Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) • EXAMINATION – WINTER 2016

Subject Code:2170106 Date:29/11/2016

Subject Name:Boundary Layer Theory(Department Elective - II)

Time:10.30 AM to 1.00 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)** Derive Von Karmann momentum equation to get hydrodynamic boundary layer thickness. **07**

(b) Derive the expressions for momentum thickness and energy thickness for boundary layer flow. **07**

Q.2 **(a)** Draw and explain growth of hydrodynamic and thermal boundary layer over the flat plate. **07**

(b) Air is flowing over a flat plate 5m long and 2.5m wide with a velocity of 4m/s at 15°C. If ρ=1.208kg/m^3 and ν=1.47×10^{-5} m^2/s. calculate 1) Length of plate over which the boundary layer is laminar, 2) Total drag force on the both sides of the plate for laminar flow only. And boundary layer thickness at the end of the plate. **07**

OR

(b) Derive the equation of Couettee flow. **07**

Q.3 **(a)** Derive Orr-Sommerfeld equation. **07**

(b) Find the ratio of displacement thickness to momentum thickness and momentum thickness to energy thickness for the velocity distribution in the boundary layer given by, $\frac{u}{U_\infty} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ **07**

OR

Q.3 **(a)** Establish a relationship among the Nusselt number, Reynolds number and the Prandtl number for thermal boundary layer over a flat plate using Pohlhausen solution for temperature gradient. **07**

(b) Derive the two dimensional energy equation for thermal boundary layer on a flat plate. **07**

Q.4 **(a)** A flat plate 1m wide and 1.5 m long is maintained at 90°C in free stream of air having 10°C. Determine the velocity with which air must flow over a flat plate such that the rate of energy transfer from plate is 3.75kW. Properties of air are ρ=1.09kg/m^3, k = 0.0278W/m°C, Cp=1.007 KJ/kg-K, μ=20×10^{-6} NS/m^2 and Pr=0.7. Also obtain thermal boundary layer thickness and hydrodynamic boundary layer thickness over the plate. **07**

(b) Write a short note on Reynolds stresses. **07**

OR

Q.4 **(a)** Write a short note on Prandtl Mixing length theory. **07**

(b) Derive the Dracy's expression for loss of head due to friction in pipes. **07**

Q.5 **(a)** Derive the expression for velocity distribution for turbulent flow in smooth pipes and rough pipes. **07**

(b) A smooth pipe of diameter 80mm and 800m long carries water at the rate of 0.48m^3/minute. Calculate the loss of head, wall shearing stress, center line velocity, velocity and shear stress at 30mm from the pipe wall. Kinematic **07**

viscosity of water is 0.015 stokes. Coefficient of friction is given as $f = \frac{0.0791}{(R_e)^{1/4}}$ where R_e = Reynolds number.

OR

Q.5 **(a)** Derive continuity and momentum equation for boundary layer flow. **07**

(b) For a Blassius solution derive expressions for boundary layer thickness, coefficient of friction, average coefficient of friction, shear stress and drag. **07**

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