



B.E. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Fourth Semester

AERONAUTICAL ENGINEERING

U18AEI4201: Low Speed Aerodynamics

COURSE OUTCOMES

- CO1:** Apply conservation laws to solve incompressible flow regime.
CO2: Solve the problems on potential flows.
CO3: Apply Joukowski transformation to fluid flow problems.
CO4: Explain airfoil and wing characteristics.
CO5: Apply propeller theory to predict blade performance.
CO6: Measure the aerodynamic forces on various aerodynamic bodies.

Time: Three Hours

Maximum Marks: 100

**Answer all the Questions:-
PART A (10 x 1 = 10 Marks)**

1. Matching type item with multiple choice code

CO1 [K₃]

List I	List II
A. Incompressible flow	i. Static pressure
B. Irrotational flow	ii. Total pressure
C. Pitot tube measures	iii. Density constant
D. static tube measures	iv. Vorticity zero

- | | A | B | C | D |
|----|-----|----|-----|----|
| a) | ii | i | iii | iv |
| b) | iii | iv | ii | i |
| c) | ii | iv | iii | i |
| d) | iii | i | ii | iv |

2. Angular displacement of individual molecules in flow field is called as

CO1 [K₁]

- | | |
|----------------------|------------------|
| a) Circulation | b) Vorticity |
| c) Irrotational flow | d) Inviscid flow |

3. Doublet flow is the combination of CO2 [K₂]
1. Uniform flow
 2. Source flow
 3. Sink flow
 4. Vortex
- a) 1,3 b) 1,4
 c) 1,2 d) 2,3
4. Drag force acting on a 2D body placed in inviscid incompressible flow with or without circulation is zero is _____ CO2 [K₁]
- a) Magnus effect b) Kutta Joukowski theorem
 c) D'Alembert Principle d) Kutta condition
5. Assertion (A): Velocity potential function exist only when the flow is irrotational. CO3 [K₃]
 Reason (R): Irrotational flow will satisfy the Laplace equation.
- $$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0,$$
- 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. Chambered airfoil generates lift atangle of attack CO3 [K₁]
- a) Constant b) High
 c) Zero d) low
7. Aerodynamically propeller should have a (1) ...efficiency and(2)...thrust for cruise and a(3).....static thrust and take-off for.....(4)working CO4 [K₁]
- 1) Optimized, 2) Sufficient 3) High 4) Higher
- a) 4-2-3-1 b) 2-3-4-1
 c) 4-3-2-1 d) 2-4-3-1
8. Which shape is traced by the trailing vortex at the tip of the airscrew blade? CO4 [K₁]
- a) Helix b) Solenoid
 c) Circle d) Sine curve

9. Assertion (A): When solidity is much lesser than 1, blade theory is applicable. CO5 [K₃]
Reason (R): First being that the spacing to the chord ratio should be high.
- 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. A..... in which the geometric pitch cannot be varied, must be matched to the various operating conditions of the engine and of the aircraft. CO5 [K₂]
- a) Constant speed propeller b) Variable pitch propeller
c) Constant variable propeller d) Fixed pitch propeller

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

11. Write down the Euler equation for steady, inviscid flow. CO1 [K₁]
12. Distinguish between Ideal and Real Fluid. CO1 [K₃]
13. Sketch variation in Cp distribution when the real and ideal fluids flow over a circular cylinder. CO2 [K₃]
14. Define source and sink flow. CO2 [K₁]
15. State Karman-Trefftz Profiles CO3 [K₁]
16. What is complex potential? CO3 [K₁]
17. Discuss the effect of aspect ratio on the lift coefficient of the finite wing. CO4 [K₂]
18. State Helmholtz's Theorem. CO4 [K₁]
19. Write the assumption of actuator disk theory in propeller performance. CO5 [K₂]
20. Define Froude's Propeller Theory. CO5 [K₁]

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

21. a) Consider a velocity field where the x and y components of velocity are given by (7) CO1 [K₃]

$$u = \frac{cx}{(x^2 + y^2)}$$

&

$$v = \frac{-cy}{(x^2 + y^2)}$$

Where c is constant. Obtain the equations of the streamlines.

- b) A pitot tube on an airplane flying at standard sea level reads $1.07 \times 10^5 \text{ N/m}^2$ and the flow velocity is 130m/s. calculate the velocity of the airplane and pressure coefficient. (7) CO1 [K₃]
22. a) Show the source and sink pair in uniform flow will generate a symmetric oval by dividing streamline. (10) CO2 [K₃]
- b) Prove that velocity potential and stream function for a uniform flow satisfies Laplace's equation. (4) CO2 [K₄]
23. a) Obtain an expression for the thickness to chord ratio of a symmetrical airfoil section transformed from a circle of radius b by using the joukowski transformation $w = z + \frac{a^2}{z}$ (14) CO3 [K₃]
24. The variation of circulation over a wing having elliptic plan form with span 'b' given below. 14 CO4 [K₃]

$$\Gamma(y) = \Gamma_0 \sqrt{1 - \left(\frac{2y}{b}\right)^2}$$

Determine:

i)Downwash (ii) Induced Angle of Attack (iii) Induced Drag

25. Explain in detail with necessary equations about the momentum theory. 14 CO5 [K₂]
26. Derive the expression for induced velocity by an infinite long vortex filament at any arbitrary point located at a distance 'r' from the vortex filament. 14 CO4 [K₃]
