U.S.N.										

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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 22AS4PCBAD **Max Marks: 100**
Course: Basic 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)	Derive the momentum equations and hence deduce the Euler equations with all the assumptions involved in it.	*CO1*	*PO1*	**8**
	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*	**8**
	c)	Consider the lifting flow over a circular cylinder. The lift coefficient is 4π. Calculate the peak (negative) pressure coefficient.	*CO1*	*PO2*	**4**
		UNIT - II			
2	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)	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. Calculate the angle of attack assuming the thin airfoil theory	*CO2*	*PO2*	**6**
	c)	Write short notes on Kelvin's Circulation theorem	*CO2*	*PO1*	**4**
		OR			
3	a)	Using thin airfoil theory for symmetric airfoil, show that center of pressure and aerodynamic center coincide with each other.	*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)	Describe nomenclature of an airfoil. Considering NACA 4 digit series 0012, write down the significance of each digit with neat sketches.	*CO2*	*PO2*	**4**

			UNIT - III			
	4	a)	Define Biot-Savart law and derive the expression for the velocity induced by (1) Infinite vortex filament (2) Semi-infinite vortex filament	*CO3*	*PO1*	**10**
		b)	Considering elliptical lift distribution $\Gamma(y) = \Gamma_0\sqrt{1-\left(\frac{2y}{b}\right)^2}$ and 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.	*CO3*	*PO2*	**10**
			UNIT - IV			
	5	a)	Consider a complex potential function given as $w(z) = Uz + \frac{m}{2\Pi}\ln(z)$ Calculate the following a) Velocity potential and stream function b) Velocity components c) Stagnation points d) Sketch stream lines and equi-potential lines.	*CO4*	*PO2*	**10**
		b)	What is method of singularities? Explain it with an example	*CO4*	*PO1*	**5**
		c)	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 cylinder is r.	*CO4*	*PO1*	**5**
			UNIT - V			
	6	a)	What is boundary layer and write the differences between laminar boundary layer and turbulent boundary layer?	*CO5*	*PO1*	**10**
		b)	Deduce boundary layer equations from Navier stokes equations using order of magnitude analysis using the boundary layer assumptions. Assume the flow to be two dimensional.	*CO5*	*PO1*	**10**
			OR			
	7	a)	Explain how flow separation happens over a cylinder and indicate the favorable and unfavorable pressure gradients.	*CO5*	*PO1*	**10**
		b)	Derive the similarity solution (Blasius equation) for flow over a flat plate considering the laminar boundary layer.	*CO5*	*PO1*	**10**

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