Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- VIIth SEMESTER–EXAMINATION – MAY/JUNE- 2012

Subject code: 170106 **Date: 29/05/2012**

Subject Name: Viscous & Boundary Layer Theory

Time: 02:30 pm – 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** A long, thin flat plate is placed parallel to a 20-ft/s stream of water at 20°C. At what distance *x* from the leading edge will the boundary-layer thickness be 1 in? Assume for water, $\nu = 1.09 \times 10^{5}$ ft^2/s; **07**

(b) Consider flow at *U* = 1 ft/s past a flat plate 1 ft long. Compute the boundary-layer thickness at the trailing edge for (*a*) air and (*b*) water at 20°C. Compare boundary layer thickness for water and air and conclude your remarks with proper justification. **07**

Q.2 **(a)** Explain boundary layer with pressure gradient and Explain effect of adverse pressure gradient on boundary layer. **07**

(b) Prove that for laminar flat plate flow the shape factor is equal to 2.59. **07**

OR

(b) Prove that for turbulent flat plate flow the shape factor is equal to 1.3. **07**

Q.3 **(a)** Derive boundary layer equation for laminar flat plate flow using linear momentum principle. **07**

(b) Use the linear momentum principle and the constitutive theory to show the velocity profile between two plates is linear. Assume there is no imposed pressure gradient or body force. Assume constant viscosity μ. **07**

OR

Q.3 **(a)** Derive boundary layer equation for turbulent flat plate flow using momentum integral equation. **07**

(b) Consider flow between a slot separated by two plates, the lower at y = 0, the upper at y = h, both plates stationary. The flow is driven by a pressure difference. At x = 0, P = Po; at x = L, P = P_1. The fluid has constant viscosity μ. Assuming the flow is steady, there is no body force, pressure varies only with x, and that the velocity is only in the x direction and only a function of y; i.e. v = u(y) i. Find the velocity profile u(y) parameterized by P_o, P_1, h, and μ **07**

Q.4 **(a)** Explain transition in pipe flow with suitable diagram. Explain critical Reynolds number and its importance in transition. **07**

(b) A 1/2-in-diameter water pipe is 60 ft long and delivers water at 5 gal/min at 20°C. What fraction of this pipe is taken up by the entrance region? **07**

OR

Q.4 **(a)** Explain exact solution for thermal boundary layer. If necessary justify your answer with suitable mathematical derivation. **07**

(b) A sharp flat plate with *L* = 1 m and *b* = 3 m is immersed parallel to a stream of velocity 2 m/s. Find the drag on one side of the plate, and at the trailing edge find the thicknesses δ, δ^*, and θ for (*a*) air, ρ = 1.23 kg/m^3 and $\nu = 1.46 \times 10^{5}$ m^2/s, and (*b*) water, ρ = 1000 kg/m^3 and $\nu = 1.02 \times 10^{6}$ m^2/s. **07**

Q.5 **(a)** Derive equation for velocity profile for turbulent pipe flow **07**

(b) Explain Prandtl's mixing length theory **07**

OR

Q.5 **(a)** Explain velocity profile for laminar flow and turbulent flow and list characteristics of each. **07**

(b) Explain stability principle for laminar flow. What are the factors that effect stability of laminar flow? **07**

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