CBCS SCHEME

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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 $u = \frac{Y}{(X^2+Y^2)}$ and $v = \frac{-X}{(X^2+Y^2)}$. 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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