Reg. No. : | | | | | | | | | | |

J 3005

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Fourth Semester

Aeronautical Engineering

AE 1251 — AERODYNAMICS – I

(Regulation 2004)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the basic principle involved in the derivation of general momentum equation in Fluid mechanics?

2. State the condition for irrotationality for a flow.

3. Briefly explain D' Alembert's paradox.

4. Define circulation.

5. Sketch the flow pattern around a spinning cylinder when $\Gamma = 0$ and $\Gamma = 4\pi RV_\infty$.

6. What is the importance of Kutta condition?

7. Enumerate the applications of thin airfoil theory.

8. What is 'horse shoe vortex'?

9. Define boundary layer thickness.

10. State 2-D Navier-Stokes equation.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive energy equation for unsteady three dimensional flow in partial derivative form. (10)

(ii) Explain angular velocity, vorticity and dilation of a fluid element. (6)

Or

(b) (i) Derive the expressions for stream function and velocity potential function for a doublet flow.

(ii) Obtain the stagnation points for the flow over a non-lifting circular cylinder by combining elementary flows.

12. (a) (i) Explain vortex flow with all the characteristics and derive stream function. (6)

(ii) State and prove Kutta-Joukowski's theorem. (10)

Or

(b) Calculate peak negative pressure coefficient, location of the stagnation points and the points on the cylinder where the pressure equals freestream state pressure for lifting flow over a circular cylinder. The lift coefficient is 5. (16)

13. (a) Using conformal transformation, transform a circle to cambered airfoil profile by deriving necessary equations. (16)

Or

(b) (i) Explain Balsius theorem for a steady two dimensional irrotational flow. (6)

(ii) Explain with neat sketches flow over an aerofoil with $\Gamma = \Gamma_{kutta}$, $\Gamma < \Gamma_{kutta}$ and $\Gamma > \Gamma_{kutta}$. (10)

14. (a) (i) Explain thin aerofoil theory and its applications. (10)

(ii) Explain Karman-Trefftz profiles. (6)

Or

(b) (i) Derive fundamental equation of Prandtl's lifting line theory and state assumptions used. (10)

(ii) What are the limitations of lifting line theory? (6)

15. (a) (i) What are the types of drag produced due to the effects of viscosity? (4)

(ii) Derive Navier-Stokes equations for an unsteady, compressible three dimensional viscous flow. (12)

Or

(b) State the assumptions involved in Blasius solution. Derive the Blasius solution and obtain an expression for local skinfriction coefficient. (16)

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Reg. No. :

D 0039

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009

FOURTH SEMESTER

AERONAUTICAL ENGINEERING

AE1251 AERODYNAMICS – I

(REGULATION 2007)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the assumptions made in Bernoulli's equation.

2. Differentiate between substantial derivative and local derivative.

3. What do you mean by D'Alembert's paradox?

4. Define circulation.

5. What do you mean by singular point in conformal transformation?

6. What is meant by Complex Potential Function?

7. What is the importance of Kutta condition?

8. State Biot-Savart law.

9. Define critical Reynold's number.

10. Define shape factor. Write down its approximate values for laminar and turbulent boundary layers.

PART B — (5 × 16 = 80 marks)

11. (a) The velocity components of a two-dimensional inviscid incompressible flow are given by

$$u = 2y - \frac{y}{\sqrt{x^2 + y^2}}, \quad v = -2x - \frac{x}{\sqrt{x^2 + y^2}}$$

Find the stream function and the vorticity, and sketch the streamlines. (6)

(b) In a two-dimensional flow, the fluid velocity components are $u = x - 4y$ and $v = -y - 4x$. Show that the flow satisfies the continuity equation and obtain the expression for the stream function. If the flow is potential, obtain also the expression for the velocity potential. (10)

Or

12. Derive the momentum equation and state the assumptions. (16)

13. (a) A circular cylinder of 1.2 m diameter and 7 m length rotates at 100 rpm with its axis perpendicular to an airstream of velocity 40 m/s. Calculate

(i) the circulation around the cylinder,

(ii) the lift (or side force) acting on the cylinder and

(iii) the position of stagnation points. (8)

