Code.No: RR312103 | RR | SET-1

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
AERODYNAMICS –II
(AERONAUTICAL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) List and explain the different fluid models used in aerodynamics along with their governing equations.
b) For an incompressible, inviscid three dimensional flow, deduce an expression for the momentum equation along the x-direction from Newton's second law. [8+8]

2.a) Discuss briefly about the following.
i) Control volume and its importance in aerodynamics
ii) Streamlines and stream tube
iii) Angular velocity and vorticity.
b) Assume a two dimensional body moving in an incompressible and invisicid flow. Derive the following relationship to estimate drag.

$$D' = \rho\int_a^b u_2(u_1 - u_2)\,dy\,.$$ [8+8]

3.a) What are boundary conditions? Enumerate its significance in aerodynamics. State different boundary conditions in inviscid flows.
b) The stream function 'ψ' across an incompressible, irrotational, two dimensional flow is given as '2xy'.
i) Obtain Velocity at (x=2 and y=2) and (x=3 and y=1). Are these points on the same streamline?
ii) Obtain Velocity potential function for this flow. [8+8]

4.a) Define doublet. Derive a suitable stream function for doublet. Sketch the streamlines across the flow.
b) Considering a potential flow over a non-rotating circular cylinder, show that the pressure coefficient $C_p = 1 - 4\sin\theta$. [8+8]

5.a) What is thin airfoil theory? Explain the significance of Kutta condition for an airfoil producing lift with suitable equations and expressions.
b) Consider potential flow over a rotating circular cylinder with drag coefficient C_D, Lift coefficient C_L, Circulation around the cylinder Γ, free stream velocity V_∞, Radius of cylinder 'R' and Pressure coefficient C_p.

Prove that $C_D = 0$, $C_L = \dfrac{\Gamma}{RV_\infty}$ and $C_p = 1 - 4\sin\theta$. [6+10]

6.a) From thin airfoil theory, show that circulation around a symmetrical airfoil is $\Gamma = cV_{\infty}\left[\pi A_0 + \left(\frac{\pi}{2}\right)A_1\right]$.

b) An airfoil kept in a potential flow is observed and following data is obtained. Chord of the airfoil is making 5^0 angle with a free stream velocity of 32 m/s. Determine C_L and slope of 'C_L' versus 'α' by using mean camber line as $(z/c) = 0.125\left[0.8(x/c) - (x/c)^2\right]$. [8+8]

7.a) Discuss briefly about the following.
i) Biot-Savart law
ii) Horse shoe Vortex
iii) Effective angle of attack
iv) Wing tip vortices and down wash.

b) Define Vortex filament and derive a suitable expression for velocity induced by a vortex filament running from $-\infty$ *to* $+\infty$ at a distance r from the filament, taking strength of the filament as Γ and constant across the length. [8+8]

8. Consider an airplane that weighs 12,800 N and cruises in level flight at 350 km/hr at an attitude of 2700 m. The wing has a surface area of $15\,m^2$ and an aspect ratio of 5.8. Assuming 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 induced drag coefficient and value of circulation at the center of the wing. Assume density of air as $0.94\,\text{kg}/m^3$. Also calculate the downwash. [16]

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SET-2

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
AERODYNAMICS –II
(AERONAUTICAL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) What are boundary conditions? Enumerate its significance in aerodynamics. State different boundary conditions in inviscid flows.

b) The stream function 'ψ' across an incompressible, irrotational, two dimensional flow is given as '2xy'.

i) Obtain Velocity at (x=2 and y=2) and (x=3 and y=1). Are these points on the same streamline?

ii) Obtain Velocity potential function for this flow. [8+8]

2.a) Define doublet. Derive a suitable stream function for doublet. Sketch the streamlines across the flow.

b) Considering a potential flow over a non-rotating circular cylinder, show that the pressure coefficient $C_p = 1 - 4\sin\theta$. [8+8]

3.a) What is thin airfoil theory? Explain the significance of Kutta condition for an airfoil producing lift with suitable equations and expressions.

b) Consider potential flow over a rotating circular cylinder with drag coefficient C_D, Lift coefficient C_L, Circulation around the cylinder Γ, free stream velocity V_∞, Radius of cylinder 'R' and Pressure coefficient C_p.

