Code.No: 07A40103 | R07 | SET-1

II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
HYDRAULICS AND HYDRAULIC MACHINERY
(CIVIL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Define critical depth. Establish the following criterion for critical flow in an open Channel.
(i) $\frac{Q^2}{g}=\frac{A^3}{T}$ (ii) $\frac{V^2}{g}=\frac{A}{T}=D$ (iii) $F_r=1$

b) A rectangular channel 8 m wide and 1.5 m deep has a slope of 0.001 in 1 and is lined with smooth concrete plaster. It is desired to enhance the discharge to a maximum by changing the dimension of the channel but keeping the same lining, workout the new dimensions and percentage of increase in discharge. Assume Manning's constant n = 0.015. [8+8]

2.a) Distinguish between Gradually Varied Flow and Rapidly Varied Flow. Derive the differential equation for water surface in case of a steady Gradually Varied Flow in prismatic channel.

b) The depth of flow water at a certain section of rectangular channel of 2.35 m wide is 0.375m. The discharge through the channel is 1.65 m^3/s. Determine whether a hydraulic jump will occur and if so find its height and loss of energy per kg of water. [8+8]

3.a) What is meant by geometric, kinematic and dynamic similarities? Are these similarities truly attainable? If not why?

b) A 1: 6 model scale of a passenger car is tested in a wind tunnel. The prototype velocity is 60 kmph. If the model drag is 250 N, what is the drag and the power required to overcome the drag in the prototype. The air in the model and prototype can be assumed to have same properties. [8+8]

4. A jet of water having a velocity of 25m/s impinges on a series of vanes moving with a velocity of 17.5 m/s. The jet makes an angle of 40^o to the direction of motion of vanes when entering and leaves at an angle of 130^o. Draw the velocity triangles at inlet and outlet and find
i) The angles of vanes tip so that water enters and leaves without shock
ii) The work done for N of water entering the vanes and
iii) The efficiency. [16]

5.a) How do the losses in the draft tube effect the pressure at the runner exit. What is the efficiency of the draft tube?

b) A turbine is to operate under a head of 40 m and a speed of 350 r p m. The discharge is 12 m^3/s. If the efficiency of the turbine is 90% determine
i) The specific speed of the turbine
ii) Power generated and
iii) Type of turbine. [8+8]

6.a) What do you meant by Unit quantities and specific quantities? Explain the 'specific speed' of a turbine and deduce the expression for the same.
b) What are the characteristic curves of a hydraulic turbine? How are they useful to Practical Engineer? [9+7]

7.a) What is the role of volute and vortex chamber in a centrifugal pump.
b) What are the operating characteristic curves of a centrifugal pump? Explain them.
c) When are centrifugal pumps coupled in parallel? Sketch and explain. [5+6+5]

8.a) What are the different types of hydropower plants? Describe each one briefly?
b) Explain in detail various components of hydro power plants. [8+8]

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II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
HYDRAULICS AND HYDRAULIC MACHINERY
(CIVIL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Define the term economical section of channel. Show that a trapezoidal channel is most efficient when the sides are inclined at 60^0 to the horizontal.

b) The discharge of water rectangular channel of width 6.5 m is 18 m^3/s, when depth of water is 2.1 m. Calculate
i) Specific energy of flowing water
ii) Critical depth and critical velocity
iii) Value of minimum specific energy. [7+9]

2.a) Determine from first principle the conditions required for the formation of a hydraulic jump in the case of rectangular channel of constant width and calculate loss of head in terms of depth just before and after the jump.

b) A rectangular channel 6 m wide has a uniform slope of 1 in 2000 and a normal depth of flow is 0.90 m when flowing at 8.75 m^3/s. Now a dam is constructed across and water depth on upstream side of dam raises to 1.90m for the same discharge. Find how far the depth 1.5 m will be? [8+8]

3.a) Explain the distinction between Rayleigh's method and Buckingham's method of dimensional analysis.

b) Derive the relation $\Delta p = \rho V^2 \phi(R_e, K/D)$ for the pressure loss in turbulent flow through a rough pipe. Where V is average velocity through the pipe, ρ fluid density, R_e is Reynold's number, D is pipe diameter and k is average height of roughness Projections and ϕ is a functional notation. [8+8]

4.a) Derive an expression for work done per second in the case of a radial curved vane.

