Code No: R2022013 **R20** **SET - 1**

II B. Tech II Semester Regular Examinations, June/July - 2022
HYDRAULICS AND HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Derive the condition for most economical trapezoidal channel section. [8M]

b) Find the critical depth and critical velocity of water flowing through a rectangular channel of width 5 m, when discharge is 15 m^3/s. [6M]

Or

2 a) Find the velocity of flow and rate of flow of water through a rectangular channel of 6m wide and 3 m deep, when it is running full. The channel having bed slope as 1 in 2000. Take Chezy's constant C=55 [7M]

b) Derive an expression for the discharge through an open channel by Chezy's formula. [7M]

UNIT-II

3 a) Write the applications and types of hydraulic jumps. [7M]

b) A rectangular channel 10m wide is laid with a break in its bottom slope from 0.01 to 0.0064. If it carries $125m^3/sec$, determine the nature of the surface profile and compute its length. Take n=0.015 [7M]

Or

4 a) A horizontal rectangular channel 4m wide carries a discharge of $16m^3/sec$. Determine whether a jump ay occur at an depth of 0.5m or not. If a jump occurs, determine the sequent depth to this initial depth. Also determine the energy loss in the jump. [7M]

b) State and discuss the assumptions made in the derivation of the dynamic equation for gradually varied flow. [7M]

UNIT-III

5 a) What do you under stand by repeating variables? How are you repeating variables selected for dimensional analysis? [7M]

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

Or

6 The pressure difference ΔP in a pipe diameter of D and a length of L due to flow turbulent flow depends on the velocity V, viscosity 'μ', density 'ρ', roughness K. Using Buckingham's π theorem obtain an expression for ΔP. [14M]

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UNIT-IV

7 a) Obtain an expression for the force exerted by a jet of water on fixed vertical plate in the direction of the jet. [7M]

b) A nozzle outer diameter 55 mm diameter delivers a stream of water at 25 m/sec perpendicular to plate that moves away from the jet at 8 m/sec. Find the force on the plate, the work done , the efficiency of jet. [7M]

Or

8 a) Derive the equation for force exerted by a jet on stationary inclined flat plate and draw with its neat sketch? [7M]

b) A jet of water having a velocity of 35 m/s strikes a series of radial curved vanes mounted on a wheel. The wheel has 200 rpm. The jet makes 20^o with the tangent to wheel at inlet and leaves the wheel with a velocity of 5 m/s at 130^o to tangent to the wheel at outlet. The diameters of wheel are 1 m and 0.5 m. Find (i) Vane angles at inlet and outlet for radically outward flow turbine. (ii) Work done (iii) Efficiency of the system. [7M]

UNIT-V

9 a) A Kaplan turbine develops 25000 KW power at an average head of 40 meters. Assuming a speed ratio of 0.63, diameter of the boss equal to 0.4 times the diameter of the runner and an overall efficiency of 90%, calculate the diameter , speed and specific speed of the turbine. [8M]

b) What are the characteristics curves of a hydraulic turbine? How are they useful to a practical engineer? [6M]

Or

10 a) A centrifugal pump is to discharge $0.15m^3$ /s at a speed of 1500 r.p.m. against a head of 30m. The impeller diameter is 275mm, its width at outlet is 50mm and manometric efficiency is 85%. Determine the vane angle at the outlet periphery of the impeller. [8M]

b) Describe the working principle and working of a reciprocating pump. [6M]

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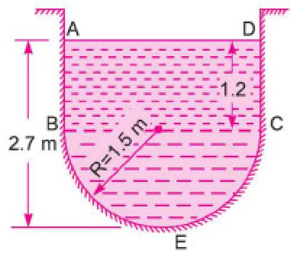
UNIT-I

1 a) A most economical trapezoidal channel has side slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 1500. The area of the section is 40 m^2. Determine the dimensions of the section and the discharge. Take C = 50. [8M]

b) Explain the terms briefly: [6M]
(i) Rapidly varied flow and (ii) Gradually varied flow.

Or

2 a) Find the discharge of water through the channel shown in Fig. below. Take the value of Chezy's constant=62 and slope of the bed as 1 in 2200. [6M]



b) Prove that for the rectangular channel of most economical section Width of the Channel = Two times the depth of the channel; Hydraulic mean depth= Half the depth of flow. [8M]

UNIT-Ii

3 a) A sluice gate discharges water into a horizontal rectangular channel of width 10m with a velocity of 9 m/s. The depth of flow is 0.5m. Determine whether a hydraulic jump will occur, or not and if so, find its height and loss of energy per kg of water. [7M]

b) What are the essential difference between gradually varied flow and rapidly varied flow? Illustrate with neatly drawn sketches. [7M]

Or

4 a) Classify the various water surface profiles and discuss briefly. [7M]

b) Find the slope of the free water surface in a rectangular channel of width 20m, having depth of flow 5m. The discharge through the channel is 50m^3/sec. The bed of the channel is having a slope of 1 in 4000. Take the value of Chezy's constant C=60 [7M]

