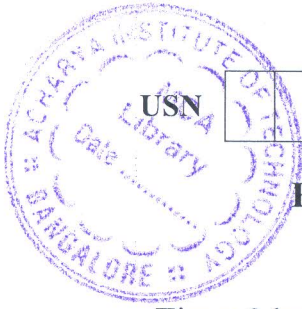


CBCS SCHEME



USN

--	--	--	--	--	--	--	--	--	--

18AE/AS42

Fourth Semester B.E. Degree Examination, June/July 2024 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. Derive the integral form of continuity equation and hence deduce the differential form. (10 Marks)
- b. Explain the following aerodynamic flows:
 - (i) Inviscid versus Viscous flow
 - (ii) Incompressible versus compressible flow (10 Marks)

OR

- 2 a. Obtain an expression for angular velocity and vorticity and also show the condition of irrotationally for two-dimensional flow. (10 Marks)
- b. Derive speed of sound in terms of density and isentropic compressibility. (10 Marks)

Module-2

- 3 a. Explain typical airfoil aerodynamic characteristics at low speeds. (09 Marks)
- b. Name the classifications of NACA airfoils and write down the explanation of the digits:
 - (i) NACA 2412
 - (ii) NACA 23012
 - (iii) NACA 65-218 (11 Marks)

OR

- 4 a. Define aerodynamic center. (02 Marks)
- b. Derive $x_{ac} = -\frac{m_0}{a_0} + 0.25$, where \bar{x}_{ac} - location of the aerodynamic center, m_0 - slope of the moment coefficient curve, a_0 - slope of the lift coefficient curve. (10 Marks)
- c. In low-speed, incompressible flow, the following experimental data are obtained for NACA 4412 airfoil section at an angle of attack of 4° : $c_l = 0.85$ and $c_{m, c/4} = -0.09$. Calculate the location of the center of pressure. (08 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. (10 Marks)
- b. Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. The free stream velocity is 25 m/s, and the maximum velocity on the surface of the cylinder is 75 m/s. The free stream conditions are those for a standard altitude of 3 km. Calculate the lift per unit span on the cylinder. (Take at an altitude of 3 km, $\rho = 0.90926 \text{ kg/m}^3$) (10 Marks)

OR

- 6 a. Using classical airfoil theory, obtain the expression for a symmetric airfoil. (10 Marks)
- b. For symmetric airfoil, prove that the quarter-chord point is both the center of pressure and the aerodynamic center. (10 Marks)

Module-4

- 7 a. Obtain the expression for the velocity induced by infinite and semi-infinite vortex filament using the Biot Savart Law. (10 Marks)
- b. Discuss briefly the following : (10 Marks)
- Downwash and Induced drag
 - Helmholtz's Vortex theorem

OR

- 8 a. Consider Elliptical Lift Distribution given by $\Gamma(y) = \Gamma_0 \sqrt{1 - \left(\frac{2y}{b}\right)^2}$. Derive the expression for the induced angle of attack and induced drag coefficient. (12 Marks)
- b. Consider a finite wing with an aspect ratio of 8 and a taper ratio of 0.8. The airfoil section is thin and symmetric. Calculate the lift and induced drag coefficients for the wing when it is at an angle of attack of 5° . Assume that $\delta = \tau = 0.055$. (08 Marks)

Module-5

- 9 a. Describe the aerodynamic characteristics of swept wings with relevant graphs and sketches. (10 Marks)
- b. What are high lift devices? Discuss in detail about the high lift devices. (10 Marks)

OR

- 10 Write short notes on the following: (20 Marks)
- Influence of downwash on tail plane
 - Ground effects
 - Critical Mach Number
 - Drag-Divergence Mach Number
