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**B.Tech. Degree III Semester Examination in  
Marine Engineering December 2019**

**MRE 1305 FLUID MECHANICS AND MACHINERY  
(2013 Scheme)**

Time : 3 Hours

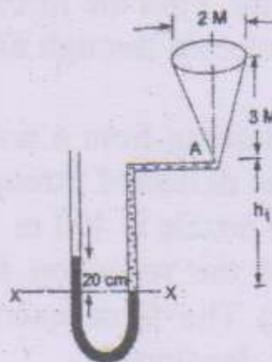
Maximum Marks : 100

(5 × 20 = 100)

- I. (a) The dynamic viscosity of oil used for lubrication between a shaft and a 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. (5)
- (b) Explain the phenomenon of capillarity. Obtain an expression for capillary rise of liquid. (5)
- (c) Using Buckingham's pie-theorem, Show that the thrust developed by a propeller is given by  $P = D^2 V^2 \rho f \left[ \frac{D\omega}{V}, \frac{\mu}{DV\rho}, \frac{C}{V} \right]$  where **P** is the thrust upon angular velocity  $\omega$ , speed of advance **V**, Diameter **D**, dynamic viscosity  $\mu$ , mass density  $\rho$ , elasticity of the fluid medium which can be denoted by the speed of sound in the medium **C**. (10)

OR

- II. (a) The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12.5 mm. The upper plate, which moves at 2.5 meter per sec, requires a force of 98.1 N to maintain the speed. Determine (i) The dynamic viscosity of the oil in poise (ii) The kinematic viscosity of the oil in stokes if the specific gravity of the oil is 0.95. (5)
- (b) Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by  $p = \frac{4\sigma}{d}$ . (5)
- (c) A ship model of scale  $\frac{1}{40}$  is towed through sea water at a speed of 1 m/s. A force of 2 N is required to tow the model. Determine the speed of ship and the propulsive force on the ship, if prototype is subjected to wave resistance only. (5)
- (d) Figure below shows a conical vessel having its outlet at A to which a U-tube manometer is connected. The reading of the manometer given in the figure shows when the vessel is empty. Find the reading of the manometer when the vessel is completely filled with water. (5)



- III. (a) The velocity vector in a fluid flow is given by  $V = 4x^3 i - 10x^2 y j + 2tk$ . Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time  $t=1$ . (5)
- (b) Derive an expression for Bernoulli's equation from first principle and state the assumptions made for such a derivation. (5)
- (c) Write short notes on various Hydraulic co-efficients. (5)
- (d) Find the head loss due to friction in a pipe of diameter 300 mm and length 50 m, through which water is flowing at a velocity of 3 m/s using (i) Darcy formula (ii) Chezy's formula which  $C = 60$ . Take kinematic viscosity of water as 0.01 stoke. (5)

OR

(P.T.O.)

