Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)
END SEMESTER EXAMINATIONS, NOV/DEC 2018

SUBJECT: HYPERSONIC AEROTHERMODYNAMICS [AAE 4003]

REVISED CREDIT SYSTEM
(31/12/2018)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- Gas tables will be provided by the department

1A. What is hypersonic equivalence principle? Also prove that according to blast wave theory the pressure distribution for the blunt nosed slab varied inversely with '$x^{2/3}$' (distance) **(05)**

1B. Explain the followings: **(05)**

a) Why Newtonian theory only applicable to hypersonic flow?
b) What is the reason behind hypersonic boundary layer thicker than other flow regimes?
c) At high temperature effects y-axis boundary layer hypersonic theory is not valid, why?
d) At hypersonic speed which property is crucial compared to velocity and drag? Explain why?
e) What are limitations of Method of Characteristics?

2A. Draw the schematic diagrams of gas dynamic laser and electric discharge laser. Explain their functions and operations. **(05)**

2B. Draw the schematic diagram of Hypersonic Shock Wave Boundary layer interactions and explain their features. **(05)**

3A. Explain the followings: **(05)**

a) Adiabatic wall enthalpy
b) Similarity parameter
c) Wave rider
d) Entropy layer
e) Croccos theorem

3B. Derive the basic hypersonic shock relations and prove that wave angle is 20% larger than deflection angle in hypersonic flows. **(05)**

4A. Consider the flat plate at an angle of attack 8deg in a Mach 6 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 **(05)**

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

4B. Consider a flat plate at zero angle of attack in airflow at 15km altitude with chord length 3.2m and reference area 65m^2(assume area per unit span). If then calculate the followings **(05)**

Case A- Insulated plate	Case B- Hot wall	
i) Local shear stress at 1.2m from leading edge ($C_f \sqrt{Re.x} = 0.415$) ii) Total drag of the plate	i) Local shear stress at 1.2m from L.E ($C_f \sqrt{Re.x} = 0.54$) ii) Total drag of the plate iii) Heat transfer rate at 1.8m from leading edge(T_W=576K) and $C_H \sqrt{Re.x} = 0.32$	P_∞=11kPa,T_∞=216.6K, $T_e=T_\infty$, $\mu_\infty=1.42*10^{-5}$kg/m.s, V_∞=3800m/s, Pr=0.725, R=287, γ=1.4

5A. What is the role of $\bar{\chi}$ (chi bar) in hypersonic viscous interactions and derive the equation for weak viscous interactions. **(05)**

5B. What are the importance of Ballistic and Lifting coefficients in Hypersonic flows? Explain it with their derivations and Velocity – Altitude Map. **(05)**