EX. 4.7 only 1,2,4 (skip 3: M_{ts})

axial gas turbine stage

$\dot{W} = 3.36$ MW

$\dot{m} = 27.2$ kg/s

$P_{01} = 772$ kPa

$T_{01} = 727°C = 1000$ K

$P_2 = 482$ kPa

$\alpha_2 = 72°$

c_x cost

$c_1 = c_3 = c_x$

stator: 1 → 2 rotor: 2 → 3

Determine: 1) c_2

2) u

~~3) M_{ts}~~

4) R (Reaction)

1) $\Delta W_T = \frac{\dot{W}}{\dot{m}} = \frac{3.36 \times 10^6 \frac{J}{s}}{27.2 \frac{kg}{s}} = 123.5 \times 10^3 \frac{J}{kg}$

If we assume there are no losses in the stator: $P_{02} = P_{01}$

no work in stator: $T_{02} = T_{01}$

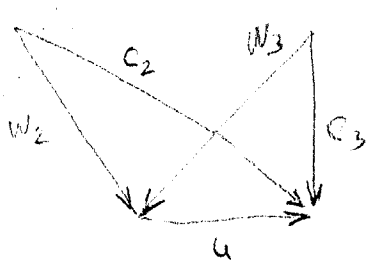
$$T_2 = T_{02}\left(\frac{P_2}{P_{02}}\right)^{\frac{\gamma-1}{\gamma}} = 1000\left(\frac{482}{772}\right)^{\frac{0.33}{1.33}} = 889.7\,K$$

$$T_{02} = T_2 + \frac{c_2^2}{2c_p} \rightarrow c_2 = \sqrt{2c_p(T_{02}-T_2)} = \sqrt{2 \times 1148\,(1000-889.7)} = 503.2 \frac{m}{s}$$

2) $\Delta W_T = u\,(c_{\theta_3}^{\,0} + c_{\theta_2}) = u\,c_{\theta_2}$

$c_{\theta_2} = c_2 \sin\alpha_2 = 503.2 \sin 72° = 478.6 \frac{m}{s}$

$u = \frac{\Delta W_T}{c_{\theta_2}} = \frac{123.5 \times 10^3 \frac{J}{kg}}{478.6} = 258 \frac{m}{s}$



3) Reaction $R = \frac{w_{\theta_3} - w_{\theta_2}}{2u}$

$w_{\theta_3} = u$

$w_{\theta_2} = c_{\theta_2} - u = 478.6 - 258 = 220.6$ m/s

$R = \frac{258 - 220.6}{2 \times 258} = 0.07$ (almost zero but positive)

ok!