UNIT-III

5 The drag force F_D on a sphere in laminar flow is known to depend on its diameter D, velocity of flow V, density of fluid ρ, coefficient of viscosity μ. Obtain an expression for F_D using Raleigh's method. [14M]

Or

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6 a) In 1:30 model of a spill way, the velocity and discharge are 1.5 m/s and 2 m/s. Find the corresponding velocity and discharge in the prototype. [6M]

b) Explain in detail various types of dimensionless numbers. [8M]

UNIT-IV

7 a) Show that force exerted by a jet of water on a inclined fixed plate in the direction of the jet given by: $F_x = \rho AV^2 \sin\alpha$ Where 'V' is the velocity of the jet; 'A' is the area of the jet; 'α' is the inclination of plate to the direction of the jet. [7M]

b) A jet of water with diameter 0.1m strikes on a series of symmetrical hemispherical curved vanes at the center attached to the circumference of a wheel with a velocity of 15 m/sec. The linear velocity of the vane is 5m/sec in the direction of the jet. Assuming that the vane is smooth, find the (i) the force exerted on the vane in the direction of the jet,(ii) worked one per second (iii) efficiency of the jet. [7M]

Or

8 a) Show that the efficiency of a free jet striking normally as series of flat plates mounted on the periphery of a wheel never exceed 50% [7M]

b) The diameter of the nozzle fitted at the end of pipe is 75mm through which water is flowing and the head of water at the center of nozzle is 200m. The jet strikes the plate perpendicular to it. Determine the force exerted by the jet of water on the plate if the plate is moving away from the jet with a velocity of 10m/sec. Also find work done per second on the plate and the efficiency of the jet. The coefficient of velocity is given as 0.95 [7M]

UNIT-V

9 a) What is meant by cavitation? How can it be avoided in reaction turbine? [6M]

b) A Pelton wheel is to be designed for the following specifications; Shaft power=11,775 KW; Head 400 m; speed 750 r.p.m; Overall efficiency =87%; jet diameter is not to exceed one-sixth of wheel diameter. Determine the wheel diameter, the number of jets required and diameter of jet. Take Kv_1=0.985, Ku_1=0.45. [8M]

Or

10 a) A double-acting reciprocating pump, running at 45 r.p.m., is discharging 1.5m^3 of water per minute. The pump has a stroke of 450 mm. the diameter of piston is 225 mm. The delivery and suction head are 22 m and 7 m respectively. Find the slip of the pump and power required to derive the pump. [7M]

b) List the main component parts of a centrifugal pump and explain them briefly. [7M]

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UNIT-I

1	a)	Classify the different type of flow in channels?	[7M]
	b)	Find the rate of flow of water through a triangular channel having the total angle between the sides as 60. Take the value of Manning's constant n=0.015 and the slope bed as 1m in 1km. The depth of flow is 1.6m	[7M]

Or

2	a)	Derive an expression for maximum velocity of flow through a circular section	[7M]
	b)	Find the discharge through a trapezoidal channel of width 8 m and side slope of 1 horizontal to 3 vertical. The depth of flow of water is 2.4 m and value of chezy's constant c = 50. The slope of the bed of the channel is given 1 in 3000	[7M]

UNIT-II

3	a)	Define hydraulic jump. Explain various types of hydraulic jumps.	[7M]
	b)	A rectangular channel 10 m wide carries a discharge of 40 m3 /s. If at a section in this channel the depth is 1.5 m, how far (upstream and downstream) from this section will the depth be 2.0 m. Take S_0 = 0.00009 and n = 0.017. Use direct step method for computation.	[7M]

Or

4	a)	Deduce the dynamic equation for gradually varied flow.	[7M]
	b)	A hydraulic jump forms at the downstream end of spillway carrying 20 m^3 /sec discharge. If the depth before jump is 1m, determine the depth after the jump and energy loss.	[7M]

UNIT-III

5	a)	In a 1 in 20 model of stilling basin, the height of the hydraulic jump in the model is observed to be 0.2m. What is the height of the hydraulic jump in the prototype? If the energy dissipated in the model is 1/10 kW, what is the corresponding value in prototype?	[8M]
	b)	Explain the concept of similarities with suitable examples.	[6M]

Or

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6	a)	A 8m height and 20 m long spill way discharges 100 m^3/s discharge under a head of 2.5 m. If a 1:10 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 8kN, determine force on the prototype.	[8M]
	b)	State Buckingham π-theorem. Why this theorem is considered superior over Rayleigh's method for dimensional analysis.	[6M]

UNIT-IV

7	a)	A jet of water of diameter 15 cm strikes a flat plate normally with a velocity of 18 m/s. The plate is moving with a velocity of 9 m/s in the direction of the jet and away from the jet. Calculate (i) The force exerted by the jet on the plate. (ii) Work done by the jet on the plate per second. (iii) Efficiency of the jet.	[6M]
	b)	Define the term impact of jets and explain in detail stationary and movable jets with neat sketch	[8M]

