Code: 9A01402

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B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013
HYDRAULICS & HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours　　　　　　　　　　　　　　　　　　　　　　　　　　　Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
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1　(a)　State and explain Bazin's formula for determining the constant C.
　(b)　For a flow in a rectangular channel of width 5 m and depth of flow 2.3 m, the Darcy-Weisbach friction factor is estimated to be 0.02. Estimate the values of Chezy's 'C' and Manning's 'n'.

2　　　Write short note on integration method of solving GVF equation.
　　　A rectangular channel carries a discharge of 3 cumecs per m width. If the loss of energy in the hydraulic jump is found to be 3.2 m, determine the conjugate depths before and after the jump.

3　　　Explain in detail about Rayleigh's method of dimensional analysis. What are the practical uses?

4　(a)　Derive the expression for the force exerted by a jet of water on an inclined fixed plate in the direction of the jet.
　(b)　A jet of water of diameter 100 mm moving with a velocity of 30 m/s 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.

5　(a)　Assuming the required data, design a pelton wheel to generate a power of 1.5 MW when working under a head of 150 m and a speed of 450 rpm.
　(b)　A Kaplan turbine develops 2150 KW under a head of 7.5 m with an overall efficiency of 88%. It is fitted with an elbow type draft tube having efficiency of 90%.The inlet of the draft tube is 1.8 m in diameter. Determine how much above or below the tail race level should the draft tube inlet be set so that the vacuum pressure there does not exceed 48 cm of mercury.

6　(a)　What do you understand by specific speed of a turbine? What is its use?
　(b)　Define cavitation. What are the effects of cavitation? Give the necessary precautions against cavitation.

7　(a)　What is the principle behind a centrifugal pump and derive an expression for the minimum starting speed of a centrifugal pump.
　(b)　The internal and external diameters of the impeller of a centrifugal pump are 20 cm and 40 cm respectively. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20^0 and 30^0 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per kg. of water.

8　(a)　Discuss critically, how you plan a power house.
　(b)　The designed capacity of a hydropower plant is 1.32×10^5 KW. If the power generated in the plant is 9×10^4 KW, find the efficiency of the plant. If the peak discharge is 1.5 times the normal discharge, determine the plant capacity, plant factor and total energy produced in a year.

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1 (a) What is an open channel? What are the various types of open channel? Give examples. What causes the flow an open channel?

(b) The rate of flow of water through a circular channel of diameter 0.6 m is 150 lit/s. Find the slope of the bed of the channel for maximum velocity. Take C = 60.

2 (a) Distinguish between alternate, conjugate and sequent depths in open channel flow.

(b) A hydraulic jump occurs in a horizontal rectangular channel with sequent depths of 0.70 m and 4.2 m. Calculate the rate of flow per unit width, energy loss and the initial Froude number.

3 (a) What do you mean by model testing? What are pre requisites for model testing?

(b) Properties of a structure can be calculated by analytical method and by model analysis, which is more suitable? Why?

4 (a) Derive an expression for the hydraulic efficiency when a liquid jet strikes a single moving curved vane.

(b) A jet of water having a velocity of 35 m/s impinges on a series of vanes moving with a velocity of 20 m/s. The jet makes an angle of 30^0 to the direction of motion of the vanes when entering and leaves at an angle of 120^0. Draw the velocity triangle and find:
(i) The angles of vane tips so that water enters and leaves without shock.
(ii) The work done per unit weight of water entering the vanes and (iii) The efficiency.

5 The following data is given for a Francis turbine:
Net head = 70 m, speed = 600 r.p.m, shaft power = 367.875 KW, η_o= 85%, η_h = 95%, flow ratio = 0.25, breadth ratio = 0.1, outer diameter of the runner = 2 x inner diameter of runner. The thicknesses of vanes occupy 10% of the circumferential area of the runner. Velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine: (i) Guide blade angle. (ii) Runner vane angles at inlet and outlet. (iii) Diameters of runner at inlet and outlet and (iv) Width of wheel at inlet.

6 (a) A turbine develops 8000 KW at 100 r.p.m. The head on the turbine is 30 m. If the head is 15 m, determine the power developed and the speed.

(b) How do you govern the speed of an impulse turbine? Explain with a neat sketch.

7 (a) Explain the role of cavitation in centrifugal pumps.

(b) Two geometrically similar pumps are running at the same speed of 1440 r.p.m. One pump has an impeller diameter of 40 cm and lifts 1000 liters per minute of water against a head of 20 m. Determine the head and the impeller diameter of the second pump to deliver 50% discharge.

8 (a) Discuss critically the economics of a hydal power plant for power generation.

