CBCS SCHEME

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15AE42

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Aerodynamics – I

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing one full question from each module.***

Module-1

1 a. Derive x component of the momentum equation using control volume approach. **(08 Marks)**

b. Define following with relevant expressions:
(i) Path line (ii) Stream line (iii) Streak line (iv) Circulation. **(08 Marks)**

OR

2 a. Obtain an expression for Angular velocity and vorticity and also show the condition of irrotationality for two-dimensional flow. **(08 Marks)**

b. Derive speed of sound in terms of density and isentropic compressibility. **(08 Marks)**

Module-2

3 a. Define center of pressure. Explain equivalent ways of specifying the force and moment system on an airfoil. **(06 Marks)**

b. In low-speed, incompressible flow, the following experimental data are obtained for an NACA 4412 airfoil section at an angle of attack of 4°; $C_l = 0.85$ and $C_{m,C/4} = -0.09$. Calculate the location of the center of pressure. **(06 Marks)**

c. Draw a schematic diagram of an airfoil and explain the salient geometric features. **(04 Marks)**

OR

4 a. Derive $\bar{x}_{ac} = -\frac{m_0}{a_0} + 0.25$, where $\bar{x}_{ac}$ is the location of the aerodynamic center as a fraction of the chord length, M_0 is the slope of moment coefficient curve and a_0 is the slope of lift co-efficient curve. **(08 Marks)**

b. List different types of drag and explain. **(08 Marks)**

Module-3

5 a. Consider Non-lifting flow over a circular cylinder and derive the expression, $C_p = 1 - 4\sin^2\theta$ and also show the C_P variation over the surface of the cylinder graphically. **(08 Marks)**

b. Consider the lifting flow over a circular cylinder. The lift co-efficient is 5. Calculate the location of the stagnation points and the points on the cylinder where the pressure equals free stream static pressure. **(08 Marks)**

OR

6 a. Briefly explain the following, with neat sketches and relevant expressions:
(i) Kelvin's circulation theorem.
(ii) The starting vortex. **(08 Marks)**

b. Derive an expression for lift co-efficient for symmetrical airfoil, using classical thin airfoil theory. **(08 Marks)**

Module-4

7 a. Discuss briefly the following:
(i) Vortex filament.
(ii) Induced drag. **(08 Marks)**

b. Obtain the fundamental equation of Prandtl's , lifting-line theory. **(08 Marks)**

OR

8 a. Explain Prandtl's lifting line theory and its limitations. **(08 Marks)**

b. Consider a rectangular wing with an aspect ratio of 6, an induced drag factor $\delta = 0.055$, and a zero-lift angle of attack of -2°. At an angle of attack of 3.4°, the induced drag co-efficient for this wing is 0.01. Calculate the induced drag co-efficient for a similar wing (a rectangular wing with the same airfoil section) at the same angle of attack, but with an aspect ratio of 10. Assume that the induced factors for drag and the lift slope, δ and τ respectively, are equal to each other (i.e. $\delta = \tau$). Also, for AR = 10, $\delta = 0.105$. **(08 Marks)**

Module-5

9 a. What are swept wings? Describe the typical aerodynamic characteristics with relevant graphs and sketches. **(10 Marks)**

b. Explain the effect of flaps on the lift curve. **(06 Marks)**

OR

10 Write short notes on the following:
a. Influence of downwash on tail plane.
b. Ground effects.
c. Critical Mach Number.
d. Subsonic and supersonic leading edges. **(16 Marks)**

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