Code: 9A21403

II B.Tech II Semester (R09) Regular & Supplementary April/May 2012 Examinations
AERODYNAMICS-I
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 70**

Answer any FIVE Questions
All Questions carry equal marks

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1. Derive the continuity equation for the mass of a fluid in a finite control volume in a flow in the integral form. From this derive the continuity equation relating the flow field variables at a point in a fluid flow in th form of a differential equation.

2. Explain
   (a) Angular velocity.
   (b) Vorticity.
   (c) Strain in fluid elements.

3. Write the Navier-Stokes equations and explain all the terms in the equations.

4. Derive the fundamental equation of thin airfoil theory.

5. State the fundamental equation of Prandtl's lifting line theory and explain all the terms clearly. Making necessary assumptions, find an expression for the induced drag over a wing.

6. Describe the subsonic flows over rectangular, elliptical and delta wings.

7. Explain
   (a) Drag polar.
   (b) Leading edge extensions to wings.
   (c) Multi-element airfoils.

8. Derive an expression for the thrust generated by a propeller. Explain all the terms used very clearly.

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1. Considering a control volume, derive the momentum equation for a fluid in integral form.

2. (a) Define curl and vorticity.
   (b) Prove that the curl of the velocity is equal to the vorticity in a velocity field.

3. Write short notes on
   (a) Laminar boundary layers.
   (b) Surface friction drag.
   (c) Eddy viscosity.

4. State the fundamental equation of thin airfoil theory and derive an expression for the lift slope of a symmetrical airfoil.

5. Define vortex filament and explain in detail how it helps in finding the lift over a wing.

6. Describe the flow over a transport aircraft at low and high angles of attack, with special reference to wings and fuselage.

7. Explain the different components of drag and explain how they can be reduced for a wing.

8. Derive an expression for the thrust generated by a propeller with the help of blade element theory.

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1. Derive the energy equation in integral form, considering a control volume in fluid flow.

2. Define the terms source and sink. Obtain the expressions for the velocity components in a flow which is a combination of uniform flow, a sink and a source.

3. Explain
   (a) Boundary layer growth along a flat surface.
   (b) Viscosity.
   (c) Reynolds analogy.

4. State and explain
   (a) Kutta condition.
   (b) Kelvin's circulation theorem.
   (c) Aerodynamic centre.

5. Derive the fundamental equation of Prandtl's lifting line theory.

6. Derive an expression for the velocity of incompressible flow over a sphere.

7. Define Reynolds number. Explain how it affects the boundary layer. Also explain how drag over a body can be reduced.

8. Derive an expression for the thrust generated by a propeller based on momentum theory.

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4

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1. Write notes on
   (a) Aerodynamic force and moment coefficients.
   (b) Dimensional Analysis.

2. Defining the pertinent terms accurately, obtain an expression for the stream function for a lifting flow over a circular cylinder.

3. (a) With the help of neat sketches, explain the boundary layer over a flat plate.
   (b) Explain the concept of thermal boundary layer.

4. State the fundamental equation of thin airfoil theory and derive an expression for the lift slope of a cambered airfoil.

5. State and explain
   (a) Biot - Savart Law.
   (b) Helmholtz theorems.
   (c) Starting, bound and trailing vortices.

6. Define three dimensional source and doublet. State the expressions for the coefficients of pressure over a cylinder and a sphere. With the help of these, explain the concept of three dimensional relief.

7. Describe NACA airfoils of four and five digit series.

8. Write short notes on
   (a) Geometry of propeller.
   (b) Vortex system of an airscrew.
   (c) Geometric pitch of a propeller.
   (d) Power coefficients.

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