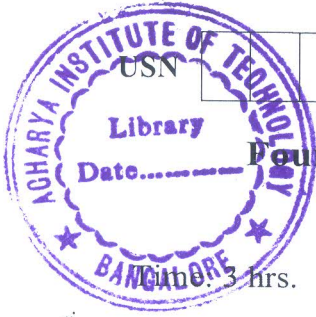


# CBCS SCHEME

17AE/AS42



## Fourth Semester B.E. Degree Examination, July/August 2021 Aerodynamics – I

hrs.

Max. Marks: 100

**Note: Answer any FIVE full questions.**

- 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)
- 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 ( $\phi$ ) 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  $\phi$  represents a possible case of flow. (06 Marks)
- 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)
- 4 a. Derive the relationship to calculate the aerodynamic forces  $N'$  and  $A'$  and the moment  $M'_{LE}$  in terms of  $P$ ,  $\theta$  and  $\tau$ . (12 Marks)  
b. Explain different types of drag. (08 Marks)
- 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. (12 Marks)  
b. Consider the lifting flow over a circular cylinder with a diameter of 0.5m. The free stream velocity is 25 m/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 at altitude 3km,  $\rho = 0.90926 \text{ kg/m}^3$ . (08 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.

- 6 a. Prove that the center of pressure is at the quarter – chord point for a symmetric airfoil. (10 Marks)
- b. Consider a thin flat plate at 5 deg. angle of attack. Calculate the
- lift co-efficient
  - moment co-efficient about the leading edge
  - moment co-efficient about the quarter – chord point and
  - moment co-efficient about the trailing edge. (10 Marks)
- 7 a. Derive the expression for the induced angle of attack and induced drag co-efficient using elliptical lift distribution. (12 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  $-2^\circ$ . At an angle of attack of  $3.4^\circ$ , 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  $\delta = \tau$ . Also, for  $AR = 10$ ,  $\delta = 0.105$ . (08 Marks)
- 8 a. Obtain the expression for the velocity induced by infinite and Semi-infinite vortex filament using Biot – Savart law. (10 Marks)
- b. Briefly explain Prandtl's Classical Lifting – Line theory and its Limitations. (10 Marks)
- 9 a. Explain the horse-shoe vortex system over a lifting wing. (08 Marks)
- b. Discuss the advantages of swept wings in model airplane. (04 Marks)
- c. Explain in detail about lift enhancing devices. (08 Marks)
- 10 a. Write short note on the following:
- Transonic area rule. (08 Marks)
  - Super critical airfoil. (04 Marks)
- b. What is critical Mach number and Tip effects? (04 Marks)
- c. Explain in detail drag divergence. (08 Marks)

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