BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)
B.Tech.Sem - V MECHANICAL : WINTER- 2022
SUBJECT : TURBO MACHINERY

Day : Thursday

Date : 8/12/2022

W-24506-2022

Time : 02:30 PM-05:30 PM

Max. Marks : 60

N.B.:

1) All questions are COMPULSORY.
2) Figures to the right indicate FULL marks.
3) Use of non-programmable CALCULATOR is allowed.
4) Assume suitable data if necessary.

Q.1 a) Show that the force exerted by a jet of water on an inclined fixed plate in the direction of the jet is given by $F_x = \rho a V^2 \sin^2\theta$ where a = Area of the jet, V = Velocity of the jet and θ = Inclination of the plate with the jet. **(05)**

b) A jet of water having a velocity of 30 m/s 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 20^0 with the tangent to the wheel at inlet and leaves the wheel with a velocity of 5 m/s at an angle of 130^0 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 0.5 m and 0.25 m respectively. Determine: **(05)**
i) Vane angles at inlet and outlet
ii) Work done per unit weight of water and
iii) Efficiency of the wheel

OR

Q.1 a) Show that for a curved radial vane, the work done per second is given by $\rho a V_1 \left[V_{w_1} u_1 \pm V_{w_2} u_2\right]$. **(05)**

b) A jet of water moving at 12 m/s impinges on vane shaped to deflect the jet through 120^0 when stationary. If the vane is moving at 5 m/s, find the angle of the jet so that there is no shock at inlet. What is the absolute velocity of the jet at exit in magnitude and direction and the work done per second per unit weight of water striking per second? Assume that the vane is smooth. **(05)**

Q.2 a) What are different types of efficiencies of turbines? **(05)**

b) A Pelton wheel is working under a gross head of 400 m. The water is supplied through penstock of diameter 1 m and length 4 km from reservoir to the Pelton wheel. The co-efficient of friction for the penstock is given as 0.008. The jet of water of diameter 150 mm strikes the buckets of the wheel and gets deflected through an angle of 165^0. The relative velocity of water at outlet is reduced by 15% due to friction between inside surface of the bucket and water. If the velocity of the buckets is 0.45 times the jet velocity at inlet and mechanical efficiency as 85% determine: **(05)**
i) Power given to the runner.
ii) Shaft power
iii) Hydraulic efficiency and overall efficiency

OR

Q.2 a) Differentiate between: a) The impulse and reaction turbines, b) Radial and axial flow turbines **(05)**

P. T. O.

b) A 137 mm diameter het of water issuing from a nozzle impinges on the buckets of a Pelton wheel and the jet is deflected through an angle of 165^0 by the buckets. The head available at the nozzle is 400 m. Assuming co-efficient of velocity as 0.97, speed ratio as 0.46 and reduction in relative velocity while passing through buckets as 15% find: **(05)**
i) The force exerted by the jet on buckets in tangential direction.
ii) The power developed.

Q.3 a) What is a draft- tube? Why is it used in a reaction turbine? Describe with sketch two different types of draft tubes. **(05)**

b) A Francis turbine working under a head of 30 m has a wheel diameter of 1.2 m at the entrance and 0.6 m at the exit. The vane angle at the entrance is 90^0 and guide blade angle is 15^0. The water at the exit leaves the vanes without any tangential velocity and the velocity of flow in the runner is constant. Neglecting the effect of draft tube and losses in the guide and runner passages, determine the speed of wheel in r.p.m. and vane angle at the exit. **(05)**

OR

Q.3 a) What do you understand by the characteristic curves of a turbine? Name the important types of characteristics curves. **(05)**

b) A Kaplan turbine working under a head of 20 m develops 11772 kW shaft power. The outer diameter of the runner is 3.5 m and hub diameter is 1.75 m. The guide blade angle at the extreme edge of the runner is 35^0. The hydraulic and overall efficiencies of the turbines are 88% and 84% respectively. If the velocity of whirl is zero at outlet, determine: **(05)**
i) Runner vane angles at inlet and outlet at the extreme edge of the runner, and
ii) Speed of the turbine.

Q.4 a) Define the terms: suction head, delivery head, static head and manometric head. **(05)**

b) A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 r.p.m. The vanes are curved back to an angle of 30^0 with the periphery. The impeller diameter is 300 mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95%. **(05)**

OR

Q.4 a) What do you understand by characteristics curves of a pump? What is the significance of the characteristics curves? **(05)**

b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 r.p.m. works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40^0 at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine: **(05)**
i) Vane angle at inlet,
ii) Work done by impeller on water per second, and
iii) Manometric efficiency

Q.5 a) What is negative slip in a reciprocating pump? Explain with neat sketches the function of air vessels in a reciprocating pump. **(05)**

b) The cylinder bore diameter of a single-acting reciprocating pump is 150 mm and its stroke is 300 mm. The pump runs at 50 r.p.m. and lifts water through a height of 25 m. The delivery pipe is 22 m long and 100 mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 litres/s, find the percentage slip. (05)

OR

Q.5 a) Define indicator diagram. How will you prove that area of indicator diagram is proportional to the work done by the reciprocating pump? (05)

b) A single- acting reciprocating pump has piston diameter 12.5 cm and stroke length 30 cm. The centre of the pump is 4 m above the water level in the sump. The diameter and length of suction pipe are 7.5 cm and 7 m respectively. The separation occurs if the absolute pressure head in the cylinder during suction stroke falls below 2.5 m of water. Calculate the maximum speed at which the pump can run without separation. Take atmospheric pressure head = 10.3 m of water. (05)

Q.6 a) What is surging in axial-flow compressors? What are its effects? (05)

b) What is the application of Euler's turbomachinery equation for centrifugal compressor? (05)

OR

Q.6 a) What are the elements of centrifugal compressor? (05)

b) Demonstrate the specific work on h-s (Mollier) diagram for axial flow compressors. (05)

* * * *