M.E. Mechanical Engineering - First Year - Second Semester, 2018

Subject: Gas Dynamics

Time : Three hours **Full Marks: 100**

Answer any four [4]

1a) Derive normal shock wave relations in terms of Mach number. 15
b) Consider a supersonic flow with $M = 2$, $p = 1$ atm, and $T = 288$ K. This flow is deflected at a compression comer through 20°. Calculate M, p, T, p_o, and T_o behind the resulting oblique shock wave. 10

2a) What is oblique shock wave? Discuss with example. 9
b) Calculate the lift and drag co-efficients for a flat plate at a 5° angle of attack in a Mach 3 flow. 9
c) What do you mean by reflection of oblique shock wave? 7

3a) What do you mean by expansion waves? Explain it. 10
b) Discuss about reflection and interaction of expansion waves with suitable diagram. 15

4a) How to measure the speed of a supersonic jet plane using pitot tube attached with the body. How will it differ in case the velocity of the plane becomes subsonic. 15
b) A Pitot tube is inserted into an airflow where the static pressure is 1 atm. Calculate the flow Mach number when the Pitot tube measures (a) 1.276 atm, (b) 2.714 atm, (c) 12.06 atm. 10

5a) Consider a normal shock wave in air where the upstream flow properties are $u_1 = 680$ m/s, $T = 288$ K, and $p_1 = 1$ atm. Calculate the velocity, temperature, and pressure downstream of the shock. 7
b) Consider a point in an air flow where the local Mach number, static pressure and static temperature are 3.5, 0.4 atm and 180K. Calculate the local values of p_0, T_0, p^*, T^* and M^* at the point. 6
c) Consider an oblique shock wave with a wave angle of 30°. The upstream f low Mach number is 2.4. Calculate the deflection angle of the flow, the pressure and temperature ratios across the shock wave, and the Mach number behind the wave. 6
d) Consider an oblique shock wave with $\beta = 35°$ and a pressure ratio $p_2 / p_1 = 3$. Calculate the upstream Mach number. 6