Section-C

1. Drive the hydraulic efficiency of turbine

Ans 1. work done/sec = $\rho a V_1 [V_{w1} + V_{w2}] u$

2. KE of jet/sec = $\frac{1}{2} m v_1^2 = \frac{1}{2} (\rho a v_1) v_1^2$

3. For Pelton wheel turbine hydraulic efficiency is given by.

$$\eta_h = \frac{\text{work done/sec}}{\text{KE of jet/sec}}$$

$$\eta_h = \frac{\rho a v_1 [V_{w1} + V_{w2}] u}{\frac{1}{2} (\rho a v_1) v_1^2} \quad \text{---(1)}$$

4. For a Pelton wheel we have.

$$V_{w1} = V_1 \; ; \; V_{r1} = V_1 - u_1 = V_1 - u$$

$$V_{r2} = V_1 - u.$$

$$V_{w2} = V_{r2} \cos\phi - u_2$$

$$= V_{r2} \cos\phi - u = (V_1 - u) \cos\phi - u$$

5. substitute the value of V_{w1} and V_{w2}

$$\eta_h = \frac{2[V_1 + (V_1 - u)\cos\phi - u] u}{V_1^2}$$

$$= 2\,[v_1 - u + (v_1 - u)\cos\phi]\,u$$

$$= \frac{2(v_1 - u)(1+\cos\phi)\,u}{v_1^2}$$

6. For maximum efficiency

$$\frac{d}{du}(\eta_u) = 0$$

$$\frac{d}{du}\left[\frac{2(v_1-u)(1+\cos\phi)u}{v_1^2}\right] = 0$$

$$\frac{(1+\cos\phi)}{v_1^2}\cdot\frac{d}{du}\left[2(v_1-u)u\right] = 0$$

$$\frac{d}{du}\left[2v_1u - 2u^2\right] = 0$$

$$2v_1 - 4u = 0$$

$$\boxed{u = \frac{v_1}{2}}$$

Ans