

AE 4251 Test 2

Closed Book. One 8.5" x 11" sheet of your handwriting allowed.

1. An axial compressor has an overall stagnation pressure ratio of 32, and has 10 stages of equal stagnation pressure ratio per stage. The polytropic efficiency is 0.93. Assume that the stagnation enthalpy rise per unit mass flow rate is uniform along the blade from root to tip, and that radial flow is negligible. Draw the stage velocity diagram at the mean radius and calculate the vectors **c1**, **c2**, **w1**, and **w2**, given:

The absolute velocity at the inlet to the rotor is directed at 20 degrees to the axial direction.

Mean radius : 0.8m.

Constant axial velocity component: 100m/s

Stagnation temperature upstream of rotor : 410K

Shaft RPM : 3900

Also, sketch the rotor and stator blades, and show the direction of rotation.

(40)

2. C_8H_{18} reacts with air.

a) Find the stoichiometric fuel/air mass ratio.

b) If the effective equivalence ratio is actually 0.6, find the fuel/air ratio. Indicate clearly what you understand by the term "effective equivalence ratio".

(30)

3. As the new propulsion expert at Bulldawg Hypersonics, Inc., you are to develop a program to calculate the final temperature and composition of the gas leaving a supersonic combustor (the duct tested by Colorado Hot Air). The engine for the proposed Flying Dawg (To transport the Coach and the Team at five times the speed of Uga's bark) uses hydrogen fuel. One of the concerns in Athens is the effect of NO and NO₂ on the lung power of the Alumni when they are exposed to the atmosphere at Sanford Stadium. This means that you must include these species (NO and NO₂, not the Alumni) in your calculations.

Explain how you will solve for the composition and final temperature of the gas leaving the combustor. Your explanation must satisfy the mean old critics from the North Avenue School of A.E., who have been complaining about the lack of technical detail in previous proposals from B.H.I. It is normal practice at B.H.I. to ask people to come up with the technical content of proposals in 15 minutes, so that they have plenty of time left to spend on developing color charts in big letters for presentation to the management.

(30)