II B.Tech II Semester Supplementary Examinations,
November/December 2005
HYDRAULICS AND HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss the factors affecting Chezy's c and Manning's n. What are the different values of 'n' for different surfaces?
   (b) Determine the dimensions of an economical Trapezoidal section of an open channel with sides slope 2H:1V laid at a slope of 1 in 1600 to carry a discharge of 36 cumecs assuming chezy's coefficient C = 50. [8+8]

2. (a) Show that for an open channel of any section Froude number is unity when the specific force for a given discharge is minimum.
   (b) Calculate the critical specific depth, critical velocity and critical specific energy for a flow of 12 m^3/S in a rectangular channel of width 3.5 m and energy coefficient 1.1. What is the state of flow when the depth is 0.9 m? What is the Froude number at this depth? [8+8]

3. Water flows at a steady and uniform depth of 2 m in an open channel of rectangular cross - section having base width equal to 5 m and laid at a slope of 1 in 100. It is desired to obtain critical flow in the channel by providing a hump in the bed. Calculate hump height and sketch the flow profile. Consider the value of Mannings rugosity coefficient n = 0.02 for the channel surface. [16]

4. By dimensional analysis obtain an expression for the drag force R on a partially submerged body moving with a relative velocity V in a fluid; the other variables being the linear dimension l , height of surface roughness K, fluid density ρ, and the gravitational acceleration g. [16]

5. (a) Find the expression for the force exerted by the jet on a flat vertical plate moving in the direction of the jet. [8+8]
   (b) A jet of diameter 150mm strikes a flat plate normally with a velocity of 20m/sec. The plate is moving with a velocity of 5m/sec in the direction of the jet and away from the jet. Find
      i. The force exerted by the jet on the plate
      ii. Wok done by the jet on the plate per second.

6. Obtain an expression to the work done per second 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 the bucket speed. [16]

7. (a) Tests were conducted on a Francis turbine of 0.8m diameter under a head of 9m. The turbine developed 115 KW running at 240 rpm and consuming 1.2 m^3/sec. If the same turbine is operated under a head of 16m predict its new speed, discharge and power. [10]

   (b) What are the requirements of a governor in hydropower Installation? [6]

8. (a) Draw typical characteristic curves for a centrifugal pump at constant speed and explain how the specific speed is determined from these curves.

   (b) The impeller of a centrifugal pump has 1.2m outside diameter. It is used to lift 1.8 m^3/s of water to a height of 6m. Its blades make an angle of 150^0 with the direction of motion at outlet and runs at 200 rpm. If the radial velocity of flow at outlet is 2.5m/s, find the useful H.P and efficiency. [8+8]

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1. (a) Derive the condition for depth of flow of a most economical circular channel section subject to the condition for maximum velocity.
   (b) Water flows in a channel of the shape of isosceles triangle of bed width 'a'and sides making an. angle of 45^0 with the bed. Determine the relation between depth of flow d., and the bed width 'a' for maximum velocity and for maximum discharge condition. Use Manning's formula and note that d is less than 0.5 a. [8+8]

2. (a) Explain the term's specific energy of a flowing liquid, minimum specific energy, critical depth, critical velocity and alternate depths as applied to non-uniform flow.
   (b) A river is 30 m wide and has a rectangular shape. At a bridge location the flow width is restricted to 25 m by the piers of the bridge and the river bed is approximately horizontal. Describe the flow, which obtains underneath the bridge with minimum upstream depth when a flood of 450 m^3/s flows in the river. Also determine the upstream depth. [8+8]

3. Water flows at a steady and uniform depth of 2 m in an open channel of rectangular cross - section having base width equal to 5 m and laid at a slope of 1 in 100. It is desired to obtain critical flow in the channel by providing a hump in the bed. Calculate hump height and sketch the flow profile. Consider the value of Mannings rugosity coefficient n = 0.02 for the channel surface. [16]

4. (a) What do you mean by scale effect? [6]
   (b) Name and discuss the dimension-less numbers generallyused in fluid flow problems. [10]

5. (a) Show that the efficiency of free jet striking normally on a series of flat plates mountedon the periphery of a wheel can never exceed 50%.
   (b) A jet of water of diameter 50mm moving with a velocity of 40m/sec, strikes a curved fixed symmetrical plate at the center. Find the force exerted by the jet of water in the direction of the jet, if the jet is deflected through an angle of 120^0 at the outlet of the curved plate. [8+8]

6. A Pelton wheel working under a head of 500m has an overall efficiency of 85% and runs at 400 rpm, and developes 7000 kw of power. Taking the bucket speed as 0.47 times the jet speed and assuming Cv = 0.97, find [16]

(a) The wheel diameter and

(b) The jet diameter

7. (a) What do you understand by unit speed of a turbine? What is its use? Derive the equation for specific speed.

