

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech II Year II Semester Examinations, May - 2015

## HYDRAULICS AND HYDRAULIC MACHINERY

(Common to CE, CEE)

Time: 3 Hours

Max. Marks: 75

Note: This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A.

Part B consists of 5 Units. Answer any one full question from each unit.

Each question carries 10 marks and may have a, b, c as sub questions.

## PART- A

(25 Marks)

- 1.a) Explain the terms rapidly varied flow and gradually varied flow. [2M]
- b) Define the terms afflux back water curve. [3M]
- c) What do you mean by fundamental units and derived units? [2M]
- d) What is meant by geometric, kinematic, and dynamic similarities? Are these similarities truly attainable? If not why? [3M]
- e) Show a layout of a typical hydroelectric power plant. [2M]
- f) Show that the force exerted by a jet of water on an inclined fixed plate in the direction of the jet is given by  $F_x = \rho a V^2 \sin^2 \theta$ .  
Where  $a$  = Area of the jet.  $V$  = Velocity of the jet and  $\theta$  = Inclination of the plate with the jet. [3M]
- g) Define the terms Hydraulic machines. Turbines and Pumps. [2M]
- h) Differentiate between the impulse and the reaction turbines. [3M]
- i) Define Specific speed of centrifugal pump. Derive an expression for the same. [2M]
- j) How the model testing of the centrifugal pumps are made? [3M]

## PART- B

(50 Marks)

2. Water is flowing through a circular channel at the rate of 500 liters/s. The depth of water in the channel is 0.7 times the diameter and the slope of the bed of the channel is 1 in 8000. Find the diameters of the circular channel if the value of Manning's,  $N = 0.015$ . [10]

OR

3. A sluice gate discharges water into a horizontal rectangular channel with a velocity of 8 m/s and depth of flow is 0.5 m. The width of the channel is 6 m. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water. Also determine the horse power lost in the hydraulic jump. [10]

4. A ship 250 m long moves in sea-water, whose density is  $1030 \text{ kg/m}^3$ . A 1 : 125 model of this ship is to be tested in wind tunnel. The velocity of air in the wind tunnel around the model is 20m/s and the resistance of the model is 50 N. Determine the velocity of ship in sea-water and also the resistance of the ship in sea-water. The density of air is given as  $1.24 \text{ kg/m}^3$ . Take the kinematic viscosity of sea-water and air as 0.012 stokes and 0.018 stokes respectively. [10]

**OR**

5. What is the significance of the non-dimensional numbers: Reynolds number, Froude number and Mach number in the theory of similarity? What is the dimensional analysis? How is this analysis related to the theory of similarity? [10]
- 6.a) Find an expression for the efficiency of a series of moving curved vanes when a jet of water strikes the vanes at one of its tips. Prove that maximum efficiency is when  $u = V$  and the value of maximum efficiency is 50%.
- b) Show that for a curved radial vane, the work done per second is given by  $\rho a V_1 [V_{w1} u_1 \pm V_{w2} u_2]$ . [5+5]

**OR**

7. A jet of water having a velocity of 30 m/s, strikes a series of radial curved vanes mounted on a wheel which is rotating at 300 r.p.m. The jet makes an angle of  $30^\circ$  with the tangent to wheel at inlet and leaves the wheel with a velocity 4 m/s at an angle of  $120^\circ$  to the tangent to the wheel at outlet. Water is flowing from outward in a radial direction. The outer and inner radii of the wheel are 0.6 m and 0.3 m respectively. Determine: (a) Vane angles at inlet and outlet, (b) work done per second per kg of water, and (c) efficiency of the wheel. [3+3+4]
8. Water under a head of 300 m is available for a hydel-plant situated at a distance of 2.35 km from the source. The frictional loss of energy for transporting water is equivalent to 26 (J/N). A number of Pelton wheels are to be installed generating a total output of 18 MW. Determine the number of units to be installed, diameter of Pelton wheel and the jet diameter when the following are available: Wheel speed 650 r.p.m.; ratio of bucket to jet speed 0.46; specific speed not to exceed 30 (m, kW, r.p.m.);  $C_v$  and  $C_d$  for the nozzle 0.97 and 0.94 respectively and the overall efficiency of the wheel 87%. [10]

**OR**

- 9.a) What is meant by the speed ratio of a Pelton wheel?
- b) What is draft-tube? What are its functions?
- c) Differentiate between an inward and an outward flow reaction turbine. [3+3+4]
10. A centrifugal pump with 1.2 m diameter runs at 200 r.p.m. and pumps 1880 litres/s, the average lift being 6 m. The angle which the vanes make at exit with the tangent to the impeller is  $26^\circ$  and the radial velocity of flow is 2.5 m/s. Determine the manometric efficiency and the least speed at start pumping against a head of 6 m. the inner diameter of the impeller being 0.6 m. [10]

**OR**

- 11.a) What is cavitation and what are its causes? How will you prevent the cavitation in hydraulic machines?
- b) Define the terms load factor, utilization factor and capacity factor. [5+5]