(b) Considering the basic solutions of Laplace equation, discuss the flow past a circular cylinder kept in an ideal fluid. Determine the maximum and minimum values of pressure coefficients and their locations on the cylinder. (8)

Or

14. Consider the non-lifting flow over a circular cylinder. Derive an expression for the pressure coefficient at an arbitrary point (r, θ) in this flow, and show that it reduces to $C_p = 1 - 4\sin^2\theta$ on the surface of the cylinder. (16)

15. By using Kutta-Zhukovsky transformation, transform a circle into symmetrical aerofoil profile and also find the thickness to chord ratio. (16)

Or

16. (a) Sketch the streamline pattern of the flow given by the complex potential function $w = Az^2$ where A is a constant, $w = \phi + i\psi$ and $z = x + iy$. Find the magnitude and direction of the velocity of the stream at the point $x = 1$, $y = 2$ when A = 10. (6)

(b) Derive Blasius theorem. (10)

17. (a) Derive the basic governing equation of thin airfoil theory. (10)

(b) Calculate the theoretical lift coefficient of a Zhukovsky aerofoil having a thickness to chord ratio of 0.2, and 2% camber, set at 4° incidence in a two-dimensional flow. (6)

Or

18. The NACA 4412 airfoil has a mean camber line given by

$$\left(\frac{z}{c}\right) = 0.25\left[0.8\frac{x}{c} - \left(\frac{x}{c}\right)^2\right] \quad \text{for } 0 \le \frac{x}{c} \le 0.4$$

$$\left(\frac{z}{c}\right) = 0.111\left[0.2 + 0.8\frac{x}{c} - \left(\frac{x}{c}\right)^2\right] \quad \text{for } 0.4 \le \frac{x}{c} \le 1$$

Using thin airfoil theory, calculate

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

(b) c_l when $\alpha = 3°$. (16)

19. What do you mean by horseshoe vortex? Derive fundamental equation of Prandtl's lifting line theory. (16)

Or

20. (a) Making use of Navier-Stokes equations for a 2-d fluid flow, develop Prandtl's boundary layer equations for flow over 2-d flat plate. Provide the boundary conditions. Hence define displacement thickness and momentum thickness. (12)

(b) The velocity distribution in the laminar boundary layer of a flat plate is given by

$$u = u_0\left[\frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3\right]$$

where u_0 is the velocity at the edge of the boundary layer where y equals δ.

Find the vorticity on the surface of the plate. (4)

Reg. No. :

Question Paper Code : P 1010

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fourth Semester

Aeronautical Engineering

AE 1251 — AERODYNAMICS – I

(Regulation 2004)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Write down the equation of continuity in polar co-ordinates for unsteady, compressible flow in 2 dimensions.

2. Write down the Navier-Stokes equations for 3 dimensional steady flows.

3. Distinguish between a Free Vortex and a Forced Vortex.

4. Which combination of basic flows will represent a Rankine Oval?

5. Explain Conformal Transformation.

6. What is Kutta condition for a lifting aerofoil?

7. State Blasius theorem.

8. State Biot-Savart law and explain its usefulness in aerodynamics.

9. What is Boundary Layer and why is this concept necessary?

10. Define Momentum thickness and Displacement thickness in boundary layer flows.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the steady three dimensional flow continuity equation in partial differential form using finite volume approach. (12)

(ii) Check whether the flow is possible with the following velocity components.

$u = -2x^2y + 4yzx$; $v = 2xy^2 + 4x^2yz$; $w = -2x^2z^2 - 2z^2y$. (4)

Or

(b) (i) Derive the Euler's equations of motion for 3-d incompressible, steady flows. (10)

(ii) Show how Bernoulli's equation and hydrostatic equation can be deduced from Euler's equation. (6)

12. (a) (i) What is Magnus effect? Mention a few applications of this effect. (4)

(ii) Show that the combination of a doublet flow and uniform flow is equivalent to a non-lifting flow over a circular cylinder. Obtain expressions for the velocity potential, stream function and the location of stagnation points. (12)

