



Time: 3 hours

Max. Marks: 80

Answer any five questions All questions carry equal marks

- 1. Make use of the thin airfoil theory to work out an expression for C1 and Cm for a flat plate of chord 150 mm. Obtain the results at $\alpha = 1^{0}$. Where does the centre of pressure lie in this case? What is C_{mLE} in this case? [16]
- 2. What are the basic features of the Kutta-Joukowaki transformation? Show that on application of Kutta-Joukowaski transformation, a circle transforms to

 a) a flat plate and
 b) an ellipse.
 Extend the procedure further to transform a circle into a cambered airfoil. [8+8]
- 3. Take a low aspect ratio tapered planform with LE sweep. Make use of Lifting surface theory to develop the following expression (present your work out)

$$w(x,y) = -\frac{1}{4\pi} \iint_{s} \frac{(x-\xi)\gamma(\xi,\eta) + (\gamma-\eta)\delta(\xi,\eta)}{\left[(x-\xi)^{2} + (y-\eta)^{2}\right]^{3/2}} d\xi d\eta - \frac{1}{4\pi} \iint_{w} \frac{(\gamma-\eta)\delta(\xi,\eta)}{\left[(x-\xi)^{2} + (y-\eta)^{2}\right]^{3/2}} d\xi d\eta$$

Where the terminology is standard is standard for such work in aerodynamics.

[16]

- 4.a) Explain the term Drag Polar as referred to the airplane drag. What are its components? Explain each with example.
 - b) Compare the drag force on i) a flat plate at $\alpha \neq 0$ and ii) symmetrical airfoil at $\alpha \neq 0$. [8+8]
- 5. A solution to the Laplace's equaiton for incompressible potential flow and pressure distribution over s circular cylinder is sought by a numerical technique. Making use of fourteen numbers of constant source panels develop the procedure for obtaining pressure distribution over the circular cylinder. [16]
- 6.a) Prove from the first priciple that the condition for a flow field to be 'irrotational' is represented by, $\nabla \times \nabla \phi = 0$ where ϕ is defined as velocity potential function.
 - b) Demonstrate that the stream lines formed by a uniform source are radial lines originating from the centre of the source. [8+8]
- 7.a) Enumerate Biot-Savart's law.
 - b) Describe its application in calculating vortex induced velocities aerodynamics, Considering

i) a finite length vortex filament,

ii) an infinite length vortex filament and

iii) a semi-infinite length vortex filament each having circulation Γ .

Work our general expressions for vortex induced velocities in each of these three cases. [4+4+4+4]

- 8.a) Explain difference between
 - i) a point vortex,

ii) a constant strength vortex panel and

iii) a linearly varying strength vortex panel. Make a comparison of the three in your judgment, and bring out your conclusions.

b) A planar horse shoe vortex is placed symmetrically along OX on the x-axis with its BV (bound vortex) aligned with the y axis. Derive a general expression for the down wash in the plane of symmetry. [8+8]







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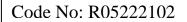
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