27.04.2022

AE306 HW-2

(Due: MIDTERM-2 START 12.05.2022 at 8.30 A.M. in A11 class)

USE TABLES SEPARATELY AND EQUATIONS SEPARATELY FOR YOUR SOLUTIONS.

FOR EXAMPLE:

Q1) a. Using Table A1.....

b. Using Equations derived in class....

<u>Note:</u> You will get 50% of your grade from table used solution, 50% of your grade from equations used solution. If one of those is not applicable in the question or the question itself shows the direction of your selection, then you should follow the question's directives.

Q1) At the inlet to the combustor of a supersonic combustion ramjet (SCRAMjet), the flow Mach number is supersonic. For a fuel–air ratio (by mass) of 0.03 and a combustor exit temperature of 4800°R, calculate the inlet Mach number above which the flow will be unchoked. Assume one-dimensional frictionless flow with $\gamma = 1.4$, with the heat release per slug of fuel equal to 4.5×10^8 ft ·lb.

Q2) Consider the adiabatic flow of air through a pipe of 0.2-ft inside diameter and 3-ft length. The inlet flow conditions are $M_1 = 2.5$, $p_1 = 0.5$ atm, and $T_1 = 520$°R. Assuming the local friction coefficient equals a constant of 0.005, calculate the following flow conditions at the exit: M_2, p_2, T_2, and p_{o2}.

Q3) Consider a normal shock wave moving with a velocity of 680 m/s into still air at standard atmospheric conditions ($p_1 = 1$ atm and $T_1 = 288$ K).

a. Using the equations derived in lecture, calculate T_2, p_2, and up behind the shock wave.

b. The normal shock table can be used to solve moving shock wave problems simply by noting that the tables pertain to flow velocities (hence, Mach numbers) relative to the wave. Use Table to obtain T_2, p_2, and up for this problem.

Q4) Consider an incident normal shock wave that reflects from the endwall of a shock tube. The air in the driven section of the shock tube (ahead of the incident wave) is at $p_1 = 0.01$ atm and $T_1 = 300$ K. The pressure ratio across the incident shock is 1050. Calculate

a. The reflected shock wave velocity relative to the tube

b. The pressure and temperature behind the reflected shock

Q5) The driver and driven gases of a pressure-driven shock tube are both air at 300 K. If the diaphragm pressure ratio is $p_4 / p_1 = 5$, calculate:

a. Strength of the incident shock (p_2/p_1)

b. Strength of the reflected shock (p_5/p_2)

c. Strength of the incident expansion wave (p_3/p_4)