Or

(b) (i) State and prove Kutta-Joukowski's theorem. (12)

(ii) Sketch the flow pattern over an aerofoil for

$\Gamma < \Gamma_{Kutta}$; $\Gamma = \Gamma_{Kutta}$ and $\Gamma > \Gamma_{Kutta}$;

Where Γ denotes the circulation over the aerofoil. (4)

13. (a) (i) Explain Joukowski's transformation to obtain a symmetrical aerofoil profile from a circle. (10)

(ii) Using the above transformation show how a flat plate of length 'l' can be obtained. (6)

Or

(b) Write short notes on the following :

(i) Von Mises and Karman-Trefftz profiles.

(ii) Assumptions of thin aerofoil theory.

(iii) Pressure distribution on circular Cylinder in ideal and real flows.

(iv) Bluff and Streamlined bodies. (4 × 4 = 16)

P 1010

14. (a) (i) Using Biot-Savart law derive an expression for the induced velocity at a point by a semi-infinite vortex filament. (8)

(ii) Based on the lifting line theory show that the downwash is constant over the span for elliptic lift distribution. (8)

Or

(b) (i) Explain the horse-shoe vortex system over a lifting wing. (6)

(ii) What are the limitations of the lifting line theory? (4)

(iii) Explain how induced drag is produced by a lifting wing. (6)

15. (a) (i) Explain the phenomenon of boundary layer separation with a neat sketch. (8)

(ii) Prove that the laminar boundary layer thickness on a flat plate at a distance x from the leading edge is proportional to $x/\sqrt{R_{ex}}$. (8)

Or

(b) (i) Derive the Von Karman momentum integral equation for boundary layer flows. (6)

(ii) Using the above theorem derive expressions for the boundary layer thickness and the drag coefficient over one side viscous flow of a flat plate in laminar flow. (5 + 5)

Reg. No. :

F 0189

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010

FOURTH SEMESTER

AERONAUTICAL ENGINEERING

AE1251 AERODYNAMICS – I

(REGULATION 2007)

Time : Three hours   **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain the nomenclature of NACA 65-218 Airfoil.

2. What is D'Alembert Paradox?

3. Differentiate Stream line, Equi potential line and Path line.

4. In a 2-D flow, $u = y/b^2$ and $v = -x/a^2$. Determine the Stream line and potential line passing through $(a,0)$.

5. What do you mean by singular point in conformal transformation?

6. What is the practical importance of Kutta condition?

7. State Kelvin's circulation theorem.

8. What is horse shoe vortex?

9. Define : Wash in and wash out.

10. What is boundary layer separation?

PART B — (5 × 16 = 80 marks)

11. Derive the continuity for a generalized fluid flow in polar coordinates and explain its importance. (16)

Or

12. (a) Derive energy equation for unsteady three dimensional flow in integral form. (10)

(b) Determine the condition that the velocity components $u = ax + by$ and $v = cx + dy$ will satisfy the equation of continuity and find the magnitude of vorticity. (6)

13. State Kutta – Joukowski theorem. Prove the theorem with respect to a lifting flow over a cylinder. (16)

Or

14. (a) Derive the relation for combination of uniform flow with a source and sink flow and also explain the Rankine oval. (8)

(b) For the velocity field $u = y/(x^2 + y^2)$ and $v = -x/(x^2 + y^2)$. Calculate the circulation around a circular path of radius 5 m. Assume that u and v are in units of m/s. (8)

15. (a) Show that points on a circle $x^2 + y^2 = a^2$ are transformed to points on the ellipse by Joukouski transformation. How this ellipse transforms to a flat plate? (8)

(b) Consider a lifting flow over a cylinder. The lift co-efficient $C_L = 5$, calculate the peak pressure coefficient and calculate the location of the stagnation points and the points on the cylinder where the pressure equals the free stream static pressure. (8)

Or

16. Based on the principle of conformal transformation show that a circle can be transformed into a Cambered airfoil and obtain an expression for its thickness to chord ratio. (16)

17. Derive the fundamental equation of Prandtl's lifting line theory and obtain an expression for induced drag for elliptic lift distribution. (16)

