BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTECH **SEMESTER : I**
BRANCH: AEROSPACE **SESSION : MO/2025**

SUBJECT: SR502 ELEMENTS OF AERODYNAMICS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Define the following terms and write their mathematical expressions: (a) Stream function (b) Velocity potential (c) Vorticity	[5]	1	1
Q.1(b)	Explain how the momentum equation can be applied to estimate the drag on a two-dimensional body immersed in a steady flow. Illustrate your answer with a neat sketch showing the control volume and forces acting on it.	[5]	1	2
Q.2(a)	Explain the working principle of a Pitot tube used in a low-speed wind tunnel. Derive the expression for the velocity of flow in terms of pressure difference measured by the device.	[5]	2	2
Q.2(b)	Using the Kutta–Joukowski theorem, determine the lift per unit length on a circular cylinder of radius r rotating with angular velocity ω in a uniform free stream of velocity U_∞. Show the relation between circulation and lift.	[5]	2	3
Q.3(a)	Define the following terms related to aerofoil nomenclature: (a) Chord line (b) Camber line (c) Angle of attack (d) Leading edge (e) Trailing edge	[5]	3	1
Q.3(b)	Explain Kutta's condition and its significance in determining the circulation and lift generation over an aerofoil. Support your answer with a neat sketch.	[5]	3	2
Q.4(a)	Explain the concept of downwash and induced drag in finite wings. How are they related to the trailing vortices generated by the wing? Illustrate with a schematic diagram.	[5]	4	2
Q.4(b)	Using Prandtl's lifting line theory, derive the relation between circulation distribution and induced angle of attack for a finite wing. Show how this relation can be used to estimate the induced drag coefficient.	[5]	4	3
Q.5(a)	Explain the formation of a boundary layer on a flat plate. Define and differentiate between displacement thickness, momentum thickness, and energy thickness with the help of suitable sketches.	[5]	5	2
Q.5(b)	Starting from the Navier–Stokes equations, derive Prandtl's boundary layer equations, clearly stating the assumptions made during simplification. Discuss how these equations help in analyzing viscous flow near a solid surface.	[5]	5	4

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