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B.Tech. Degree III Semester Supplementary Examination in Marine Engineering December 2015

MRE 305 FLUID MECHANICS AND MACHINERY

Time: 3 Hours

Maximum Marks: 100

(5 × 20 = 100)

- I. (a) Explain what is meant by metacentric height of a floating body. Derive an expression for it. (10)
- (b) A trapezoidal channel of 4 m wide at the bottom and 2 m deep, has side slopes of 1:1. It has a vertical gate closing the channel with full of water on one side. Determine (i) total pressure (ii) the centre of pressure on the vertical gate. (10)
- OR**
- II. (a) State Buckingham's π theorem. What are repeating variables? How are they selected in dimensional analysis? (8)
- (b) The resisting torque T is a function of viscosity μ , the rotational speed N , the diameter D and bearing pressure intensity p , show that $T = \mu ND^3 \phi \left[\frac{p}{\mu N} \right]$. (12)
- III. (a) (i) Differentiate stream function and velocity potential function. (2 × 4 = 8)
(ii) State Bernoulli's theorem for incompressible flow. What are its limitations?
- (b) In a two dimensional incompressible flow, the fluid velocity components are given by $u = x - 4$ and $v = -y - 4x$. Show that velocity potential exists and find its form as well as stream function. (12)
- OR**
- IV. (a) Derive Darcy-Weisbach formula equation. (8)
- (b) In a refinery, crude oil of sp.gravity 0.85 and viscosity 0.1 poise flow through a pipe of 300 mm diameter with an average velocity of 3m/sec. Find the pumping power required to maintain the flow per km length of the pipe. (12)
- V. (a) Prove that the velocity distribution in laminar flow through a circular pipe is parabolic and hence deduce that the average velocity is half the maximum velocity. (10)
- (b) An oil of viscosity 0.1 poise and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and length of 300 mm. The rate of flow of fluid through pipe is 3.5 lit/sec. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. (10)
- OR**
- VI. (a) Prove that the free surface of a liquid in a forced vortex flow is parabolic. (10)
- (b) An open cylinder of 140 mm diameter and 900 mm length contains water up to 600 mm. Find the speed up to which the cylinder is to be rotated about its vertical axis, so that the axial depth becomes zero. (10)

- 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 the jet. (8)
- (b) A jet of water 50 mm diameter impinges on a curved vane and is deflected through an angle of 135° . The vane moves in the same direction as that of jet with a velocity of 5m/sec. If the rate of flow of water is 30 lit/sec. neglecting friction determine (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. (6)
- (b) Obtain an expression for the work done per second by water on the runner of a pelton wheel. Also derive an expression for maximum efficiency of the pelton wheel giving relationship between jet speed and bucket speed. Draw inlet and outlet velocity triangles for pelton wheel and indicate direction for various velocities. (14)
- IX. (a) Define a centrifugal single stage centrifugal pump. (8)
- (b) The internal and external diameter of the impeller of a centrifugal pump are 250 mm and 500 mm respectively. The pump is running at 1250 rpm. The vane angle of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. (12)
- OR**
- X. (a) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes of a reciprocating pump. Find the expression for work done per second in case of a single acting reciprocating pump. (8)
- (b) A single acting reciprocating pump has piston diameter 12.5 cm and stroke length 30 cm. The centre of the pump is 4 m above the water level in the sump. The diameter and length of suction pipe are 7.5 cm and 7 m respectively. Separation occurs if the absolute pressure head in the cylinder during suction stroke falls below 2.5 m of water. Calculate the maximum speed at which the pump can run without separation. Take atmospheric pressure head as 10.3 of water. (12)