Or

18. (a) State Biot savart law and derive an expression for the velocity induced by an infinite vortex filament. (8)

(b) What is Karman – Treffetz airfoil? Explain with neat sketches. (8)

19. Consider an NACA 23012 airfoil. The mean camber line for this airfoil is given by

$$\left[\frac{z}{c} = 2.6595\left[\left(\frac{x}{c}\right)^3 - 0.6075\left(\frac{x}{c}\right)^2 + 0.1147\left(\frac{x}{c}\right)\right]\right] \text{ for } 0 \le \frac{x}{c} \le 0.2025$$

and $\left[\frac{z}{c} = 0.02208\left(1 - \frac{x}{c}\right)\right]$ for $0.2025 \le \frac{x}{c} \le 1.0$.

Calculate :

(a) The angle of attack at zero lift,

(b) The lift coefficient when $\alpha = 4°$

(c) The moment coefficient about the quarter chord point. (16)

Or

20. (a) Derive an expression for displacement thickness and momentum thickness of flow over a flat plate. (8)

(b) Explain different types of Boundary layer. (8)

Reg. No. :

F 0341

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010

FOURTH SEMESTER

AERONAUTICAL ENGINEERING

AE1251 AERODYNAMICS — I

(REGULATION 2008)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Differentiate between incompressible flow and compressible flow.

2. Write the continuity equation using polar coordinates.

3. Define stream function.

4. Differentiate between streamline and potential line.

5. Write the stream function expression for doublet.

6. What is Kutta Joukowski's theorem?

7. Plot the pressure distribution over a circular cylinder without circulation.

8. What is meant by Kutta condition?

9. State the Biot Savart law.

10. State the Newton's law of viscosity.

PART B — ($5 \times 16 = 80$ marks)

11. With a neat sketch and description, derive the continuity for a three dimensional incompressible flow. State the assumptions made.

Or

12. (a) Show that the velocity of the fluid, $V = \frac{4x}{x^2+y^2} i + \frac{4y}{x^2+y^2} j$ satisfies continuity at every point except the origin. (8)

(b) State the assumptions made in deriving the Bernouli's equation. Also explain the significance of each term in the Bernoulli's equation. (8)

13. Explain the development of stream functions for the elementary flows: uniform flow along x-direction, uniform flow along y-direction, source, and free and forced vortex.

Or

14. Obtain the expression for stream function for the uniform flow past a doublet and hence prove that the tangential component of fluid velocity on the surface of the cylinder, over which incompressible and inviscid fluid is flowing, is 2U $\sin\theta$.

15. Prove the following equation of Blasius theorem

$$X - iY = \frac{i\rho}{2} \oint_c \left(\frac{dw}{dz} \right)^2 dz .$$

Or

16. Explain with sketches the Kutta condition over an airfoil.

17. (a) Write short notes on wing tip vortices. (8)

(b) Explain Karman-Trefftz profiles. (8)

Or

18. Derive the fundamental equation of thin airfoil theory and find the lift curve slope.

19. If a boundary layer similarity profile is given by $\frac{y}{\delta} = \left[\frac{v}{u_\infty} \right]^{\frac{1}{n}}$, estimate the displacement thickness (δ^*), momentum thickness (θ), energy thickness (δ_e) and shape factor (H).

Or

20. Describe with a neat sketch the boundary layer formation over a flat plate. Show the velocity profiles in the laminar and turbulent regions.

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Reg. No. : | | | | | | | | | | |

G 0042

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

FOURTH SEMESTER

AERONAUTICAL ENGINEERING

AE1251 AERODYNAMICS — I

(REGULATION 2007)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain the nomenclature of NACA 23012 Airfoil.

2. Which combination of basic flows represents lifting flow over circular cylinder?

3. State equation of continuity 2D, incompressible unsteady flow in differential form.

4. 2D incompressible flow is described by stream lines $\psi = x^2 - y^2$. Find the pressure coefficient at (1, 2).

