Code: 15A01404 **R15**

B.Tech II Year II Semester (R15) Regular & Supplementary Examinations May/June 2018

HYDRAULICS & HYDRAULIC MACHINERY

(Civil Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Determine the hydraulic depth for the flow through a circular pipe of radius r, flowing half full, under the action of gravity.

(b) State any four conditions for critical flow in open channels.

(c) Illustrate the M3 type surface profile with an example.

(d) State the governing principles used for analysis of hydraulic jump.

(e) A jet of water issues from a nozzle with a velocity of 20 m/s and it impinges normally on a flat plate moving away from it at 10 m/s. The cross sectional area of the jet is 0.01 m^2 and the density of water is 1000 kg/m^3. Determine the force developed on the plate.

(f) State the conditions under which a pelton wheel is recommended for power production in a hydropower plant.

(g) A hydraulic turbine has a discharge of 5 m^3/s when operating under a head of 20 m with a speed of 500 r.p.m. If it is to operate under a head of 15 m, for the same discharge, determine the corresponding rotational speed of the turbine.

(h) A pump can lift water at a discharge of 0.15 m^3/s to a head of 25 m. The critical cavitation number for the pump is found to be 0.144. The pump is to be installed at a location where the barometric pressure is 9.8 m of water, vapour pressure of water is 0.3 m of water and the intake pipe friction loss is 0.4 m. Using the minimum value of Net positive suction head (NPSH) as 3.6 m, determine the maximum allowable elevation above the sump water surface at which the pump can be located.

(i) The drag force F_D on sphere kept in a uniform flow field depends on the diameter of the sphere D, flow velocity V, fluid density ρ and dynamic viscosity μ. Which of the following options represents the non-dimensional parameters which could be used to analyse this problem? Give justification for the answer.

(i) $\frac{F_D}{VD}, \frac{\mu}{\rho VD}$. (ii) $\frac{F_D}{\rho VD^2}, \frac{\rho VD}{\mu}$. (iii) $\frac{F_D}{\rho V^2 D^2}, \frac{\rho VD}{\mu}$. (iv) $\frac{F_D}{\rho V^3 D^3}, \frac{\mu}{\rho VD}$.

(j) A stationary smooth flat plate is kept in a parallel flow stream. Assuming the average skin friction coefficient is proportional to $Re_x^{(-1/2)}$ determine the ratio of drag over the upstream half of the plate to that over the entire plate?

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 (a) A certain stretch of a lined trapezoidal channel has one side vertical side wall and the other 45° sloping wall. If it is to deliver water at 30 m^3/s with a velocity of 1 m/s, compute the bed width and flow depth for minimum lining area.

(b) State the concept of specific energy E in open channel flow. For a given discharge, sketch the variation of specific energy E with respect to depth of flow.

OR

3 A rectangular channel 5 m wide is carrying a discharge of 20 m^3/s at a depth of flow of 2 m. (i) Determine the width to which the channel should be contracted so that the depth in contracted section is critical. (ii) What will be the depth at the contracted section if the width there is 4 m? (iii) What will be the depths of flow in the upstream and in the contracted section if the width of the channel is reduced to 2.5 m?

Contd. in page 2

UNIT – II

4 A very wide rectangular channel carries a discharge of 8 cumecs/m width. The channel has a bed slope of 1 in 250 and Manning's roughness coefficient n = 0.015. At a certain section of the channel the flow depth is 1 m. What gradually varied flow profile exists at this section? Also find the distance from this section (specify upstream or downstream) where the flow depth will be 0.9 m? Use direct step method with a single step for computation.

OR

5 A hydraulic jump occurs in a wide rectangular channel with initial and sequent depths of 0.5 m and 2 m respectively. (i) Calculate the discharge in m^3/s per m width of channel? (ii) Find the possible critical depth for the above discharge through the channel? (iii) Also compute the energy loss in the jump.

UNIT – III

6 A stationary vane having an inlet angle of zero degree and an outlet angle of 25° receives water at a velocity of 50 m/s. (i) Determine the components of force acting on it in the direction of jet velocity and normal to it. (ii) If the vane stated above is moving with a velocity of 20 m/s in the direction of the jet, calculate the force components in the direction of vane velocity and normal to it. (iii) Also find the work done per kg of water.

OR

7 In a Pelton wheel the buckets deflect the jet by 170° and the relative velocity is reduced by 12% due to bucket friction. For a speed ratio of 0.47, calculate the hydraulic efficiency of the wheel. The bucket circle diameter of the wheel is 90 cm and there is one jet for which C_V = 0.98. Take the actual efficiency of the wheel as 90% of its theoretical efficiency. If the wheel develops a power of 1700 kW under a head of 550 m, compute the speed of the wheel and diameter of nozzle.

UNIT – IV

8 A centrifugal pump has an impeller of 50 cm outer diameter and 25 cm inner diameter. When running at 6000 rpm the pump discharges 130 liters of water per second against a gross head of 12 m. At this discharge water enters the impeller without shock. The vane angle at the inlet is 45° to the tangent at outlet and the area of flow which is constant from inlet to outlet of the impeller is 0.061 m^2. Determine: (i) The manometric efficiency of the pump. (ii) Loss of head at inlet to the impeller when the discharge is reduced by 50%, the speed of rotation being unchanged.

OR

9 A slow speed Francis turbine has an outer diameter of 0.8 m and inner diameter of 0.4 m. The flow area is constant, equal to 0.25 m^2. The head is 60 m and the turbine runs at 500 r.p.m. The guide vane angle at the inlet is 25° and the inlet blade angle 110° respectively. If the outflow is radial, find: (i) Blade angle at the outlet. (ii) Discharge. (iii) Power developed. (iv) Hydraulic efficiency. (v) Specific speed.

UNIT – V

10 State Buckingham's Pi theorem. The drag of a ship depends on the length of the ship l, its velocity v, density ρ, dynamic viscosity μ and the acceleration due to gravity g. Show that the drag F can be expressed as $F = \rho v^2 l^2 \phi (F_N, R_N)$ where F_N and R_N indicate the Froude number and Reynolds number of the flow.

OR

11 (a) An automobile with projected area 2.6 m^2 is running on a road with a speed of 120 km/hr. The mass density and kinematic viscosity of air are 1.2 kg/m^3 and 1.5 x 10^{-5} m^2/s respectively. Take the drag coefficient as 0.3. (i) Determine the drag force on the automobile. (ii) Also find out the power required to overcome the drag.

(b) A tidal model has been made with horizontal scale ratio of 1 : 7200 and vertical scale ratio of 1 : 400. What is the period in which a tide of its natural period 12 hours can be simulated in the model?

*****