Aerothermodynamics and Propulsion
AERO351

Homework 6
Assigned: November 8, 2015
Due: November 16, 2015

1. The flow enters axially the fan of a turbofan engine with a velocity of 180 m/s. What should be value of the flow coefficient such that the flow is subsonic on the fan blade? (Hint: assume the speed of sound is 340 m/s.)

2. The flow coefficient for a compressor stage is $\phi = 0.5$. The flow enters and leaves the stage in the axial direction. The turning angle of the stator is 20 deg.
   (a) What is the turning angle of rotor?
   (b) Draw the velocity triangles.

3. Air at 101.3 kPa and 288 K enters an axial-flow compressor with a velocity of $160 + A$ m/s. There are no inlet guide vanes. The stage has a tip diameter of $0.68 + B$ m and a hub diameter of 0.46 m. The angular velocity of the rotor is $8500 + C$ RPM. The air enters the rotor axially and leaves the stator as close to the axial direction as possible. The turning angle is 15 deg in the rotor and up to 12 deg in the stator.

   One assumes:
   (a) constant specific heat and $\gamma = 1.4$;
   (b) air enters and leaves the blades at the blade metal angles;
   (c) the axial components of the velocities are constant in the stage.

   Divide the blade in three equal span-wise sections.
   (a) Construct the velocity diagrams at the middle of each section, for both the rotor and stator;
   (b) Plot the radial variation of the camber line for the rotor and stator;
   (c) Calculate the power required by the compressor;
   (d) Calculate and plot the radial variation of the total enthalpy at the exit of the stage;
   (e) Calculate and plot the radial variation of the total-to-total pressure ratio for the stage;
   (f) Calculate and plot the radial variation of the degree of reaction, flow coefficient, work coefficient, Mach number and the De Haller number.

Note: If the last three digits of your student ID number are $abc$, then $A$, $B$ and $C$ are defined as following:

   $A = 3a$
   $B = 0.01b$
   $C = 100c$