No. of Printed Pages : 3 **BAS-015**

B.Tech. AEROSPACE ENGINEERING (BTAE)

Term-End Examination

00471 **December, 2015**

BAS-015 : AERODYNAMICS – II

Time : 3 hours *Maximum Marks : 70*

Note : *Question no. 1 is* ***compulsory****. Attempt any* ***six*** *questions from the remaining. All questions carry equal marks.*

1. Attempt any ***four*** of the following : $4\times2\frac{1}{2}=10$

(a) What is a detached shock wave ? When is it formed ? Explain in brief.

(b) Detail any two important differences between shock waves and expansion waves in a supersonic flow.

(c) How is laminar flow airfoil geometry different from a conventional airfoil ? Describe in brief.

(d) Explain the formation of wingtip vortices.

(e) An airplane is flying at 3·0 Mach at an altitude, where the pressure and temperature are respectively 0·5 atm and – 20°C. Calculate the pressure and temperature at the leading edge of the wing.

2. Derive the relationship for the ratios of stagnation pressure to static pressure and Mach number for an isentropic flow. Derive the similar relations for temperature and density ratio. 10

3. (a) What are the flow losses that are suffered by a compressible flow in variable area ducts ? How does the back pressure affect the losses ? 4

   (b) Air flows isentropically through a divergent passage of initial area 7 cm^2. If inlet conditions are $M_1 = 1{\cdot}4$, $p_1 = 1$ atm, $T_1 = 27°C$ and exit Mach No. $M_2 = 3{\cdot}0$. Find 6

   (i) the mass flow rate,

   (ii) exit pressure, and

   (iii) exit area.

4. (a) What is an Expansion Hodograph ? What is its use in supersonic aerodynamics ? 4

   (b) A supersonic stream of air at $M = 3$, $T_1 = 300$ K and $P = 1$ atm passes through a sudden convex corner and then a sudden concave corner of turning angle of 12° each. Determine the Mach number, temperature and pressure of flow downstream of the concave corner. 6

5. (a) Why is a golf ball dimpled ? Explain. 4

   (b) A thin plate of length 1 m and width 1 m is moving in air along its length at a speed of 50 m/s. Calculate the total skin friction drag on the plate assuming sea level conditions. 6

6. State Biot-Savart law and derive an expression for the velocity induced by an infinite vortex filament at a point, which is at a distance 'n' from the filament. *10*

7. (a) Derive a general expression for the speed of sound in a compressible gas. *4*

   (b) Air at 30°C and 1 atm is drawn through a C-D nozzle, which discharges into a large vacuum tank. Determine the conditions upstream and downstream of a normal shock, which is located at the nozzle exit. The nozzle throat and exit areas are $0{\cdot}025\ m^2$ and $0{\cdot}0724\ m^2$, respectively. *6*

8. Explain in brief the superiority of lifting surface theory, for predicting lift distribution on a wing with an arbitrary platform, with the help of sketches and other representations. *10*

9. With the help of a graph, explain the viscous interaction effect on a hypersonic flow. *10*