Code No: NR422101 **NR**

IV B.Tech II Semester Supplementary Examinations, Apr/May 2006
BOUNDARY LAYER THEORY
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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1. A sphere 1.4 cm in diameter is placed in a free stream of 18m/s at 20^0C and 1 Atm. Compute the diameter Reynolds number of the sphere if the fluid is
   (a) Air,
   (b) water,
   (c) hydrogen. [16]

2. Write a short note on the following things:
   (a) Real fluids and ideal fluids
   (b) Newton's Law of viscosity
   (c) Reynolds number and its importance [16]

3. Given laminar fully developed flow in an elliptical duct of semiaxes a and b. Show that, for a given pressure gradient, the flow rate per unit area is a maximum when a = b. [16]

4. A long, uniformly porous cylinder of radis R exudes fluid at velocity U_o into an unbounded fluid of constant β and μ. The pressure at the cylinder surface is Po. Assuming purely radial outflow with negligible gravity, find the velocity and pressure distributions in the fluid. [16]

5. Repeat the integral momentum analysis of the flat plate for the assumed velocity profile
   $\frac{\mathrm{u}}{\mathrm{U}} = \frac{3}{2}\frac{y}{\delta_u} - \frac{1}{2}\frac{y}{\delta_u}^3$
   Where δ_u is the velocity boundary-layer thickness. Is this profile any more (or less) realistic than the approximation of Equation $u \approx \{2y/\delta - y^2/\delta^2\}$? For the above profile, compute
   (a) $(\theta/\mathrm{x})\sqrt{R}e_x$
   (b) $(\delta*/x)\sqrt{R_e}x$
   (c) $(\delta/x)\sqrt{R_e}x$
   (d) $C_f\sqrt{R_e}x$
   (e) $C_D\sqrt{R_e}x$ [16]

6. A horizontal pipe of outer diameter 5 cm is immersed in air at 20^0C and 1 atm. If the cylinder surface is at 300^0C, how much heat (in W) is lost to the air per meter of pipe length? [16]

7. By direct substitution of the fluctuation definitions and use of the averaging rules, develop the three-dimensional time-averaged x-momentum equation and show what reductions occur in a steady two-dimensional turbulent boundary layer. [16]

8. Use the log-law, to analyze Couette flow between parallel plates a distance 2h apart, with the upper plate moving at velocity U. Show that the turbulent-flow velocity profile is S-shaped. Sketch the profile for Uh/v = 10^5 and compute the ratio $T_w h/\mu$U for this condition. [16]

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