(3 hours) **Total marks : 80**

N.B : (1) Question no. 01 is compulsory.
(2) Attempt any 3 questions out of the remaining 5 questions.
(3) Assume data wherever necessary and clearly mention the assumption made.
(4) Draw neat figures as required.

Q1:- Attempt Any Four **(20)**

a) State and derive moment of momentum equation
b) Explain the terms distorted models and undistorted models. What is the use of distorted models?
c) Show that the angle of swing of vertical hinged plate is given by $Sin\ \theta = \frac{\rho a V^2}{W}$
d) Define the specific speed of a turbine. Derive an expression for the specific speed.
e) Define cavitation .What are the effects of cavitation?
f) Derive conditions for the most economical trapezoidal channel section.

Q2:- **(20)**

a) A 120^0 bend reduces from 300mm diameter at inlet to 200mm diameter at outer end . When it carries a flow of 0.3 m^3/s of water. The pressure at inlet section 210 kN/m^2 . Assuming no energy loss in the bend, determine the force exerted by the water on the bend. The bend is in horizontal plane.

b) The pressure difference Δp in pipe of diameter D length l due to viscous flow depends on the velocity V, viscosity μ and density ρ . Using Buckingham's π theorem, obtain an expression for Δp.

Q3:- **(20)**

a) i) A ship model of scale 1/50 is towed through sea water at a speed of 1m/s .A force of 2 N is required to tow the model. Determine the speed of ship and the propulsive force on the ship, if prototype is subjected to wave resistance only.
ii) A jet of water of diameter 7.5 cm strikes a curved plate at its center with a velocity of 20 m/s. The curved plate is moving with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of 165^0 .Assuming The plate smooth find force exerted on the plate in direction of the jet , power of the jet and efficiency of the jet .

b) A jet of water having a velocity of 15m/s strikes a curved vane which is moving with velocity of 5 m/s. The vane is symmetrical and is so shaped that the jet is deflected through 120^0. Find the angle of the jet at inlet of the vane so that there is no shock. What is the absolute velocity of the jet at outlet in magnitude and direction and work done per second per unit weight of water striking per second? Assume vane to be smooth.

Q4:- **(20)**

a) The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is $2m^3/s$ .The angle of deflection of the jet is 165^0. Determine the power given by the water to the runner and also hydraulic efficiency of Pelton wheel. Take speed ratio = 0.45 and C_V=1.

b) An inward flow reaction turbine has external and internal diameter as 0.9 m and 0.45m respectively. The turbine is running at 200 r.p.m. and width of turbine at inlet is 200mm .The velocity of flow through the runner is constant and is equal to 1.8m/s . The guide blades make an angle of 10^0 to the tangent of the wheel and discharge at the outlet of the turbine is radial. Draw the inlet and outlet velocity triangles and determine:

i. The absolute velocity of water at inlet of runner
ii. The velocity of whirl at inlet
iii. The relative velocity at inlet
iv. The runner blade angles
v. Head at the inlet of the turbine
vi. Power developed and hydraulic efficiency of the turbine.

Q5:- **(20)**

a) i) Explain different type of efficiencies of hydraulic turbine.
ii) Find the power required to drive a centrifugal pump which deliverers $0.04m^3/s$ of water to a height of 20 m through a 15 cm diameter pipe and 100 m long. The overall efficiency of Pump is 70% and coefficient of friction f = 0.015.

b) i) What is priming? Why is it necessary?
ii) The discharge of water through a rectangular channel of width 6m, is 18 m^3/s when depth of flow of water is 2 m calculate:
a) Specific energy of flowing water , b) critical depth and critical velocity , c) value of minimum specific energy

Q6:- **(20)**

a) Explain term hydraulic jump. Drive an expression for the depth of hydraulic jump in term of the upstream Froude number.

b) Determine the length of the back water curve caused by afflux of 2m in rectangular channel of width 40m and depth 2.5m. The slope of bed is given as 1*in*11000. Take Manning's N = 0.03

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