AE236: Compressible Fluid Mechanics
Quiz 3
March 4, 2020

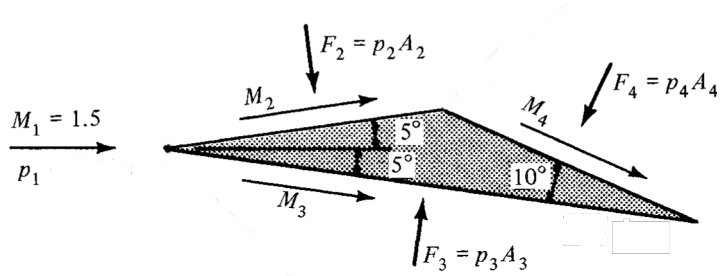
Duration: 45 minutes **Maximum Marks: 15**

Answer all questions succinctly. All the best!

1. Air is flowing through a long pipe at a velocity of $160m/s$ at a pressure and temperature of $150kPa$ and 100^0C respectively. Discuss the waves that are generated in the pipe when (2)
   (1) the inlet valve is suddenly closed, and when
   (2) the exit valve is suddenly closed.
   Find the pressure acting on the inlet valve in the first case.

2. On a $T - s$ diagram, mark the initial and final states of a strong oblique shock along with the static and stagnation states. Also represent the shock. On a separate $T - s$ diagram, do the same for a weak oblique shock. Explain your drawing briefly. (3)

3. A supersonic airfoil is designed as an isosceles triangle with 10^0 equal angles and a chord of $2.5m$ (see figure). When operating at an angle of 5^0, find the pressures on the various surfaces and the lift and drag forces when flying at $M = 1.5$ through air with a pressure of $55kPa$. (5)



4. Air at a pressure of $40kPa$ and -30^0C flows at Mach 3 down a wide duct. The upper wall of the duct turns sharply through an angle of 5^0 leading to the formation of an oblique shock wave. (5)
   (a) Find the Mach number, temperature and pressure behind this shock wave.
   This shock wave strikes the lower wall of the duct exactly at a point where the lower wall turns away from the flow through an angle of 2^0.
   (b) Find the Mach number, pressure and temperature behind the reflected wave.