Name: BITS ID:

BITS Pilani, Pilani campus

Mid-semester examination, First semester 2022-2023

ME F415 Gas Dynamics

Total marks: 30, Weightage: 30%, and Date & Time: 31/10/2022 & 2:00 pm to 3:30 pm.

Assume any missing data and state the assumptions if any.

Questions

1. With the aid of any gas dynamics relation, explain the effect of Mach number on compressibility? [2 marks]
2. Draw Mach cone for M=2, mark the salient features and explain them all? [3 marks]
3. Explain with adequate justification why the compression by shock waves is effective but not efficient as compared to the isentropic one. [4 marks]
4. Consider flow of nitrogen expanding through a CD nozzle from stagnation condition to a controlled atmosphere where the back pressure conditions can be controlled. Discuss the change of Mach number in the nozzle for various subsonic and supersonic exit conditions. Also, briefly explain what are under and over expansions. [5 marks]
5. Consider air flow through a CD nozzle which has an exit to throat area ratio of 1.8. It is noted that a normal shock occurs at a location where the cross sectional area is 1.2 times that of the throat. For the above conditions, what is the (a) ratio of exit static pressure to inlet stagnation pressure and (b) ratio of exit static temperature to inlet stagnation temperature? If the stagnation conditions at the inlet is given as 10 bar and 500 K, calculate the Mach number, pressure and temperature at the throat and exit. [8 marks]
6. Consider a blunt nosed aerodynamic model mounted inside the driven section of a shock tube. The axis of the model is aligned parallel to the axis of the shock tube, and the nose of the model faces towards the on-coming incident shock wave. The driven gas is air initially at temperature and pressure of 218.15 K and 0.2 bar, respectively. After the diaphragm is broken, an incident shock wave with a pressure ratio of $p_2/p_1 = 29$ propagates into the driven section. (a) Calculate the pressure and temperature at the nose of the model shortly after the incident shock sweeps by the model. (b) Calculate the pressure and temperature at the nose of the model after the reflected shock sweeps by the model. [8 marks].