

## HYDROELECTRIC POWER PLANT SET OF PROBLEMS

1. A hydraulic turbine receives water from a reservoir at an elevation of 100 m above it. What is the minimum water flow in kg/s to produce a steady turbine output of 50 MW.
- a. 50 247  
b. **50 968**  
c. 50 672  
d. 59 465

### Solution:

Mass flow rate = Density X Volume Flow Rate

$$m = 1\,000\,Q$$

Solving for Q:

$$P_w = \gamma Q h$$

$$50\,000 = 9.81 Q (100)$$

Thus,

$$Q = 50.968 \frac{m^3}{s} = 50\,968 \frac{kg}{s}$$

2. A reaction turbine develops 500 BHP. Flow through the turbine is 50 cfs. Water enters at 20 fps with a 100 ft pressure head. The elevation of the turbine above the tailwater level is 10 ft. Find the effective head.
- a. 130.2 ft  
b. 120.2 ft  
c. 110.2 ft  
d. **116.2 ft**

### Solution:

$$h = \frac{P}{\gamma} + z + \frac{VA^2 - VB^2}{2g}$$

$$h = 100 + 10 + \frac{(20)^2 - (0)^2}{2(32.2)}$$

$$h = 116.2 \text{ ft}$$

3. A Pelton wheel is to be designed to run at 300 rpm under an effective head of 150 m. The ratio of the nozzle diameter to the diameter of the pitch circle is 1/12. Assuming efficiency of 84 %, what is the size of the wheel in m. Assume a speed ratio of 0.45.

- a. 1.05  
b. 2.00

- c. 1.55**  
d. 2.86

**Solution:**

$$\Phi = \frac{\pi DN}{\sqrt{2gh}}$$

$$\Phi = \frac{\pi D (300/360)}{\sqrt{2(9.81)(150)}}$$

$$\mathbf{D = 1.55 \text{ m}}$$

4. A hydro-electric power plant consumes 60 000 000 Kw-hr per year. What is the net head if the expected flow is 1 500  $\frac{m^3}{min}$  and over-all efficiency is 63 %.

- a. 34.34 m  
b. 43.43 m

- c. 44.33 m**  
d. 33.44 m

**Solution:**

$$P_w = \gamma Q h$$

Solving for water power,  $P_w$  :

$$e_{net} = \frac{\text{Generator Output}}{\text{Water Power}}$$

$$0.63 = \frac{60\,000/8760}{P_w}$$

$$P_w = 10\,871.93 \text{ KW}$$

Then; substituting:

$$10\ 871.93 = 9,81 (1500 / 60) h$$

$$\mathbf{H = 44.33\ m}$$

5. The pressure gage leading to the turbine casing of a Francis turbine reads 0.5 Mpa and the center of the spiral casing is 5 m above the tail race. What is the net head if the velocity of water entering the turbine is 10 m/s?

- a. 67.01 m
- b. 76.01 m

- c. 70.61 m
- d. **61.07 m**

**Solution:**

$$h = \frac{P}{\gamma} + z + \frac{VA^2 - VB^2}{2g}$$

$$h = \frac{500}{9.81} + 5 + \frac{10^2}{2(9.81)}$$

$$\mathbf{h = 61.07\ m}$$