b) A jet of water of diameter 40 mm moving with a velocity of 22 m/s strikes a fixed plate in such a way that the angle between the jet and the plate is 60^0. Find the force exerted by the jet on the plate
i) in the direction normal to the plate
ii) in the direction of the plate. [8+8]

5.a) What is a draft tube? Why is it used in a reaction turbine? Explain with neat sketches Two different types of draft tubes.

b) Flow through a Pelton wheel turbine is 260 liters per second under a head of 300m. Determine the power developed and efficiency if the mean bucket speed is 32 m/s. The bucket deflects the jet through 160^0. Take C_V as 0.97. [9+7]

6.a) What are the requirements of a governor in hydropower Installation? Where servo motor is used in governing mechanism of turbines? Explain its use.

b) A Kaplan turbine is to develop 2400 kW when running at 250 r p m under a net head head of 49 m. In order to predict its performance a model of scale 1:5 is tested under a net head of 25m. At what speed should the model run and what power would it develop. Determine the discharge in the model and in full scale turbine if the overall efficiency of the model is 85%. [7+9]

7.a) Discuss in general the important operating characteristic curves of a centrifugal pump.

b) What is meant by priming? Why it is necessary?

c) A single stage centrifugal pump with impeller diameter of 0.3 m rotates at 2000 r p m and lifts 3 m^3 of water per second to a height of 30 m with an efficiency of 75%. Find the number of stages and diameter of each impeller of a similar multistage pump to lift 5 m^3 water per second to a height of 200 m when rotating at 1500 r p m. [4+4+8]

8.a) What are the different types of hydropower plants? Describe each one briefly?

b) A run-off-river hydel power plant with an installed capacity of 10000 kW operates at 22% load factor when it serves as a peak load station. What should be the minimum discharge in the stream so that it may serve as the base load station? The plant efficiency may be taken as 85% when working under a head of 14 m. Also calculate the maximum load factor of the plant when the discharge in the stream is 28 m^3/s. [8+8]

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II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
HYDRAULICS AND HYDRAULIC MACHINERY
(CIVIL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) What do you meant by most economical section of channel. Show that a trapezoidal channel is most economical section when
i) Half of the top width is equal to length of one of the sloping sides
ii) Hydraulic mean depth is equal to half of the depth of the flow.

b) Water flows at a depth of 1 m in a masonry rectangular channel of 2 m wide and laid on 1% gradient. Determine the diameter of a semi circular tube which carries the same discharge when laid on a slope of 1m/150m. Manning's n for masonry and concrete is 0.025 and 0.015 respectively. [8+8]

2.a) With neat sketches discuss the various water surface profiles occurring in the open channels with reference to bottom slopes of the channels.

b) Show that the head loss in a hydraulic jump formed in rectangular channel may be expressed as $\Delta E = \frac{(V_1 - V_2)^3}{2g(V_1 + V_2)}$, where V_1 and V_2 are the mean velocities of flow before and after the jump respectively. [10+6]

3.a) If power P is required to transport a fluid through length *l* of pipe of diameter D and surface roughness K, depends on discharge Q, fluid viscosity μ, perform dimensional analysis and obtain the set of dimensionless parameters.

b) A harbor model is built to a horizontal scale of 1: 100. If the tidal period and discharge entering the harbor at high tide are 12.2 hours and 1.5×10^6 m^3/s, compute the corresponding values for the model. [8+8]

4.a) Series of curved vanes mounted equidistantly fixed on the periphery of a wheel. For maximum efficiency of the wheel show that the peripheral speed is one-half of the velocity of the jet.

b) A jet of water having a velocity of 30 m/s strikes a series of radial vanes mounted on a wheel which is rotating at 250 r p m. The jet makes an angle of 25^o with the tangent to the wheel at inlet and leaves the wheel with a velocity of 6 m/s at an angle of 130^o to the tangent to the wheel at outlet. Water is flowing from outward in a radial direction. Determine
i) Vane angle at inlet and outlet
ii) Work done per second per N of water, and
iii) Efficiency of Wheel. [8+8]

5.a) Define hydraulic, volumetric and mechanical efficiencies of a turbine. What is Overall efficiency?

b) A Pelton wheel turbine operates under a head of 320 m and produces 5000kW. The speed of runner is 250 r p m and the overall efficiency is 0.85. Determine the values of unit speed, unit discharge and unit power. If the head on the turbine falls to 160 m, find the new values of the speed, the discharge and power. Assume that the efficiency of the turbine remains constant. [6+10]

