Code No: NR422101 **Set No.1**

IV B.Tech. II Semester Supplementary Examinations, July -2005
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. Estimate the thermal conductivity of helium at 420°C and 1 atm. Compare with the measured value of 0.28 W / (m . K).
2. Write about general of stress state of deformable bodies. Explain the stress Tensor?
3. Consider the plane stagnation-point flow. Derive the equation for displacement thickness and boundary layer thickness.
4. Develop an implicit numerical algorithm for the two-dimensional unsteady viscous diffusion relation. Comment on a possible solution procedure and possible instability.
5. Derive a relation for skin-friction coefficient Cf as a function of local Reynolds number Rex for boundary-layer flow toward a point sink. Compare your result with the Falkner-Skan relations.
6. Assume a boundary-layer velocity profile approximating a Pohlhausen polynomial with any nonzero value of $\wedge$ (have each member of the class select a different $\wedge$). Estimate the critical (instability) value of $Re\delta*$ for this profile.
7. Consider fully developed turbulent flow through a duct of square cross section. Taking advantage of the double symmetry, analyze this problem using the log-law, plus a suitable assumption about variation of shear stress around the cross section. Compare your result for $\wedge$ with the hydraulic-radius concept.
8. Water at 20°C and 1 atm flows at 6m /s past a smooth flat plate 1 m long and 60 cm wide. The plate surface temperature is 50°C. Estimate the total heat loss (in W) from one side of the plate.

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Code No: NR422101 **Set No.2**

IV B.Tech. II Semester Supplementary Examinations, July -2005
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. Simplify the equation of continuity in cylindrical coordinates (r, θ z) to the case of steady compressible flow in polar coordinates (∂/∂z = 0) and derive a stream function for this case.

2. Derive the Navier-stokes equations.

3. Explain the flow at a rotating disc.

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

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-flow boundary layer,β = -0.19884, use any appropriate correlation to estimate the position Re_x where transition first occurs? Assume free stream turbulence level of 1 percent.

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.

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).

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Code No: NR422101 **Set No.3**

IV B.Tech. II Semester Supplementary Examinations, July -2005
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. Simplify the equation of continuity in cylindrical coordinates to the case of steady compressible flow in axisymmetric coordinates ($\partial/\partial\theta = 0$) and derive a stream function for this case.

2. Derive the Boundary Layer equations from Navier-stokes equations.

3. Explain Asymmetric bee jet.

4. Derive a three-dimensional Poisson relation for pressure, analogous to Poissons for unsteady imcompressible flow.

5. For a flat plate, U = U_0, and a wall temperature distribution T_w - T_e =Δ To$[1-(x/L)^3]$, use the superposition method to compute the value of x at which the local heat transfer q_w changes sign.

6. For the Howarth free stream velocity $U = U_0$(1- x/L), if UoL/v = $2X10^6$, use the correlation of Michel, to estimate the point (x/L) where boundary-layer transition occurs? Assume a free stream turbulence level of 1 percent.

7. Air at 20°C and approximately 1 atm flows through a smooth square duct of cross section 30 by 30cm. The flow rate is $2.5m^3/s$. Estimate the pressure drop in pascals per meter of length, using both the hydraulic-radius and effective-diameter methods.

8. Evaluate the temperature law of the wall numerically, using the van Driest eddy viscosity , for $Pr_1 = 1.0$ and various values of Pr.

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Code No: NR422101 **Set No.4**

IV B.Tech. II Semester Supplementary Examinations, July -2005
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. For steady incompressible flow with negligible viscosity, show that the Navier-Stokes relation for constant density reduces to the condition that $p/p + [V]^2/2 + gh$ is constant along a streamline of the flow, where h denotes the height of the fluid 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 $\to \infty$.

3. Write about fully developed nozzle and diffuser flows.

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

5. For a flat plate, U = U0, and a wall temperature distribution $T_w - T_e = \Delta To[1 - (x/L)^3]$, use the explicit or implicit finite-difference method to compute the value of x at which the local heat transfer $q_w$changes sign.

6. For potential free stream flow across a circular cylinder, U = 2Uo sin (x/a), if $Re_D = 2X10^6$, use the correlation of Michel, to estimate the position$(x/a)_{tr}$ where boundary-layer transition first occurs? Assume a free stream turbulence level of 1 percent.

7. Water at 20°C flows through a smooth pipe of diameter 3 cm at 30 m^3/h. Assuming developed flow, 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 flow rate for which the flow would be laminar? What flow rate would give Tw = 100 Pa?

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

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