- IV. (a) In a two dimensional incompressible flow, the fluid velocity components are given by  $u = x - 4y$  and  $v = -y - 4x$ . Show that velocity potential exists and determine its form. Find also the stream function. (5)
- (b) Find the discharge of water flowing through a pipe 30 cm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 15 cm. The difference of pressure between the main and throat is measured by a liquid of specific gravity 0.6 in an inverted U-tube which gives a reading of 30 cm. The loss of head between the main and throat is 0.2 times the kinetic head of the pipe. (5)
- (c) The head of water over an orifice of diameter 100 mm is 10 m. The water coming out from orifice is collected in a circular tank of diameter 1.5 m. The rise of water level in this tank is 1 m in 2s seconds. Also the co-ordinates of a point on the jet measured from vena-contracta are 4.3 m horizontal and 0.5 m vertical. Find the hydraulic co-efficients. (5)
- (d) Prove that the head loss due to friction is equal to one-third of the total head at inlet for maximum power transmission through pipes. (5)
- V. (a) What power is required per kilometre of a line to overcome the viscous resistance to the flow of glycerine through a horizontal pipe of diameter 100 mm at the rate of 10 litres/sec? Take dynamic viscosity equal to 8 poise and kinematic viscosity as 6 stokes. (5)
- (b) Prove that in case of forced vortex the rise of liquid at the ends is equal to the fall of liquid level at the axis of rotation. (5)
- (c) Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. (10)
- OR**
- VI. (a) Water at 15 degree flows between two large parallel plates at a distance of 1.6 mm apart. Determine (i) the maximum velocity (ii) the pressure drop per unit length (iii) the shear stress at the walls of the plate if the average velocity is 0.2 m/s. The viscosity of water at 15 degree is given as 0.01 poise. (5)
- (b) Derive an expression for the depth of paraboloid formed by the surface of a liquid contained in a cylindrical tank which is rotated at a constant angular velocity  $\omega$  about its vertical axis. (5)
- (c) Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and half times the average velocity. (10)
- VII. (a) What are the uses of a draft tube? Describe with neat sketches the different types of draft tubes. (5)
- (b) A jet of water of diameter 50 mm moving with a velocity of 40 m/s, strikes a curved fixed symmetrical plate at the centre. Find the force exerted by the jet of water in the direction of the jet, if the jet is deflected through an angle of 120 degree at the outlet of the curved plate. (5)
- (c) A 137 mm diameter jet of water issuing from a nozzle impinges on the buckets of a pelton wheel turbine and the jet is deflected through an angle of 165 degree by the buckets. The head available at the nozzle is 400 m. Assuming co-efficient of velocity as 0.97, speed ratio as 0.46, and the reduction in relative velocity while passing through buckets as 15%, find (i) The force exerted by the jet on the buckets in tangential direction (ii) The power developed. (10)
- OR**
- VIII. (a) A nozzle of 50 mm diameter delivers a stream of water at 20 m/s perpendicular to a plate that moves away from the jet at 5 m/s. Find (i) the force on the plate (ii) the work done (iii) the efficiency of the jet. (5)
- (b) Write short notes on selection of type and speed regulation of turbines. (5)
- (c) In a tidal power plant an axial flow turbine operates a 5 MW generator at 150 r.p.m under a head of 5.5 m. The generator efficiency is 93% and the overall efficiency of the turbine is 88%. The tip diameter of the runner is 4.5 m and hub diameter is 2 m. Assuming hydraulic efficiency of 94% and no exit whirl, determine the runner vane angle at inlet and exit at the mean diameter of the vanes. (10)

- IX. (a) What is cavitation and what are its causes? How will you prevent cavitation in hydraulic machines? (5)
- (b) What is indicator diagram? How will you prove that area of indicator diagram is proportional to the work done by the reciprocating pump? (5)
- (c) The outer diameter of an impeller of a centrifugal pump is 400 mm and outlet width is 50 mm. The pump is running at 800 r.p.m and is working against a total head of 15 m. The vane angle at outlet is 40 degree and manometric efficiency is 75 %. Determine (i) Velocity of flow at outlet (ii) Velocity of water leaving the vane (iii) angle made by the absolute velocity at outlet with the direction of motion at outlet (iv) Discharge. (v) Work done by impeller on water per second. (10)

OR

- X. (a) What is an air vessel? Describe the function of air vessel for reciprocating pump. (5)
- (b) Explain Net positive suction Head. (5)
- (c) A single acting reciprocating pump has a stroke length of 15 cm. The suction pipe is 7 meter long and the ratio of the suction diameter to the plunger diameter is  $\frac{3}{4}$ . The water level in the sump is 2.5 meter below the axis of the pump cylinder and the pipe connecting the sump and pump cylinder is 7.5 cm diameter. If the crank is running at 75 r.p.m, determine the pressure head on the piston: (i) in the beginning of the suction stroke, (ii) in the end of the suction stroke (iii) in the middle of the suction stroke. Take co-efficient of friction as 0.01. (10)

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