AE 330/708
Assignment 3
Due date: 29/09/2020

1. Using a propellant of molecular weight 12 and flame temperature 2950 K, determine the rocket throat and exhaust areas required for a thrust of 55 kN and an ideal specific impulse of 295 sec. The ambient pressure is 0.101 MPa and the specific heat ratio of the propellant is 1.3. How much thrust would this rocket develop if the ambient pressure were changed to 0.03 MPa? How much thrust would be developed by a rocket designed to expand to 0.03 MPa if it had the same stagnation conditions, thrust area and propellant?

2. The actual conditions for an optimum expansion nozzle operating at sea level are given below. Calculate v_2, T_2, and C_F. The mass flow = 3.7 kg/sec; P_1 = 2.1 MPa; T_1 = 2585 K; MW = 18.0 kg/kg-mol; and k = 1.30.

3. Design a nozzle for an ideal rocket that has to operate at 25 km altitude and give 5.5 kN thrust at a chamber pressure of 2.068 MPa and a chamber temperature of 2900 K. Assuming that k = 1.30 and R = 355.4 J/kg-K, determine the throat area, exit area, throat velocity, and exit temperature. (At 25 km, pressure is 0.002549 MPa)

4. Design a supersonic nozzle to operate at 10 km altitude with an area ratio of 8.0. For the hot gas take To = 3000 K, R = 378 J/kg-K and k = 1.3. Determine the exit Mach number, exit velocity, and exit temperature, as well as the chamber pressure. If this chamber pressure is doubled, what happens to the thrust and the exit velocity? Assume no change in gas properties. How close to optimum nozzle expansion is this nozzle? (Pressure at 10 km altitude is 265 millibars)

5. Hot gases are generated at a temperature of 2000 K and a pressure of 15 MPa in a rocket chamber. The values of *k* and molecular weight are 1.32 and 22 kg/kmol respectively. The gases are expanded to the ambient pressure of 0.1 MPa in a convergent-divergent nozzle having a throat area of 0.1 m^2. Determine exhaust jet velocity, characteristic velocity, thrust, thrust coefficient and specific impulse.