

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

**CLASS: MTECH
BRANCH: SER**

**SEMESTER : II
SESSION : SP/2025**

SUBJECT: SR577 BOUNDARY LAYER THEORY

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.
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Q.1(a)	Describe how the Blasius solution applies to laminar flow over a flat plate. Also, mention any assumptions involved in the Blasius solution.	[5] 1	2
Q.1(b)	Derive the boundary layer equations by reducing the Navier-Stokes equations under the boundary layer approximations. Discuss the physical significance of the assumptions made in this reduction. Also, briefly describe the conditions under which boundary layer separation occurs.	[5] 1	4
Q.2(a)	Using the Kármán-Pohlhausen method, derive the momentum integral equation for boundary layer flow over a flat plate.	[5] 2	4
Q.2(b)	Compare exact and approximate methods for solving boundary layer equations over a flat plate at zero incidence. Highlight the key assumptions, advantages, and limitations of each method. Provide an example where both approaches can be applied and discuss how their results differ.	[5] 2	3
Q.3(a)	Derive the energy equation for a steady, incompressible, viscous flow with constant properties. Clearly state the assumptions made during the derivation and explain the physical significance of each term in the final equation.	[5] 3	4
Q.3(b)	Discuss the effect of the Prandtl number on the thermal boundary layer in forced convection. How does the Prandtl number influence the relationship between the velocity and temperature profiles in a boundary layer?	[5] 3	4
Q.4(a)	Explain the process of boundary layer formation in accelerated motion of a flat plate. How does unsteadiness affect the development of the boundary layer compared to steady flow?	[5] 4	3,4
Q.4(b)	Discuss the characteristics of a turbulent boundary layer over a flat plate. What are the key differences between turbulent and laminar boundary layers in terms of velocity profiles and shear stress distribution?	[5] 4	3,4
Q.5(a)	Describe how suction and injection influence boundary layer behavior. Derive or outline the fundamental boundary layer equation modified to include suction or injection at the wall.	[5] 5	4
Q.5(b)	Explain how boundary layer control techniques can help prevent flow separation on an aerofoil. What methods are commonly used, and how do they contribute to increasing lift and reducing drag?	[5] 5	4,5

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