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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; 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 valve 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
ii) Subcritical flow and Super critical flow
iii) Alternate depth and Conjugate depth 6

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 m^3/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 π 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 ρ and dynamic viscosity μ by Rayleigh's method. 8

4 a. What do you mean by model analysis? Give the advantages of model analysis. 6

b. Distinguish between;
i) Geometric similarity and Kinematic similarity
ii) Undistorted model and Distorted model
iii) Reynold's number and Froude's number 6

c. In a 1:40 model of a spillway the velocity and discharge are 2 m/s and 2.5 m^3/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

Contd….2

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 values 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°. 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 impller diameter and width at outlet are 0.3 m and 0.05 m respectively. Vanes are curred back at angle of 30° with periphery at outlet. Find the discharge. Take; $\eta_{mano} = 0.92$. 6

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