Code.No: R05422107 | R05 | SET-4

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 momentum equations for a fluid in motion in the form of differential equations. [16]

2. Define displacement thickness. Derive an expression for the displacement thickness over a body in a two dimensional viscous flow. [16]

3. State the Generalized Hooke's Law and explain in detail. [16]

4. Starting from Navier – Stokes equations, derive the equation of motion of the flow at a wall suddenly set into motion (First Stokes problem), and derive the expression for the boundary layer thickness. [16]

5.a) Define the following terms:
(i) Velocity thickness,
(ii) Displacement thickness,
(iii) Momentum thickness and
(iv) Energy thickness.
Illustrate these parameters on one sketch showing laminar boundary layer on a flat plate at zero incidence.

b) Explain with sketches /figures laminar boundary layer profiles on a circular cylinder
(i) In increasing velocity,
(ii) At separation and
(iii) Decreasing velocity.
What are your observations? [8+8]

6. Define the terms thermal boundary layer and enthalpy thickness. Show that for steady, low speed, constant density, constant property flows, the exact energy equation becomes $u\frac{\partial T}{\partial x}\, v\frac{\partial T}{\partial y} = \frac{v}{\Pr}\frac{\partial^2 T}{\partial y^2}$. And that it can be anticipated to provide similar solution for the energy equation. List the conditions and the non-dimensional temperature parameter. Illustrate with a plot the temperature profiles over a flat plate having constant temperature. [16]

7. Illustrate with details the following properties of turbulent flows:
   (a) Randomness.
   (b) Kinetic energy.
   (c) Reynolds stresses.
   (d) Dissipation. [4×4]

8.a) The universal velocity profile near a wall is represented by the following equation; $\frac{\bar{u}}{v_*} = 5.75 \log_{10} \frac{v_* y}{V} + 5.5$. Explain the flow mechanism for this type of plot. Illustrate the velocity profiles it represents.

b) Explain difference between viscosity of fluid and viscosity of flow. How does this occur in turbulent flow? [10+6]

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