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Course Code **AAE004**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech IV Semester CIE – II, May – 2018

Regulations: IARE-R16

LOW SPEED AERODYNAMICS

Time: 2 Hours

(AE)

Max Marks: 25

Answer all question from Part – A

Answer any four questions from Part – B

All parts of the question must be answered in one place only

PART – A

1. (a) Explain the importance of Kelvin's circulation theorem. [BL: Remember | CO: 2 | Marks: 1]
- (b) Explain Biot-Savart Law. [BL: Understand | CO: 2 | Marks: 1]
- (c) What is vortex panel method? [BL: Remember | CO: 7 | Marks: 1]
- (d) What are the commonly used singularities to model potential flows over airfoils?
[BL: Remember | CO: 9 | Marks: 1]
- (e) Write short notes on the general effects of the propeller slipstream on the wing and tail.
[BL: Understand | CO: 11 | Marks: 1]

PART – B

2. (a) Describe the stalling of an airfoil and the related aerodynamic phenomena.
[BL: Understand | CO: 4 | Marks: 2]
- (b) Consider a thin, symmetric airfoil at 1.5° angle of attack. From the results of thin airfoil theory, calculate the lift coefficient C_l , and the moment coefficient about the leading edge, $C_{m,LE}$.
[BL: Understand | CO: 4 | Marks: 3]
3. (a) Consider a vortex filament of strength Γ in the shape of a closed circular loop of radius R. Obtain an expression for the velocity induced at the center of the loop in terms of Γ and R.
[BL: Understand | CO: 1 | Marks: 2]
- (b) The Piper Cherokee (a light, single-engine general aviation aircraft) has a wing area of 170 ft^2 and a wing span of 32 ft. Its maximum gross weight is 2450 lb. The wing uses an NACA 65-415 airfoil, which has a lift slope of $0.1033 \text{ degree}^{-1}$ and $\alpha_{L=0} = -3^\circ$. Assume $\tau = 0.12$. If the airplane is cruising at 120 mi/h at standard sea level at its maximum gross weight and is in straight-and-level flight, calculate the geometric angle of attack of the wing.
[BL: Remember | CO: 1 | Marks: 3]
4. (a) Obtain the expression for induced drag and minimum induced drag for elliptic planform.
[BL: Understand | CO: 8 | Marks: 2]
- (b) A constant strength vortex panel of strength 50 units is located on the axis from $X_1=3.5$ to $X_2=6.65$. Determine the influence of this vortex panel at a point P (4.5, 4.5) to evaluate V (u, w). Develop the expressions used for determining velocity potential.
[BL: Understand | CO: 8 | Marks: 3]

5. (a) Explain the basic methodology to study potential axisymmetric flow past a slender body of revolution, using the method of singularities. [BL: Understand | CO: 8 | Marks: 2]
- (b) An aircraft weighing 40,000 lbs, has a wing area of 350 ft^2 and a wing span of 50 ft. At sea-level, the aircraft flies at (i) 200ft/sec (ii) 600ft/sec. For the entire aircraft, determine the estimated values of the induced drag and the associated drag coefficients for the two cases? Note that lift = weight in level flight. Also, assume Oswald efficiency factor of 0.85. [BL: Understand | CO: 8 | Marks: 3]
6. (a) Describe the method of singularities. How is it used to study potential flow over an arbitrary body? [BL: Understand | CO: 11 | Marks: 2]
- (b) Extend the source panel code for NACA0012 airfoil (at zero AOA) to generate the pressure coefficient distribution. Plot the distribution. [BL: Understand | CO: 11 | Marks: 3]