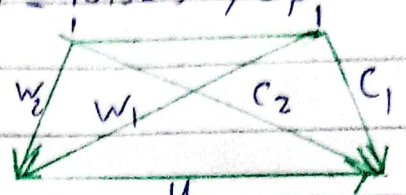
Given:

$P_{ratio} = 3$, $\dot{m} = 50$ kg/sec, $N = 10 \times 10^3$ rpm

DF = 0.5, $T_{t1} = 288$, $P_{t1} = 101325$, $C_p = 1004.5$

assume $C_x = 150$ m/s, $\eta = 0.9$

Velocity triangle




$$\beta_1 = \tan^{-1}\left(\frac{R + 0.5 * \Psi}{\phi}\right) = \tan^{-1}\left(\frac{0.5 + 0.5 \times 0.3792}{0.6}\right) = 48.02^\circ$$

$$\alpha_1 = \tan^{-1}\left(\frac{1 - R \times 0.5 \times \Psi}{\phi}\right) = \tan^{-1}\left(\frac{1 - 0.5 - 0.5 \times 0.3792}{0.6}\right) = 27.35^\circ$$

$$C_{\theta 1} = C_x \times \tan(\alpha_1) = 27.35 \text{ m/s}$$

$$W_{\theta 1} = C_x \times \tan(\beta_1) = 172.41 \text{ m/s}$$

$$W_1 = \frac{C_x}{\cos(\beta_1)} = 228.528 \text{ m/s}$$

$$C_1 = \frac{C_x}{\cos(\alpha_1)} = 168.970$$

$$\beta_2 = \tan^{-1}\left(\frac{R - 0.5 \times \Psi}{\phi}\right) = 27.35^\circ$$

$$\alpha_2 = \tan^{-1}\left(\frac{1 - R + 0.5\Psi}{\phi}\right) = 48.97^\circ$$

$$C_{\theta 2} = C_x \tan \alpha_2 = 150 \tan(48.97) = 172.41 \text{ m/s}$$

$$W_{\theta 2} = C_x \tan \beta_2 = 150 \tan(27.35) = 77.589 \text{ m/s}$$

$$W_2 = \frac{C_x}{\cos \beta_2} = \frac{150}{\cos(27.35)} = 168.88 \text{ m/s}$$

$$C_2 = \frac{C_x}{\cos \alpha_2} = \frac{150}{\cos(48.97)} = 288.528 \text{ m/s}$$

getting U

$U = W_{\theta 1} + C_{\theta 1} = 250\ m/s$

$U = \frac{2\pi N}{60} r_m$ ⟹ getting $r_m$

$r_m = 0.2387$

getting the work of the stage

$W_s = U \times (C_{\theta 2} - C_{\theta 1}) \times \dot{m} = 1.185 \times 10^6$

The temperature deffernte in stage

$T_{t2} = T_{t1} + \frac{W_s}{\dot{m} \times C_p} = 311.6\ K$

$\Delta T_T = 23.6\ K$

Number of stage

$Z_{st} = \frac{\Delta T_c}{\Delta T_s}$

$\therefore Z_{st} = 5$

total work

$W_{tot} = W_s \times Z_{st} = 1.185 \times 10^6 \times 5 = 5.926 \times 10^6$