Reg. No. : E N G G T R E E . C O M

Question Paper Code : 30016

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

Fourth Semester

Aeronautical Engineering

AE 3401 — AERODYNAMICS – I

(Regulations 2021)

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 difference between free vortex and forced vortex.
3. What is meant by D'Alembert's paradox?
4. State the importance of Kutta condition.
5. What is meant by complex potential?
6. What is the importance of conformal transformation?
7. State Holmholtz's vortex theorem.
8. What is meant by downwash and state its effects on airfoil?
9. Draw a neat sketch of boundary layer growth over a flat plate and indicate the salient features.
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 it to steady Euler equations.

Or

(b) (i) Show that the combination of a doublet flow and uniform flow is equivalent to a non-lifting flow over a cylinder. (7)

(ii) Show that streamlines and equipotential lines are mutually perpendicular to each other. (6)

12. (a) (i) Explain in detail on real flow over a circular cylinder and with necessary sketches, explain how does the flow vary as the Reynolds number increases? (10)

(ii) What is meant by Magnus effect? (3)

Or

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

(ii) Explain briefly on ideal flow over a circular cylinder. (3)

13. (a) Using Kutta-Joukowski transformation, transform a circle into symmetrical airfoil profile and also find the location of maximum thickness, thickness to chord ratio and shape of the trailing edge.

Or

(b) What are the basic assumptions made in thin aerofoil theory and derive the expression for lift coefficient and moment coefficient for a symmetrical aerofoil using thin aerofoil theory.

14. (a) (i) Show that the local jump in tangential velocity across the vortex sheet is equal to the local sheet strength. (10)

(ii) What are the imitations of lifting line theory? (3)

Or

(b) (i) Derive an expression for the velocity induced by an infinite vortex filament at a point, which is at a distance 'n' from the filament using Biot-Savart law. (10)

(ii) Write a short note on induced drag. (3)

15. (a) Derive boundary layer equations for a steady two dimensional incompressible flow over a flat plate. Also state the assumptions made while deriving those equations.

Or

(b) (i) With a neat sketch, define and derive the expression for momentum thickness. (8)

(ii) Write a short note on boundary layer separation with necessary sketches. (5)

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 & B and determine where the maximum velocity occurs. (8)

(ii) Explain Blasius theorem for a steady two dimensional irrotational flow. (7)

Or

(b) (i) A wing with an elliptical plan form 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. (8)

(ii) A sharp edge flat plate with length 0.5m and width 5m 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 any given section. (7)