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Question Paper Code : 40051

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth Semester

Aeronautical Engineering

AE 8401 – AERODYNAMICS- I

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is meant by barotropic flow?
2. Give the differences between free and forced vortex.
3. What is meant by Magnus effect?
4. Define the Kutta condition with the help of a diagram.
5. What is conformal transformation? How it is useful for aerodynamic studies?
6. What are the basic assumptions made in thin airfoil theory?
7. Define wash in and wash out.
8. What is meant by horse shoe vortex?
9. What are the characteristics that encourages the transition of flow from laminar to turbulent?
10. Define shape factor.

PART B — ($5 \times 13 = 65$ marks)

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

Or

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

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

Or

(b) (i) With aid of suitable sketches, explain the ideal and real flow over circular cylinder. (7)

(ii) Explain in brief about D'Alembert Paradox and Magnus effect. (6)

13. (a) (i) Arrive at Cauchy- Riemann relations using complex potential. (8)

(ii) What is meant by thin aerofoil theory and what are its applications? (5)

Or

(b) By using Kutta-Joukowski transformation, transform a circle into cambered aerofoil profile and also find the thickness to chord ratio.

14. (a) (i) State and Prove Biot-Savart Law. (7)

(ii) Explain in brief about induced drag and downwash. (6)

Or

(b) Derive the fundamental equation of Prandtl's lifting line theory. Also state its limitations.

15. (a) With neat illustrations, define and derive expressions for displacement thickness and momentum thickness.

Or

(b) Arrive at the Blasius solution for an incompressible 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 of a free stream is given by $\varphi_1 = 5x$ and for a doublet is $\varphi_2 = 5\dfrac{x}{x^2 + y^2}$ (8)

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

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

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

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

(ii) The velocity potential for an ideal fluid flowing around a long cylinder is given by $\left\{\dfrac{B}{r} = Ar\right\}\cos\theta = \Phi$. 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 & B and determine where the maximum velocity occurs. (7)

Or

(b) A thin airfoil has a cubic camber line defined by $z = kc\left(x^3 - 3x^2 + 2x\right)$ in Cartesian set of axis system with its origin at the leading edge. Its maximum camber is 2% of the chord. Determine C_l and C_m, C/4 at 5° incidence. (15)
