CBCS SCHEME

USN | | | | | | | | | | |

15AE42

Fourth Semester B.E. Degree Examination, June/July 2023
Aerodynamics - I

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Derive the differential form of energy equation through control volume approach. **(08 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 the streamline passing through the point (0, 5) and calculate the circulation around a circular path of radius 5m. Assume that u and v are in units of meters per second. **(08 Marks)**

OR

2 a. Derive the differential form of momentum equation through control volume approach. **(08 Marks)**

b. Derive an equation for Vorticity ξ. **(08 Marks)**

Module-2

3 a. Explain Airfoil-section nomenclature and Wing planform geometry with a neat sketch. **(08 Marks)**

b. Obtain the expression for N' and A' in terms of τ, p and θ. Deduce C_n and C_a. **(08 Marks)**

OR

4 a. Explain briefly the Center of pressure and Aerodynamic center. **(08 Marks)**

b. Consider the NACA 23012 airfoil. At $\alpha = 4^\circ$, $C_l = 0.55$ and $Cm_{C/4} = -0.005$. The zero-lift angle of attack is -1.1°. Also, at $\alpha = -4^\circ$, $Cm_{C/4} = -0.0125$. Calculate the location of the aerodynamic center for the NACA 23012 airfoil. **(08 Marks)**

Module-3

5 a. Write short notes on the following :
i) Kutta condition ii) Kelvin's Circulation Theorem. **(08 Marks)**

b. What is D'Alembert's Paradox? **(04 Marks)**

c. State Kutta – Joukowski Theorem. **(04 Marks)**

OR

6 a. Obtain an expression for the following for a lifting flow over cylinder :
i) Stream function ii) Location of stagnation points iii) Pressure coefficients.
Also explain with a neat sketch, the location of stagnation points for different values of "Γ". **(12 Marks)**

b. Define Doublet flow. **(04 Marks)**

Module-4

7 a. Derive an expression for lift coefficient and induced drag coefficient in terms of circulation strength Γ(Y) for a finite using through Prandtl's classical lifting line theory. **(08 Marks)**

b. Obtain the expression for the velocity induced by infinite vortex filament using the Biot-Savart law. **(08 Marks)**

OR

8 a. Derive the expression for the induced angle of attack and induced drag coefficient using elliptical lift distribution. **(08 Marks)**

b. Discuss briefly the following:
i) Vortex filament ii) Helmholtz's vortex theorem. **(08 Marks)**

Module-5

9 a. Briefly explain Simplified Horse-shoe Vortex model and formation flight. **(08 Marks)**

b. What are High Lift Devices? List them. Explain their effects on aerodynamic characteristic. **(08 Marks)**

OR

10 a. What is Swept Wing? Bring out the Aerodynamic characteristics of swept wing, with relevant graphs and sketches. **(08 Marks)**

b. Explain i) Drag-Divergence Mach number ii) Transonic area rule. **(08 Marks)**

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