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

(An Autonomous Institution affiliated to VTU, Belgaum)

Fourth Semester, B.E. - Civil Engineering

Semester End Examination; June/July - 2015

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 suitable missing data if any.

UNIT - I

1. a. Derive Chezy's equation for discharge through an open channel. 10

   b. A trapezoidal channel with a side slope of 1:1 has to be designed to convey 10 m^3/s at a velocity of 2 m/s, so that the amount of concrete lining for the bed and the sides is minimum. Calculate the area of lining required for one metre length of the canal. 10

2 a. What is specific energy curve? Draw the specific energy curve, and derive the expression for critical depth and critical velocity. 8

   b. Derive the condition for maximum discharge for the given value of specific energy. 6

   c. The depth of flow of water, at a certain section of rectangular channel of 2 m wide is 0.3 m. The discharge through the channel is 1.5 m^3/s. Determine whether a hydraulic jump will occur and if so, find its height and the loss of energy per kg of water. 6

UNIT – II

3 a. Distinguish between dimensional analysis and model analysis. 6

   b. State Buckingham's π - theorem. Why this theorem is considered superior over Raykigh's method of dimensional analysis. 6

   c. Find the expression for power P, developed by a pump when P depends upon the head H, the discharge Q and the specific weight w of the fluid. 8

4 a. Define similitude. Explain different types of similarities between model and proto type. 10

   b. A 1:15 model of a flying boat is towed through water. The prototype is moving in the sea water of density 1024 kg/m^3 at a velocity of 20 m/s. Find the corresponding speed of the model. Also determine the resistance due to waves on the model, if the resistance due to waves of prototype is 600 N. 10

UNIT - III

5 a. Show that the angle of swing of a vertically hanged plate is given by $\sin\theta = \frac{\rho a v^2}{W}$ 10

   b. A plate is acted upon at its centre by a jet of water of diameter 20 mm with a velocity of 20 m/s. The plate is hinged and is deflected through an angle of 15º. Find the weight of the plate. If the plate is not allowed to swing, what will be the force required at the lower edge of the plate to keep the place in the vertical position. 10

Contd…2

6 a. Show that the efficiency of a free jet striking normally on a series of flat plates mounted on the periphery of a wheel can never exceeds 50%. 10

b. A jet of water having a velocity of 40 m/s strikes a curved vane, which is moving with a velocity of 20 m/s. The jet makes an angle of 30º with the direction of the motion of the vane at the inlet and leaves at an angle of 90º to the direction of the motion of the vane @ the outlet. Draw the velocity triangles @ inlet and outlet and determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock. 10

UNIT - IV

7 a. Define turbine. Explain with a neat sketch general layout of a hydro electric power plant. 10

b. A Pelton wheel is having a mean bucket diameter of 1 m and is running at 1000 r.p.m. the net head on the Pelton wheel is 700 m. If the side clearance angle is 15º and the discharge through the nozzle is 0.1 m^3/s, find, 10

i) Power available @ the nozzle and ii) Hydraulic efficiency of the turbine.

8 a. Obtain the expression for unit speed, unit discharge and unit power of a turbine. 6

b. What are the unit quantities? Define the unit quantities of a turbine. Why are they important? 6

c. A Kaplan turbine runner is to be designed to develop a 100 kW. The net available head is 5.6 m. If the speed ratio is 2.09, flow ratio is 0.68, overall efficiency is 86% and the diameter of the boss is $\frac{1}{3}$ the diameter of the runner. Find the diameter of the runner, its speed and specific speed of the turbine. 8

UNIT - V

9 a. What is a draft tube? Why it is used in the reaction turbine? Describe with a neat sketches different types of draft tubes. 10

b. A conical draft tube having diameter at the top has 2 m and the pressure head of 7 m of water (Vacuum), discharges water at the outlet with a velocity of 1.2 m/s at the rate of 25 m^3/s. If the atmospheric pressure head is 10.3 m of water and the losses between the inlet and the outlet of the draft tubes are negligible, find the length of the draft tube immersed in water. Total length of tube is 5 m. 10

10 a. Define the specific speed of a centrifugal pump. Derive the expression for the same. 10

b. A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 r.p.m. the vanes are curved back to an angle of 30º with the periphery the impeller diameter is 300 mm and the outlet width is 50 mm. Determine the discharge of the pump, if the manometric efficiency is 95%. 10

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