End-Sem. Exam, JAN 2021

Gas Dynamics (AAE 3158) Offline Exam Paper

Exam date : 02/01/2021

Type: DES

Q1. Define the term gas dynamics and state it's practical applications. **(2)**

Q2. Air flows at Mach 0.5 through a circular pipe of diameter 50 cm. The stagnation pressure and stagnation temperatures are 800 kPa and 750 K, respectively. Considering air as a perfect gas, determine the mass flow rate of air through the pipe. **(4)**

Q3. Derive an expression for the Hugoniot equation. **(4)**

Q4. Air enters a constant area duct at Mach 2.5, 1 atm and 320 K. The heat is added inside the duct at a rate of 5×10^5 J/kg. Determine the flow properties at the exit of the duct. **(3)**

Q5. Explain with a neat sketch the intersection of shocks of opposite family. **(3)**

Q6. Air flows over a symmetrical wedge at Mach 2. The shock wave angle is 79.8°. Determine the (i) semi-vertex angle of the wedge (ii) the pressure ratio across the wave (iii) the temperature ratio across the wave and (iv) Mach number downstream of the shock wave. **(4)**

Q7. With a neat sketch describe the influence of exit-to-inlet pressure ratio on the performance of a convergent-divergent nozzle. **(3)**

Q8. Gas passes through a convergent-divergent nozzle at stagnation pressure and stagnation temperature of 18 atm and 1500 K, respectively. At the nozzle exit, the pressure is 0.022 atm. Consider the specific heat ratio as 1.3. For a nozzle mass flow rate of 250 kg/s, determine the (i) gas flow velocity at the exit of the nozzle and (ii) nozzle exit area. **(4)**

Q9. Derive the Crocco's theorem. **(3)**

Q10. The pressure coefficient for the flow of gas over an airfoil is given by

$$C_p = \frac{2}{\gamma M_\infty^2}\left(\frac{P}{P_\infty} - 1\right)$$

With reference to the above equation, obtain an expression for the linearized pressure coefficient using small perturbation theory. **(4)**

Q11. With a neat sketch, discuss the significance of supersonic flow over the cone and wedge. **(3)**

Q12. Draw a neat sketch of minimum length nozzle and explain how it is different from the supersonic nozzle. Write down the condition for the minimum length nozzle. **(3)**

Q13. Explain the following terms relevant to the hypersonic flow, (i) thin shock layers and (ii) entropy layers. **(4)**

Q14. Inviscid gas flow at Mach 11 passes over an infinitely long thin flat plate kept at an angle of 20°. Using Newtonian theory, determine the (i) pressure coefficient on the top and bottom surface of the plate (ii) the lift and drag coefficients and (iii) lift-to-drag ratio. **(3)**

Q15. Describe with a neat sketch, the working principle of velocity measurement using hot wire anemometer. (3)