Reg. No. :

Question Paper Code : 50077

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Aeronautical Engineering

AE 8401 – AERODYNAMICS - I

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the assumptions made while deriving Bernoulli's equation?

2. Give the condition for 2-D irrotational flows.

3. Sketch the fluid pattern over bluff bodies and streamlined bodies with brief explanation.

4. What is meant by Magnus effect?

5. What are the applications of conformal transformation in aerodynamics?

6. Define wash-in and wash-out.

7. Define vortex line.

8. State the reason why the lift over the wing span is not uniform

9. With a neat sketch compare the velocity profiles for laminar and turbulent flows.

10. Define shape factor.

PART B — (5 × 13 = 65 marks)

11. (a) Derive the 3-D momentum equations for incompressible flows and deduce it to the steady Euler equations.

Or

(b) (i) Show that the equation for the streamlines in doublet flow is a circle with a diameter 'd' on the vertical axis with centre located at 'd/2' above the origin. (8)

(ii) The stream function for a two-dimensional flow is given by $\psi = 2xy$, calculate the velocity at the point P (3, 2). Find the velocity potential function. (5)

12. (a) State and Prove Kutta Joukowski theorem.

Or

(b) (i) Explain briefly on ideal and real flow over a circular cylinder with appropriate sketches. (8)

(ii) State the importance of Kutta condition with the help of a diagram. (5)

13. (a) Using Kutla-Joukowski transformation, transform a circle into cambered airfoil profile and also find the location of maximum thickness and thickness to chord ratio.

Or

(b) (i) Derive the basic governing equation of thin aerofoil theory. (8)

(ii) What are Cauchy – Reimann relations? (5)

14. (a) State Biot – Savart law and derive an expression for the velocity induced by an infinite vortex filament.

Or

(b) Derive Prandtl's lifting line theory and obtain an expression for induced drag coefficient for elliptical lift distribution.

15. (a) (i) Derive the boundary layer equations for a steady, two dimensional incompressible flow over a flat plate. (8)

(ii) Define and drive the expression for the displacement thickness. (5)

Or

(b) Arrive at Blasius solution for incompressible two dimensional flow over a flat plate at zero angle of attack. Also give the expression for local skin friction coefficient, boundary layer thickness, displacement thickness and momentum thickness for an incompressible flow over a flat plate.

PART C — (1 × 15 = 15 marks)

16. (a) (i) The velocity potential for an ideal fluid flowing around a long cylinder is given by $\left\{\frac{B}{r}+Ar\right\}\cos\theta=\phi$. The cylinder has a radius R and is placed in a uniform flow of velocity which affects the velocity near to the cylinder. Determine the constants A and B and determine where the maximum velocity occurs. (8)

(ii) The potential for flow around a cylinder of radius 'a' is given by

$\phi=ux\left[1+\frac{a^2}{x^2+y^2}\right]$, where x and y are the Cartesian co–ordinates with the origin at the middle. Derive an expression for the stream function (ψ). (7)

Or

(b) (i) A wing with an elliptical planform and an elliptical lift distribution has an aspect ratio of 6 and a span of 12 m. The wing loading is 900 N/m² when flying at a speed of 150 km/hr at sea level. Compute the induced drag for this wing. (8)

(ii) Write a short note on boundary layer separation with necessary sketches. Also state the factors that encourage BL separation. (7)

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