Code No: RT22012

R13

SET - 1

II B. Tech II Semester Regular Examinations, April/May - 2016
HYDRAULICS AND HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) When do you call the flows as critical, sub critical and super critical flows?
   b) Give the advantages of Dimensional analysis.
   c) A jet of water strikes with a velocity of 40 m/s a flat plate inclined at 30^0 with the axis of the jet. If the cross sectional area of the jet is 25 cm^2 determine the force exerted by the jet on the plate.
   d) What is bondage factor?
   e) What are constant head characteristic curves?
   f) What does an indicator diagram represent?

PART –B

2. a) Find the discharge through a rectangular channel of width 2m having a bed slope of 4 in 8000. The depth of flow is 1.5m and takes the value of N in Manning's formula as 0.012.
   b) Derive dynamic equation for GVF.

3. a) What is a model and when do you call it as a distorted model and undistorted model.
   b) Explain Rayleigh's method
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4. a) A jet of water 50 mm in diameter and moving with a velocity of 26 m/s is impinging normally on a plate. Determine the pressure on the plate when it is fixed and when it is moving with a velocity of 10 m/s in the direction of the jet. Also determine the work done per second by the jet.

   b) Derive the expression for force exerted by a jet when it strikes an inclined flat plate which is moving in the same direction as the jet.

5. A Kaplan turbine develops 2100kW under a net head of 7.2m with an overall efficiency of 87%. It is to be fitted with blow type draft tube (draft tube efficiency 88%) having its inlet 1.8m diameter. Determine how much above or below the tail race level should the draft tube inlet be set so that vacuum pressure there does not exceed 460 mm of mercury

6. A centrifugal pump discharges 0.15 m^3/s of water against a head of 12.5m the speed of the impeller being 600 r.p.m. The outer and inner diameters of impeller are 500 mm and 250 mm respectively and the vanes are bent back at 35^0 to the tangent at exit. If the area of flow remains 0.07 m^2 from inlet to outlet calculate manometric efficiency of pump, vane angle at inlet and loss of head at inlet to impeller when the discharge is reduced by 40% without changing the speed.

7. a) Calculate the power developed in MW from a power plant with the following data. Available head 50m, catchment area 250sq.Km, Average annual rainfall 120cm, rainfall lost due to evaporation 20%, turbine efficiency 82%, generator efficiency 84% and head lost in penstock 4%.

   b) Give the classification of hydropower plants

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PART –A

1. a) Find the specific energy of flowing water through a rectangular channel of width 5m when the discharge is 10 m^3/s and depth of water is 3m.
   b) What is Euler's model law?
   c) What is impulse momentum principle?
   d) Explain the term "casing" with respect to centrifugal pump.
   e) What is Thomas cavitation factor?
   f) Give any three disadvantages of hydro electric power plants.

PART –B

2. a) Explain direct step method.
   b) The depth of flow of water at a certain section of a rectangular channel of 2m wide is 0.3m. The discharge through the channel is 1.5 m^3/s. Find whether a hydraulic jump will occur and if so find its height and loss of energy per kg of water.

3. a) Give the uses of dimensional analysis. Also explain different methods with respect to their application.
   b) A 1:10 scale model of a submarine moving far below the surface of water is tested in a water tunnel. If the speed of the prototype is 8 m/s, determine the corresponding velocity of water in the tunnel. Also determine the ratio of the drag for the model and the prototype. $\nu_{\textbf{sea water}}$ =1.121x 10^{-6} m^2/s, $\nu_{\textbf{water}}$ =1.00x 10^{-6} m^2/s, $\rho_{\textbf{sea water}}$ =1027 Kg/m^3,ρ_{water}=1000kg/m^3.
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4. a) A jet of water 50 mm in diameter moving with velocity of 15 m/s impinges on a series of vanes moving with a velocity of 6m/s. Find the force exerted by the jet, work done by the jet and efficiency of the jet.

   b) A stationary vane having an inlet angle of zero degree and an outlet angle of 25^0 receives water at velocity of 50 m/s. Determine the component of force acting on it in the direction of the jet velocity and normal to it. Also find the resultant force in magnitude and direction per kg of flow.

5. A double jet pelton wheel is required to generate 7500 kilowatts when the available head at the base of the nozzle is 400m. The jet is deflected through 165^0 and the relative velocity of the jet is reduced by 15% in passing over the buckets. Determine the diameter of each jet, total flow, force exerted by the jet on buckets in tangential direction. Assume generator efficiency of 95%, overall efficiency of 80%, k_v=0.97 and k_u=0.46.

