CBCS SCHEME

USN | | | | | | | | | | |

17AE/AS42

Fourth Semester B.E. Degree Examination, June/July 2019
Aerodynamics – I

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Derive the integral form of momentum equation by control volume approach. **(10 Marks)**

b. Define the following:
   i) Path line
   ii) Streak line
   iii) Circulation
   iv) Stream function
   v) Velocity potential function. **(10 Marks)**

OR

2 a. Define Mach number. Derive the equation for speed of sound and explain Mach cone. **(10 Marks)**

b. Derive the relationship between stream function and velocity potential function. **(04 Marks)**

c. The velocity potential (ϕ) is given by an expression

$$\phi = \frac{-xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2$$

   i) Find the velocity components in x and y direction.
   ii) Show that ϕ represents a possible case of flow. **(06 Marks)**

Module-2

3 a. With neat sketches, explain i) Airfoil nomenclature ii) Wing planform geometry. **(10 Marks)**

b. Explain the following:
   i) Aerodynamic center
   ii) Centre of pressure
   iii) Pressure coefficient
   iv) Aerodynamic forces and moments. **(10 Marks)**

OR

4 a. Derive the relationship to calculate the aerodynamic forces N' and A' and the moment M'_{LE} in terms of P, θ and τ. **(12 Marks)**

b. Explain different types of drag. **(08 Marks)**

Module-3

5 a. Derive an expression for lifting flow over a cylinder. **(10 Marks)**

b. Define: i) Source flow ii) Sink flow iii) Doublet iv) Vortex flow v) Uniform flow. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

6 a. State and derive Kelvin's circulation theorem. **(06 Marks)**
b. Define Kutta condition. **(04 Marks)**
c. Explain and derive Classical Thin Airfoil Theory for symmetric airfoil. **(10 Marks)**

Module-4

7 a. Explain Biot – Savart law. **(08 Marks)**
b. Explain Helmholtz's theorem. **(06 Marks)**
c. Explain: i) Down wash ii) Induced drag iii) Vortex system. **(06 Marks)**

OR

8 a. Derive Prandtl's classical lifting line theory. **(10 Marks)**
b. Consider a rectangular using with an aspect ratio of 6, an induced drag factor $\delta = .055$ and a zero lift angle of attack of -2°. At an angle of attack of 3.4°, the induced drag coefficient for this wing is 0.01. Calculate the induced drag coefficient for a similar wing 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, $\delta = 0.105$ **(10 Marks)**

Module-5

9 a. Describe simplified horse-shoe vortex model. **(08 Marks)**
b. Explain formation flight. **(06 Marks)**
c. Explain swept wings and sweep effects. **(06 Marks)**

OR

10 a. Explain various high lift devices with neat sketch. **(08 Marks)**
b. Describe transonic area rule and critical mach number. **(06 Marks)**
c. Describe drag-divergence and shock induced separation. **(06 Marks)**

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