B.Tech. Degree III Semester Examination in Marine Engineering December 2017

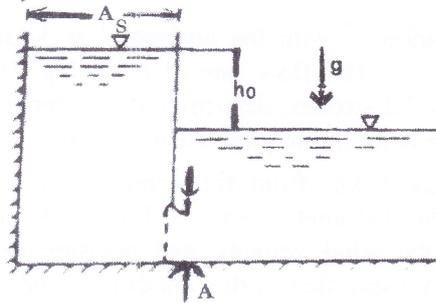**MRE 1305 FLUID MECHANICS AND MACHINERY**
(2013 Scheme)

Time : 3 Hours   Maximum Marks : 100

$(5 \times 20 = 100)$

I. (a) A sluice gate as shown in figure is suddenly opened. $A_s = 3000 m^2$,   (7)
    $h(t = 0) = h_0 = 5m$, $g = 10\ m/s^2$. How large must the cross section of the
    opening A, so that the water level of the bordering lake is attained within 10
    minutes, if quasi-steady flow is assumed?

   (b) A 1:25 scale model of a ship with surface area of 4.0 m² and length 6.0 m   (13)
    when tested in the laboratory at 2.0 m/s velocity gave a total drag force of
    40 N. Calculate the drag force and power of the prototype when it is cruising
    at the corresponding speed. Assume 20°C as the temperature of water and
    calculate skin friction by the formula $C_f = 0.074 / R_{el}^{1/5}$.

OR

II. (a) A plane 3m× 4m is vertically placed in water with the shorter side horizontal   (14)
    with the centroid at a depth of 5m as shown in figure. (i) Determine the total
    force on one side and the point of action of the force. (ii) Also determine the
    size of an inner rectangle with equal spacing on all sides, the total force on
    which will equal the force on the remaining area. (iii) Determine the centre
    of pressures for these areas and compare the moments of these forces about a
    horizontal axis passing through the centre of pressure for the whole area.
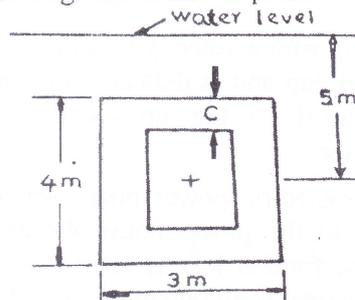
   (b) A cube of side 'a' and relative density 's' floats in water. Show that the   (6)
    relative density 's' should be greater than 0.8 or less than 0.2 approximately.

(P.T.O.)

III. (a) A tank standing on the ground is filled with water up to a height of 'H' meters (9) from its base. There is an orifice on a vertical wall of the tank at any depth 'h' meters below the free surface of water in the tank. Establish a relation between 'h' and 'H' in order that the jet of water issuing from the orifice may strike the ground at a maximum distance from the orifice.

(b) A siphon has a uniform circular bore of 8 cm diameter and consists of a bent (11) pipe with its crest 1.8 m above the water level, discharging into the atmosphere at a level 3.6 m below the free surface of water, find (i) the velocity of flow through the siphon tube (ii) the discharge through the tube and (iii) the absolute pressure at the crest level if atmospheric pressure is 10 m of water. Neglect all losses.

OR

IV. (a) Show that 1% error in the measurement of H will produce 2.5% error in (10) discharge through a triangular notch/weir. Also determine the limiting values of head above a triangular notch for $\pm$ 1.2 percentage error in measurement of discharge.

(b) Determine the least number of 150 mm diameter pipes required to transmit (10) 243 kW power to a machine 3.5 km from the pumping station, the efficiency of the transmission being 90%. The feed pressure is 6 MPa. Take $f = 0.0075$.

V. (a) A pipe of inclination 2^0 with the horizontal is 3 km long, carries an oil of (10) specific gravity 0.9. The flow rate of oil being 0.06 m^3/sec. If kinematic viscosity of oil is 2.2 strokes, determine the difference of pressure at the two ends. Assume diameter of the pipe line as 30 cm.

(b) The wind velocity 8 km from the centre of a tornado was measured as (10) 48 km/hr and the barometer was read at 73.65 cm of mercury. Make calculations for the wind velocity and pressure existing 0.8 km from the tornado centre. Assume free vortex conditions and that both points lie in the same horizontal plane. Also evaluate the depth of these points below the free horizontal surface corresponding to infinite radial distance from the centre. For air specific weight $= 11.97$ N/m^3.

