U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 23AS4PCLSA **Max Marks: 100**
Course: Low Speed Aerodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	(i) Define vorticity and circulation. Define the physical significance of vorticity and circulation and derive the mathematical derivation between the them. (ii) Derive continuity equation considering finite control volume method.	CO1	PO1	**10**
	b)	Briefly explain the following elementary flows with neat sketches and write the stream function and velocity potential for each of them: (i) Uniform flows (ii) Source and sink flows (iii) Doublet flow (iv) Vortex flow	CO1	PO1	**10**
		OR			
2	a)	Show that the pressure coefficient on the surface of a circular cylinder of radius R in a uniform stream (U_∞), without a circulation, has the form $Cp = 1 - (4\sin^2\theta)$	CO1	PO1	**10**
	b)	(i) Derive momentum equation considering finite control volume method. (ii) Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. The freestream velocity is 25 m/s, and the maximum velocity on the surface of the cylinder is 75 m/s. The freestream conditions are those for a standard altitude of 3 km (ρ = 0.90926 kg/m^3). Calculate the lift per unit span on the cylinder.	CO1	PO2	**10**
		UNIT - II			
3	a)	Derive $C_l=2\pi\alpha$, where α is angle of attack for a symmetric airfoil using thin airfoil theory.	CO2	PO1	**10**

		b)	(i) Discuss about how we can have lift without friction (ii) Define Kelvin circulation theorem. Explain in detail the formation of starting vortex with neat sketches.	CO2	PO1	**10**
			OR			
	4	a)	(i) Describe in detail the airfoil characteristics for both symmetric and unsymmetric airfoil. (ii) Describe in detail various high lift devices that are used to improve the lift over airfoil	CO2	PO1	**10**
		b)	Consider an NACA 0012 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. (i) Calculate the angle of attack assuming the thin airfoil theory (ii) Calculate the moment per unit span about the aerodynamic center (Coefficient of moment about aerodynamic center, $C_{m,ac} = -0.05$).	CO2	PO2	**10**
			UNIT - III			
	5	a)	Explain the formation of primary and secondary vortices in subsonic flow over delta wings with neat sketches. Also plot spanwise coefficient of pressure (Cp) distribution for a delta wing on both upper and lower surfaces.	CO2	PO1	**10**
		b)	Considering elliptical lift distribution given as $\Gamma(y) = \Gamma_0\sqrt{1-\left(\frac{2y}{b}\right)^2}$, where Γ_0 is maximum circulation at the origin, b is wing span and y is any location along the span Derive an expression for induced angle of attack and induced drag.	CO2	PO1	**10**
			OR			
	6	a)	(i) Consider an elliptical wing with an aspect ratio of 8. Calculate the lift and induced drag coefficients for the wing when its induced angle of attack is given as 5^0. (ii) Explain source panel method and its algorithm to estimate the flow field over any body.	CO2	PO2	**10**
		b)	Derive fundamental equation of Prandtl's lifting-line theory.	CO2	PO1	**10**
			UNIT - IV			
	7	a)	Consider a complex potential function given as $w(z) = U\left(z + \frac{a^2}{z}\right)$ where a is constant Calculate the following (i) Velocity potential and stream function (ii) Velocity components (iii) Stagnation points (iv) Sketch stream lines and equi-potential lines	CO2	PO2	**10**

		b)	What is the difference between analytical mapping and conformal mapping? Also explain the significance of Joukowski transformation.	CO2	PO1	**10**
			OR			
	8	a)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over **ellipse** in ζ plane (ζ=ξ+iη) when **Joukowski** transformation ($f(z) = z + \frac{c^2}{z}$) is applied. Assume the radius of cylinder is r.	CO2	PO1	**10**
		b)	Explain wing body interface with neat sketches.	CO2	PO1	**10**
			UNIT - V			
	9	a)	Explain how flow separation happens over a cylinder and indicate the favorable and unfavorable pressure gradients.	CO3	PO1	**10**
		b)	Derive Blasius equation for laminar flow over flat plate.	CO3	PO1	**10**
			OR			
	10	a)	Derive equations for displacement thickness, momentum thickness and energy thickness for a boundary layer.	CO3	PO1	**10**
		b)	Prove pressure gradient in x-direction is zero, when the momentum equation is applied to edge of boundary layer.	CO3	PO1	**10**

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