Speed $N = 1000$ rpm , Head , $H_m = 40$ m

Velocity of flow , $V_{f1} = V_{f2} = 2.5$ m/sec

$\phi = 40^\circ$

outer dia of impeller $D_2 = 500$ mm $= 0.50$ m

$D_1 = D_2/2 = 0.50/2 = 0.25$ m

Width at outlet , $B_2 = 50$ mm $= 0.05$

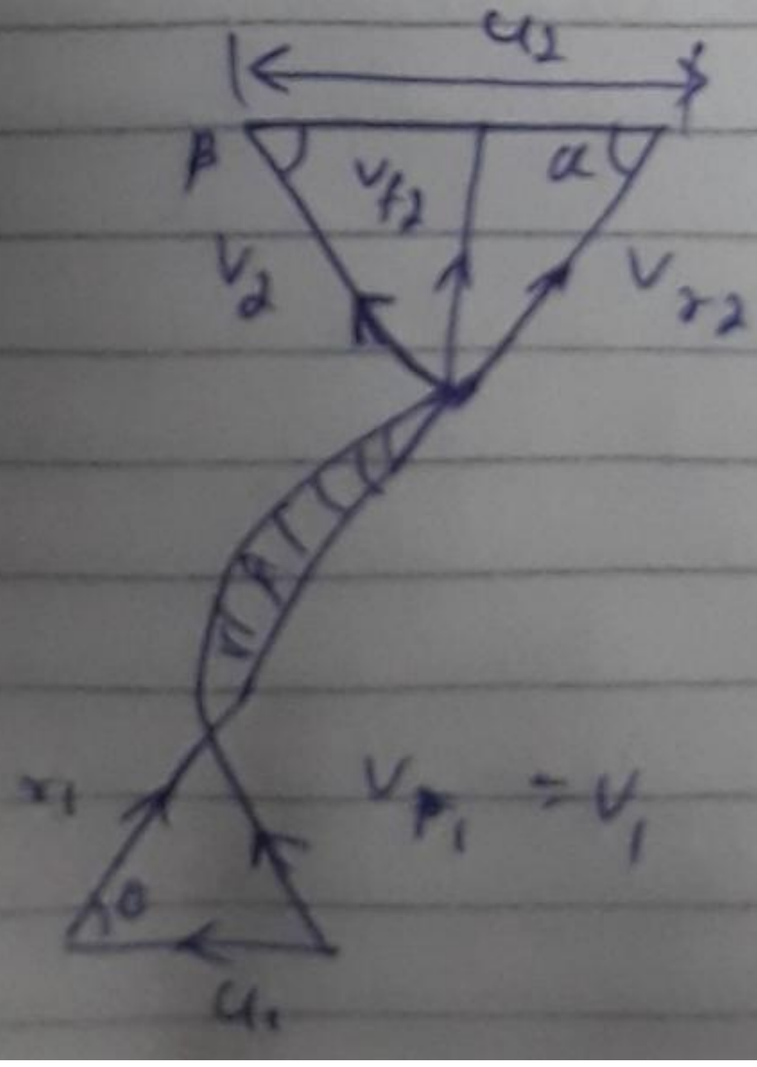
Tangential velocity of impeller at inlet and outlet are

$$u_1 = \frac{\pi D_1 N}{60} = \frac{\pi \times 0.25 \times 1000}{60}$$

$$\Rightarrow 13.09 \text{ m/sec}$$

$$u_2 = \frac{\pi D_2 N}{60} = \frac{\pi \times 0.50 \times 1000}{60}$$

$$\Rightarrow 26.18 \text{ m/sec}$$



Discharge is given by $Q = \pi D_0 B_0 \times V_{f_2}$

$= \pi \times 0.50 \times 0.05 \times 2.5$

$\Rightarrow 0.19635 \ m^3/sec$

Vane angle at inlet (θ) from inlet velocity triangle $\tan\theta \Rightarrow$

$$V_{f_1}/V_1 = \frac{2.5}{13.09} = 0.191$$

$$\theta = \tan^{-1}(0.183) = 10.813^\circ$$

Work from outlet velocity triangle

$$\tan\theta = \frac{V_2}{u_2 - V_{w_2}} = \tan 40$$

$$\Rightarrow \frac{2.5}{26.18 - V_{w_2}} \Rightarrow 23.2 \ m/sec$$

The work done by impeller

$1000 \times 0.19635 \times 23.2 \times 26.18$

$\Rightarrow 119258.28 \ N-m/sec$

(iii) Manometric efficiency

$$(\eta_{man}) = g H_m / V_{w_2} u_2$$

$$9.81 \times \frac{40}{23.2} \times 26.18 = 0.646$$

$\Rightarrow 64.6\%$ Ans