Code No: R05312103 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2008
AERODYNAMICS-II
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Methane gas flows in an adiabatic, no-work system with negligible change in potential. At one section $p_1 = 14$ bar abs., $T_1 = 500$ K, and $V_1 = 125$ m/s. At a downstream section $M_2 = 0.8$. [16]
   (a) Determine T_2 and V_2.
   (b) Find p_2 assuming that there are no friction losses.
   (c) What is the area ratio A_2/A_1?

2. (a) Assuming the flow of a perfect gas in an adiabatic, no-work system, show that sonic velocity corresponding to the stagnation conditions (a_t) is related to sonic velocity where the Mach number is unity (a^*) by the following equation: $\frac{a^*}{a_t} = \left(\frac{2}{\gamma+1}\right)^{1/2}$
   (b) Air flows with $T_1 = 250$ K, $p_1 = 3$ bar abs., $p_{t1} = 3.4$ bar abs., and the cross-sectional area $A_1 = 0.40\ m^2$. The flow is isentropic to a point where $A_2 = 0.30\ m^2$. Determine the temperature at section 2. [9+7]

3. (a) What are the various measuring instruments used in the supersonic wind tunnel testing, describe each of them briefly.
   (b) The ratio of exit to the entry area in a subsonic diffuser is 4.0. The mach number of a jet of air approaching the diffuser at P_0 =1.013 bar, T = 290 K is 2.2. There is standing normal shock just outside the diffuser entry. The flow in the diffuser is isentropic. Determine at the exit of the diffuser: Mach number, Temperature and Pressure. What is the stagnation pressure loss between the initial and final stages of the flow? [6+10]

4. Write short notes on the following: [16]
   (a) Small perturbation theory
   (b) Area rule
   (c) Critical Mach number
   (d) Drag divergence mach number.

5. Consider a 15^o half angle cone at zero angle of attack in a free stream at standard sea level conditions with $M_\infty = 2.0$. Obtain the shock angle, below what Mach number the shock will be detached? Compare with the wedge? [16]

6. What do you mean by Mach number independence principle? Show the variation of drag coefficient on a missile with Mach number. Why does it become independent of Mach number at high Mach numbers? [16]

7. What is the importance of non-dimensional parameters in aerodynamics? Give some examples of non-dimensional parameters explaining their applicability. [16]

8. (a) Draw a curve for the effect of Reynolds number on the C_L-α curve and discuss the effect?

   (b) Describe the procedure of getting full scale data from wind tunnel lift characteristics. [8+8]

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Code No: R05312103 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2008
AERODYNAMICS-II
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What do you mean by Stagnation temperature and stagnation pressure?
   (b) An Object is immersed in air flow with a static pressure of 200kPa, a static temperature of 20 ^{0}C and a velocity of 200m/s. What are the pressure and temperature at the stagnation point?
   (c) Calculate the isothermal compressibility for air at a pressure of 0.5 atm. [6+4+6]

2. (a) Carbon monoxide is expanded adiabatically from 6.9 bar, 303 K and negligible velocity through a converging-diverging nozzle to a pressure of 1.4 bar.
      i. What is the ideal exit Mach number?
      ii. What are the conditions at the throat?
   (b) Explain the flow conditions of converging diverging nozzle with a shockwave in it. [5+5+6]

3. (a) Explain the concept of expansion wave across a corner, with a neat sketch.
   (b) A uniform flow at $M_1 = 2.0$ passes over an expansion corner with wall inclination of 10^0. Find the Mach number of the flow downstream of the expansion fan. [6+10]

4. (a) What is a supercritical airfoil? How is it useful in increasing the drag divergence Mach number?
   (b) Explain the term area rule. How does it affect the performance of an airplane? [8+8]

5. Calculate the drag coefficient for a wedge with 20^o half angle at Mach 4. Assume the base pressure be same as free stream pressure. [16]

6. (a) What is hypersonic flow? Describe the characteristics of hypersonic flow?
   (b) Illustrate a thin shock layer in hypersonic flow. [8+8]

7. Name a few non-dimensional numbers; define each of these and derive expressions for commonly used non-dimensional numbers in Aerodynamic study. [16]

8. Describe the procedure for measurement and data analysis for three dimensional wings in the wind tunnel taking all the factors into consideration. [16]

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Code No: R05312103 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2008
AERODYNAMICS-II
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Sonic velocity through carbon dioxide is 275 m/s. What is the temperature in Kelvin?
   (b) Hydrogen has a static temperature of 25^0C and a stagnation temperature of 250^0C. What is the Mach number?
   (c) Oxygen flows in a constant-area, horizontal, insulated duct. Conditions at section 1 are $p_1 = 20$ bar, $T_1 = 450$K, and $V_1 = 286$ m/sec. At a downstream section the temperature is $T_2 = 1048^0$R. Calculate the pressure P_2 and velocity V_2 at the section. [4+4+8]

