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10CV45

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What is meant by dimensional homogenity of an equation? Explain with an example. **(05 Marks)**

b. Define and give expressions for,
i) Reynolds number
ii) Froude number
iii) Euler's number
iv) Weber number and
v) Mach number. **(05 Marks)**

c. A spill way model is to be built to a geometrically similar scale of 1/50 across a flume of 600mm width. The prototype is 15m high and maximum head on it is expected to be 1.5m. i) What height of the model and what head on the model should be used? ii) If the flow over the model at a particular head is 12 litre/s, what flow per metre length of the prototype is expected? iii) If the negative pressure in the model is 200mm, what is the negative pressure in prototype? Is it practicable? **(10 Marks)**

2 a. Derive an expression for discharge through open channel by Chezy's formula and obtain an expression for conveyance. **(10 Marks)**

b. A trapezoidal channel carries water of $25 m^3/s$ which has a side slope of 60°. Find the most economical channel cross section if C = 50 and slope of bed is 1 in 1000. [C = Chezy's constant]. **(10 Marks)**

3 a. Draw a typical plot of depth of flow v/s specific energy for a non-uniform flow and label the curves of energy. Further indicate point of critical depth, region of supercritical flow and subcritical flow. **(10 Marks)**

b. A rectangular channel of 8m wide discharges water through a sluice gate with a depth of flow of 0.4m, and velocity 6 m/s. Find whether hydraulic jump will occur and if so, find the height of hydraulic jump and loss of energy per kg of water. Also find the power lost in hydraulic jump. **(10 Marks)**

4 a. Using impulse-momentum principle, derive an expression for force normal to plate by the impact of jet at the centre of a stationary inclined plate. Further derive expressions for force in the direction of jet and normal to jet. The profile of plate is flat. **(10 Marks)**

b. A jet of water 150mm diameter strikes a series of flat plate normally with a velocity of 12m/s. The plate is moving with a velocity of 6m/s in the direction of jet. Find: i) the force exerted by the jet on the plate; ii) Work done by the jet on the plate per second; ii) Power of the jet; iv) Efficiency of moving plate. **(10 Marks)**

PART – B

5 a. Show that for a moving symmetrical curved vane impinged by a jet of water at the centre, the maximum hydraulic efficiency is given by, $\frac{8}{27}(1+\cos\theta)$, where θ = angle of deflection of water from the vane. **(10 Marks)**

b. A jet of water having velocity of 45 m/s impinges without shock on a series of vanes moving at 15m/s, the direction of motion of vanes being inclined at 20° to that of jet. The relative velocity at the outlet is 0.9 times of that at inlet. Absolute velocity of water at exit is to be normal to the motion of vanes. Find: i) Vane angles at entrance and exit; ii) Hydraulic efficiency. **(10 Marks)**

6 a. Draw energy block diagram of a Pelton wheel arrangement showing nozzle, Pelton wheel, shaft and give expressions for i) Power at the nozzle; ii) Kinetic energy of jet outside the nozzle; iii) Hydraulic power after the Pelton wheel; iv) Shaft power; v) Nozzle efficiency; vi) Hydraulic efficiency; vii) Mechanical efficiency and viii) Overall efficiency. **(10 Marks)**

b. Design a Pelton wheel turbine required to develop 1475 kW of power under a head of 160m at 410 rpm. Take overall efficiency as 85% and coefficient of velocity in the nozzle as 0.98 and speed ratio as 0.48, jet ratio = 12. **(10 Marks)**

7 a. Draw a neat diagram of cross section of a Kaplan turbine and explain its working principle. **(10 Marks)**

b. The hub diameter of a Kaplan turbine, working under a head of 12m, is 0.35 times the diameter of the runner. The turbine is running at 100rpm. If the vane angle of the extreme edge of the runner at outlet is 15°, and flow ratio = 0.6, find: i) Diameter of the runner; ii) Diameter of the boss and iii) Discharge through the runner.
Assume velocity of whirl at outlet as zero. **(10 Marks)**

8 a. For a centrifugal pump, write the definition and expression for i) Manometric efficiency; ii) Mechanical efficiency; iii) Overall efficiency in terms of manometric head, blade speed at outlet and velocity of whirl at outlet. **(10 Marks)**

b. A four stage centrifugal pump has four identical impellers, keyed to same shaft. The shaft is running at 400rpm and the total manometric head developed by the multistage pump is 40m. The discharge through pump is 0.2 m^3/s. The vanes of each impeller are having outlet angle as 45°. If the width and diameter of each impeller at outlet is 5cm and 60cm respectively. Find the manometric efficiency. **(10 Marks)**

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