X. (a) Define slip, percentage slip and negative slip of a reciprocating pump. (6)

(b) What is air vessel? Describe the function of the air vessel for reciprocating pumps. (6)

(c) 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)

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