CODE NO: NR422101 SET NO.4

2005 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

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

JULY -2005

TIME: 3 HOURS
MAX MARKS: 80

Answer any FIVE Questions
All Questions carry equal marks

1. *For steady incompressible °ow with negligible viscosity, show that the NavierStokes relation for constant density reduces to the condition that p=p + [V]2=2 + gh is constant along a streamline of the °ow, where h denotes the height of the°uid particle above a horizontal datum. This is the weaker form of the so-called Bernoulli relation.*

2. Explain the mathematical example of the unit re ! 1:

3. Write about fully developed nozzle and di®user °ows.

4. Develop an explicit numerical algorithm for the two-dimensional unsteady viscous di®usion relation. Determine the appropriate stability limits on time step and mesh sizes.

5. For a °at plate, U = U0, and a wall temperature distribution Tw¡Te=¢To[1 (x=L)3]; use the explicit or implicit ¯nite-di®erence method to compute the value of x at which the local heat transfer qwchanges sign.

6. For potential free stream °ow across a circular cylinder, U = 2Uo sin (x/a), if ReD= 2X106 , use the correlation of Michel, to estimate the position(x=a)tr where boundary-layer transition ¯rst occurs? Assume a free stream turbulence level of 1 percent.

7. Water at 20oC °ows through a smooth pipe of diameter 3 cm at 30 m3=h. Assuming developed °ow, estimate

(a) the wall shear stress (in Pa),

(b) the pressure drop (in Pa/m), and

(c) the centerline velocity in the pipe. What is the maximum °ow rate for which the °ow would be laminar? What °ow rate would give Tw = 100 Pa?

8. Air at 20oC and 1 atm °ows at 60m /s past a smooth °at plate 1 m long and 60 cm wide. The plate surface temperature is 50oC. Estimate the total heat loss (in W) from one side of the plate.