

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VII • EXAMINATION – WINTER 2013****Subject Code: 170106****Date: 03/12/2013****Subject Name: Viscous and Boundary Layer Theory****Time: 10:30 TO 01:00****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)** Consider two large isothermal plates separated by 3mm thick oil film. The upper plate is at the velocity of 15m/s while the lower plate is stationary both the plates are at 20°C. Obtain (1) relation for velocity and temperature distribution in oil (2) expression for maximum temperature in oil (3) maximum temperature and (4) heat flux from the oil to each plate. Conductivity is 0.145W/mK, dynamic viscosity 0.8 Ns/m<sup>2</sup>. **07**

- (b)** Attempt the followings: **07**
- a. Define turbulent flow and laminar flow.
  - b. Due to which major condition Couette flow profile becomes linear
  - c. At which range of Reynolds number boundary layer theory is useful for pipe flow?
  - d. Write down instantaneous velocity and expression for consider one dimensional flow for the turbulent flow.
  - e. Define turbulence.
  - f. Expression for the general transport equation
  - g. Expression for turbulent flow for the velocity distribution for smooth pipes and rough pipes.

**Q.2 (a)** Answer the followings. **07**

- a. Derive the expressions for Reynolds analogy and Colburn analogy.
- b. Derive the heat transfer coefficient for the combination of laminar flow and turbulent flow.

**(b)** Derive the expressions for boundary layer thickness and coefficient of friction for the velocity profile  $u/U_{\infty} = \sin(\pi/2 * y/\delta)$  **07**

**OR**

**(b)** Explain the growth of boundary layer over the flat surface. Derive the continuity and momentum equation for the same for the zero angle of incidence. **07**

**Q.3 (a)** Write a short note on the exact solution for the boundary layer flow over the flat plate at zero incidence. **07**

**(b)** Derive the expression for heat transfer coefficient and average heat transfer coefficient for the hot flow over the plate. **07**

**OR**

**Q.3 (a)** Air at 25°C blows with a 1.5m/s velocity over the flat plate of 0.5m length. Calculate the boundary layer thickness, thermal boundary layer thickness, shear stress, average shear stress, the overall drag coefficient, the point on the surface at which local shear stress and average shear stress are same, heat transfer coefficient and the mass entrainment into the boundary layer. Kinematic viscosity  $15.53 \times 10^{-6} \text{ m}^2/\text{s}$ , density  $1.183 \text{ Kg/m}^3$  and Prandtl number is 0.687. **07**

**(b)** Define critical Reynolds number and derive the Orr-Sommerfeld equation for the turbulent flow. **07**

- Q.4** (a) A smooth pipe of diameter 10cm and 1000m long carries water at the rate of  $0.49\text{m}^3/\text{min}$ . calculate the loss of head, wall shearing stress, center line velocity. Kinematic viscosity of water 0.015 stokes and  $f=0.791\text{Re}^{-1/4}$  **07**
- (b) Write a short note on boundary layer control and methods to avoid to separation. **07**
- OR**
- Q.4** (a) Derive the stress equation with the help of Reynolds stress theory. **07**
- Q.4** (b) Write down the characteristics of turbulent flow and derive the governing equations for the same. **07**
- Q.5** (a) A rough pipe is of diameter 8cm. The velocity at a point 3cm from wall is 30% more than the velocity at a point 1cm from pipe wall. Determine the average height of the roughness. **07**
- (b) Derive the equation of flow through pipe for turbulent flow. **07**
- OR**
- Q.5** (a) Write a short note on Relaminarization **07**
- (b) Define boundary layer thickness, momentum thickness and energy thickness, and derive expression for the momentum thickness and energy thickness for laminar flow over a flat plat. **07**

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