Hall Ticket No | | | | | | | | | | Question Paper Code: AAE004

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech IV Semester End Examinations (Regular / Supplementary) - May, 2019

Regulation: IARE – R16

LOW SPEED AERODYNAMICS

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Explain in detail how combination of a uniform flow and doublet flow produces non-lifting flow over a cylinder. **[7M]**

   (b) Determine the flow field governed by the stream function (units: m^2/s) defined by the expression: $\Psi = 6x + 12y$ **[7M]**

2. (a) Prove that the velocity potential and the stream function for a source flow satisfy Laplaces equation. **[7M]**

   (b) Consider the lifting flow over a circular cylinder. The lift coefficient is 5. Determine:

   i. The peak (negative) pressure coefficient

   ii. The location of the stagnation points

   iii. Points on the cylinder where the pressure equals free stream static pressure. **[7M]**

UNIT – II

3. (a) Describe the stalling of an airfoil and the related aerodynamic phenomena. **[7M]**

   (b) Consider an NACA 2412 airfoil with a chord of 0.64 m in an airstream at standard sea level conditions. The freestream velocity is 70 m/s. The lift per unit span is 1254 N/m. Calculate the strength of the steady-state starting vortex. **[7M]**

4. (a) What is the difference between aerodynamic characteristics of flow over wing of finite aspect ratio and infinte aspect ratio **[7M]**

   (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_{mLE} **[7M]**

UNIT – III

5. (a) Obtain the expression for induced drag and minimum induced drag for elliptic planform. **[7M]**

   (b) Consider a finite wing with an aspect ratio of 6. Assume an elliptical lift distribution. The lift slope for the airfoil section is 0.1/degree. Calculate and compare the lift slopes for **[7M]**

   i. Straight wing,

   ii. Swept wing, with a half-chord line sweep of 45^0.

6. (a) Explain the formation of trailing vortices and their influence on the lift generation of wing. **[7M]**

   (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 5^0. Assume that $\delta = \tau = .055$ **[7M]**

UNIT – IV

7. (a) Describe the asymmetric flow over a wing-fuselage system for a high-wing airplane. How does this affect the rolling moment compared to a wing? **[7M]**

   (b) Calculate the pressure coefficient distribution around a non-lifting circular cylinder using the source panel method. **[7M]**

8. (a) Explain the basic methodology to study potential axisymmetric flow past a slender body of revolution, using the method of singularities. **[7M]**

   (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 **[7M]**

   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.

UNIT – V

9. (a) Show that in steady state, the pressure at any station along the boundary layer is constant in the direction normal to the surface. **[7M]**

   (b) The wing on a Piper Cherokee general aviation aircraft is rectangular, with a span of 9.75 m and a chord of 1.6 m. The aircraft is flying at cruising speed 141 mi/h at sea level. Assume that the skin-friction drag on the wing can be approximated by the drag on a flat plate of the same dimensions. Calculate the skin-friction drag: **[7M]**

   i. If the flow were completely laminar (which is not the case in real life)

   ii. If the flow were completely turbulent (which is more realistic) Compare the two results.

10. (a) Describe process of transition in development of a boundary layer and its effects on flow over airfoil. **[7M]**

    (b) Write a short note on favourable pressure gradient. Illustrate Blasius equation for incompressible flow over flat plate. **[7M]**

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