CBCS SCHEME

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18AE42

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

Time: 3 hrs. Max. Marks: 100

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





**1** a. Briefly explain the Mach number Regimes with Different regimes of flow. **(12 Marks)**

b. Derive the continuity equation using Finite control volume fixed in space. **(08 Marks)**

**2** a. Briefly explain the different types of flow. **(08 Marks)**

b. Derive the expression for speed of sound $a = \sqrt{\gamma RT}$. **(12 Marks)**

**3** a. Explain the terms centre of pressure, pressure co-efficient and aerodynamic center. **(09 Marks)**

b. Consider a thin supersonic airfoil with chord length C = 1.524m in a mach 3 free stream at a Standard Altitude of 6096m. The airfoil is at an angle of attack of 5º. Data : $\gamma = 1.4$, T = 248.6K R = 348.39, $\rho = 0.654$. Calculate the lift and wave drag co-efficient and the lift and wave drag per unit span. **(11 Marks)**

**4** a. Briefly describe the NACA Airfoil Nomenclature and Airfoil characteristics **(08 Marks)**

b. Explain the different types of drag. **(06 Marks)**

c. Describe the aerodynamic forces and moments. **(06 Marks)**

**5** a. Derive the expression for uniform flow. **(10 Marks)**

b. Explain the Kutta – Joukowski theorem and the Generation of lift. **(10 Marks)**

**6** a. Briefly explain the kutta condition with relevant figure. **(10 Marks)**

b. Describe the Kelvin's circulation theorem and the starting vortex. **(10 Marks)**

**7** a. Explain the Replacement of the finite wing with a bound vortex, downwash distribution along the y-axis for a single horseshoe vortex over a Prandtl's classical Lifting Line Theory. **(10 Marks)**

b. What is downwash and Induced drag? Explain effect of downwash on the local flow over a local airfoil section of a finite wing. **(10 Marks)**

**8** a. Consider a Finite wing an aspect Ratio of 8 and a taper ratio of 0.8. The airfoil section is thin a symmetric. Calculate the lift and induced drag co-efficient for the wing when it is at an angle of attack of 5º. Assume that $\delta = \tau$. Data: $\delta = 0.055$, $a_0 = 2\pi$. **(05 Marks)**

b. Derive the Expression for Elliptical Lift distribution $\omega(\theta_0) = \frac{\Gamma 0}{2b}$ and $C_{D,i} = \frac{C_L^2}{\pi AR}$. **(12 Marks)**

c. What is Geometric Twist and aerodynamic twist? **(03 Marks)**

**9** a. With a neat sketch, explain Flaps a mechanism for high Lift. **(08 Marks)**

b. Explain with neat sketch, why almost all modern high speed aircraft have swept back wings. **(08 Marks)**

c. What is critical Mach number? Illustration of critical Mach number. **(04 Marks)**

**10** a. Explain the critical and drag – divergence Mach number with neat sketch. **(08 Marks)**

b. Explain the following Leading – Edge Slats, Camber and Aspect Ratio of wings. **(05 Marks)**

c. With a neat sketch, explain the schematic of a single horseshoe vortex and vortex lattice system of a finite wing. **(07 Marks)**

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