Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: HIGH SPEED AERODYNAMICS [AAE 429]

REVISED CREDIT SYSTEM
(06/12/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. Explain the followings: **(05)**
a) Cold wall & Hot wall
b) Entropy layer
c) Wave rider
d) Nusselt number
e) Thin shock layer theory

1B. What is the advantage of Maslen's method and explain its procedures and also mention what are the constant parameters are we considering for this method and why! **(03)**

1C. Write and prove the following 'y' momentum equation for 2D, steady flow in nondimensional variables with the help of order of magnitude gives the result as pressure is constant in normal direction of boundary layer **(02)**

$$\overline{\rho u}\frac{\partial \bar{v}}{\partial \bar{x}} + \overline{\rho v}\frac{\partial \bar{v}}{\partial \bar{y}} = -\frac{1}{\gamma M_\infty^2}\frac{\partial \bar{P}}{\partial \bar{y}} + \frac{1}{Re_\infty}\frac{\partial}{\partial \bar{x}}\left[\bar{\mu}\left(\frac{\partial \bar{v}}{\partial \bar{x}} + \frac{\partial \bar{u}}{\partial \bar{y}}\right)\right]$$

2A. What is the function of 'chi bar' in viscous interactions and derive the equation with 'chi bar' for strong viscous interactions. **(04)**

2B. Consider a flat plate at zero angle of attack in an airflow at standard sea level condition and the chord length of the plate is 1.5m with $38m^2$ planform area. Calculate the shear stress by using reference temperature method. ($T_w=T_{aw}=6350K$, $T_e=T_\infty$, $M_e=M_\infty$, $u_e=4400m/s$) **(04)**

2C. What are the basic differences in conventional hypersonic vehicles with surface reentry vehicles and explain their design features. **(02)**

3A. Explain the following wind tunnel working principles with diagrams **(05)**
a) Arc tunnel
b) Shock tunnel
c) Gas dynamic laser
d) Electric discharge laser
e) Chemical laser

3B. Draw the schematic diagrams of type IV shock-shock and shock-boundary layer interactions. Explain their features as well. **(03)**

3C. What is of Mach number independence? Write down one example of it. **(02)**

4A. Consider a flat plate at zero angle of attack in airflow at 15km altitude with chord length 1.8m and reference area $55m^2$(assume area per unit span). If then calculate the followings **(04)**

Case A- Insulated plate	Case B- Hot wall	
1) Local shear stress at 1.2m from leading edge ($C_f \sqrt{Re.x} = 0.42$) 2) Total drag of the plate	1) Local shear stress at 1.2m from L.E ($C_f \sqrt{Re.x} = 0.53$) 2) Total drag of the plate 3) Heat transfer rate at 1.2m from leading edge(T_W=576K) and $C_H \sqrt{Re.x} = 0.31$	P_∞=10kPa,T_∞=216.6K,T_e= T_∞, $\mu_\infty=1.42*10^{-5}$kg/m.s, V_∞=3200m/s, Pr=0.725, R=287, γ=1.4

4B. What is Hypersonic Equivalence principle and how it's related to solve problems in Blast wave theory for blunt nose cylinder and blunt noses slab? (Draw the diagrams). Write down their final results of pressure distribution and shock wave shape in terms of 'x'. **(03)**

4C. What are the uses of approximate methods in hypersonic? Write down few examples. Also mention how accurate these methods can be! **(03)**

5A. Derive and prove that the aerodynamic heating is inversely proportional to the radius of the body. **(04)**

5B. What is self-similar solution? Explain their procedures and write down their final results. **(03)**

5C. What are the use of nondimesionalize parameter in inviscid hypersonic? Prove with an example that in high speed hypersonic, the properties become independent of Mach number. **(03)**

6A. Consider the flat plate at an angle of attack 12deg in a Mach 7 inviscid flow. Calculate the pressure coefficients on the top and bottom surface of the plate, the lift and drag coefficients and the lift-to-drag ratio by using **(04)**

a) Exact shock – wave and expansion wave theory
b) Newtonian theory
c) Compare the both results

6B. Draw the Velocity-Altitude map for hypersonic vehicles and derive the equations for ballistic and lifting parameters. **(04)**

6C. Explain several methods to increase aero-dynamical efficiency for hypersonic vehicles **(02)**