Question bank

FLUID MACHINERY B. Tech 3rd Year

UNIT-1

IMPULSE OF JET AND IMPULSE TURBINE

1. A jet of water of diameter 5cm moving with a velocity of 25 m/sec impinges on a fixed curved plate tangentially at one end at an angle of 30˚ with the horizontal. Determine force of the jet on the plate in the horizontal and the vertical direction if the jet is deflected through an angle of 130˚. Also find direction and resultant force.
   [Ans: 2216.06N, 193.88N, 2224.5N, 4.99˚]
2. A jet of water impinges on a symmetrically curved vane at its center. The velocity of the jet is 60 m/s and the diameter 120 mm. The jet is deflected through an angle of 120°. Calculate the force on the vane if the vane is fixed. Also determine the force if the vane moves with a velocity of 25 m/s in the direction of the jet. What will be the power and efficiency?
3. A jet of water having a velocity of 20 m/sec strikes a curved vane, which is moving with a velocity of 10 m/sec. The jet makes an angle of 20˚ with the direction of motion of vane at inlet and leaves at an angle of 130˚ to the direction of motion of vane at outlet. Calculate:
   (1) Vane angles, so that the water enters and leaves the vane without shock. (2) Work done per unit weight of water striking the vane per second. [Ans: 37.876°, 6.565°, 20.24 N-m/N]
4. A jet of water having a velocity of 15 m/sec strikes a curved vane which is moving with a velocity of 5 m/sec. The vane is symmetrical and it so shaped that the jet is deflected through 120˚. 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 the work done per unit weight of water? Assume the vane to be smooth. [Ans: 20.405°, 6.62m/s, 127.83°, 9.225 N-m/N]

5. A jet of water having a velocity of 15 m/sec, strikes a curved vane which is moving with a velocity of 5 m/sec in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected through 135˚. The diameter of jet is 100mm. Assume the vane to be smooth, find:
   (1) Force exerted by the jet on the vane in the direction of motion.
   (2) Power exerted on the vane. (3) Efficiency of the vane
   [Ans: 1340.6N, 6.703KW, 50.5%]
6. A jet of water of diameter 5 cm having a velocity of 30 m/sec strikes a curved vane horizontally at one of its tip which is moving with a velocity of 15 m/sec in the direction of jet. The jet leaves the vane at an angle of 60˚ to the direction of motion of the vane at outlet. Determine : (1) The force exerted by the jet on the vane in the direction of motion (2) The work done per second by jet. [Ans: 662.68N, 9.94KW]
7. A jet of water having a velocity 25 m/s strikes on a series of vanes moving with a velocity 10 m/s. The jet makes an angle of 300 with the direction of motion of vanes when entering and leaves at an angle of 1500 with the direction of motion. Sketch the velocity triangles and calculate,
   a) Vane angles at inlet and outlet
   b) Work done when the vane discharging 325 litres/s Take loss due to friction over the vane as 10 % of relative velocity.
8. A jet of water of 40mm diameter strikes horizontally at the centre of a square plate of uniform thickness and having a mass of 16 kg and edge 25 cm with 10 m/sec. The square plate is suspended vertically by a hinge on its top horizontal edge. Find,
   (1) The force to be applied at the lower edge of the plate to keep it vertical.
   (2) The inclination of the plate with vertical under the action of the jet, if the plate is allowed to swing freely. [Ans: 62.83N, 53.13°]

9. A rectangular plate, weighing 58.86N is suspended vertically by a hinge on the top horizontal edge. The centre of gravity of the plate is 10cm from the hinge. A horizontal jet of water 2cm diameter, whose axis is 15cm below the hinge impinges normally on the plate with a velocity of

5 m/sec. Find the horizontal force applied at the centre of the gravity to maintain the plate in its vertical position. Find the corresponding velocity of the jet, if the plate is deflected through 30˚ and the same force continues to act at the centre of gravity of the plate.
[Ans: 11.775N, 9.175m/s]

10. A jet of water having a velocity of 35 m/sec impinges on a series of vanes moving with a velocity 20 m/sec. The jet makes an angle of 30˚ to the direction of motion of vanes when entering and leaves at an angle of 120˚. Draw the triangle of velocities at inlet and outlet and find:
(1) The angle of vanes tips so that water enters and leaves without shock.
(2) The work done per unit weight of water entering the vanes, and The efficiency. [Ans: 60°, 1.25°, 62.28N-m/N, 99.74%]

11. A jet of water having a velocity of 30 m/sec strikes a series of radial curved vanes mounted on a wheel which is rotating at 200 r.p.m. The jet makes an angle of 20˚ with the tangent to the wheel at inlet and leaves the wheel with a velocity of 5 m/sec at an angle of 130˚ to the tangent to the wheel at outlet. Water is flowing from outward in a radial direction. The outer and inner radii of the wheel are 0.5m and 0.25m respectively. Determine:
(1) Vane angles at inlet and outlet
(2) Work done per unit weight of water
(3) Efficiency of wheel [Ans: 30.07°, 24.39°, 31.8N-m/N, 69.32%]

12. What are Fluid machines or Hydraulic machines?
13 . State the function of breaking jet in Pelton wheel turbine.
14. Why spiral casing of varying area is employed in reaction turbine?