2. (a) What is the need of a converging-diverging section of a supersonic nozzle? Explain with an example.
   (b) Air flows steadily and isentropically through a passage. At section 1 where the cross-section area is 0.02 m^2, the air is at 40.0 kPa (abs), 60^oC and the Mach number is 2.0. At a section 2 downstream, the velocity is 519 m/s. Calculate the Mach number at section 2. Sketch the shape of the passage. [6+10]

3. (a) Explain the concept of expansion wave across a corner, with a neat sketch.
   (b) A uniform flow at $M_1 = 2.0$ passes over an expansion corner with wall inclination of 10^0. Find the Mach number of the flow downstream of the expansion fan. [6+10]

4. Consider a subsonic flow with an upstream Mach number of M. This flow moves over a wavy wall with a contour given by $y_w = h\cos(2\pi x/l)$ where y_w is the ordinate of the wall, h is the amplitude, and l is the wavelength. Assume h is small. Using the small perturbation theory, derive an equation for the velocity potential. [16]

5. (a) What are the physical aspects of conical flow?
   (b) Compare graphically the theta-beta relation for a Mach number in case of a wedge and a cone. [6+10]

6. (a) What is hypersonic flow? Describe the characteristics of hypersonic flow?
   (b) Illustrate a thin shock layer in hypersonic flow. [8+8]

7. Describe the various methods for measurement of flow turbulence? Explain their characteristics? [16]

8. Describe the procedure for measurement and data analysis for three dimensional wings in the wind tunnel taking all the factors into consideration. [16]

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Code No: R05312103 **Set No. 4**

III B.Tech I Semester Regular Examinations, November 2008
AERODYNAMICS-II
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What do you mean by Stagnation temperature and stagnation pressure?
   (b) An Object is immersed in air flow with a static pressure of 200kPa, a static temperature of 20 ^{0}C and a velocity of 200m/s. What are the pressure and temperature at the stagnation point?
   (c) Calculate the isothermal compressibility for air at a pressure of 0.5 atm. [6+4+6]

2. (a) What is a normal shock wave? Explain in detail what is meant by the thickness of the shock and what is the effect of mach number on the thickness.
   (b) A normal shock wave exists in a 500 m/s stream of nitrogen with a static temperature of -40^{o}C and static pressure of 70 kPa. Calculate the Mach number, pressure, and temperature downstream of the wave and entropy increase across the wave. For nitrogen , $r = 1.4$, $R = 297$ J/kg K. [6+10]

3. For the flow over the half-diamond wedge shown in figure 3, find the inclinations of shocks and expansion waves and the pressure distributions. [16]

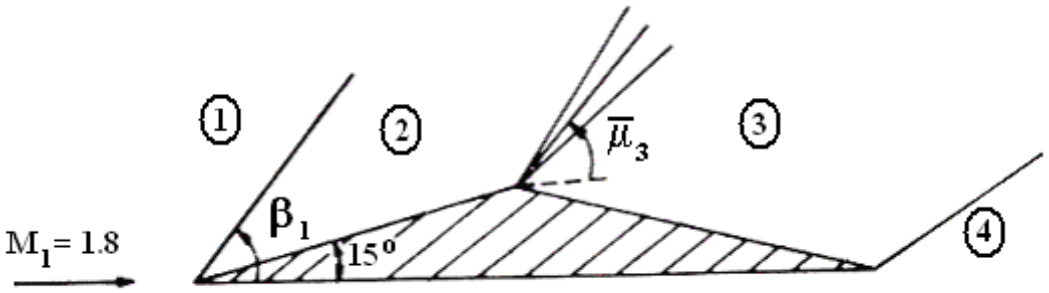

Figure 3

4. (a) Derive the expression for critical pressure coefficient for an airfoil in subsonic flow.
   (b) What are drag divergence and drag divergence Mach number? [12+4]

5. Show a flat plate airfoil at an angle of attack α. Draw the shock and expansion wave pattern on it. Draw the pressure profile above and below it. Discuss the different flow fields. [16]

6. Derive the following hypersonic small-disturbance equation for flow over slender bodies. [16]
   $\bar{\rho}\frac{\partial \bar{v}'}{\partial \bar{x}} + \bar{\rho}\bar{v}'\frac{\partial(\bar{v}')}{\partial \bar{y}} + \bar{\rho}\bar{w}'\frac{\partial(\bar{v}')}{\partial \bar{z}} = -\frac{\partial \bar{p}}{\partial \bar{y}}$

7. (a) Assuming the critical Reynolds number of a sphere to be 235,000, find the turbulence of the tunnel?
   (b) What does a turbulence sphere measure and how? [10+6]

8. Sketch neatly all the components of a wind tunnel balance to measure the forces on an airplane? Show the components of any balance to measure the different forces. [16]

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