OR

VI. (a) Oil is pumped up in a 300 mm diameter and 2 km long pipe at the rate of (10) 0.15 m^3/sec. The pipe is laid at a slope of 1 in 200. Specific gravity of oil is 0.9. Determine the head lost in friction and calculate the power required to pump the oil. Take kinematic viscosity as 22 stokes.

(b) A cylindrical container with height 60 cm and radius 10 cm is filled with water (10) to a depth of 40 cm. The container is sealed both at the top and bottom and is rotated about its vertical axis at 360 rpm. Calculate the height of the paraboloid formed. What should be the rotational speed if the parabola is to just touch the centre bottom of the vessel?

VII. (a) A jet of water moving with a velocity of 20 m/sec impinges on the centre of a (8) double hemispherical cup and is deflected through 180°. Find the impact of the jet per kg of water if (i) the cup is stationary and (ii) the cup is moving with velocity of 8m/sec.

(b) At a particular hydroelectric power plant, water available under a head of (12) 250 m is delivered to the power house through pipes each 2500 m long. Through these pipes, friction loss is estimated to be 20 m. The project is required to produce a total shaft output of 13.25 MW by installing a number of single jet Pelton wheels whose specific speed is not to exceed 38.5. Given wheel speed = 650 rpm, ratio of bucket to jet speed = 0.46, overall efficiency of the wheel = 85%, C_d of the nozzle = 0.94, C_v of the nozzle = 0.97, pipe friction coefficient = 0.005. Determine (i) the number of Pelton wheels to be used (ii) jet diameter and (iii) diameter of supply pipes.

OR

VIII.   (a)   A jet of water of 5 cm diameter impinges on a curved vane and is deflected   (9)
through an angle of 175^0. The vane moves in the same direction as that of the
jet with a velocity of 35 m/sec. If the rate of flow is 0.170 m³/sec, determine
the component of force on the vane in the direction of motion. How much
would be the power developed by the vane and what would be the vane
efficiency? Neglect friction. How would these parameters would change if
instead of one vane there is a series of vanes fixed to a wheel and moving in
the direction of jet with velocity of 35 m/sec?

    (b)   A radially inward flow turbine working under a head of 10 m and running at   (11)
250 rpm develops 185 kW at the turbine shaft. At inlet tip of the runner vane,
the peripheral velocity of the wheel is $0.9\sqrt{2gH}$ and the radial velocity of flow
is $0.3\sqrt{2gH}$; H being the effective head on the turbine. If overall efficiency of
the turbine is 78% and the hydraulic losses amount to 12% of the total head,
determine (i) diameter of the runner and its width at inlet (ii) guide blade
angle at which water is directed to runner, and (iii) inlet angle of the runner
vane. Assume a reaction turbine with radial discharge at outlet.

IX.   (a)   To predict the performance of a large centrifugal pump, its model having the   (12)
following specifications was made: Power = 18 kW, total head = 8 m,
speed = 925 rpm. Diameter of the model impeller is $1/9^{th}$ the diameter of the
prototype impeller which has to work against a head of 12 m. Find the
working speed and power required to drive the prototype. Also determine the
rate of flow in both the pumps.

    (b)   (i) What is negative slip? (ii) Why does it occur? (ii) Derive an expression   (1+2+5 = 8)
for the work saved by fitting an air vessel on the suction and delivery side of a
single acting reciprocating pump.

OR

X.   (a)   The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the   (12)
periphery, and has blades whose tip angles incline backwards 60^0 from the
radius. It delivers 17 m³/min and the impeller rotates at 1000 rpm. Assuming
that the pump is designed to admit radially, calculate: (i) speed and direction
of water as it leaves the impeller (ii) torque exerted by the impeller on water
(iii) shaft power required and (iv) lift of the pump.

    (b)   (i) State the functions of air vessels as used in reciprocating pump. (ii) A   (2 + 6 = 8)
single acting reciprocating pump has a piston of 15 cm diameter and stroke
30 cm. The delivery pipe is 6 cm in diameter and 50 m long. If f = 0.01 and
saving of power is 0.5 kW, find the position where the air vessel is to be fitted
in the delivery pipe. Assume the speed of the pump as 40 rpm.

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