(b) The load on a hydal plant varies from a minimum of 10000 KW to a maximum of 35000 KW. Two turbo generators of capacities 22000 KW each have been installed. Calculate (i) Total installed capacity of the plant. (ii) Plant factor. (iii) Load factor and (iv) Utilization factor.
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1 (a) Derive the geometrical conditions for the most economical section of rectangular channel.
   (b) Compute the value N of a trapezoidal channel section having bottom width 10 m, $y = 2.5$ m side slope of 2 horizontal to 1 vertical.

2 (a) Explain mild slope flow profiles in open channels with neat sketches and examples.
   (b) In a horizontal rectangular channel 1.5 m wide, if the observed depths before and after the jump are 0.2 m and 1.0 respectively, determine the discharge flowing through the channel.

3 (a) Example the terms geometrical, kinematics and dynamic similarities.
   (b) Give the uses of Buckingham's pi theorem.

4 (a) Derive an expression for the force exerted by a jet of water on a moving inclined plate in the direction of the jet.
   (b) A water jet of 7.5 cm diameter with a velocity of 40 m/s strikes a flat plate inclined at 45^0 to the horizontal. Determine the normal force on the plate:
        (i) When the plate is stationary and (ii) When the plate moves with a velocity of 20 m/s in the direction of jet and away from it. Also find the power and efficiency of jet when the plate is moving.

5   Design a Francis turbine for the following data:
        (i) Gross head available = 80 m. (ii) Losses in the penstocks = 15% of gross head.
        (iii) Speed = 750 r.p.m. (iv) Output power = 340 KW. (v) Hydraulic efficiency = 94%.
        (vi) Overall efficiency = 85%.
        Assume 5% of the circumferential area of the runner is occupied by the thickness of vanes. The velocity of flow remains constant throughout. Assume any missing data suitably.

6 (a) Define specific speed of a turbine and derive an expression for the same.
   (b) What are the different types of governors? Explain them in brief.

7 (a) Sketch the velocity triangles at the inlet and outlet of a centrifugal pump identifying the various velocity components.
   (b) A centrifugal pump has an impeller 45 cm in diameter running at 450 rpm. The discharge at inlet is entirely radial. The velocity of flow at outlet is 1.2 m/s. The vanes are curved backwards at outlet at 30^0 to the wheel tangent. If the discharge of the pump is 0.15 cumec, calculate the impeller horse power and the torque on the shaft.

8 (a) Describe various investigations required in connection with hydro power development.
   (b) A run-of- river plant is installed on a river having a minimum flow of 11 m^3/sec. If the plant is used as a peak load plant operating only for 5 hours a day, determine the firm capacity of the plant (i) without pondage (ii) with pondage but allowing 10% of the water to be lost in evaporation and other losses. Head at the plant is 16 m and the plant efficiency may be assumed as 75%.
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1 (a) Distinguish between the: (i) Alternate depth and conjugate depth. (ii) Critical slope and normal slope.
   (b) A rectangular channel carries a discharge of 3 cumecs per m width. If the loss of energy in the hydraulic jump is found to be 3.2 m, determine the conjugate depths before and after the jump.

2 (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.

3 Explain in detail about Buckingham's pi theorem of dimensional analysis. Give one example.

4 (a) Find the expression for the force exerted by the jet on a flat vertical plate moving in the direction of the jet.
   (b) A 4 cm diameter water jet with a velocity of 25 m/s strikes normally a smooth flat plate. Find the thrust on the plate: (i) if the plate is at rest and (ii) if the plate moves in the direction of jet and away from it with a velocity of 10 m/s. Also find the work done/second and the efficiency of jet when the plate is moving.

5 An inward flow reaction turbine has an external diameter of 1 m and its breadth at inlet is 200 mm. If the velocity of flow at inlet is 1.5 m/s, find the mass of water passing through the turbine per second. Assume 15% of the area of flow is blocked by blade thickness. If the speed of the runner is 200 r.p.m and guide blades make an angle of 15^0 to the wheel tangent, draw the inlet velocity triangle and find:
   (i) The runner vane angle at inlet. (ii) Velocity of wheel at inlet.
   (iii) The absolute velocity of water leaving the guide vanes and
   (iv) The relative velocity of water entering the runner blade.

6 (a) Distinguish between specific speed and unit speed of a turbine.
   (b) How is the Kaplan turbine governed? Explain with a neat diagram.

7 (a) Write short notes on: semi-open impeller and open impeller pumps.
   (b) Describe with the help of diagrams, the variable speed and constant speed performance curves of a centrifugal pump.

8 (a) Explain with necessary equations, how the water power potential of a power house is assessed.
   (b) For a hydropower plant, the design capacity is 150 MW. If the generated power is125 MW, determine the efficiency of the plant. If the peak discharge is 1.5 times the average discharge, determine the plant capacity and the plant factor.

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