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.
Branch: Aerospace Engineering
Course Code: 22AS4PCBAD
Course: Basic Aerodynamics

Semester: IV
Duration: 3 hrs.
Max Marks: 100

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)	Explain 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**
	b)	(i) Define vorticity and circulation. Define the physical significance of vorticity and circulation and derive the mathematical derivation between the them. (ii) Consider the lifting flow over a circular cylinder. The lift coefficient is 5. Calculate the peak (negative) pressure coefficient.	**CO1**	**PO2**	**10**
		OR			
2	a)	Derive momentum equations and deduce Euler equations with all the assumptions involved in it	**CO1**	**PO1**	**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**	**PO2**	**10**
		UNIT - II			
3	a)	Define aerodynamic center and center of pressure and estimate the location of center of pressure for a symmetric airfoil based on the assumptions of thin airfoil theory.	**CO2**	**PO1**	**10**

		b)	Consider a thin flat plate at angle of attack 5^0. Calculate the following (i) Lift coefficient (ii) Moment coefficient about the leading edge (iii) Moment coefficient about the quarter-chord point	**CO2**	**PO2**	**10**
			OR			
	4	a)	(i) Define Kelvin circulation theorem. Explain in detail the formation of starting vortex with neat sketches. (ii) Consider an NACA 2412 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. Calculate the drag per unit span and strength of the steady-state starting vortex.	**CO2**	**PO2**	**10**
		b)	(i) Differentiate between symmetric and unsymmetric airfoil. Explain how the coefficient of lift varies with angle of attack for both symmetric and unsymmetric airfoil. (ii) What are high lift airfoils. Explain various types of high lift airfoils with neat sketches, that are used to enhance the lift characteristics.	**CO2**	**PO1**	**10**
			UNIT - III			
	5	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) Briefly describe the algorithm used for source panel method and vortex lattice method. (ii) Write down the salient features of Helmholtz Theorem	**CO2**	**PO1**	**10**
			OR			
	6	a)	Define Biot-Savart law and derive the expression for the velocity induced by (1) Infinite vortex filament (2) Semi-infinite vortex filament	**CO2**	**PO1**	**10**
		b)	Considering elliptical lift distribution $\Gamma(y) = \Gamma_0\sqrt{1-\left(\frac{2y}{b}\right)^2}$, derive an expression for induced angle of attack $\alpha_i = \frac{C_L}{\pi AR}$ where AR is aspect ratio, C_L is coefficient of lift, Γ_0 is maximum circulation at the origin, b is wing span and y is any location along the span	**CO2**	**PO1**	**10**

			UNIT - IV			
	7	a)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over unsymmetric airfoil 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**	**PO2**	**10**
		b)	Using method of singularities derive an expression for flow happening in kitchen sink and calculate the following a) Velocity potential and stream function b) Velocity components c) Stagnation points d) Sketch stream lines and equi-potential lines	**CO2**	**PO1**	**10**
			OR			
	8	a)	What is method of singularities? Explain it with an example	**CO2**	**PO1**	**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 cylinder is r.	**CO2**	**PO2**	**10**
			UNIT - V			
	9	a)	Differentiate between inviscid and viscous flows and explain flow separation on an airfoil in detail with neat sketches?	**CO3**	**PO1**	**10**
		b)	Define boundary layer thickness. Derive formula for displacement thickness and momentum thickness.	**CO3**	**PO1**	**10**
			OR			
	10	a)	Write down boundary layer equations and prove that the pressure gradient across the boundary layer remains constant	**CO3**	**PO1**	**10**
		b)	What are the characteristics of boundary layer? Sketch velocity temperature profiles across the boundary layer.	**CO3**	**PO1**	**10**

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