5. What do you mean by conformal transformation?

6. State the importance of Blasius theorem in aerodynamics.

7. What is a free vortex flow?

8. State Helmholtz theorem and Circulation.

9. What is Magnus effect?

10. Sketch boundary layer over a flat plate and define Newton's Law of viscosity?

PART B — (5 × 16 = 80 marks)

11. (a) Define Angular velocity, Strain rate and Vorticity. (6)

(b) Derive the general x-momentum equation for an unsteady 3-D inviscid flow in partial differential form using a control volume approach. (10)

Or

12. (a) Derive energy equation for unsteady three dimensional flow in integral form. (10)

(b) The x and y components of velocity of a fluid flow are given by $u = x^3 - 3xy^2$ and $v = y^3 - 3x^2y$. State whether the flow is rotational. (6)

13. Consider the non lifting flow over a circular cylinder. Derive an expression for the pressure coefficient and also determine the pressure distribution on the surface of the cylinder. (16)

Or

14. (a) Derive the relation for combination of uniform flow with a source and sink flow. Also explain Rankine oval. (10)

(b) Define uniform flow and obtain an expression for stream function and velocity potential function. (6)

15. (a) Show that points on a circle $x^2 + y^2 = a^2$ are transformed to points on the ellipse by Joukouski transformation. How this ellipse transforms to a flat plate. (8)

(b) The x and y velocity components of a fluid flow are given by $u = 2xy + 4y + 6x = 0$ and $v = 3y + 2x^2 + 6xy = 0$. Is the flow irrotational and physically possible flow. (8)

Or

16. Explain how the Joukowski transformation is used to obtain a circular aerofoil and obtain the expression for its radius. (16)

17. Derive expression for lift and moment coefficient for a thin symmetrical airfoil using thin airfoil theory. What are the observations that can be made from the derivations and what is the value of C_D? (16)

Or

18. (a) State Biot savart law and drive an expression for the velocity induced by an infinite vortex filament. (8)

(b) Write short notes on Kelvin's Circulation Theorem and Starting Vortex. (8)

19. (a) What is Karman — Treffetz airfoil? Explain with neat sketches. (8)

(b) Sate and Prove Blasius theorem. (8)

Or

20. (a) Derive an expression for displacement thickness and momentum thickness of flow over a flat plate. (8)

(b) Making use of Navier Stokes equation for a 2D fluid flow, develop Prandtl's boundary layer equations for flow over a 2D flat plate and also provide the boundary conditions. (8)

Reg. No. :

G 0363

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

FOURTH SEMESTER

AERONAUTICAL ENGINEERING

AE 1251 AERODYNAMICS – I

(REGULATION 2008)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between steady and unsteady flow.

2. State the Euler's concept of analyzing a fluid flow.

3. Define streamline.

4. Write a note on Doublet.

5. Write the stream function expression for uniform flow over a source.

6. Differentiate between free and forced vortex.

7. What is meant by thin airfoil and thick airfoil in terms of application?

8. What is viscous flow?

9. State the Newton's law of viscosity.

10. Define the term: Displacement Thickness.

PART B — (5 × 16 = 80 marks)

11. Derive the Bernoulli's equation and express it in terms of

(a) Energy

(b) Pressure and

(c) Pressure head. What are the limitations of Bernoulli's equation?

Or

12. (a) Check the flow field velocity given by

$V = 5xi + 5yj + (-10z)k$ represents a possible flow. (8)

(b) Give any two examples where Bernoulli's equation can be used for the analysis. (8)

13. Starting from first principle obtain the expression for stream function of a source combined with uniform stream. Draw the streamline pattern. Prove that the mathematical expressions obtained can represent the flow over a smooth fairing.

Or

14. Sketch and explain the stream line pattern for an incompressible and inviscid flow over a circular cylinder for various circulations.

15. Using Joukowski transformation function $\zeta = z + \frac{b^2}{z}$ show that a circle can be transformed into flat plate.