UNIT-2

1. Obtain en expression for the work done per second by water on the runner of a pelton wheel. Hence derive an expression for maximum efficiency of the pelton wheel giving the relationship between the jet speed and bucket speed.

2. A pelton wheel is having a mean bucket diameter of 1 m and is running at 1000rpm. The net head on the pelton wheel is 700 m. If the side clearance angle is 15o and discharge through nozzle is 0.1 m3/s, find (1) power available at nozzle and (2) hydraulic efficiency of the turbine. Take Cv=1

3. A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 m3/s. If the efficiency is 90% determine, Specific speed of the machine power generated and type of turbine.

4. A pelton turbine is required to develop 9000 KW when working under a head of 300 m the impeller may rotate at 500 rpm. Assuming a jet ratio of 10 And an overall efficiency of 85% calculate (1) Quantity of water required. (2) Diameter of the wheel (3) Number of jets (4) Number and size of the bucket vanes on the runner.

5. An Outward flow reaction turbine has internal and external diameters of the runner as 0.5 m and 1.0 m respectively. The turbine is running at 250 rpm and rate of flow of water through the turbine is 8 m3/s. The width of the runner is constant at inlet and out let and is equal to 30 cm. The head on the turbine is 10 m and discharge at outlet6 is radial, determine (1) Vane angle at inlet and outlet. (2) Velocity of flow at inlet and outlet.

6. The Nozzle of a pelton Wheel gives a jet of 9 cm diameter and velocity 75 m/s. Coefficient of velocity is 0.978. The pitch circle diameter is 1.5 m and the deflection angle of the bucket is 170o. The wheel velocity is 0.46 times the jet velocity. Estimate the speed of the pelton wheel turbine in rpm, theoretical power developed and also the efficiency of the turbine.

7. A turbine is to operate a head of a 25 m at 200 rpm; the available discharge is 9m3/s assuming an efficiency of 90%. Determine (1)

Specific speed (2) Power generated (3) Performance under a head of 20 m (4) The type of turbine

8. A vertical reaction turbine under 6m head at 400 rpm the area and diameter of runner at inlet are 0.7 m2 and 1m respective the absolute and relative velocities of fluid entering are 15oand 60o to the tangential direction. Calculate hydraulic efficiency.

9. A Francis turbine has an inlet diameter of 2.0 m and an outlet diameter of 1.2m. The width of the blades is constant at 0.2 m. The runner rotates at a speed of 250 rpm with a discharge of 8 m3/s .The vanes are radial at the inlet and the discharge is radially outwards at the outlet. Calculate the angle of guide vane at inlet and blade angle at the outlet.

10. A Kaplan turbine develops 20000KW at a head of 35 m and at rotational speed of 420 rpm. The outer diameter of the blades is 2.5 m and the hub diameter is 0.85m. If the overall efficiency is 85% and the hydraulic efficiency is 88%. Calculate the discharge, the inlet flow angle and the blade angle at the inlet.

UNIT -3

1. A centrifugal pump discharges 5 m3/s under a head of 130 m running at 600 rpm. Outer diameter of impeller is 2 m and has a positive suction lift of 3.2 m including velocity head and friction losses in suction pipe. Experiments were conducted on a geometrically similar model of 0.4 m outer diameter of impeller under a head of 90 m. Vapour pressure of liquid is equal 0.35 m of head.Calculate the discharge, speed and suction lift for the model. Assume atmospheric pressure head = 10.2 m of water.
2. Differentiate between volute and vortex casing of a centrifugal pump.
3. What is meant by manometric head for centrifugal pump?
4. What is NPSH? liters water per second, the average lift being 6 m. The angle which the vanesmake at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5 m/s. The inner diameter of the impeller is 0.6 m. Determine: The power required to drive the pump, the manometric efficiency and the minimum rpm to start pumping against a head of 6 m.

5. What is priming in centrifugal pump? Why it is done? What is self-priming pump? Explain.
6. How will you obtain an expression for minimum speed for starting of a starting of a centrifugal pump.
7. Define specific speed of a centrifugal pump. Derive an expression for the same.
8. What do you understand by characteristic curve of a pump?

UNIT-4

1. What is meant by positive displacement pump
2. Define the term SLIP of Reciprocating pump.
3. What do you understand by an indicator diagram? Explain ideal indicator diagram.
4. A single acting reciprocating pump of 12 cm diameter and 24 cm stroke is delivering water to the tank which is 10 m above the center of pump. The pump is located 5 m above the center of sump. The diameter and the length of the suction pipe are 5 cm and 5 m respectively, and diameter and length of delivery pipe are 4 cm and 20 m respectively. Find the maximum speed of the pump to avoid separation either in suction pipe or delivery pipe. Take atmospheric pressure head 10.33 m of water and separation occurs at 80 kN/m2 below.
5. A single acting reciprocating pump, running at 50 rpm, delivered $0.01 m^3/s$ of water.the diameter of the piston is 200 mm and stroke length 400mm. Determine:
   1 Theoretical discharge, 2.coefficient of discharge 3. Slip and % of slip

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