



# 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; May/June - 2019 Hydraulics and Hydraulic Machines

Time: 3 hrs

Max. Marks: 100

**Note:** i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.  
ii) Assume missing data suitably.

### UNIT - I

- 1 a. What do you mean by open channel flow? Give the classifications of open channels with examples. 6
- b. Derive the conditions for hydraulic efficient trapezoidal channel section and show that hydraulic radius is half the depth of flow. 6
- c. A rectangular channel 4 m wide has a depth of water 1.5 m. The slope of channel is 1 in 1000 and value of  $C = 55$ . It is desired to increase the discharge to a maximum by changing the dimensions of section for constant area of cross section, slope and roughness of the channel. Find the new dimensions of the channel and increase in discharge. 8
- 2 a. Distinguish between; i) Uniform flow and Non-uniform flow 6  
ii) Subcritical flow and Super critical flow 6  
iii) Alternate depth and Conjugate depth
- b. Define hydraulic jump. Derive the expressions for depth of hydraulic jump in terms of upstream Froude's number. 6
- c. Water flows at  $12.5 \text{ m}^3/\text{s}$  in a channel of 2 m wide at a velocity of 1.2 m/s. Calculate specific energy head. Find also the critical depth, critical velocity and value of minimum specific energy. 8

### UNIT - II

- 3 a. Define dimensional homogeneity. List uses of dimensional analysis. 6
- b. State and explain Buckingham  $\pi$  theorem of dimensional analysis. Highlighting the repeating variables. 6
- c. Find an expression for the drag force on a smooth sphere of diameter  $d$  moving with uniform velocity  $V$  in a fluid of density  $\rho$  and dynamic viscosity  $\mu$  by Rayleigh's method. 8
- 4 a. What do you mean by model analysis? Give the advantages of model analysis. 6
- b. Distinguish between; 6  
i) Geometric similarity and Kinematic similarity 6  
ii) Undistorted model and Distorted model 6  
iii) Reynold's number and Froude's number
- c. In a 1:40 model of a 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. If the energy dissipated in the model is 1/10 kW, what is the corresponding value in the prototype? 8

**UNIT - III**

- 5 a. State the impulse momentum principle and hence obtain an expression for the force exerted by a jet water on a fixed vertical plate. 6
- b. Show that the efficiency of jet striking on a series of curved vanes mounted in the periphery of wheel is 100%. 8
- c. A jet having a diameter 75 mm with a velocity of 30 m/s strikes a flat plate held normal to the direction of jet. Estimate the force exerted and work done by the jet. If, 6
- i) The plate is stationary
- ii) The plate is moving with velocity of 15 m/s away from the jet in the same direction
- 6 a. Prove that curved vanes are hydraulically efficient than flat vanes. 6
- b. Show that efficiency of a jet striking normally on a series of flat plates mounted on the periphery of a rotating wheel never exceeds 50%. 8
- c. A jet of water diameter 100 mm strikes a curved vane at its centre with a velocity of 15 m/s. The curved vane is moving with a velocity of 7 m/s in the direction of the jet. The jet is deflected through an angle of  $150^\circ$ . Assume vane to be smooth. Evaluate; 6
- i) Force exerted on the vane in the direction of jet    ii) Power of the jet    iii) Efficiency

**UNIT - IV**

- 7 a. Define hydraulic turbine. Give the classifications of turbines with example. 6
- b. With a neat sketch, explain the various components of a Pelton wheel turbine. 6
- c. Design a pelton wheel turbine for a head of 80 m runs at 300 rpm develops 110 kW power. Take;  $C_v = 0.98$ ,  $K_u = 0.48$  and overall efficiency = 80%. 8
- 8 a. With a neat sketch, explain the various components of a Francis turbine. 8
- b. Bring out the differences between Francis and Kaplan turbine. 6
- c. A Kaplan turbine develops 58800 kW under a head of 25 m with an overall efficiency of 90%. Take;  $K_u$  as 1.6 and  $\psi = 0.5$  and hub diameter as 0.35 times the outer diameter, find the diameter and speed of the turbine. 6

**UNIT - V**

- 9 a. What is a draft tube? Why it is employed? Describe different types of draft tubes with neat sketches. 8
- b. Define specific speed. Derive the expression for the same state its significance. 6
- c. A turbine develops 10000 kW under a head of 20 m at 150 rpm. What is the specific speed? What type of the turbine? What would be its normal speed and output under a head of 25 m? 6
- 10 a. With neat sketches, explain the working of a centrifugal pump. 8
- b. Obtain an expression for minimum starting speed of a centrifugal pump. 6
- c. A centrifugal pump runs at 1000 rpm delivers water against a head of 15 m. The impeller diameter and width at outlet are 0.3 m and 0.05 m respectively. Vanes are curved back at angle of  $30^\circ$  with periphery at outlet. Find the discharge. Take;  $\eta_{mano} = 0.92$ . 6