Or

16. Explain with sketches the Kutta condition over an airfoil.

17. Explain the formation of vortex system around the three dimensional wing and its consequences.

Or

18. (a) Explain the limitations of lifting line theory. (8)

(b) Explain the uses of thin airfoil theory and its outcome. (8)

19. With a neat sketch and description, derive the Navier-Stokes equation along x-direction.

Or

20. Applying boundary-layer equations, derive the Blasius equation $2f'' + f\,f'' = 0$ for an incompressible flow over a flat plate.

Reg. No. : [| | | | | | | | | | | |]

Question Paper Code : 11020

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fourth Semester

Aeronautical Engineering

AE 2251/111401/AE 42/AE 1251/10122 AE 402/080180011 — AERODYNAMICS — I

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Gradient of pressure.

2. What are the applications of Bernoulli's equations in aerodynamics?

3. Give the equations of stream lines and the potential lines when the flows are parallel to X axis and Y axis.

4. Define Doublet. Give the streamline for doublet.

5. Explain lift in an aerofoil with respect to Kutta Joukowshi's theorem.

6. Define Kutta Condition with the help of a diagram.

7. What are the applications of thin aerofoil theory?

8. What are the limitations of lifting line theory?

9. Write the Navier Stokes equation for a cylindrical coordinate system.

10. What is the Blasius solution for a flow over a flat plate at zero angle of attack?

PART B — (5 × 16 = 80 marks)

11. (a) Derive Continuity equation in integral form. (16)

Or

(b) Explain the drag of a two dimensional body using momentum equation. (16)

12. (a) Show that the combination of doublet flow and the uniform flow is equivalent to a non-lifting flow over a cylinder. Obtain the expression for velocity potential function and stream function for the combination. (16)

Or

(b) (i) What is a rankine oval? What combination of flows is required to obtain the Oval? (6)

(ii) The X and Y velocity components of a fluid flow are given by

$u = 2xy + 4y + 6x$ and $v = 3y + 2x^2 + 6xy$.

Is the flow irrotational? Is it a physically possible flow? (10)

13. (a) Derive the Kutta Joukowski's equation for a lifting flow over a circular cylinder. (16)

Or

(b) Derive Blasius theorem for an incompressible flow over a flat plate. Conclude the Blasius equation in terms of stream functions. (16)

14. (a) (i) 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. (8)

(ii) What are Karman – trefftz and Von-mises airfoils? Explain your answers with neat sketch? (8)

Or

(b) Derive Prandtl's Lifting line theory. (16)

15. (a) Derive Navier Stokes equation for a viscous flow in Cartesian coordinates. (16)

Or

(b) (i) Write notes on Newton's law of viscosity, Kinematic viscosity and momentum diffusivity. (8)

(ii) Explain the Boundary layer properties. (8)

Reg. No. :

Question Paper Code : 21021

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fourth Semester

Aeronautical Engineering

AE 2251/AE 42/AE 1251/10122 AE 402/080180011 — AERODYNAMICS — I

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between ideal and real fluid.

2. What is meant by D'Alembert's paradox?

3. What is the condition for irrotationality?

4. What is meant by Magnus effect?

5. Define complex potential function.

6. What is the importance of Kutta condition?

7. Define washin and washout.

8. What are the limitations of lifting line theory?

9. State Newton's law of viscosity.

10. Define shape factor.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the momentum equation and state the assumptions. (12)

(ii) Derive the Bernoulli's equation and state the assumptions made in deriving. (4)

Or

(b) (i) Define the terms velocity potential, circulation and vorticity. Describe how you can relate these terms. (8)

(ii) Derive an expression for stream function and velocity potential function for a vortex flow. (8)

12. (a) (i) Find the velocity potential, velocity distribution and location of stagnation points for the combination of a source, a sink and free stream. (12)

(ii) A 90 kg paratrooper jumps out of an airplane. If the chute diameter is 6 m, calculate his sinking descent speed. (Take drag coefficient of parachute is 1.2) (4)

Or

(b) The velocity potential of a free stream is $\phi_1 = 5x$ and for a double is $\phi_2 = 5\frac{x}{x^2+y^2}$.

(i) Write the velocity potential for the combined doublet and free stream.

(ii) Calculate the velocity distribution that is due to this velocity potential.

(iii) Find the stagnation points along the x axis.

