Example #3: Compressor

- **Given:** Engine compressor with known inlet conditions and specified pressure ratio (p_{o3}/p_{o2})

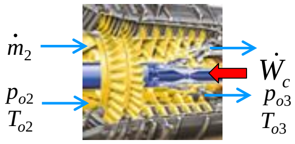


Image copyright of Rolls-Royce PLC (2005)

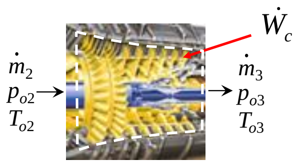
- **Find:** Stagnation temperature (T_{o3}) at compressor outlet and power per unit mass flow required to run the compressor

- **Assume:** __________ , ___________ , ________ , _______

Example #3: Compressor

- **Analysis:**

1st define CV



Mass

Energy

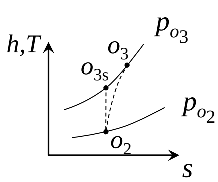
Entropy

Adiabatic Efficiency

- η≡ ratio of enthalpy change across device and enthalpy change if device was: 1) reversible, 2) adiabatic, 3) same inlet state, 4) same exit pressure AND must be < 1
- For a compressor,

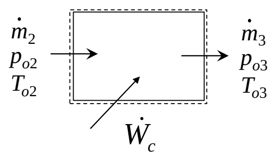
$$\eta_c = \frac{h_{o_{3s}} - h_{o_2}}{h_{o_3} - h_{o_2}} \quad \text{OR} \quad \eta_c = \frac{h_{o_3} - h_{o_2}}{h_{o_{3s}} - h_{o_2}}$$

$$= \frac{\dot{W}_{c,ideal}}{\dot{W}_{c,actual}} < 1$$



Example #3: Compressor

r• **Analysis:**

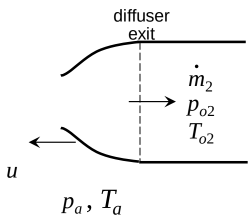


(II.11) $$T_{o_3} = T_{o_2}\left\{1 + \frac{1}{\eta_c}\left(\left[\frac{p_{o_3}}{p_{o_2}}\right]^{\gamma-1/\gamma} - 1\right)\right\}$$

$$\dot{W}_c / \dot{m}_a = c_p\left(T_{o_3} - T_{o_2}\right)$$

Example #4: Engine Diffuser

- **Given:** Engine diffuser on aircraft flying at known velocity and ambient conditions



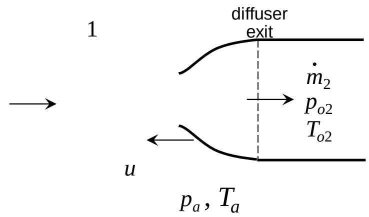
- **Find:** Stagnation temperature (T_{o_2}) and pressure (p_{o_2}) at diffuser outlet

- **Assume:** ________ , _________ , ______ , ______

Example #4: Engine Diffuser

- **Analysis:**

1st define CV



Mass

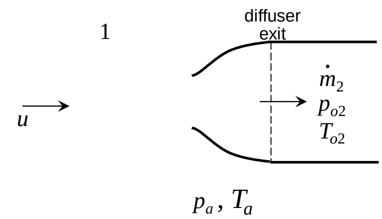
Energy

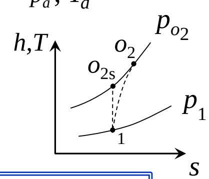
Georgia Tech College of Engineering School of Aerospace Engineering

Example #4: Engine Diffuser

- **Analysis:**

$$\eta_d = \frac{h_{o_{2s}} - h_1}{h_{o_2} - h_1} \quad \text{OR} \quad \eta_d = \frac{h_{o_2} - h_1}{h_{o_{2s}} - h_1}$$





$$\frac{p_{o_2}}{p_1} = \left\{1 + \eta_d \left(\frac{T_{o_2}}{T_1} - 1\right)\right\}^{\gamma/\gamma-1} \Rightarrow \boxed{p_{o_2} = p_1 \left\{1 + \eta_d \frac{\gamma - 1}{2} M^2\right\}^{\gamma/\gamma-1}}$$ **(II.12)**