Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE008

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Regular) - November, 2019

Regulation: IARE – R16

HIGH SPEED AERODYNAMICS

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Obtain the equations for the conservations of mass in integral form with the help of neat sketch. **[7M]**

   (b) An aircraft is flying at a speed of 1000 kmph. Compute the variations in speed of sound a, and Mach number M with altitude change from sea level and at 11 Km. **[7M]**

2. (a) What do you understand by speed of sound.Derive the equation for speed of sound in a perfect gas in the form a=γRT **[7M]**

   (b) Hydrogen gas in a cylinder at 7 atm and 300 k is expanded isentropically through a nozzle to a final pressure 1 atm. Assuming hydrogen to be perfect gas with specific heats ratio γ =1.4, determine the velocity and Mach number corresponding to the final pressure **[7M]**

UNIT – II

3. (a) Why the Mach number is always subsonic behind the normal shock? Justify your Answer. **[7M]**

   (b) For a flow with M=2, P=1atm and T=288k, this flow is deflected at a compression corner through 20^0. calculate M,P,T. **[7M]**

4. (a) Write short notes on shockwave and boundary layer interaction and explain them. **[7M]**

   (b) An oblique shock wave occurs at the leading edge of a symmetrical wedge. Air has a Mach number of 2.1 and deflection angle of 150. Determine the following for strong and weak waves. i) Wave angle ii) Pressure ratio iii) Density ratio iv) Temperature ratio v) Down Stream Mach number **[7M]**

UNIT – III

5. (a) Give a brief outline of operation of supersonic wind tunnels employing convergent - divergent nozzles? **[7M]**

   (b) The pressure, temperature and velocity of a gas in a combustion chamber at entry are 0.35 bar, 300 K and 55 m/s. The increase in stagnation enthalpy of the gas between entry and exit is 1170 KJ/Kg. Calculate the following i) Exit Mach number, M_2 ii) Exit Pressure, P_2 iii) Exit temperature, T_2 iv) Exit Velocity, V_2 Take C_p = 1.005 KJ/Kg K, γ = 1.4 **[7M]**

6. (a) Write short notes on Fanno flow and Rayleigh flow with the reference conditions. **[7M]**

   (b) The pressure, temperature and fluid velocity of air at the entry of a flow passage are 3 bar, 280 k and 140 m/s. The pressure, temperature and velocity at the exit of a flow passage are 2 bar, 260 K and 250 m/s. The area of cross section at entry is 600 cm^2. Determine for adiabatic flow, i) Stagnation temperature ii) Maximum velocity iii) Mass flow rate iv) Area of cross section at exit. Take $\gamma = 1.3$, R=287 J/Kg K. **[7M]**

UNIT – IV

7. (a) Based on small perturbation theory, derive the linearized velocity potential equation for compressible flows. **[7M]**

   (b) For certain aerofoil at given point on the upper surface of the aerofoil, the pressure coefficient is -0.27 at very low speed. If the free stream Mach number is 0.75, calculate C_p and C_m at this point. **[7M]**

8. (a) Explain briefly the procedure to be followed for the design of a supersonic nozzle using method of characteristics. **[7M]**

   (b) At a given point on the surface of the aerofoil, the pressure coefficient is -0.3 at very low speed. If the free stream Mach number is 0.6, calculate C_p at this point. **[7M]**

UNIT – V

9. (a) Illustrate the working principle of supersonic wind tunnel with neat sketch. **[7M]**

   (b) What is the reservoir pressure for the tunnel if the nozzle of a supersonic wind tunnel has an exit to throat area ratio of 6.79 when the tunnel is running, a pitot tube mounted in the test section, measures 1.448 atm. **[7M]**

10. (a) Discuss about expansion shock tubes and their characteristic feature. **[7M]**

    (b) Explain interferometry flow visualization technique with neat sketch. **[7M]**

– ○ ○ ◯ ○ ○ –