U.S.N.										

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

Autonomous Institute Affiliated to VTU

February 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.

		UNIT - I	CO	PO	Marks
1	a)	(i) Derive continuity equation considering finite control volume method. (ii) Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. The free stream velocity is 25 m/s, and the maximum velocity on the surface of the cylinder is 75 m/s. Assume the free stream conditions at standard sea level altitude. Calculate the lift per unit span on the cylinder.	*CO1*	*PO2*	**10**
	b)	Show that the pressure coefficient on the surface of a circular cylinder of radius R in a uniform stream (U_∞), with a circulation Γ around the cylinder, has the form $$Cp = 1 - \left(4\sin^2\theta + \frac{2\Gamma \sin\theta}{\pi R V_\infty} + \left(\frac{\Gamma}{2\pi R V_\infty}\right)^2\right)$$	*CO1*	*PO1*	**10**
		OR			
2	a)	(i) Define vorticity and circulation. Define the physical significance of vorticity and circulation and derive the mathematical expression between them. (ii) Derive momentum equation considering finite control volume method for inviscid, incompressible fluid.	*CO1*	*PO1*	**10**
	b)	Explain non-lifting flow over a circular cylinder from fundamental flows of potential theory. Deduce the (i) Stream function (ii) Velocity components (iii) Locate the stagnation points (iv) Pressure coefficient	*CO1*	*PO1*	**10**

			UNIT - II			
	3	a)	Derive $C_l = 2\pi\alpha$, where C_l is coefficient of lift and α is angle of attack for a symmetric airfoil using thin airfoil theory.	*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 free stream 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**
			OR			
	4	a)	Using thin airfoil theory for symmetric airfoil, show that center of pressure and aerodynamic pressure coincide with each other at one fourth of the chord.	*CO2*	*PO1*	**10**
		b)	Write short notes on Kutta condition. Show that, for a vortex sheet, there is a discontinuous change in the tangential component of velocity across the sheet and is equal to the local sheet strength.	*CO2*	*PO1*	**6**
		c)	With neat sketches, describe nomenclature of an airfoil and write the characteristics of airfoil.	*CO2*	*PO1*	**4**
			UNIT - III			
	5	a)	Explain the formation of primary and secondary vortices in subsonic flow over delta wings with neat sketches. Also plot span wise 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) What is the best spanwise lift distribution for a wing? and how do you arrive at such a conclusion. (ii) 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	*CO2*	*PO2*	**10**
		b)	(i) With neat sketches, define Biot-Savart law and derive the expression for the velocity induced by Infinite vortex filament and Semi-infinite vortex filament. (ii) Write down the salient features of Helmholtz Theorem	*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)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over **symmetric airfoil** in ζ plane (ζ=ξ+iη) when Joukowski transformation ($f(z) = z + \frac{c^2}{z}$) is applied. Assume the radius of circle is r.	*CO2*	*PO1*	**10**
			OR			
	8	a)	Using method of singularities derive an expression for flow happening in kitchen sink and calculate the following (i) Velocity potential and stream function (ii) Velocity components (iii) Stagnation points (iv) Sketch stream lines and equi-potential lines	*CO2*	*PO1*	**10**
		b)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over **flat plate** in ζ plane (ζ=ξ+iη) when Joukowski transformation ($f(z) = z + \frac{c^2}{z}$) is applied. Assume the radius of circle is r.	*CO2*	*PO1*	**10**
			UNIT - V			
	9	a)	What is boundary layer and write differences between laminar boundary layer and turbulent boundary layer.	*CO3*	*PO1*	**10**
		b)	Derive similarity solution (Blasius equation) for flow over a flat plate considering the laminar boundary layer.	*CO3*	*PO1*	**10**
			OR			
	10	a)	Explain the flow separation over a circular cylinder and indicate the favorable and unfavorable pressure gradients.	*CO3*	*PO1*	**10**
		b)	Derive an expression for displacement thickness, momentum thickness and energy thickness for the boundary layer.	*CO3*	*PO1*	**10**

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