ME 18b, HW 5

Due Thursday May 14, 2009 (accepted until 4 pm)

Note: This homework is due on a Thursday not a Tuesday

TAs for HW #5:
Dan Alvarez, Sunday 8-10 pm, SFL 229;
Mary Dorman, Monday 7-9 pm, SFL 331

Number of classes attended: _____

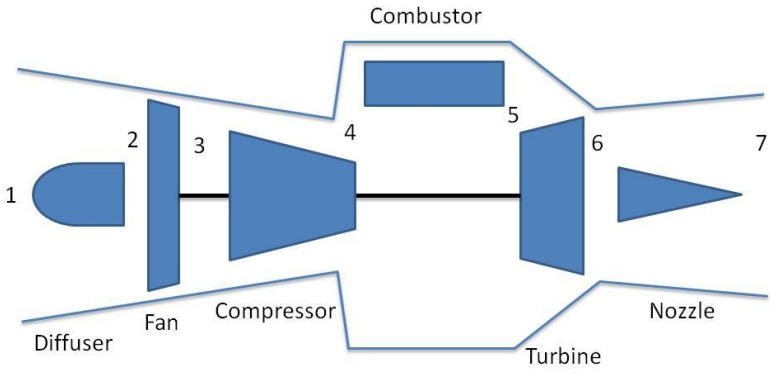
Hours spent on homework: _____

1. Brayton Cycle Jet Aircraft Engine The General Electric GE90 is a family of high-bypass turbofan engines built by GE-Aviation for the Boeing 777, with thrust ranging from 74,000 to 115,000 lbf (329 to 512 kN). It was first introduced in November 1995. The GE90 series are physically the largest engines in aviation history. The fan diameter of the latest variant, the GE90-115B, has a diameter of 325 cm (128 in). This means that the GE90 has a diameter larger than most cabins in business aircraft. For more info on this engine go to: http://www.turbokart.com/about_ge90.htm

Using the state numbers shown in the figure below for your analysis; determine the following operating conditions of the engine as power is applied prior to take-off while the plane is still stationary on the runway:

a. Air mass flow rate for a thrust of 400 kN.
b. Air volumetric flow rate in m^3/min and cfm.
c. The work of the fan, compressor and turbine. The fan has a pressure ratio of 2.1 and the compressor has a pressure ratio of 19.0. Ignore the portion of fan work that provides bypass air (which is not shown).
d. The heat input for final combustion temperature of T_5 = 1400 K.
e. The exhaust velocity
f. The fuel consumption in kg/hr if the fuel has a heating energy value of 45 MJ/kg.

You will need to make your own assumptions about the inlet conditions.



2. Otto Cycle Engine: A 3.3 L gasoline engine runs at 2400 RPM with a compression ratio of 10:1. The intake is at 95 kPa, 7°C. The heat addition to the engine during combustion is 900 kJ/kg. Determine the following using a method that accounts for variation in specific heat:

a. The temperature and pressure at each point in the cycle.

b. The cycle thermal efficiency.

c. The power of the engine in kW.

3. Diesel Cycle Engine: A 4-stroke diesel engine has a bore of 0.1 m, a stroke of 0.11 m. The compression ratio is 19:1. The temperature at the end of combustion is 2400 K. State your own assumptions for inlet conditions. Determine the following using cold air assumptions:

a. The pressure and temperature at each point in the cycle.

b. The cycle thermal efficiency.

c. The engine power in kW and horsepower, hp. for a 6 cylinder engine running at 2000 RPM.