

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)

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.

- 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 $\rho = 0.90926 \text{ kg/m}^3$ at 3km altitude, Maximum velocity occurs at when $\theta = 90^\circ$). (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)
