Code.No: R05422107 | R05 | SET-2

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
IV B.TECH II SEM–REGULAR/SUPPLEMENTARY EXAMINATIONS MAY - 2010
BOUNDARY LAYER THEORY
(AERONAUTICAL ENGINEERING)

Time: 3hours **Max.Marks:80**

Answer any FIVE questions
All questions carry equal marks

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1. Derive the continuity equation for a fluid in motion in terms of the substantial derivative. [16]

2. Write short notes on:
   (a) General stress system,
   (b) General strain system on a fluid element in viscous flow. [16]

3. Discuss the solutions for Navier – Stokes equations. [16]

4. Derive the equations for the velocities of flow of a viscous fluid near a disc rotating at a constant angular velocity ω. Explain all the assumptions, and draw neat sketches. [16]

5.a) Write down Navier-Stokes equations in Vector form. Hence make use of these equations in developing Prandtl's boundary layer equations stating all the assumptions.

b) Given the velocity profile in laminar boundary layer as $\frac{u}{U} = 6\eta^2 - 8\eta^3 + 3\eta^4$ where $\eta = \frac{Y}{\delta}$. Determine the displacement thickness and momentum thickness of the boundary layer. [8+8]

6. Obtain the following equation frequently used in laminar flows:
$\rho c_p \left[\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} \right] = u \frac{\partial p}{\partial x} + \frac{\partial p}{\partial t} - \frac{\partial q_y}{\partial y} + T\frac{\partial u}{\partial y}$. State all the procedure and present your work out. [16]

7.a) Describe the well known mixing length theory of Prandtl's, in some details. What are its merits over Boussinesq's theory?

b) Explain various regions of turbulent boundary layer flow over a flat wall. Make use of detailed sketches to bring home your points. [8+8]

8.a) Write down the expression for Law of the wall in a turbulent flow. Show that it originates from the dependence of the mean velocity on

(i) The wall shear stress,

(ii) Fluid properties and distance ‘y’ from the wall.

b) Explain the terms

(i) Generation of stress and

(ii) Dissipation as referred to in the Reynolds stress equation. [8+8]

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