Prove that $C_D = 0$, $C_L = \frac{\Gamma}{RV_\infty}$ and $C_p = 1 - 4\sin\theta$. [6+10]

4.a) From thin airfoil theory, show that circulation around a symmetrical airfoil is $\Gamma = cV_\infty\left[\pi A_0 + \left(\frac{\pi}{2}\right)A_1\right]$.

b) An airfoil kept in a potential flow is observed and following data is obtained. Chord of the airfoil is making 5^0 angle with a free stream velocity of 32 m/s. Determine C_L and slope of 'C_L' versus 'α' by using mean camber line as $\left(z/c\right) = 0.125\left[0.8(x/c) - (x/c)^2\right]$. [8+8]

5.a) Discuss briefly about the following.
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b) Define Vortex filament and derive a suitable expression for velocity induced by a vortex filament running from $-\infty \ to + \infty$ at a distance r from the filament, taking strength of the filament as Γ and constant across the length. [8+8]

6. Consider an airplane that weighs 12,800 N and cruises in level flight at 350 km/hr at an attitude of 2700 m. The wing has a surface area of $15 m^2$ and an aspect ratio of 5.8. Assuming 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 induced drag coefficient and value of circulation at the center of the wing. Assume density of air as $0.94 \, \text{kg}/m^3$. Also calculate the downwash. [16]

7.a) List and explain the different fluid models used in aerodynamics along with their governing equations.

b) For an incompressible, inviscid three dimensional flow, deduce an expression for the momentum equation along the x-direction from Newton's second law. [8+8]

8.a) Discuss briefly about the following.
   i) Control volume and its importance in aerodynamics
   ii) Streamlines and stream tube
   iii) Angular velocity and vorticity.

b) Assume a two dimensional body moving in an incompressible and invisicid flow. Derive the following relationship to estimate drag.

$$D' = \rho \int_a^b u_2 (u_1 - u_2) \, dy .$$ [8+8]

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SET-3

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
AERODYNAMICS –II
(AERONAUTICAL ENGINEERING)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) What is thin airfoil theory? Explain the significance of Kutta condition for an airfoil producing lift with suitable equations and expressions.

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Prove that $C_D = 0$, $C_L = \dfrac{\Gamma}{RV_\infty}$ and $C_p = 1 - 4\sin\theta$. [6+10]

2.a) From thin airfoil theory, show that circulation around a symmetrical airfoil is $\Gamma = cV_\infty\left[\pi A_0 + \left(\dfrac{\pi}{2}\right)A_1\right]$.

b) An airfoil kept in a potential flow is observed and following data is obtained. Chord of the airfoil is making 5^0 angle with a free stream velocity of 32 m/s. Determine C_L and slope of 'C_L' versus 'α' by using mean camber line as $(z/c) = 0.125\left[0.8(x/c) - (x/c)^2\right]$. [8+8]

3.a) Discuss briefly about the following.
i) Biot-Savart law
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iii) Effective angle of attack
iv) Wing tip vortices and down wash.

b) Define Vortex filament and derive a suitable expression for velocity induced by a vortex filament running from $-\infty$ to $+\infty$ at a distance r from the filament, taking strength of the filament as Γ and constant across the length. [8+8]

4. Consider an airplane that weighs 12,800 N and cruises in level flight at 350 km/hr at an attitude of 2700 m. The wing has a surface area of $15\,m^2$ and an aspect ratio of 5.8. Assuming 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 induced drag coefficient and value of circulation at the center of the wing. Assume density of air as $0.94\,\text{kg}/m^3$. Also calculate the downwash. [16]

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ii) Obtain Velocity potential function for this flow. [8+8]

8.a) Define doublet. Derive a suitable stream function for doublet. Sketch the streamlines across the flow.

b) Considering a potential flow over a non-rotating circular cylinder, show that the pressure coefficient $C_p = 1 - 4\sin\theta$. [8+8]

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SET-4

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
AERODYNAMICS –II
(AERONAUTICAL ENGINEERING)

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

Answer any FIVE questions
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- - -

1.a) Discuss briefly about the following.
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   iii) Effective angle of attack
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b) Define Vortex filament and derive a suitable expression for velocity induced by a vortex filament running from $-\infty\ to + \infty$ at a distance r from the filament, taking strength of the filament as Γ and constant across the length. [8+8]

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b) Assume a two dimensional body moving in an incompressible and invisicid flow. Derive the following relationship to estimate drag.

$$D' = \rho\int_a^b u_2(u_1 - u_2)\,dy\ . \qquad [8+8]$$

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