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# P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Civil Engineering

Semester End Examination; June - 2017

Hydraulics and Hydraulic Machines

Time: 3 hrs

Max. Marks: 100

**Note:** i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.  
ii) Missing data may be suitably assumed.

## UNIT - I

1. a. In what ways the Open channel flow differ from the flow in closed conduits? 6
- b. Show that for a rectangular channel with given area is most economical when hydraulic radius is half of depth flow. 6
- c. A power canal of trapezoidal section has to be excavated through hard clay at the least cost. Determine the dimensions of the channel. Given discharge equal to  $14 \text{ m}^3/\text{s}$ , bed slope 1:2500 and Manning's  $N = 0.020$ . 8
2. a. Define specific energy. Draw specific energy diagram. Explain all the details. 6
- b. Show that the hydraulic Jump in a rectangular channel, the alternate depths are related by expression  $y_2 = \frac{y_1}{2} \left( \sqrt{1 + 8F_1^2} - 1 \right)$  with usual notations. 6
- c. Water flows at the rate of  $16 \text{ m}^3/\text{s}$  in a channel 10 m wide at a velocity of 1.6 m/s. Calculate specific energy head. Find also the critical depth, the critical velocity and the minimum value of the specific energy head. 8

## UNIT - II

3. a. What is dimensional analysis? Enumerate the uses of dimensional analysis. 6
- b. Explain Rayleigh's method of dimensional analysis. 6
- c. The resisting force of a supersonic plane during flight can be considered as dependent on the length of the aircraft  $L$ , Velocity  $V$ , Viscosity  $\mu$ , mass density  $\rho$ , Bulk modulus  $K$ . Express the fundamental relationship between resisting force and their variables. 8
4. a. What do you mean by similitude? Explain different types of similarities. 6
- b. What is meant by distorted model? Explain its advantages and disadvantages. 6
- c. In 1 in 40 model of spillway, the velocity and discharge are 2 m/s and  $2.5 \text{ m}^3/\text{s}$ . Find the corresponding velocity and discharge in the prototype. 8

## UNIT - III

5. a. Prove that the force exerted by a jet of water on a fixed semi circular plate in the direction of jet when the jet strikes at the centre of the semicircular plate is two times the force exerted by the Jet on a fixed vertical plate. 10

- b. A Jet of water having a velocity of 20 m/s strikes a curved vane, which is moving with a velocity of 10 m/s. The jet makes an angle of  $20^\circ$  with the direction of motion of Vane at inlet and leaves at an angle of  $130^\circ$  to the direction of motion of Vane at outlet. Calculate; 10
- Vane angles so that water enters and leaves without shock.
  - Work done per second per unit weight of water striking the Vane/second.
6. a Show that when a jet of water impinges on a series of curved vanes, maximum efficiency is obtained when the vane is semicircular and velocity of jet is double the velocity of Vane. 10
- b. A jet of water of diameter 75 mm strikes a curved plate at its centre with a velocity of 20 m/s. The curved plate is at its centre with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of  $165^\circ$ . Assuming the plate smooth. Find; 10
- The force exerted on the plate in the direction of jet
  - Power of the Jet
  - Efficiency of jet.

#### UNIT - IV

- 7 a. Explain the classifications of turbines. 6
- b. Describe briefly the functions of various components of Pelton wheel turbine with neat sketch. 6
- c. A Pelton wheel is to be designed for the following specifications: shaft power = 11772 kW, head = 380 m, speed = 750 rpm,  $\eta_o = 86\%$  and Jet dia =  $\frac{1}{6}$  of wheel dia. Determine; 8
- Wheel dia
  - Number of Jets
  - dia of Jet. Take  $C_v = 0.985$  and  $\phi = 0.45$ .
- 8 a. Compare Francis turbine with Kaplan turbine. 6
- b. With a neat sketch explain the components of a Francis turbine. 6
- c. The hub diameter of a Kaplan turbine working under a head of 12 m is 0.35 times the diameter of the runner. The turbine is running at 100 rpm. If the vane angle of the extreme edge of runner at outlet is  $15^\circ$  and flow ratio 0.6 find; 8
- Diameter of the runner
  - Diameter of the boss
  - Discharge through the runner. Velocity of whirl at outlet is given as zero.

#### UNIT - V

- 9 a. What is a draft tube? What are its functions? Sketch different types of draft tube. 8
- b. Define specific speed. Derive the equation for specific speed. 6
- c. A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 cumecs. If the efficiency is 90%. Determine the performance of the turbine under a head of 20 m. 6
- 10 a. Explain the working of centrifugal pump with a sketch. 6
- b. Derive the expression for minimum speed of starting of a centrifugal pump. 6
- c. A centrifugal pump running at 1450 rpm discharges 110 liter/sec against a head of 23 m. If the diameter of the impeller is 250 mm and its width is 50 mm, find the Vane angle at the outer periphery. The manometric efficiency of the pump is 75%. 8