16.50 Spring 2001
Problem Set #8
Assigned: 4/4/01
Due Date: 4/11/01

In our analyses of the performance of aircraft engines, we have thus far assumed isentropic compression and expansion processes. The purpose of this problem is for you to explore the effect of losses in the fan of a turbofan engine, on the performance.

To this end we introduce a fan efficiency, defined as follows

$$\eta_f = \frac{\pi_f^{\frac{\gamma-1}{\gamma}} - 1}{\tau_f - 1}$$

As you can see, for an efficiency of unity this reduces to the expression we have used to connect the pressure and temperature ratios.

a) Repeat the cycle analysis for the turbofan, using this expression, and find an expression for the thrust (with the pressure ratio chosen for maximum thrust as before). To avoid a messy algebra problem, assume that the fan temperature ratio has the same value as would give equal core and duct jet velocities for an ideal fan (i.e. one with efficiency of unity).
b) Now calculate the thrust per unit of core mass flow, for θ_t=6, α=6, M_0=0.80, for both the ideal turbofan and for η_f=0.9. Assume T_0= 222 K