



- 3. Maximum camber is  $0.02c$
- 4. Maximum thickness is  $0.05c$

- a) 1,3
- b) 1,4
- c) 1,2
- d) 2,3

4. In a lifting flow over a cylinder, how many stagnation points occur over the cylinder for the case  $\Gamma/4\pi V_\infty R < 1$  CO2 [K<sub>1</sub>]

- a) 0
- b) 1
- c) 2
- d) 3

5. Assertion (A): Streamlines can cross one another if the fluid has higher velocity. CO1 [K<sub>1</sub>]  
Reason (R): At sufficiently high velocity, the Reynolds number is high and at sufficiently high Reynolds numbers, the structure of the flow is turbulent type.

- a) Both A and R are Individually true and R is the correct explanation of A
- b) Both A and R are Individually true but R is not the correct explanation of A
- c) A is true but R is false
- d) A is false but R is true

6. The Joukowski airfoil is studied because CO3 [K<sub>1</sub>]

- a) it is used in many aircraft
- b) it has a simple geometry
- c) it has the highest lift curve slope
- d) it is easily transformed into a circle, mathematically

7. Arrange the following bodies in order of increasing value of drag coefficient at higher Reynolds numbers CO4 [K<sub>1</sub>]

1. A cylinder, 2. A sphere, 3. An airfoil, 4. A flat plate normal to flow, 5. A racing car

- a) 2-3-4-1-5
- b) 5-1-3-2-4
- c) 3-2-5-1-4
- d) 4-1-3-5-2

8. Due to downwash, the nature of the lift distribution over wings of an aircraft is CO4 [K<sub>1</sub>]

- a) equal throughout
- b) parabolic
- c) elliptical
- d) hyperbolic

9. Assertion (A): The energy supplied to the ideal actuator is not completely supplied to the air passing through it. CO5 [K<sub>1</sub>]

Reason (R): Frictional losses are considered to be zero in the ideal actuator.

- a) Both A and R are Individually true and R is the correct explanation of A
- b) Both A and R are Individually true but R is not the correct explanation of A
- c) A is true but R is false
- d) A is false but R is true

10. The purpose of using reverse pitch propellers is to CO5 [K<sub>1</sub>]
- a) provide aerodynamic braking                      b) allow aircraft to taxi backwards
- c) reverse the direction of rotation of the      d) increase the speed  
propeller

**PART B (10 x 2 = 20 Marks)**  
**(Answer not more than 40 words)**

11. Consider the velocity field given by  $u = y/(x^2 + y^2)$  and  $v = -x/(x^2 + y^2)$ . Calculate the equation of the streamline passing through the point (0, 5). CO1 [K<sub>3</sub>]
12. In a two dimensional flows the velocity potential flow is  $\phi = y(2x-1)$ . At a point P (3, 4), Calculate: (i) The velocity and (ii) The value of stream function. CO1 [K<sub>3</sub>]
13. Consider a velocity field  $u = cx/(x^2 + y^2)$  and  $v = cy/(x^2 + y^2)$  where c is a constant. For source flow, calculate: (a) The time rate of change of the volume of a fluid element per unit volume. (b) The vorticity. CO2 [K<sub>3</sub>]
14. Define D'Alembert Paradox and Magnus effect CO2 [K<sub>2</sub>]
15. What is meant by conformal transformation? CO3 [K<sub>2</sub>]
16. Explain Cauchy-Riemann equation CO3 [K<sub>2</sub>]
17. State Kutta condition CO4 [K<sub>2</sub>]
18. Consider a thin, symmetric airfoil at 1.5 deg angle of attack. From thin airfoil theory, calculate the lift coefficient and the moment coefficient about the leading edge. CO4 [K<sub>2</sub>]
19. Differentiate between fixed and variable pitch propeller CO5 [K<sub>2</sub>]
20. What are propeller coefficients? CO5 [K<sub>2</sub>]

**Answer any FIVE Questions:-**  
**PART C (5 x 14 = 70 Marks)**  
**(Answer not more than 350 words)**

21. a) Consider two different flows over geometrically similar airfoil shapes, one airfoil being twice the size of the other. The flow over the smaller airfoil has free stream properties given by  $T_\infty = 200$  K,  $\rho_\infty = 1.23$  kg/m<sup>3</sup>, and  $V_\infty = 100$  m/s. The flow over the larger airfoil is described by  $T_\infty = 800$  K,  $\rho_\infty = 1.739$  kg/m<sup>3</sup>, and  $V_\infty = 200$  m/s. Assume that both  $\mu$  and  $a$  are proportional to  $T^{1/2}$ . Are the two flows dynamically similar? 8 CO1 [K<sub>3</sub>]
- b) Consider a low-speed open-circuit subsonic wind tunnel with an inlet-to-throat area ratio of 12. The tunnel is turned on, and the pressure difference between the inlet (the settling chamber) and the test section is read as a height difference of 10 cm on a U-tube mercury manometer. (The density of liquid mercury is  $1.36 \times 10^4$  kg/m<sup>3</sup>.) Calculate the velocity of the air in the test section. 6 CO1 [K<sub>3</sub>]

22. List out the body forces and surface forces. Derive the general x-momentum equation for an unsteady 3-D inviscid flow in partial differential form using a control volume approach. 14 CO1 [K<sub>3</sub>]
23. a) Derive an expression for stream function of streamline passing through stagnation point of semi-infinite body and draw the flow pattern. 8 CO2 [K<sub>3</sub>]  
 b) Consider a lifting flow over a cylinder. The lift co-efficient  $C_l = 5$ , calculate the peak pressure coefficient and calculate the location of the stagnation points and the points on the cylinder where the pressure equals the free stream static pressure. 6 CO2 [K<sub>3</sub>]
24. Explain how the Joukowski transformation is used to obtain a circular arc airfoil and also obtain an expression for its radius. 14 CO3 [K<sub>4</sub>]
25. a) Consider a thin flat plate at 5 degree angle of attack. Calculate (a) the lift coefficient, (b) the moment coefficient about the leading edge, (c) moment coefficient about the quarter chord point, and (d) moment coefficient about the trailing edge. 8 CO4 [K<sub>4</sub>]  
 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  $5^\circ$ . Assume that  $\delta = \tau$ . 6 CO4 [K<sub>4</sub>]
26. a) Derive the Froude's efficiency of propulsive system from momentum theory 8 CO5 [K<sub>3</sub>]  
 b) Differentiate between: 6 CO4 [K<sub>3</sub>]  
 (i) Wash in and wash out,  
 (ii) Centre of pressure and Aerodynamic center,  
 (iii) Geometric twist and Aerodynamic twist.

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