CODE NO: NR422101 SET NO.2

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. Simplify the equation of continuity in cylindrical coordinates (r, µ z) to the case of steady compressible °ow in polar coordinates (@=@z = 0) and derive a stream function for this case.

2. Derive the Navier-stokes equations.

3. Explain the °ow at a rotating disc.

4. Derive the two-dimensional Poisson relation for pressure, analogous Poisson, assuming unsteady incompressible °ow.

5. Investigate the use of the Crank-Nicolson (1947) method for computer analysis of a laminar boundary layer, as implemented, e.g., by Blottner (1970). What are its numerical advantages and disadvantages?

6. For the separating Falkner-Skan wedge-°ow boundary layer,¯ = -0.19884, use any appropriate correlation to estimate the position Rex where transition ¯rst occurs? Assume free stream turbulence level of 1 percent.

7. By direct substitution of the °uctuation de¯nitions 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.

8. As part of a low-temperature thermal-power design, a long 5-m diameter vertical circular cylinder is placed in the ocean. The current across the cylinder is 60 cm/s. At a point 1 km downstream of the cylinder, estimate

(a) the wake width (in m) and

(b) the maximum velocity defect (in cm / s).