Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VII SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: HIGH SPEED AERODYNAMICS [AAE 429]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Explain briefly the Aerodynamic and Thermodynamic properties that are involved in hypersonic vehicle design with neat diagrams and justify your answer. **(05)**

1B. Consider an infinitely thin flat plate at an angle of attack of 15 deg in a mach 8 flow. Assume inviscid flow. Calculate the pressure coefficients on the top and bottom surface of the plate, the lift and drag coefficients, and lift-to-drag ratio using i. exact shock-wave and expansion wave theory ii. Newtonian theory. Compare the results. **(05)**

2A. Solve the 2-D, steady, inviscid, fully supersonic flow equation given below, using the method of characteristics. **(06)**

$$\left[1-\frac{1}{a^2}\left(\frac{\partial\phi}{\partial x}\right)^2\right]\frac{\partial^2\phi}{\partial x^2}+\left[1-\frac{1}{a^2}\left(\frac{\partial\phi}{\partial y}\right)^2\right]\frac{\partial^2\phi}{\partial y^2}-\frac{2}{a^2}\frac{\partial\phi}{\partial x}\frac{\partial\phi}{\partial y}\frac{\partial^2\phi}{\partial x\partial y}=0$$

2B. Derive hypersonic relations for prandtl - meyer expansion waves. **(04)**

3A. Explain briefly the Slender-Wing theory with the help of sketches. **(04)**

3B. Write a short note on the Reference Temperature Method and Entropy layer effects on Aerodynamic Heating? **(04)**

3C. Explain how does compressibility affect the boundary layer profile? **(02)**

4A. Derive an expression for Linearized pressure coefficient starting from exact equation which is valid for small perturbations and depends only on x-component of the perturbation velocity. **(04)**

4B. Explain the following Methods for computing turbulent boundary layers **(04)**

a. Thwaites' method b. Thwaites' method II c. Thwaites' method III d. Thwaites' method IV.

4C. Why Mach waves under transonic conditions are perpendicular to flow. **(02)**

5A. Derive the expression for C_p using Newtonian impact theory for flow over flat plate. State your assumptions. **(05)**

5B. Consider a flat plate at zero angle of attack in an airflow at standard sea-level conditions. The chord length of the plate (distance from leading edge to trailing edge) is 2m. The planform area of the plate is $40m^2$. At standard sea-level conditions, $\mu_\infty = 1.7894 \times 10^{-5}$kg/ms. Assume the wall temperature is the adiabatic-wall temperature T_{aw}. Assuming laminar flow, calculate the local shear stress on the plate at the location 0.5 m downstream from the leading edge when the freestream velocity is 3402 m/s. ($c_f\sqrt{Re_x} = 0.43$). **(03)**

5C. What is meant by High Temperature flows. **(02)**

6A. Describe about tangent wedge/ tangent cone method. **(04)**

6B. Explain briefly shock wave/boundary layer interaction with neat diagrams? **(04)**

6C. Discuss briefly the physics behind the turbulence. **(02)**