DEPARTMENT OF AEROSPACE ENGINEERING

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Course	:	**23AST202 – Fluid Mechanics for Aerospace**			

UNIT IV – PUMPS

(1) The internal and external diameters of the impeller of a centrifugal pump are 200mm and 400mm respectively. The pump is running at 1200rpm. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. [AU-A/M-13]

Sol

Internal diameter of impeller, $D_1 = 200mm = 0.20m$

External diameter of impeller $D_2 = 400mm = 0.40m$

Speed $N = 1200rpm.$

Vane angle at inlet $\theta = 20^\circ$

Vane angle at outlet, $\phi = 30^\circ$

Water enters radially* means $\alpha = 90^\circ$ and $V_{w1} = 0$

Velocity of flow $V_{f1} = V_{f2}$

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$$u_1 = \frac{\pi D_1 N}{60} = \frac{\pi \times 0.20 \times 1200}{60} = 12.56 \text{ m/s}$$

$$u_2 = \frac{\pi D_2 N}{60} = \frac{\pi \times 0.4 \times 1200}{60} = 25.13 \text{ m/s}$$

∴ From inlet velocity triangle, $\tan\theta = \frac{V_{f1}}{u_1} = \frac{V_{f1}}{12.56}$

$$V_{f1} = 12.56 \tan\theta = 12.56 \times \tan 20^\circ = 4.57 \text{ m/s}$$

$$V_{f2} = V_{f1} = 4.57 \text{ m/s}$$

From Outlet velocity triangle, $\tan\theta = \frac{V_{f2}}{u_2 - V_{w2}}$

$$= 4.57 / 25.13 - V_{w2}$$

$$25.13 - V_{w2} = \frac{4.57}{\tan\theta} = \frac{4.57}{\tan 30^\circ} = 7.915$$

$$V_{w2} = 25.13 - 7.915 = 17.215 \text{ m/s}$$

The work done by impeller/kg of water per second is given by equation as

$$= \frac{1}{g} V_{w2} u_2 = \frac{17.215 \times 25.13}{9.81} = 44.1 \text{ Nm/N}.$$