ASE 376K Homework #6

1. The GE90-85B engine has an overall compression ratio for the core air-flow of 39.3 that is achieved with a total of 14 compression stages.
(a) Assuming that each stage has the same pressure ratio (this is **NOT** the real situation) estimate the pressure ratio of each stage.
(b) If the stage pressure ratio could be increased by 4% what would be the compression ratio of a 14 stage compressor?
(c) How many stages would be needed if the stage compression ratio were to be increased 4% and the overall pressure ratio were kept fixed at 39.3.

2. The air entering the first stage of an axial flow compressor has a <u>stagnation temperature</u> of 260 K and is moving at Mach 0.42. The inlet flow is purely axial, the compressor has a mean radius of 0.52 m, and the rotor is rotating at 6000 rpm. The compressor is designed for constant axial velocity and $w_2 = 0.74\ w_1$. Assume an effectiveness factor $\lambda = 0.97$.
(a) Sketch the velocity triangles and calculate the Mach number of the flow relative to the blade at the mean radius.
(b) Calculate the air angles β_1, α_2, and β_2 at the mean radius.
(c) Calculate the stagnation temperature rise across the stage.
(d) Estimate the stage compression ratio assuming a stage efficiency of 0.93.

3. The high pressure compressor of an aircraft engine has an inlet stagnation temperature of 372 K and stagnation pressure of 220 kPa. The overall pressure ratio is 10 and the air mass flow rate is 56 kg/s. The polytropic efficiency of the compressor is 0.90 and the stagnation temperature rise per stage must not exceed 30 K. Calculate the number of stages required if ΔT_o is the same for all stages. (Note: If you end up with a non-integer number of stages, you will have to round up to the next integer).