AA210A Homework 4 2020 -2021

Due Wednesday October 14

Read Chapter 6 and Chapter 7, Chapter 8 Sections 8.1 to 8.3

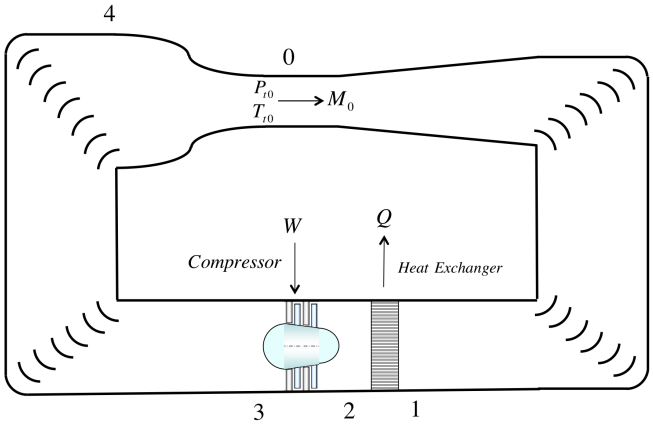
Chapter 6 – Problem 1

Chapter 7 – Problems 3 and 4

Chapter 8 – Problem 1 and 3

Problem (from a previous midterm, this was also a PhD quals question) – The figure below shows flow in a wind tunnel circuit driven by a compressor. Low speed air from the settling chamber is accelerated from left to right through a contraction into the tunnel test section. The air enters the test section at station 0 with stagnation temperature T_{t0}, stagnation pressure P_{t0}, and Mach number M_0. From the test section, the air passes into a diffuser designed to decelerate the flow back to low speed. Heat is removed from the flow by a heat exchanger between stations 1 and 2. Work is done on the flow by the compressor between stations 2 and 3. The stagnation temperature ratio across the compressor is $T_{t3}/T_{t2} = 1.15$.

i) Assume the heat removed from the flow by the heat exchanger causes no change in stagnation pressure between stations 1 and 2.
ii) Assume the entire wind tunnel is adiabatic except for the heat exchanger.
iii) Assume the work done on the flow by the compressor causes no change in the entropy of the flow between stations 2 and 3.



1) Determine P_{t3}/P_{t2}.

2) Determine the entropy change across the heat exchanger $(s_2 - s_1)/C_p$.

3) Due to viscous friction, the entropy change from station 3 to station 4 is measured to be one half of the entropy difference between station 1 and station 2. Determine P_{t3}/P_{t4} and P_{t4}/P_{t1}.

4) Wall pressure sensors are used to determine the static pressure ratio across the contraction, $P_4/P_0 = 1.2$. Estimate the test section Mach number.

5)Why is a heat exchanger needed?