Or

8	a)	Derive an expression for the force exerted by a jet of water on a Stationary curved plate when jet strikes the curved plate at the center.	[7M]
	b)	A jet of water 50 mm in diameter with a velocity of 25m/sec impinges on a series of plates. The plates are so arranged that each plate appears successfully before the jet in the same direction and always moves with a velocity of 8m/sec. Find the force on the plate, work done per second, power and efficiency of the system.	[7M]

UNIT-V

9	a)	Explain the functions of following parts of reaction turbine: (i) Guide blades (ii) Scroll casing (iii) Draft tube (iv) Runner	[8M]
	b)	A power develops 10000 kW when running at 100 r.p.m. The head on the turbine is 30 m. If the head of the turbine s reduced to 10m, determine the speed and the power developed by the turbine.	[6M]

Or

10	a)	Draw and discuss the operating characteristics of a centrifugal pump.	[7M]
	b)	A single-acting reciprocating pump, running at 50 r.p.m., delivers 0.015 m^3 /s of water. The diameter of the piston is 300 mm and stroke length 550 mm. Determine: (i) the theoretical discharge of the pump, (ii) Co-efficient of discharge and (iii) Slip and the percentage slip of the pump.	[7M]

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UNIT-I

1 a) Differentiate between: [7M]
(i) steady and unsteady flow (ii) laminar and turbulent flow (iii) critical, sub-critical and super-critical flow in an open channel.

b) A Rectangular channel carries water at the rate of 0.4 m^3 /sec when bed slope in 1 in 2000. Find the most economical dimensions of the channel if C= 50 [7M]

Or

2 a) Determine the expression for the most economical trapezoidal section in terms of side slope [7M]

b) The discharge of water through a rectangular channel of width 8m, is 15m^3/sec when depth of flow is 1.2m, calculate the following terms: [7M]
(i) Specific energy of the flowing water
(ii) Critical depth and critical velocity
(iii) Value of minimum specific energy

UNIT-II

3 a) Derive the expression for loss of energy due hydraulic jump. [8M]

b) Define rapidly varied flow and discuss its assumptions. [6M]

Or

4 a) Derive the equation for gradually varied flow and write the basic assumptions in analyzing the GVF [6M]

b) A rectangular channel 10 m wide carries a discharge of 40 m^3 /s. If at a section in this channel the depth is 1.5 m, how far (upstream and downstream) from this section will the depth be 2.0 m. Take S_0 = 0.00009 and n = 0.017. Use direct step method for computation [8M]

UNIT-III

5 Prove that the discharge over a spillway is given by the relation: [14M]

$$Q= VD^2 f\left[\frac{\sqrt{gD}}{V}, \frac{H}{D}\right]$$

Where V= Velocity of flow; D= depth at the throat; H=Head of water and g= acceleration due to gravity.

Or

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6 a) Explain in detail various types of dimensionless numbers. [7M]

b) In 1:30 model of a spill way, the velocity and discharge are 1.5 m/s and 2 m/s. Find the corresponding velocity and discharge in the prototype. [7M]

UNIT-IV

7 a) Water flows over series of curved vanes of a hydraulic turbine wheel, the diameter of which between inlet tips of vanes is 2 m and that outlet tips is 1 m. The wheel rotates at 240 r. p. m. Jet of water enters at an angle of 30^0 to the tangent to wheel at inlet with a velocity of 40 m / s and leaves with a velocity of 10 m / s at an angle of 30^0 to the tangent to wheel at outlet tip. Find (a) Vane angles at entry and exit; (b) Work done on the wheel per newton of water; (c) Hydraulic efficiency of wheel; (d) power developed by the wheel when the discharge flowing through it is 0.3 m^3 / s [7M]

b) Derive an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of the jet. [7M]

Or

8 a) Show that force exerted by a jet of water on a moving inclinedplate in the direction of the jet is given by: $F_x = \rho A(V-u)^2 \sin^2\theta$ Where 'A' is the area of the jet; ' θ ' is the inclination of plate with the jet; 'V' is the velocity of the jet. [7M]

b) A jet of water with diameter 55 mm moving with a velocity of 40m/sec strikes a curved fixed vane tangentially at one end at an angle of 30^0 to the horizontal. The jet leaves the vane at angle of 20^0 to the horizontal. Find the force exerted by the jet on the plate in horizontal and vertical directions. [7M]

UNIT-V

9 a) A Kaplan turbine runner is to be designed to develop 9100 kW. The net available head is 5.6 m. If the speed ratio = 2.09, flow ratio = 0.68, overall efficiency = 86% and the diameter of the boss is 1/3 the diameter of the runner. Find the diameter of the runner, its speed and the specific speed of the turbine. [8M]

b) Obtain an expression for the work done by impeller of a centrifugal pump on water per second per unit weight of water. [6M]

Or

10 a) Define the terms 'unit power', 'unit speed' and 'unit discharge' with reference to a hydraulic turbine. Also derive expressions for these terms. [7M]

b) With help of neat sketch, explain the working principle of reciprocating pump. [7M]