Code: 9A21403 **R09**

B.Tech II Year II Semester (R09) Supplementary Examinations May/June 2017

AERODYNAMICS – I

(Aeronautical Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

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1 The drag on the hull of a ship depends in part on the height of the water waves produced by the hull. The potential energy associated with these waves therefore depends on the acceleration of gravity, g. Hence the wave drag on the hull is $D = f(\rho_\infty, V_\infty, c, g)$ where c is a length scale associated with the hull, say, the maximum width of the hull. Define the drag coefficient as $C_D = D/q_\infty c^2$. Using Buckingham's pi theorem, prove that $C_D = f(Fr)$ where Fr is Froude number $\left(Fr = V/(gc)^{1/2}\right)$.

2 Define angular velocity, vorticity and prove that the curl of the velocity is equal to the vorticity in a velocity field.

3 Derive an expression for the lift slope of a symmetrical airfoil with the help of the fundamental equation of thin airfoil theory.

4 Discuss briefly about real flow over an airfoil at different angles of attack and effect of boundary layer transition and surface roughness on the aerodynamic forces.

5 (a) Explain about Horseshoe vortex and its importance in arriving elliptical lift distribution.

(b) The measured lift slope for the NACA 23012 airfoil is 0.1080 per degree, and $\alpha_{L=0} = -1.3°$. Consider a finite wing using this airfoil, with AR = 8 and taper ratio = 0.8. Assume that $\delta = 0.054$. Calculate the lift and induced drag coefficients for this wing at a geometric angle of attack = 7°.

6 Write briefly about the mechanism of lift generation on delta wings at subsonic speeds and the use of leading edge extensions to wings.

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

8 Derive an expression for thrust generated by the propeller by blade element theory.

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