   (b) What are the constant efficiency curves of a turbine? What are their uses? [8+8]

8. (a) If a centrifugal pump does not deliver any water when started, what may be the probable causes and how can they be remedied ? [6]

   (b) The impeller of a centrifugal pump is 35 cm outside diameter and 17.5 cm internal diameter. The vane angles of the impeller at inlet and outlet are 30^0 and 25^0 respectively. The pump runs at 1400 rpm. The velocity of flow through the impeller is constant. Find the work done by the impeller per second per kg of water. [10]

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Code No: RR220103 **Set No. 3**

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1. (a) Derive the condition for depth of flow of a most economical circular channel section subject to the condition for maximum velocity.
   (b) Water flows in a channel of the shape of isosceles triangle of bed width 'a'and sides making an. angle of 45^0 with the bed. Determine the relation between depth of flow d., and the bed width 'a' for maximum velocity and for maximum discharge condition. Use Manning's formula and note that d is less than 0.5 a. [8+8]

2. (a) What do you mean by critical slope of an open channel. How do you evaluate it?
   (b) Construct the specific force diagram for a discharge of 2.5 m^3/S through a rectangular channel of width 2 m. using the diagram, estimate the critical depth minimum specific force and conjugate depths for a specific force of 1.1 m^3. The following depths of flow may be used in computations and in drawing the graph: 0.3, 0.4, 0.5, 0.6, 0.7 and 0.9 m. [8+8]

3. (a) What is direct method of finding length of water profile in open channel.
   (b) Water at a velocity of 8 m/s and at a depth of 1 m is flowing through a rectangular channel 8 m wide. Determine whether a hydraulic jump will occur, and if so, calculate the depth of water after the jump and power lost. [8+8]

4. Define the following dimensionless numbers with their suitability: [4 x4 =16]
   (a) Reynold's Number.
   (b) Froude's Number.
   (c) Euler's Number.
   (d) Weber Number.

5. (a) Define momentum equation. Write any two applications. [6]
   (b) A rectangular plate weighing 60N is suspended vertically by a hinge on the top horizontal edge. The center of gravity of the plate is 100mm from the hinge. A horizontal jet of water 20mm diameter, whose axis is 150mm below the hinge, impinges normally on the plate with a velocity of 5m/sec. find the horizontal force applied at the C.G to maintain the plate in its vertical position. Find the corresponding velocity of the jet, if the plate is deflected through 30^0 and the same force continues to act at the C.G of the plate. [10]

6. An outward flow reaction turbine has inner and outer diameter of the wheel as 1000mm and 2000 mm respectively. The water enters the vane at an angle of 20^0 and leaves the vane radially. If the velocity of flow remains constant at 10m/sec and the speed of the wheel is 300rpm, find the vane angles at inlet and outlet.[16]

7. (a) A model turbine 1m in diameter acting under a head of 2m runs at 150 rpm. Estimate the scale ratio if the prototype develops 20 KW under a head of 225 m with a specific speed of 100. [10]

   (b) What are the physical indicators for the presence of cavitation in turbines? [6]

8. (a) What are the limitations for installing a centrifugal pump above the liquid surface in the sump ? [6]

   (b) A centrifugal pump has to work against a head of 25 m at a speed of 850 rpm. The flow component of the velocity at outlet is 2.5 m/s. The outlet vane angle is 40^0. If the discharge of the pump is 0.25 cumec find [10]

      i. The diameter of the impeller and

      ii. The width of impeller at outlet. Neglect losses.

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Code No: RR220103 **Set No. 4**

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2. (a) What is critical flow? Derive the condition for maximum discharge for a given value of specific energy.
   (b) The specific energy for a 6 m wide rectangular channel is to be 5 kg-m/kg. If the rate of flow of water through the channel is 24 m^3/s. Determine the alternate depths of flow. [8+8]

3. (a) What are the different types of slopes in open channel flow? Explain
   (b) Water flows at the rate of 1 cumec along a channel of rectangular section 1.60 metres in width. Calculate the critical depth, if a standing wave occurs at a point where the upstream depth is 0.25 metre. What would be the rise in water level produced and the horse power lost in the standing wave? [8+8]

4. (a) State whether the following equations are dimensionally homogeneous [6]
      i. Q = Πdbv
      ii. Q = C_d a $\sqrt{2gh}$
      iii. Q = Ac $\sqrt{mi}$
   (b) What are the fields of application of Froude's Law and Mach Law? [10]

5. (a) Define momentum equation. Write any two applications. [6]
   (b) A rectangular plate weighing 60N is suspended vertically by a hinge on the top horizontal edge. The center of gravity of the plate is 100mm from the hinge. A horizontal jet of water 20mm diameter, whose axis is 150mm below the hinge, impinges normally on the plate with a velocity of 5m/sec. find the horizontal force applied at the C.G to maintain the plate in its vertical position. Find the corresponding velocity of the jet, if the plate is deflected through 30^0 and the same force continues to act at the C.G of the plate. [10]

6. An outward flow reaction turbine has inner and outer diameter of the wheel as 1000mm and 2000 mm respectively. The water enters the vane at an angle of 20^0 and leaves the vane radially. If the velocity of flow remains constant at 10m/sec and the speed of the wheel is 300rpm, find the vane angles at inlet and outlet.[16]

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      i. The diameter of the impeller and

      ii. The width of impeller at outlet. Neglect losses.

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