Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, DECEMBER 2016

SUBJECT: HIGH SPEED AERODYNAMICS [AAE 429]

REVISED CREDIT SYSTEM
(06/01/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. What is the reason behind that the Newtonian theory is only applicable in Hypersonic regimes? Also determine the values for following in Newtonian theory **(05)**

a) Coefficients of pressure on upper and lower surface of an airfoil
b) Coefficients of lift and drag
c) Lift to drag ratio
d) Graphical representation of Newtonian theory on a flat plate with C_P, L/D, C_L and C_D

1B. Write down the hypersonic equivalence principle and prove that according to blast wave theory the pressure distribution for the blunt nosed cylinder varied inversely with x. **(03)**

1C. Why the hypersonic boundary layer is thicker than subsonic and supersonic boundary layers? **(02)**

2A. Consider a flat plate at zero angle of attack in airflow at standard sea level conditions. The chord length of the plate is 2m and platform area is $35m^2$. Assume the wall temperature is the adiabatic wall temperature (T_{aw}) and assume it's a laminar flow over the surface and the total friction drag is caused by shear stress acting on both the top and bottom surfaces. Then Calculate:- **(05)**

a) The local shear stress on the plate at the location of 0.6m from the leading edge when the free stream velocity is 4012 m/s. ($C_f\sqrt{R_e}$= 0.42)
b) The skin friction drag for the whole plate
c) The local heat- transfer rate at the quarter-chord location (assume with a constant wall temperature (T_W=576K)$C_H\sqrt{R_e} = 0.31$)
d) Calculate the shear stress at location 0.5m from leading edge by using reference temperature method (assume $T_{aw}=T_w$)
e) Compare the results from (a) and (d) and write the conclusion.

2B. Derive and explain the hypersonic small disturbance equations? Write down the application of these equations. **(03)**

2C. What is wave rider? Explain the advantages and disadvantageous when we compare it with conventional aircrafts in hypersonic. **(02)**

3A. What is similarity parameter? Derive the hypersonic shock relations in terms of hypersonic similarity parameter. **(03)**

3B. Explain Strong and Weak viscous interactions and derive derivations P_e/P_∞ for weak interactions **(04)**

3C. What are the importance of Ballistic and Lifting coefficients in Hypersonic flows? Explain it with their derivations and Velocity – Altitude Map. **(03)**

4A. Draw the schematic diagram of Hypersonic Shock Wave Boundary layer interactions and explain their features **(05)**

4B. Derive the basic hypersonic shock relations and prove that wave angle is 20% larger than deflection angle in hypersonic flows. **(05)**

5A. Derive and explain the centrifugal force correction to Newtonian theory (Newtonian – Busemann theory) **(05)**

5B. Explain the followings: **(05)**

a) Hypersonic similarity parameter
b) Viscous layer
c) Shooting technique
d) Self-similar solution
e) Stanton number

6A. What is thin shock layer theory? And Write down flow field solution of Maslen's method. **(05)**

6B. Consider the flat plate at an angle of attack 11deg in a Mach 8 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 both results