Code No: RR312103 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006

AERODYNAMICS-II

(Aeronautical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. What is the physical principle behind the energy equation? Derive the energy equation by applying this principle to a fixed control volume in space? What is the form of this equation? [16]

2. By considering the gradient of a scalar field, show that the velocity potential lines and stream lines are perpendicular to each other? [16]

3. Mention the various applications of Bernoulli's equation? Explain the functioning and applications of pitot-static probe with a neat sketch? [16]

4. A sink of strength of 120 m^2/s is situated 2 m downstream from a source of equal strength in an irrotational uniform stream of 30 m/s. Find the fineness ratio of the oval formed by the stream line ψ= 0. [16]

5. Show that rotating circular cylinder in potential flow produces lift? [16]

6. What are the assumptions in thin airfoil theory? By applying thin airfoil theory to a symmetrical airfoil show that C_l= $2\pi\alpha$.Here α is AoA. [16]

7. What is elliptical lift distribution? Calculate the aerodynamic characteristics of a finite wing having elliptical lift distribution? [16]

8. Consider an airplane that weighs 14,700 N and cruises in level flight at 300 km/h at an altitude of 3000 m. the wing has a surface area of 17 square meters and an aspect ratio of 6.2. Assume that the lift coefficient is a linear function of the angle of attack and $\alpha_L = 0 =$ -1.2. If the load distribution is elliptic, calculate the value of the circulation at the centre of the wing, the downwash, induced drag coefficient? Take density value at 3000 m is 0.74225 kg/ m^3 [16]

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Code No: RR312103 **Set No. 2**

III B.Tech I Semester Regular Examinations, November 2006

AERODYNAMICS-II

(Aeronautical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. Explain the Importance of aerodynamics in the design of aircraft? Also discuss about the some non-aeronautical applications of aerodynamics? [16]

2. Show that integral conservation form of the momentum equation can be used to estimate the drag over a 2D body? [16]

3. Mention the various applications of Bernoulli's equation? Explain the functioning and applications of pitot-static probe with a neat sketch? [16]

4. Derive the stream function and velocity potential function for a double flow? Sketch the stream line pattern? [16]

5. (a) Define an airfoil? Draw a neat sketch?
   (b) Define Chord, Camber, Mean camber line, Leading edge radius and Thickness of an airfoil? Draw a neat sketch of the airfoil by showing all these features? [16]

6. The camber line of a thin circular arc airfoil is given by Z/c =4c(x/c)[1-(x/c)]. Find the lift coefficient and the moment at the quarter chord point by using thin airfoil theory. [16]

7. State the Helmholtz's theorems? Explain the philosophy of the Prandtl's lifting line theory? [16]

8. Consider an airplane that weighs 14,700 N and cruises in level flight at 300 km/h at an altitude of 3000 m. the wing has a surface area of 17 square meters and an aspect ratio of 6.2. Assume that the lift coefficient is a linear function of the angle of attack and $\alpha_L = 0 =$ -1.2. If the load distribution is elliptic, calculate the value of the circulation at the centre of the wing, the downwash, induced drag coefficient? Take density value at 3000 m is 0.74225 kg/ m^3 [16]

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Code No: RR312103

Set No. 3

III B.Tech I Semester Regular Examinations, November 2006

AERODYNAMICS-II

(Aeronautical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. For a 2D flow of incompressible air near the surface of a flat plate, the stream- wise (or x) components of velocity may be approximated by the relation $U = a_1yx^{-0.5} - a_2y^3x^{-1.5}$ a_1 *and* a_2 are constants Using the continuity equation, find the velocity component v in the y direction? Evaluate the constant of integration by noting that v=0 at y=0. [16]

2. Show that integral conservation form of the momentum equation can be used to estimate the drag over a 2D body? [16]

3. The velocity field is of 2D flow is given below. $u = x^2 + y^2 v = 2xy^2$ Is the flow is incompressible? Is it a irrotational flow? If so calculate the velocity potential function? [16]

4. A uniform flow is added to a doublet flow. Show that the resulting flow is flow over a circular cylinder of radius $r = R = [k/2\pi V_\infty]^{1/2}$

   Here k - strength of doublet

   V_∞ - velocity of uniform flow [16]

5. Write a short note on development of NACA airfoils? In 4 digit, 5 digit and 6 digit airfoils, what does these digits means? [16]

6. Explain the thin airfoil theory and its application to a cambered airfoil? [16]

7. What is effective AoA? Why AoA changes at the local airfoil sections of a wing? Explain? What is induced drag? [16]

8. The span wise distribution of circulation on an untwisted rectangular wing of aspect ratio 5 can be written in the form of

   $\Gamma(y) = 2bV_\infty\alpha[0.02340\sin\theta + 0.00268\sin3\theta + 0.00072\sin5\theta + 0.00010\sin7\theta]$

   Calculate the lift and induced drag coefficients when the zero lift angle of attack is 10 degrees. [16]

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Code No: RR312103

Set No. 4

III B.Tech I Semester Regular Examinations, November 2006

AERODYNAMICS-II

(Aeronautical Engineering)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. For a 2D flow of incompressible air near the surface of a flat plate, the stream- wise (or x) components of velocity may be approximated by the relation $U = a_1 y x^{-0.5} - a_2 y^3 x^{-1.5}$ a_1 *and* a_2 are constants Using the continuity equation, find the velocity component v in the y direction? Evaluate the constant of integration by noting that v=0 at y=0. [16]

2. Show that integral conservation form of the momentum equation can be used to estimate the drag over a 2D body? [16]

3. Consider a low speed steady flow around the thin airfoil shown below Figure-3. We know the velocity and altitude at which the vehicle is flying. Thus we know P_∞ and V_∞. We have obtained experimental values of the local static pressure at points 2 through 6. At which of these points we can use Bernoulli's equation to determine the local velocity? If we cannot, why not? [16]
   Point 2: at the stagnation point of the airfoil
   Point 3: at a point in the inviscid region just outside the laminar boundary layer
   Point 4: at a point in the laminar boundary layer
   Point 5: at point in the turbulent boundary layer
   Point 6: at a point in the inviscid region just outside the turbulent boundary layer

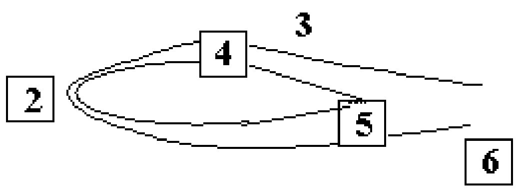

Figure 3

4. Derive the pressure and velocity distribution for flow about a rotating cylinder? Also calculate lift and drag forces? Draw the stream lines showing stagnation points? [16]

5. (a) Define an airfoil? Draw a neat sketch?
   (b) Define Chord, Camber, Mean camber line, Leading edge radius and Thickness of an airfoil? Draw a neat sketch of the airfoil by showing all these features? [16]

6. Using thin airfoil theory show that for a cambered airfoil location of centre of pressure $X_{cp} = (C/4)[1 + (\pi/C_1)(A_1 - A_2)]$ [16]

7. Explain the following [16]
   (a) Wing tip vortices, downwash
   (b) Induced AoA and Induced drag
   (c) Span wise lift distribution over a finite wing.

8. Discuss and prove the statement that minimum induced drag of wing is associated with the elliptical loading? Plot the curve showing the induced drag coeficient against lift coeficient for wing of aspect ratio 7.63 [16]

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