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10CV45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Hydraulics and Hydraulic Machines

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer any FIVE full questions, selecting at least TWO full questions from each part.
 2. Missing data if any may be assumed suitably.

PART – A

- 1 a. Define and explain the following:
 - i) Froude's Number
 - ii) Hydraulic similarities
 - iii) Distorted and undistorted models. (06 Marks)
- b. Derive an expression for the Reynold's number. Also explain the significances of this number is model analysis. (06 Marks)
- c. A 1:15 model of a flying boat is towed through water. The prototype is moving in sea water of density 1024kg/m^3 at a velocity of 20m/s . Find the corresponding speed of the model. Also determine the resistance due to waves on model if the resistance due to waves of prototype is 600N . (08 Marks)

- 2 a. Explain the terms
 - i) Rapidly varied flow
 - ii) Gradually varied flow. (04 Marks)
- b. Prove the condition for maximum discharge for circular section for most economical circular channel. (08 Marks)
- c. The rate of flow of water through a circular channel of diameter 0.6m is 150 litres/s . Find the slope of the bed of the channel for maximum velocity. Take $C = 60$. (08 Marks)

- 3 a. Show that in a rectangular channel the critical depth is two third of specific energy. (04 Marks)
- b. Explain the term hydraulic jump. Derive an expression for the depth of hydraulic jump. Also list out its assumptions. (08 Marks)
- c. Find the slope of the free water surface in a rectangular channel of width 20m having depth of flow 5m . The discharge through the channel is $50\text{m}^3/\text{s}$. The bed of the channel is having a slope of 1 in 4000. Take the value of Chezy's $C = 60$. (08 Marks)

- 4 a. Show that the angle of swing of a vertical hinged plate is given by $\sin \theta = \frac{\rho a v^2}{w}$. (06 Marks)
- b. Derive an expression for the force exerted by a jet on stationary inclined flat plate. (06 Marks)
- c. A jet of water of diameter 75mm moving with a velocity of 30m/s , strikes a curved fixed plate tangentially at one end at an angle of 30° to the horizontal. The jet leaves the plate at an angle of 20° to the horizontal. Find the force exerted by the jet on the plate in the horizontal and vertical direction. (08 Marks)

**PART – B**

- 5 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 exceed 50%. **(08 Marks)**
- b. A jet of water having a velocity of 40m/s strikes a curved vane, which is moving with a velocity of 20m/s. The jet makes an angle of 30° with the direction of motion of vane at inlet and leaves at angle of 90° to the direction of motion of vane at outlet. Draw the velocity triangles at inlet and outlet and determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock. **(08 Marks)**
- c. Explain the term Impact of jet. **(04 Marks)**
- 6 a. Explain the different types of the efficiency of a turbine. **(04 Marks)**
- b. Obtain an expression for the work done/sec by water on the runner of a pelton wheel. Hence derive an expression for maximum efficiency of the pelton wheel giving the relationship between the jet speed and bucket speed. **(08 Marks)**
- c. Determine the power given by the jet of water to the runner of a pelton wheel which is having tangential velocity as 20m/s. The net head on the turbine is 50m and discharge through the jet water is $0.3\text{m}^3/\text{s}$. The side clearance angle is 15° and take $C_v = 0.975$. **(08 Marks)**
- 7 a. What do you understand by the characteristic curve of a turbine? Also explain with a neat sketch ISO-efficiency curves in a turbine. **(06 Marks)**
- b. With a neat sketch, explain the turbine for which the vanes on the hub are adjustable. **(06 Marks)**
- c. A conical draft-tube having diameter at the top as 2.0m and pressure head at 7m of water (vacuum) discharges water at the outlet with a velocity of 1.2m/s at the rate of $25\text{m}^3/\text{s}$. If atmospheric pressure head is 10.3m, of water and losses between the inlet and outlet of the draft-tubes are negligible. Find the length of draft tube immersed in water. Total length of tube is 5m. **(08 Marks)**
- 8 a. Define specific speed of a centrifugal pumps. Derive an expression for the same. **(06 Marks)**
- b. Obtain an expression for the work done by impeller of a centrifugal pump on water/sec per unit weight of water. **(06 Marks)**
- c. A centrifugal pump delivers water against a net head of 14.5m and a design speed of 1000rpm. The vanes are curved back to an angle of 30° with the periphery. The impeller diameter is 300mm and outlet width is 50mm. Determine the discharge of the pump if manometric efficiency is 95%. **(08 Marks)**

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