6. a) A double acting reciprocating pump running at 40r.p.m. is discharging $1.0m^3$ of water per minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump.

   b) Compare and contrast centrifugal and reciprocating pumps.

7. a) Give the classification of hydropower plants.

   b) Define and describe load factor and utilization factor.

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PART –A

1. a) When does a hydraulic jump occur?
b) Give the dimensions of force, viscosity and power.
c) Find the force exerted by a jet of water of diameter 80 mm on a stationary flat plate when the jet strikes the plate normally with velocity of 20 m/s.
d) Why does not a draft tube have a constant cross sectional area throughout its length.
e) What is slip and when does a negative slip occur.
f) Give any three advantages of hydro electric power plants.

PART –B

2. a) Explain specific energy curve.
b) A trapezoidal channel with side slopes of 3 horizontal to 2 vertical has to be designed to convey 10 m^3/s at a velocity of 1.5 m/s so that the amount of concrete lining for the bed and sides is minimum. Find the wetted perimeter and slope of the bed if Maning's N=0.014 in the formula $C=m^{1/6}(1/N)$.

3. When can you apply the results of a model to prototype? Explain in detail.

4. a) A 25mm diameter jet exerts a force of 1kN in the direction of flow against a flat plate which is held inclined at an angle of 30^0 with the axis of the stream. Find the rate of flow.
b) Give the classification of turbines.

5. a) The following data were obtained from a test on a pelton wheel: Head at the base of the nozzle=32m, discharge of the nozzle=0.18m^3/s, area of the jet=7500sq.mm, power available at the shaft=44 kW and mechanical efficiency=94%. Calculate the power lost in the nozzle, in the runner and in mechanical friction.
b) Derive the expression for specific speed of a turbine.

6. Explain working of a centrifugal pump with neat sketch.

7. a) The following data relate to a proposed hydro electric station. Available head=28m, catchment area=420sq.km, rainfall=140cm/year, percentage of total rainfall utilised=68%, penstock efficiency=94%, turbine efficiency=80%, generator efficiency=84% and load factor=44%. Calculate the power developed.
b) How do you estimate hydropower potential?
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PART –A

1. a) Give the distribution of velocity in an open channel.
   b) Water at 15^0C flows at 4 m/s in a 150 mm pipe. At what velocity must oil at 30^0C flow in a 75 mm pipe for the two flows to be dynamically similar. Take γ_{water} at 15^0 C as $1.145\text{x}10^{-6}\text{m}^2$/s and that for oil at 30^0c as $3.0\text{x}10^{-6}\text{m}^2$/s.
   c) Differentiate between impulse and reaction turnines.
   d) What is meant by priming?
   e) Give the role of surge tanks in hydroplants
   f) Define load factor and utilisation factor.

PART –B

2. a) What is momentum correction factor. Also derive the expression for the same.
   b) A power canal of trapezoidal section has to be excavated through hard clay at the least cost. Determine the dimensions of the channel if it has to carry a discharge of 14 m^3/s with bed slope of 1:2500 and Maning's N=0.020.

3. a) Explain any four dimensionless numbers.
   b) If the capillary rise h depends on specific weight w, surface tension σ of the fluid and the radius of the tube r show that $h/r = \Phi\ (\sigma/wr^2)$.

4. A jet of water having a velocity of 30 m/s impinges on a series of vanes with a velocity of 15 m/s. The jet makes an angle of 30^0 to the direction of motion of vanes when entering and leaves at an angle of 120^0. Sketch velocity triangles at entrance and exit and determine the vane angles so that the water enters and leaves without shock.

5. a) Define and differentiate unit and specific quantities.
   b) A kaplan turbine produces 60000 kW under a net head of 25 m with an overall efficiency of 90%. Taking the value of speed ratio k_u as 1.6, flow ratio Ψ as 0.5 and the hub diameter as 0.35 times the outer diameter find the diameter and speed of the turbine.

6. a) Derive the expression for minimum starting speed of a centrifugal pump.
   b) A single acting reciprocating pump running at 50 r.p.m., delivers 0.01m^3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine the theoretical discharge of the pump, coefficient of discharge, slip and percentage slip of the pump.

7. What are hydro electric power plants? Also give the advantages and disadvantages.

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