

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VIII • EXAMINATION – SUMMER 2013****Subject Code: 180105****Date: 09-05-2013****Subject Name: High Speed Aerodynamics and Experimental Techniques****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

Important Relations for Hypersonic Shock:

$$1) \frac{P_2}{P_1} = \frac{2\gamma}{\gamma+1} M_1^2 \sin^2 \beta \quad (2) \frac{u_2}{V_1} = 1 - \frac{2 \sin^2 \beta}{\gamma+1}$$

$$(3) C_p = \left(\frac{4}{\gamma+1}\right) \sin^2 \beta \quad (4) \frac{\rho_2}{\rho_1} = \frac{\gamma+1}{\lambda-1}$$

$$(5) \frac{v_2}{V_1} = \frac{\sin 2\beta}{\lambda+1} \quad (6) \frac{T_2}{T_1} = \frac{2\gamma(\gamma-1)}{(\gamma+1)^2} M_1^2 \sin^2 \beta$$

$$(7) C_p = 2\theta^2 \left[\frac{\gamma+1}{4} + \left(\sqrt{\frac{\lambda+1}{4}} + \sqrt{\frac{1}{K^2}} \right) \right]$$

$$(8) \frac{P_2}{P_1} = 1 + \frac{\gamma(\gamma+1)}{4} K^2 + \gamma K^2 \sqrt{\left(\frac{\gamma+1}{4}\right)^2 + \frac{1}{K^2}}$$

Consider $\gamma = 1.4$ for all case.

- Q.1 (a)** 1. Which kind of body should be preferred for hypersonic vehicles as per aerodynamics heating point view? **07**
 2. State expression for C_p on the upper surface of the flat plate placed in the uniform Newtonian flow of M_∞ at a positive angle of attack with free stream.
 3. What is wave rider?
 4. Why boundary layer grows more rapidly in hypersonic flow.
 5. Define Hypersonic flow.
 6. Draw entropy layer in hypersonic flow.
 7. Difference between airfoil and wing in aerodynamics.
- (b)** A flat plate placed in the uniform flow of $M_\infty = 15$, and at an angle of attack 3° , Calculate L and D per unit area of the plate. ($\rho_\infty = 0.225 \text{ kg/m}^3$ and $T_\infty = 157 \text{ K}$) **07**
- Q.2 (a)** Write a short note on low density flows associated with hypersonic flow. **07**
(b) To explain $\theta - \beta - M$ diagram and prove $\beta = 1.20$ for hypersonic flow. **07**
- OR**
- (b)** Explain conical flow method treatment for Rectangular wings. **07**
- Q.3 (a)** Define with neat sketch physical effects characteristics of hypersonic flow. **07**
(b) Explain construction & working of supersonic wind tunnels. **07**

OR

- Q.3** (a) Explain Newtonian flow for a flat plate with neat sketch. **07**
(b) Write a short note on **Lift Effect** in wind tunnels. **07**

- Q.4** (a) Apply centrifugal force correction to Newtonian flow theory. **07**
(b) Explain Modified Newtonian law. **07**

OR

- Q.4** (a) Write a short note on Flow Visualization technique. **07**

- Q.4** (b) Explain Shock-Expansion Method. **07**

- Q.5** (a) Explain viscous Interaction with neat sketch. **07**

- (b) What is wind tunnel? Explain construction of subsonic open wind tunnel. **07**

OR

- Q.5** (a) Describe aerodynamic design consideration for the super-sonic aircraft. **07**

- (b) Write a short note on Aerodynamic Interaction for supersonic flow over the wings. **07**
