UNIT - IV

SHORT ANSWER QUESTIONS

1. Show that the force exerted by a jet of water on moving inclined plate in the direction of jet is given by $F_x = \rho a(V-u)^2 \sin^2\Theta$.

2. Derive an expression for the force exerted by a jet of water on stationary inclined plate in the direction of jet.

3. List out the applications of impact of free jets.

4. Explain the basic principle involved in the impact of free jets.

5. Write an expression for the force exerted by the jet on the stationary plate in the direction of jet
   (i) When flat plate is held normal to the jet
   (ii) When the flat plate is held inclined to the jet.

6. Write an expression for the force exerted by the jet on the moving plate in the direction of jet
   (i) When flat plate is held normal to the jet
   (ii) When the flat plate is held inclined to the jet.

7. Define the term Impacts of jets.

8. Obtain an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of the jet.

9. Define the term Jet propulsion.

10. What is the importance of inclined and curved plates when the plates are moving is in the direction of jet.

11. 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.

12. What is impulse momentum principle?

13. Derive the expression for the force exerted by a water jet on a plate moving in the same direction of the jet with a velocity less than that of the jet.

14. Differentiate between the force exerted by a jet of water on a fixed vertical plate and moving vertical plate.

15. Differentiate between the force exerted by a jet on a single curved moving plate and a series of curved moving plate.

16. Prove that the force exerted by a jet of water on a fixed semi-circular plate in the direction of the jet when the jet strikes at the center of the semi-circular plate is two times the force exerted by the jet on an fixed vertical plate.

UNIT IV

ESSAY ANSWER QUESTIONS

1. A 75 mm diameter jet having a velocity of 30m/s strikes a flat plate, the normal of which is inclined at 450 to the axis of the jet. Find the normal pressure on the plate when it is moving with a velocity of 15 m/s in the direction of the jet, away from the jet. Also determine the power and efficiency of the jet when the plate is moving.

2. A jet of water from a nozzle is deflected through 600 from its original direction by curved plate which it enters tangentially without the shock with a velocity of 30 m/s and leaves with a mean velocity of 25 m/s. If the discharge from the nozzle is 0.8 kg/s, Calculate the magnitude and direction of the resultant force on the vane, if the vane is stationary.

3. A 30 mm diameter jet strikes without shock on a series of vanes. The jet velocity is 60 m/s and the vanes move in the same direction as the jet. The shape of each vane is such that, when stationary, it would deflect the jet through an angle of 1500.The friction reduces the relative velocity by 10% as water flows across the vanes and there is a further wind age loss is given by $\frac{u^2}{2}$ Nm/kg of water, where u is the vane speed. Determine:
   (i) The velocity of vanes corresponding to maximum efficiency, and
   (ii) The corresponding thrust on the vanes in the direction of motion.

4. The rotor of inward flow hydraulic turbine has a diameter over the tips of the moving vanes of 1.2 m. The diameter at the bottom of the vanes is 0.72 m. The speed is 300 rpm. The water is supplied through fixed vanes at 100 to the tangent to the outer circumference of the rotor, the velocity of water being 12m/s. If the water leaves the moving vanes with the velocity entirely radial and equal to 4.2 m/s, determine:
   (i) The blade angles at entry and exit, so that the water may enter and leave the moving blades without shock.
   (ii) The velocity of water relative to the vanes at the exit.

5. A jet of water of diameter 150 mm strikes a flat plate normally with a velocity of 12 m/s. The plate is moving with a velocity of 6 m/s in the direction of the jet and away from the jet. Find: (i) The force exerted by the jet on the plate, (ii) Work done by the jet on the plate per second, (iii) power of the jet, and (iv) efficiency of the jet.

6. A jet of water having a velocity of 20 m/s strikes a curved vane which is moving with a velocity of 9 m/s. The vane is symmetrical and is 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 second per unit weight of water striking? Assume the vane to be smooth.

7. A jet of water having a velocity of 30 m/s strikes a curved vane, which is moving with a velocity of 15 m/s. The jet makes an angle of 30° with the direction of motion of vane at inlet and leaves at an angle of 120° to the direction of motion of vane at outlet. Calculate: (i) Vane angles, If the water enters and leaves the vane without shock, (ii) Work done per second per unit weight of water striking the vanes per second.

8. A jet of water of diameter 50 mm, having a velocity of 30 m/s strikes a curved vane which is moving with a velocity of 15 m/s in the direction of the jet. The jet leaves the vane at an angle of 60° to the direction of motion of vanes at outlet. Determine: (i) The force exerted by the jet on the vane in the direction of motion, (ii) work done per second by the jet.

9. A jet of water of diameter 100 mm strikes a curved plate at its centre with a velocity of /s. The curved plate is moving with a velocity of 7 m/s in the direction of the jet. The jet is deflected through an angle of 150o. Assuming the plate smooth find (i) forced exerted on the plate in the direction of the jet (ii) power of the jet (iii) efficiency.

10. A jet of water strikes with a velocity of 40 m/s a flat plate inclined at 300 with the axis of the jet. If the cross sectional area of the jet is 25 cm2 determine the force exerted by the jet on the plate.

11. 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.

12. 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.

13. A stationary vane having an inlet angle of zero degree and an outlet angle of 250 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.

14. 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.

15. 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 300 with the axis of the stream. Find the rate of flow.
16. 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 300 to the direction of motion of vanes when entering and leaves at an angle of 1200. Sketch velocity triangles at entrance and exit and determine the vane angles so that the water enters and leaves without shock.

17. A blade turns the jet of diameter 3 cm at a velocity of 20 m/s by 60°. Determine the force exerted by the blade on the fluid.

18. A water jet 20 mm in diameter and having a velocity of 90 m/s strikes series of moving blades in a wheel. The direction of the jet makes 20° with the direction of movement of the blade. The blade angle at inlet is 35°. If the jet should enter the blade without striking, what should be the blade velocity? If the outlet angle of the blade is 30°, determine the force on the blade. Assume that there is no friction involved in the flow over the blade.

19. A jet of water of diameter 50 mm moving with a velocity of 20 m/s strikes a fixed plate in such a way that the angle between the jet and the plate is 60°. Find the force exerted by the jet on the plate (i) in the direction normal to the plate, and (ii) in the direction of the jet.

20. Find the force exerted by a jet of water of diameter 100 mm on a stationary flat plate, when the jet strikes the plate normally with a velocity of 30 m/s.