6.a) What is meant by cavitation? How it can be avoided in reaction turbine? What are the factors on which cavitation in water turbines depend?

b) What is a surge tank and forebay and what are their functions? Describe with neat sketches different types of surge tanks. [8+8]

7.a) What is NPSH of a centrifugal pump? How is it related to the cavitation index of the pump? If NPSH is 2m and H_m is 48 m, what is the Thoma's number of the centrifugal pump?

b) A centrifugal pump has to work against a head of 20 m at a speed of 800 r p m. The flow component of velocity at outlet is 2 m/s. The outlet vane angle is 45^0. If the discharge of the pump is 0.23 m^3/s. Find the diameter of the impeller and the width of the impeller at the outlet. Neglect losses. [8+8]

8.a) What are the different types of hydropower plants? Explain about pumped storage plants and run-off-river plants.

b) How do you assess the water potential of hydroelectric scheme?

c) Write a short note on selection of suitable type of turbine for a hydroelectric scheme. [8+4+4]

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II B.TECH – II SEM EXAMINATIONS, DECEMBER - 2010
HYDRAULICS AND HYDRAULIC MACHINERY
(CIVIL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Define the terms Rapidly Varied flow and Gradually Varied Flow. Prove that for a channel of circular section, the depth of flow, d = 0.81 D for maximum velocity and d = 0.95 D for maximum discharge. Where d is depth of flow and D is diameter of circular channel.

b) The cross-section of an open channel consists of semi circular bottom 1.20 m diameter and with vertical sides. If the depth of water is 1.20 m and the bed slope 1 in 2500, calculate the discharge. Assume Chezy's C as 65. [8+8]

2.a) Water discharges at the rate of 8.5 m^3/s from under sluice gate into a rectangular channel 2.5 m wide which has a slope of 0.002. A hydraulic jump is formed in which the ratio of conjugate depths is 2.5. Estimate the value of Manning's n for the channel.

b) A rectangular channel 4 m wide and laid on a slope of 0.005 carries a flow at a depth of 1.2 m. A weir is located at the downstream end, which rises the water level to 4 m above the bed of the channel. Compute the water surface profile using 4 steps. Assume Manning's n as 0.002. [8+8]

3.a) What do you mean by dimensionally homogeneous equation? Give any two examples.

b) State Buckinghams π–theorem. What do you mean by repeating variables? How are the repeating variables selected in dimensional analysis?

c) A spillway 7.2 m high and 150 m long discharges 2,150 m^3/s under a head of 4 m. If a 1:16 scale model of the spillway is to be constructed, find the model dimensions head over the model and model discharge. [3+6+7]

4. A jet of water having a velocity of 60m/s is deflected by a vane moving at a velocity of 25 m/s in direction at 30^o to the direction of jet. The water leaves the vane normally to motion of the vane. Draw the inlet and outlet velocity triangles and find out the vane angles for no shock at entry and exit. Take the relative velocity at the exit as 0.8 times the relative velocity at the entrance. [16]

5.a) Describe any eight points of distinction between Impulse turbine and Reaction turbine.

b) A Kaplan turbine operates under a head of 5 m. The runner diameter is 2 m and the boss diameter is ⅓ of the runner diameter. If the speed ratio and flow ratios are 2.3 and 0.3 respectively, find the speed of rotation of the turbine and the horse power developed assuming the overall efficiency to be 82%. [8+8]

6.a) What do you understand by Unit quantities and Specific quantities? What is the significance these quantities in performance of turbines?

b) A Francis turbine working under a head of 5 m at a speed of 210 r p m develops 75 kW when the rate of flow of water is 1.8 m^3/s. If the head is increased to 16 m, determine the speed, discharge and power. [8+8]

7.a) What do you understand by
i) NPSH ii) Priming of pump
iii) Minimum starting speed of pump iv) Multistage pumps

b) A centrifugal pump has an impeller of 0.3 m diameter. The discharge at the outlet is radial. The diameter ratio is 2. Calculate the manometric efficiency of the pump if the total lift is 24 m. Also calculate the blade angle and relative velocity at the inlet. [8+8]

8.a) What are the different types of hydropower plants? Describe each one briefly?

b) The load on the hydel power plant varies from a minimum of 10,000kW to a maximum of 35,000 kW. Two turbo generators of capacities 22,000 kW each have been installed. Calculate
i) total installed capacity ii) Plant factor
iii) Maximum demand iv) Load factor and
v) Utilization factor. [8+8]

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