Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – SUMMER • 2014

Subject Code: 170106 **Date: 31-05-2014**

Subject Name: Viscous and 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)**	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**
Q.2	**(a)**	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**
	(b)	Explain transition in pipe flow with suitable diagram. Explain critical Reynolds number and its importance in transition.	**07**
		OR	
	(b)	Write a short note on relaminarization.	**07**
Q.3	**(a)**	Prove that for turbulent flat plate flow the shape factor is equal to 1.3.	**07**
	(b)	Explain exact solution for thermal boundary layer. If necessary justify your answer with suitable mathematical derivation.	**07**
		OR	
Q.3	**(a)**	Derive Orr-Sommerfeld equation.	**07**
	(b)	Define boundary layer thickness, momentum thickness and energy thickness, and derive expression for the energy thickness for laminar flow over a flat plate.	**07**
Q.4	**(a)**	Explain Prandtl's mixing length theory.	**07**
	(b)	Write a short note on boundary layer separation and the methods to control it.	**07**
		OR	
Q.4	**(a)**	Derive momentum equation for turbulent flow in terms of Reynolds stresses.	**07**
	(b)	Explain the flow development in laminar duct flow entering in a tube with uniform velocity of U_∞, show velocity profiles at different length from entry. Relate entry length with height of duct.	**07**
Q.5	**(a)**	Find the ratio of friction drag on the front half and rear half of the flat plate kept at zero incidence angle in a stream of uniform velocity, if the boundary layer is turbulent over whole plate.	**07**
	(b)	What is critical Reynolds number? State OSE, discuss the solution of it and show how critical Reynolds number is obtained from that. Also derive Rayleigh equation from the OSE.	**07**
		OR	
Q.5	**(a)**	Explain in detail the growth of hydrodynamic boundary layer and the thermal boundary layer when the viscous cold fluid is past over the hot flat surface.	**07**
	(b)	Derive the expressions for Reynolds analogy and Colburn analogy.	**07**

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