

AerE 411, Homework 5 (9 points)

Figures are required for those HW solutions which have figures

To receive credit for computer solutions, you must include the source code

Note: this document is subject to change by the instructor during the semester.

Note: To receive credit for a numerically solved problem, you must include a listing of your source code and all of your plots must be computer generated.

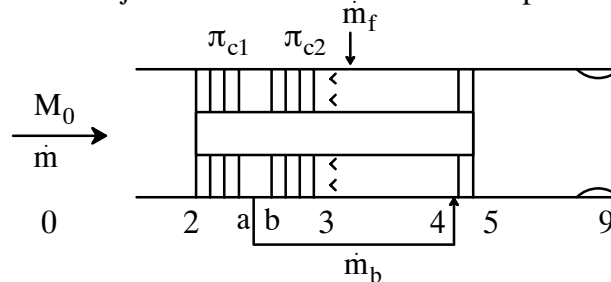
1. (1 point each) Oates Chapter 6 (Component Properties): 6.12, 6.14

2. (2 points) Reproduce the analysis for the turbofan with losses in Oates Chapter 7 (i.e. the equations “Summary of the Equations – Turbofan with Losses and Bypass Ratio Prescribed”).

3. (1 point each) Oates Chapter 7 (Non-Ideal Cycle Analysis): 7.2 (note that $P_9 = P_0$), 7.4. You must validate your solutions by first reproducing the results from Oates Figs. 7.2, 7.3 and 7.4.

4. (2 points) Solve Oates problem 7.5 using a global search to numerically locate the minimum specific fuel consumption from a direct solution of the equations for a turbofan with losses (i.e. the equations developed in problem 2) Before solving problem 7.5, validate your solution by calculating the results shown in Figs. 7.6 and 7.7.

5. (1 point) Consider a turbojet with air bled from the compressor to cool the turbine blades:



This problem is to be solved using ideal cycle analysis assumptions. The only component that must be retained in the non-ideal cycle analysis is the air mass flow that is bled off the compressor to cool the turbine blades. All fuel mass fluxes may be assumed to be small. All pressure losses may be neglected. All changes in thermodynamic parameters with temperature may be neglected. The engine geometry is shown above. The air is bled from the compressor between stations a and b. Assume that the sections of the compressor upstream and downstream of the bleed point have the pressure ratios shown in the figure. The mass flow rate of the bleed air is assumed to be \dot{m}_b . The bleed air is re-introduced into the air stream at station 4. You may assume that the bleed air mass flux is small enough that it does not substantially effect the overall stagnation temperatures or pressures at station 4 or near the bleed point (i.e. you only need to account for the changes in air mass flux and you do not need to use a mixed stream model at the point where the bleed air is re-introduced into the main air stream). Show that the specific thrust for this engine is, where $\beta = \dot{m}_b/\dot{m}$:

$$\frac{F}{\dot{m}} = a_0 \left\{ \left[\frac{2}{\gamma - 1} \frac{\tau_\lambda}{\tau_r \tau_{c1} \tau_{c2}} \left(\tau_r \tau_{c1} \tau_{c2} \left\{ 1 - \frac{\tau_r}{\tau_\lambda} [\tau_{c1} - 1 + (1 - \beta) \tau_{c1} (\tau_{c2} - 1)] \right\} - 1 \right) \right]^{1/2} - M_0 \right\}$$