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

III B.Tech. I Semester Regular Examinations, November -2005

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 continuity equation? Consider an unsteady viscous 3D flow, apply the above physical principle to a fixed control volume in space and derive the continuity equation? What is the form of this equation? [16]

2. What is a stream function? What are the assumptions involved in defining it? How the mass flow between two stream lines is related to stream function? [16]

3. Consider a low speed steady flow around the thin airfoil shown below Figure-1. 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

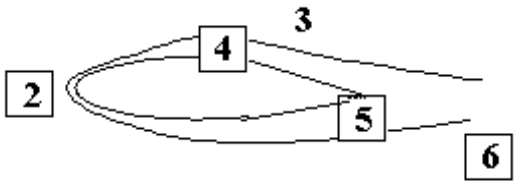

Figure 1:

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. By considering the potential flow over a rotating circular cylinder, derive the equation of Cp in terms of radius of the cylinder R, Circulation around the cylinder Γ , and free stream velocity V_∞? Show that this expression reduces to $Cp = 1 - 4sin^2\theta$. [16]

6. The NACA 4412 airfoil has a mean camber line given by $(Z/C) = 0.25[0.8(x/c) - (x/c)^2]$, using thin airfoil theory

(a) $\alpha_{L=0}$

(b) C_l *when* $\alpha = 3^0$ [16]

7. Show that for an elliptical wing, downwash is constant along its span? [16]

8. Explain the difference between the symmetrical and unsymmetrical loading? When we can have unsymmetrical loading on the finite wings? By considering the general lift distribution derive the expression for downwash of unsymmetrical loading?[16]

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

III B.Tech. I Semester Regular Examinations, November -2005

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) Explain the physical meaning of gradient of a scalar field. Also write the mathematical expression for gradient of pressure in Cartesian coordinate system.
   (b) Define the divergence and curl of velocity field? Write down the mathematical Expressions for the same? [16]
2. The velocity field for a 2D flow is given as u=y / (x^2+y^2) and v = -x / (x^2+y^2) Calculate the circulation around a circular path of radius 5? Assume the S.I unit system. [HINT: in polar coordinate system V.dS = $V_r$dr+rV_θdθ] [16]
3. The velocity field is of 2D flow is given below. u = x^2+y^2v = 2xy^2 Is the flow is incompressible? Is it a irrotational flow? If so calculate the velocity potential function? [16]
4. Consider the potential flow over a non-rotating circular cylinder, show that pressure distribution is symmetrical on top, bottom surfaces and front, rear surfaces of the cylinder. [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. Explain the difference between the symmetrical and unsymmetrical loading? When we can have unsymmetrical loading on the finite wings? By considering the general lift distribution derive the expression for downwash of unsymmetrical loading?[16]

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Code No: RR312103 **Set No.3**

III B.Tech. I Semester Regular Examinations, November -2005

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 are the non-dimensional numbers used in Aerodynamics. Explain their importance? [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 steady, inviscid, incompressible flow in a convergent divergent nozzle. Area of the nozzle and other flow properties are varying as $A = A_(x), V = V_(x), P = P_(x)$. Derive the continuity and momentum equations for this flow? What is the momentum equation called? [16]
4. Consider the potential flow over a non-rotating circular cylinder, show that pressure distribution is symmetrical on top, bottom surfaces and front, rear surfaces of the cylinder. [16]
5. Show that rotating circular cylinder in potential flow produces lift? [16]
6. Explain the thin airfoil theory and its application to a cambered airfoil? [16]
7. Show that for an elliptical loading on a finite wing, the downwash induced along its span is constant? [16]
8. A monoplane weighing 73.6 KN has elliptic wings of 15.23 m in span. For a speed of 90 m/s in steady and level flight at low altitudes find
   (a) Induced drag
   (b) Circulation at the section of a distance of 3 m from the tips. [16]

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Code No: RR312103 **Set No.4**

III B.Tech. I Semester Regular Examinations, November -2005

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. The velocity components of a 2D inviscid incompressible flow are given by
   $U = 2y - y/(x^2+y^2)^{1/2}$
   $v = -2x - x/(x^2+y^2)^{1/2}$
   Find the stream function and the vorticity and sketch the stream lines. [16]

3. Show that the Bernoulli's equation is a statement of Newton's second law for a steady, inviscid, incompressible flow with no body force? [16]

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) What is laminar flow airfoil? Explain?
   (b) Write a brief note about airfoil characteristics such as lift variation and drag variation with AoA. [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. Derive the fundamental equation of the Prandtl's lifting line theory? [16]

8. What is the induced drag? Explain the effect of aspect ratio on the induced drag? Consider elliptical, modified elliptical, general lift distribution for your explanation? [16]

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