B.Tech. Degree III Semester Examination in Marine Engineering December 2012

MRE 305 FLUID MECHANICS AND MACHINERY

Time : 3 Hours   Maximum Marks : 100

I.   (a)   Explain how the surface tension accounts for (i) formation of a drope   (ii) rise of   (5)
liquid in a capillary.

     (b)   The pressure inside an air bubble of diameter 0.01mm is 29.2KPa in excess of   (8)
ambient pressure. Workout the surface tension at air-water interface.

     (c)   What is meant by viscosity of a liquid, how does it manifest and in what units it is   (7)
measured?

OR

II.   (a)   Explain the term total pressure acting on a plane surface immersed in a fluid at any   (5)
angle. Obtain an expression for this and also for the corresponding depth of the
center of pressure.

     (b)   A hollow circular plate 2m external and 1m internal diameter is immersed vertically   (8)
in water such that the center of plate is 4m deep from the water surface. Find the
total pressure and the depth of center of pressure. Take specific weight of water
$10kN/m^3$.

     (c)   What are the various methods of dimensional analysis to obtain a functional   (7)
relationship between various parameters affecting a physical phenomenon? Describe
with an illustration.

III.   (a)   Define the stream function and clearly bring out its physical significance. Enumerate   (5)
some of the salient features of the stream function.

     (b)   Air is flowing through a high speed subsonic wind tunnel. At a point in the tunnel   (10)
the velocity and density are 30m/s and $1.2kg/m^3$ respectively. At another point in the
tunnel where the cross section in one third of that at the first point, the density is
$0.6 kg/m^3$. Estimate the velocity at the second point.

     (c)   Define and distinguish between rotational and irrotational flow.   (5)

OR

IV.   (a)   Derive an expression for the head loss due to sudden enlargement in pipe flow and   (8)
there from deduce the head loss due to sudden contraction.

     (b)   Comment on the validity of the statement that "Bernoulli's theorem is derived under   (7)
assumption if no external force except that gravity is acting on the liquid."

     (c)   Define a weir and point out the difference between a notch and a weir.   (5)

V.   (a)   What is the critical velocity of flow in a circular pipe? What are the upper and lower   (7)
critical velocity values?

     (b)   Establish a relation for the average and maximum velocity for one dimensional   (8)
viscous flow of fluid between two fixed parallel plates.

     (c)   What is free vortex? Give some examples of its occurrence. Show how the velocity   (5)
and pressure vary with radius in a free vortex flow.

OR

VI. (a) A cylinder containing oil of specific gravity 0.85 is rotated about its vertical axis with a constant angular velocity. Pressure measurement indicate equal pressures at two points 1 and 2 which are respectively at 0.5m and 0.75 radial distance from the axis of rotation. If point 2 lies 1.0m above the point 1, calculate the rotational speed in revolutions per minute. (10)

(b) A pipeline 10cm diameter conveys glycerine (density 1260 kg/m³; dynamic viscosity 15 poise) at a velocity of 5m/s. Make calculations for the maximum shear stress at the pipe wall, head loss in 10m length of pipe and the power expended to maintain the flow of glycerine at the prescribed rate. (10)

VII. (a) A stream of water issues from a 50mm dia. nozzle with a velocity of 18m/s and impinges on a series of vanes. The vanes are so arranged that each vane appears successively before the jet in each position and always moves with a velocity of 6m/s. Determine the work done and efficiency of the jet system. (10)

(b) Show that when a jet of water impinges on a series of curved vanes, maximum efficiency is obtained when the vane is semi-circular in section and the velocity of vane is half of jet. (10)

OR

VIII. (a) What are the important component parts of a reaction turbine and what are their functions? (5)

(b) Why does the efficiency of a Pelton wheel eventually begin to drop as the number of blades is increased? (7)

(c) A Francis turbine has inlet wheel diameter of 2m and outlet diameter of 1.2m. The runner turns 250 rev/min. and water flow rate is 8m³/s. The blades have a constant breadth of 0.2m. If the vanes are radial at inlet and the discharge is radially outwards at exit, make calculations for the angle of guide vane at inlet and the blade angle at outlet. (8)

IX. (a) Make a neat sketch of centrifugal pump installation showing the position of gauges and other necessary fittings. (6)

(b) Give a brief account of providing air vessels on the suction and delivery sides of a reciprocating pump. (6)

(c) A double acting reciprocating pump having cylinder diameter of 15cm and stroke 30cm is used to raise water through a height of 30 meters. If the pump is working at 30 rpm and the pump efficiency is 73%, what power is required to drive the pump? (Neglect the effect of piston rod area). (8)

OR

X. (a) Enumerate the salient points of difference between the centrifugal and reciprocating pumps. (5)

(b) Give a sketch of the theoretical pressure-volume diagram for the cylinder of a reciprocating pump, which is not fitted with air vessels. Show clearly the effect of acceleration and friction in both the suction and delivery pipes. (7)

(c) A centrifugal pump was built to supply water against a head of 22.5 meters. But later on it was required to supply the required quantity of water against a head of 20 meters. Find the necessary reduction in the impeller diameter, if it is planned to reduce the original diameter of 30cm without reducing the speed of impeller. (8)

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