16.050 Thermal Energy

Recitation #1 – Fall 2002

Problem 1:

A piston/cylinder arrangement contains 1 kg of air. The piston is spring loaded and initially rests on some stops (with the spring uncompressed). A pressure of 300 kPa will just float the piston (*i.e,* the spring is still uncompressed). At a volume of 1.5 m^3 and a pressure of 500 kPa the piston is balanced (*i.e,* the weight of the piston and the spring force are balanced). The initial state of the air is 100 kPa with a volume of 0.5 m^3. Heat is now added until a pressure of 400 kPa is reached. Assume air behaves as a perfect gas.

a) Find the final volume.
b) Find the final temperature.
c) Find the work and heat transfer in the process.
d) Plot the P-V diagram.

Problem 2:

The core of a certain gas turbine system, as drawn on the board, has a compressor, a combustor, and two turbines. The first turbine, the high pressure turbine, provides the power for the compressor through a coupling shaft. The second turbine provides the net power output of the system. You are given the following system specifications:

$T_{t,2}$= 300 K (compressor inlet total temperature)
T_{t4}= 1500 K (high pressure turbine max inlet total temperature)
T_{t6}= 500 K (low pressure turbine exit total temperature)
r_c= 20 (compressor stagnation pressure ratio)
$\dot{m}$ = 100 kg/s

You may assume that air behaves as a perfect gas with cp=1000 J/kgK in the compressor and cp=1100 J/kgK in the turbines. You may also assume that the compressor is adiabatic and reversible.

Find the power output of the low pressure turbine.