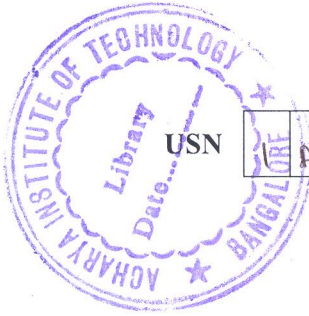


# CBCS SCHEME

17AE/AS42



USN

A Y I S A E U O S

## Fourth Semester B.E. Degree Examination, Jan./Feb. 2021 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. Develop continuity equation for any finite control volume fixed in space. (08 Marks)  
b. Explain the following aerodynamic flows :  
i) Inviscid Vs Viscous flow  
ii) Laminar Vs Turbulent flow  
iii) Steady Vs Unsteady flow  
iv) Rotational Vs Irrotational flow (12 Marks)

OR

- 2 a. Explain Mach Number regimes. (10 Marks)  
b. Derive the relationship between the following :  
i) Stream function and velocity potential function  
ii) Circulation and Vorticity. (10 Marks)

### Module-2

- 3 a. Name the classifications of NACA airfoils and write down the explanation of the digits in each if the following :  
i) NACA 2414  
ii) NACA 23014  
iii) NACA 65-214 (10 Marks)  
b. Consider an airfoil in a flow with a free stream velocity of 45.72m/s. The velocity at a given point on the airfoil is 68.58m/s. Calculate the pressure co-efficient at this point. (04 Marks)  
c. Derive an expression for the pressure co-efficient for incompressible flow using Bernoulli's equation. (06 Marks)

OR

- 4 a. Define Aerodynamics center. Derive an expression for the location of the aerodynamics center. (10 Marks)  
b. Consider the NACA 23012 airfoil. It shows that, at  $\alpha = 4^\circ$ ,  $C_l = 0.55$  and  $C_{m,C/4} = -0.005$ . The zero lift angle of attack is  $-1.1^\circ$ . Also at  $\alpha = -4^\circ$ ,  $C_{m,C/4} = -0.0125$ . From the given information, calculate the location of the aerodynamic center. (06 Marks)  
c. Explain the airfoil aerodynamic characteristics. (04 Marks)

### Module-3

- 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.

OR

- 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)

**Module-4**

- 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)

OR

- 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)

**Module-5**

- 9 Write short notes on the following :
- Formation of Flight
  - Influence of downwash on fail plane
  - Ground effect
  - Simplified Horseshoe Vortex. (20 Marks)

OR

- 10 a. Briefly explain Critical Mach Number and Drag divergence Mach Number. (08 Marks)
- b. Write short notes on Subsonic and Supersonic Leading edges. (06 Marks)
- c. Explain Transonic area rule. (06 Marks)

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