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BASE-003

00190

B.Tech. AEROSPACE

Term-End Examination

June, 2013

BASE-003 : HIGH SPEED AERODYNAMICS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any seven** questions. All questions carry **equal** marks. Use of scientific calculator, steam table and normal shock table is **permitted**.*

1. (a) Define entropy. What is it's unit ? Is it an extensive property or intensive property ? 4

(b) If the change in entropy of the surroundings for a process at 451 K and constant pressure is -326 J/K, what is the heat flow absorbed by for the system ? 2

(c) A change of state that occurs in a system is accompanied by 64 kJ of heat, which is transferred to the surroundings at a constant pressure and a constant temperature of 300 K. Calculate ΔS surr. for this process. 4

2. (a) Prove the relation $M_2^* = \dfrac{1}{M_1^*}$. 5

(b) Hence show that $M_2^2 = \dfrac{1 + \dfrac{\gamma - 1}{2} M_1^2}{\gamma M_1^2 - \dfrac{\gamma - 1}{2}}$. 5

3. Air at $M_1 = 2.0$ and at a pressure of 70 KPa flows along a wall which bends away at an angle of 12° from the direction of flow. Determine the Mach number and pressure after the bend. If in another case, the flow experiences a compression over the concave wall which actually bends through the same angle determine the Mach number and pressure with same free stream conditions. Sketch the flow fields in both the cases. **10**

4. Define the following terminology in compressible aerodynamics. Critical Mach number, sub critical Mach number, super critical Mach number, crest critical Mach number and transonic Mach number. Also present all of the above on a plot. **10**

5. (a) Write a short note on low density flows associated with hypersonic flow. **5**

   (b) Describe in brief the lift effect in wind tunnels. **5**

6. (a) Explain conical flow method treatment for swept back wings. **5**

   (b) What are the design considerations for Supersonic Aircraft ? **5**

7. (a) Derive co-efficient of pressure for hypersonic Prandtl Mayer flow in terms of hypersonic similarity parameter. **5**

   (b) What is the consequence of linearity ? Explain solution by it in detail. **5**

8. The $\theta - \beta - M$ relation for an oblique shock wave is given by $\tan\theta = 2\cot\beta \frac{M_1^2 \sin\beta - 1}{M_1^2 (\gamma + \cos 2\beta) + 2}$. 10

Consider the $\theta - \beta - M$ diagram and explain the following situation :
If in a given physical problem θ is fixed and M_1 is increased.

9. Consider the equation of continuity under isentropic flow conditions and define the non-dimensional mass flow parameter. Obtain the relationship for the same as given below. 10

$$\frac{m\sqrt{T_o}}{AP_o}\sqrt{\frac{R}{\gamma}} = \left(\frac{2}{\gamma + 1}\right)^{(\gamma + 1)/2(\gamma - 1)}.$$