Hall Ticket No | | | | | | | | | | | Question Paper Code: ACE011

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R16

HYDRAULICS AND HYDRAULIC MACHINES

Time: 3 Hours **(CE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) A channel is designed to carry a discharge of 20 m^3/s with Manning's n = 0.015 and bed slope of 1 in 1000 . Find the channel dimensions for the most efficient section if the channel is
(i) Trapezoidal (side slope = $\frac{1}{\sqrt{3}}$) **[7M]**
(ii) Rectangular.

(b) A rectangular channel 2 m deep and 8 m wide is running full of water. The slope of the channel bed is 1 in 950. Take Chezy's constant(C) as 50. Calculate the discharge through the channel. **[7M]**

2. (a) Calculate the specific energy, critical depth and the velocity of the flow if the discharge of the flow is 10 m^3/s in a cement lined rectangular channel 2.5m wide with 2 m depth of water. Is the given flow is sub critical or super critical? **[7M]**

(b) A power canal of trapezoidal section has to be excavated through hard clay at the least cost. Determine the dimensions of the channel Given: discharge equal to 14 m^3/s, bed slope 1/2500, Manning's n = 0.02. **[7M]**

UNIT – II

3. (a) Explain the different types of similarities that must exist between a prototype and its model. **[7M]**

(b) The resistance R experienced by a partially submerged body depends upon the velocity 'V', length 'L', viscosity 'μ', mass density 'ρ' and acceleration due to gravity 'g'. Obtain a dimensionless expression for R. Using Buckingham-π theorem. **[7M]**

4. (a) Using Buckingham's π theorem, determine the expression for velocity of a fluid flowing through a circular orifice (v) which depends on head causing the flow (H), diameter of the orifice (D), coefficient of viscosity (μ), mass density (ρ) and acceleration due to gravity (g). **[7M]**

(b) A 7.2 m height and 15 m long spill way discharges 94 m^3/s discharge under a head of 2.0 m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If the model experiences a force of 7500 N, determine force on the prototype. **[7M]**

UNIT – III

5. (a) Explain in detail the force exerted by a jet on a moving plate with a neat sketch. **[7M]**

   (b) Find the force exerted by a jet of water of diameter 7.5 cm on a stationary flat plate with a velocity of 20 m/sec.
   (i) Normally (ii) At an angle of 45^0 **[7M]**

6. (a) Derive an expression for the impact of jet hitting a moving symmetrical curved vane at its center with a neat sketch. **[7M]**

   (b) A nozzle has an exit diameter of 15 mm and discharges water into the atmosphere. The gauge pressure behind the nozzle is 400kPa. The coefficient of velocity is 0.98 and there is no contraction of the jet. The jet hits a stationary flat plate normal its direction. Determine the forces on the plate. The density of water is 1000 kg/m^3. Assume the velocity of approach into the nozzle is negligible. **[7M]**

UNIT – IV

7. (a) The following data pertain to a Kaplan turbine. Power available at shaft = 8850 kW, Net available head = 5.5m, Speed ratio=2.1, flow ratio=0.67, overall efficiency=85%, Assuming that hub diameter of the wheel is 0.35 times the outside diameter, determine **[7M]**
   (i) Runner diameter
   (ii) Runner speed

   (b) Design a Francis turbine runner with the following data. Net head = 68m, speed = 750 rpm, output power = 330 kW, hydraulic efficiency = 94%, overall efficiency = 85%, flow ratio = 0.15, breadth ratio = 0.1, inner dia of runner is 0.5 outer dia. Also assume 6% of circumferential area of the runner to be occupied by the thickness of the vanes. Velocity of flow remains constant throughout the flow and is radial at exit **[7M]**

8. (a) What is a draft tube? Explain the uses of draft tube and mention some engineering applications of it. **[7M]**

   (b) A Pelton wheel has to develop 13230 kw under a net head of 80m running at a speed of 600 rpm. If the C_v = 0.97, speed ratio = 0.46, ratio of jet diameter is 1/6 of wheel diameter, calculate the number of jets required for the Pelton wheel. Assume overall efficiency 85%. Also calculate diameter of jet and diameter of pitch circle. **[7M]**

UNIT – V

9. (a) Explain the working of single acting reciprocating pump with a neat sketch. **[7M]**

   (b) A double acting reciprocating pump has piston of diameter 250 mm and piston rod of diameter 50mm which is on one side only. Length of piston stroke is 350 mm and speed of crack moving the piston is 60 rpm. The suction and delivery heads are 4.5 m and 18m respectively. Determine the discharge capacity of the pump and the power required to operate the pump. **[7M]**

10. (a) Describe the working principle of a cetrifugal pump with a neat sketch. **[7M]**

    (b) A centrifugal pump works against a head of 30 m and discharges 0.25 m^3/s while running at 1000 rpm. The velocity of flow at the outlet is 3 m/s and the vane angle at outlet is 30^0. Determine the diameter and width of the impeller at outlet if the hydraulic efficiency is 80%. **[7M]**

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