(iv) What kind of flow is described by ϕ?

13. (a) Derive Kutta-Joukowski theorem.

Or

(b) State Blasius theorem and derive the expression for the lift using Blasius theorem.

14. (a) By using Kutta-Zhukovsky transformation transform a circle into symmetrical aerofoil profile and also find the thickness to chord ratio.

Or

(b) (i) A wing with an elliptical platform and an elliptical lift distribution has an aspect ratio of 6 and a span of 12 m. The wing loading is 900 N/m^2 when flying at a speed of 150 km/hr at sea level. Compute the induced drag for this wing. (6)

(ii) Derive the basic governing equation of thin airfoil theory. (10)

15. (a) (i) Making use of Navier-Stokes equations for a 2-d fluid flow, develop Prandtl's boundary layer equations for flow over 2-d flat plate. Provide the boundary conditions. Hence define displacement thickness and momentum thickness. (10)

(ii) The velocity distribution in the laminar boundary layer of a flat plate is given by $u = u_0\left[\frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3\right]$ where u_0 is the velocity at the edge of the boundary layer where y equals δ. Find the vorticity on the surface of the plate. (6)

Or

(b) (i) A wind tunnel has a square test section of 305 mm. At a section (1), the free stream speed is 26 m/s and $\delta^* = 1.5\,\text{mm}$. At a section (2) downstream of (1), $\delta^* = 2.1\,\text{mm}$. Calculate the change in static pressure between sections (1) and (2). (6)

(ii) Derive Blasius equation for an incompressible flow over a flat plate. (10)

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Reg. No. :

Question Paper Code : 31021

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Fourth Semester

Aeronautical Engineering

AE 2251/AE 42/AE 1251/10122 AE 402/080180011 — AERODYNAMICS — I

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is a fluid? And what are the two abundant fluids on earth most useful?

2. What are the basic fluid and fluid flow parameter's VALUE(S) for standard atmospheric air?

3. Distinguish between two dimensional motion and three dimensional motion.

4. What is meant by complex potential function?

5. What is conformal transformation? How is it useful for aerodynamic studies?

6. Where do we come across Kutta condition in Aerodynamics? And how do we apply this?

7. State Biot - Savart Law.

8. Clearly illustrate downwash and induced drag.

9. Define boundary layer and its development.

10. Do we deal with Newtonian fluids or Non-Newtonian fluids in this course? Justify.

PART B — ($5 \times 16 = 80$ marks)

11. (a) Derive continuity equation for a general fluid flow.

Or

(b) Derive momentum equation(s) useful for this course.

12. (a) Define all the planar flow concepts and mathematical formulations along with their units.

Or

(b) Draw pressure distributions over different types of objects, fluid boundaries and along the flow itself for a chosen flow situation(s).

13. (a) State and prove Blasius theorem.

Or

(b) State and establish Kutta – Joukowski's theorem.

14. (a) Provide all details of airfoils, classification of airfoils. Distinguish between theoretical and practical airfoils. What is stalling of airfoils?

Or

(b) State and prove lifting line theory. What are its limitations?

15. (a) (i) A sharp edge flat plate with length 0.5 m and width 5 m is kept parallel to a stream of air at velocity 2.7 m/s. Calculate the Drag on one side of the flat – plate and the boundary layer thickness at various sections. (8)

(ii) Distinguish between boundary layer and wake. (2)

(iii) How do you identify laminar boundary layer from a Turbulent boundary layer? (2)

(iv) What was Ludwig – Prandtl's suggestions for calculations of flow past objects in viscous flows? (4)

Or

(b) (i) Can there be a source or sink in a boundary layer? Justify. (4)

(ii) What types of winds we come across in our atmosphere? And are they helpful for the operation of airplanes up in the sky and at ground level? (4)

(iii) Show that the streamlines for a flow, whose velocity components are $u = c(x^2 - y^2)$ and $v = -2cxy$, are given by $x^2 y - \frac{y^3}{3} = \text{constant}$. In the flow field, where is/are the flow parallel to the x axis and, y axis and what are its stagnation points? (c – constant). (8)

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