Code No: NR312104 **NR**

III B.Tech I Semester Supplementary Examinations, November 2006
GAS DYANAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Derive the energy equation [16]
$\frac{a^2}{r-1} + \frac{1}{2}C^2 = \frac{1}{2}C^2_{\max} = \frac{a_0^2}{r-1} = L_0$
Stating the assumptions used
An air jet (r = 1.4, R=287 J/kg K) at 400K has sonic velocity. Determine
   (a) Velocity of sound at 400K
   (b) Velocity of sound at the stagnation condition
   (c) Maximum velocity of the jet
   (d) Stagnation enthalpy
   (e) Crocco Number.

2. (a) Explain briefly the following terms [2 × 5]
      i. Control volume
      ii. Internal energy and enthalpy
      iii. II^{nd} law of thermodynamics
      iv. Adiabatic and isentropic process
      v. Non-flow process
   (b) Define stagnation enthalpy and stagnation temperature. Do these quantities define the stagnation state. [6]

3. Describe the behaviour of flow in a convergent divergent nozzle when it is operated at [16]
   (a) Design pressure ratio
   (b) Pressure ratio higher than design value and
   (c) Pressure ratio lower than the design value

4. The ratio of the exit to entry area in a subsonic diffuser is 4.0. The mach number of a jet of air approaching the diffuser at $p_0 = 1.013 bar$, T=288 is 2.3. There is standing a normal shock wave just outside the diffuser entry. The flow in the diffuser is isentropic. Determine at the exit of the diffuser. [16]
   (a) Mach number
   (b) Temperature and
   (c) Pressure

5. (a) Show that the Mach number downstream of the normal shock wave is given by [2 × 8]

$$My^2 = \frac{\frac{2}{r-1}+M_x^2}{\frac{2r}{r-1}M_x^2-1}$$

M_x=Upstream Mach number

(b) Explain how strong compression and expansion waves are formed in a compressible fluid.

6. A combustion chamber in a gas turbine plant receives air at 320 K, 0.5 bar and 70m/s. The air fuel ratio is 27 and calorific value of the fuel is 40.87MJ/Kg. Taking r=1.4 and R=0.287KJ/kg K for the gas. determine [16]

(a) The initial and final Mach number

(b) Final pressure, temperature and velocity of the gas

(c) Percent stagnation pressure loss in the combustion chamber and

(d) The maximum stagnation temperature attainable.

7. Derive the following Equation for Fanno flow. [16]

(a) $\frac{C}{C^*} = \frac{\rho^*}{\rho} = \left[\frac{(r+1)M^2}{2+(r-1)M^2}\right]^{1/2}$

(b) $\left(\frac{4\bar{f}L_{\max}}{D}\right)_M = \frac{1-M^2}{rM^2} + \frac{r+1}{2r}\ l_n\ \frac{(r+1)M^2}{2+(r-1)M^2}$

8. Explain what is Prandtl-Meyer angle? Starting from flow geometry show that the value of Pramdtl-Meyer angle is [16]

$$W\left(M\right) = \int \frac{\sqrt{M^2-1}}{2M^2\left(1+\frac{r-1}{2}M^2\right)}$$

Also obtain the value of the above integral and show that the maximum Prandtl-Meyer angle is

$$\left(\sqrt{\frac{r+1}{r-1}}-1\right)\frac{\Pi}{2} = 130.5^0(for\ r=1.4)$$

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