Reg. No. :

**Question Paper Code : 50022**

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Fourth Semester
Aeronautical Engineering
AE 6401 – AERODYNAMICS – I
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Write down the Euler equation for steady, inviscid flows.
2. Define convective derivative.
3. Sketch variation in Cp distribution when the real and ideal fluids flow over a circular cylinder.
4. State Kelvin's circulation theorem.

5. Give Cauchy – Riemann relations.
6. Write down the important theoretical results for a symmetric airfoil from thin airfoil theory.
7. State Helmholtz's vortex theorem.
8. Differentiate aerodynamic twist and geometric twist.
9. What is meant by adverse pressure gradient ? Sketch the adverse pressure gradient in a flow field.
10. Define boundary layer.

PART – B (5×13=65 Marks)

11. a) Consider the boundary – layer velocity profile is given as $u / V_{\infty} = (y / \delta)^{0.25}$.
Is the flow rotational or irrotational ?

(OR)

b) i) A Rankine half-body is formed as shown in fig. 11. b. For the conditions shown, compute :
a) The source strength m in $m^2/s$;
b) The distance a
c) The distance h and
d) The total velocity at point A **(8)**

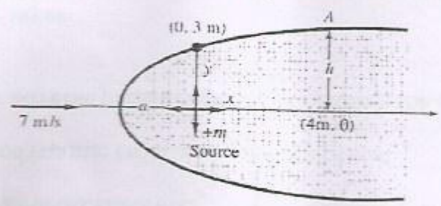


**Fig. 11. (b)**

ii) Consider the two-dimensional velocity distribution $u = -B_y$, $v = +B_x$, where B is a constant. If this flow possesses a stream function, find its form. If it has a velocity potential, find that also. Compute the local angular velocity of the flow, if any and describe what the flow might represent. **(5)**

12. a) Determine the drag and lift coefficient using velocity components of a lifting flow over circular cylinder and state to prove the Kutta-Joukowski theorem.



(OR)

b) i) Show that the local jump is tangential velocity across the vortex sheet is equal to the local sheet strength. **(6)**

ii) Consider the lifting flow over a circular cylinder. The lift coefficient is 5. Calculate the peak negative pressure coefficient. And find the location of stagnation points. **(7)**

13. a) Transform the straight lines, parallel to the x-axis in the physical plane, with the transformation function $\zeta = 1 / z$.

(OR)

b) Consider a thin flat plate at 5 degree angle of attack. Calculate :
a) Lift coefficient
b) Moment coefficient about the leading edge
c) Moment coefficient about the quarter chord point
d) Moment coefficient about the trailing edge.

14. a) Using Biot-Savart law. Obtain the expression for the geometric angle of attack of a finite wing.

(OR)

b) A wing with elliptical loading, with span 15 m, planform area 45 $m^2$ is in level flight at 750 km/h, at an altitude where density is 0.66 $kg/m^3$. If the induced drag on the wing is 3222 N. Determine :

a) The lift coefficient

b) The downwash velocity, and

c) The wing loading.

15. a) For the given velocity profile as $(u/U) = 2n - n^2$ where $n = (y/\delta)$. Determine the displacement thickness, the momentum thickness, and the energy thickness. Where $\delta$ is the boundary layer thickness.

(OR)

b) i) Consider a flat plate at zero angle of attack in an airfoil at standard sea level conditions. The chord length of the plate from the leading edge to trailing edge is 3 m. The rectangular planform of a span 12 m at standard atmospheric conditions $\mu_\infty = 1.7894 \times 10^{-5}$ kg/ms. Assume wall temperature is the adiabatic wall temperature. Calculate the friction drag on the plate when the free stream velocity is 200 m/s. (8)

ii) Sketch the variation of thermal and velocity boundary layer based on the variation of Prandtl number. (5)



PART – C (1×15=15 Marks)

16. a) Using the transformation function $\zeta = z + \frac{b^2}{z}$. Trace the symmetric airfoil from a circle of radius 'a' where a = b + be. The value of b = 25 mm and eccentricity e = 0.2. Determine the chord length, maximum thickness and thickness to chord ratio. Trace the airfoil shape using graph sheet in your answer sheet.

(OR)

b) Using order analysis, reduce the Navier stroke equations into boundary layer equations for flow over a flat plate.

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