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2006 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

IV B.TECH II SEMESTER SUPPLEMENTARY EXAMINATIONS
BOUNDARY LAYER THEORY
(AERONAUTICAL ENGINEERING)

Apr/May 2006

TIME – 3 HOUR
MARK – 80

Answer any FIVE Questions
All Questions carry equal marks

1. A sphere 1.4 cm in diameter is placed in a free stream of 18m/s at 200C and 1 Atm. Compute the diameter Reynolds number of the sphere if the fluid is

(a) Air,
(b) water,
(c) hydrogen. *[4+6+6]*

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 *[4+4+8]*

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 Uo into an unbounded fluid of constant 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 Where u is the velocity boundary-layer thickness. Is this profile any more (or less)realistic than the approximation of Equation u {2y - y2/2}? For the above profile, compute

(a) (/x)pRex

(b) /x)pRex

(c) (/x)pRex

(d) CfpRex

(e) CDpRex[*[3+3+4+6]*

6. A horizontal pipe of outer diameter 5 cm is immersed in air at 200C and 1 atm. If the cylinder surface is at 3000C, 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 = 105 and compute the ratio Twh/µU for this condition.

[16]