AE236: Compressible Fluid Mechanics
Quiz 5
April 15, 2021

Duration: 45 minutes **Maximum Marks: 15**

Answer all questions succinctly. All the best!

1. A gaseous mixture of air and fuel enters a ramjet combustion chamber with velocity 60 m/s, temperature 50^0C and pressure 35 kPa. The heat added due to reaction of the mixture in the chamber is 1160 kJ/kg. Find the Mach number, pressure and temperature at the exit of the chamber if friction is neglected and the cross-sectional area is assumed constant. Assume the properties of the gaseous mixture before and after reaction are the same as that of air. (3)

2. Air at inlet to an insulated constant area duct of diameter 160 mm has a Mach number of 0.36. The mean friction factor of the duct for the flow conditions is 0.0025. What length of the pipe would give a 10% loss in stagnation pressure? What is the Mach number at the corresponding exit section? What is the percentage loss in stagnation pressure if the flow extends to sonic condition? (4)

3. Answer the following questions briefly without elaboration: (8)
   (a) Draw a Fanno line on a T-s diagram and mark two points on the top branch. Explain, using logical reasoning with suitable markings on the T-s diagram, what happens to the density and stagnation pressure as the flow moves between the two points.
   (b) Repeat this exercise for the lower branch.
   (c) Draw a Rayleigh line on a T-s diagram and mark two points on the top branch. Explain, using logical reasoning with suitable markings on the T-s diagram, what happens to the density and stagnation pressure as the flow moves between the two points.
   (d) Repeat this exercise for the lower branch.
   (e) Imagine the supersonic Fanno flow leading into a normal shock. The shock merely causes the flow to jump from the supersonic branch to the subsonic branch of the same Fanno line. Why? Mark the initial and final states on the Fanno line on a separate T-s diagram
   (f) On a T-s diagram draw both the Fanno line and the Rayleigh line. They intersect in exactly two points. Why? Can you imagine a process that goes from one intersection point to the other?