CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐   **18AE/AS42**

Fourth Semester B.E. Degree Examination, July/August 2022
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. State the law of Conservation of mass. Derive an expression for one – dimensional form of continuity equation. **(06 Marks)**
   b. Define and explain the Compressibility. **(04 Marks)**
   c. Define Mach number. Explain the classification of the flow regimes based on Mach number with a neat sketch. **(10 Marks)**

OR

2. a. Obtain the relation between Stream function and Velocity potential stating its inference. **(04 Marks)**
   b. Define the following : i) Path line   ii) Stream line   iii) Streak line. **(06 Marks)**
   c. Derive the integral form of momentum equation for a control volume fixed in space. **(10 Marks)**

Module-2

3. a. Derive the relation to calculate the Aerodynamic forces N′ and A′ and the momentum M′$_{LF}$ in terms of P, θ and τ. **(10 Marks)**
   b. Consider the velocity field given by $u = \dfrac{Y}{(X^2 + Y^2)}$ and $v = \dfrac{-X}{(X^2 + Y^2)}$. Calculate the equation of stream line passing through the point (0, 4). **(04 Marks)**
   c. Define the term : i) Centre of Pressure   ii) Co-efficient of Pressure
   iii) Aerodynamic center. **(06 Marks)**

OR

4. a. With a neat sketch, explain in detail the Airfoil nomenclature. **(08 Marks)**
   b. With a neat sketch, explain the wing planform geometry. **(06 Marks)**
   c. Explain different types of drag. **(06 Marks)**

Module-3

5. a. Write short notes on the following :
   i) Kutta condition   ii) Kelvin's Circulation theorem. **(08 Marks)**
   b. Obtain an expression for the following for a lifting flow over cylinder :
   i) Stream function   ii) Location of stagnation points   iii) Pressure co-efficient.
   Also explain with a neat sketch, the location of stagnation point for different values of 'Γ'. **(12 Marks)**

OR

6. a. Derive the relation for Lift co-efficient and lift slope for a Cambered airfoil based on Classical thin Airfoil theory. **(10 Marks)**

b. Consider the lifting flow over a circular cylinder with a diameter of 0.5m. The free stream velocity is 25m/s and the maximum velocity on the surface of the cylinder is 75m/s. The free stream conditions are those for a standard altitude of 3km. Calculate the lift per unit span on the cylinder. (Assume $\rho = 0.90926$ kg/m^3 at 3km altitude , Maximum velocity occurs at when $\theta = 90°$). **(10 Marks)**

Module-4

7 a. Explain in detail about Lifting surface theory and Vortex lattice method. **(10 Marks)**
   b. Prove that induced drag co-efficient is directly proportional to square of lift co-efficient using elliptical lift distribution. **(10 Marks)**

OR

8 a. Explain and derive Prandtl's lifting theory and its limitations. **(12 Marks)**
   b. Explain the following :
      i) Biot – Savart law   ii) Helmholtz's theorem   iii) Downwash. **(08 Marks)**

Module-5

9 a. Explain in detail about Lift enhancing devices. **(10 Marks)**
   b. Briefly explain Simplified horse – shoe vortex model and formation flight. **(10 Marks)**

OR

10 a. What is Swept Wing? Bring out the aerodynamic characteristics of swept wing , with relevant graphs and sketches. **(10 Marks)**
    b. Write short note on the following :
       i) Transonic Area Rule   ii) Super Critical Airfoil. **(10 Marks)**

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