Birla Institute of Technology and Science, Pilani

Semester I Session: 2016-2017

CHE F414 Transport Phenomena

Mid-semester Test (Close Book + Open Book)

Date: 03/10/2016 Maximum Marks: 90

Duration: 90 minutes Weightage: 30 %

Close Book (Time: 45 min)

Q 1 **[2+6+6 = 14]**

a) Fluid *A* has a viscosity twice that of fluid *B*; which fluid would you expect to flow more rapidly through a horizontal tube of length L and radius *R* when the same pressure difference is imposed?

b) Compare and contrast the molecular, convective and turbulence mechanisms for momentum transport

c) Cite the differences between the Newton's Law of Viscosity with Fourier's law of heat conduction

Q 2 **[16]**

Draw the qualitative legible sketch of the velocity profiles in following cases for a fluid of constant density and viscosity and provide proper justification for the same

a) Flow between two horizontal plate with top plate moving with constant velocity and bottom plate stationary. The fluid is moving due to top plate movement only.

b) Flow between two horizontal plate with top plate moving with constant velocity and bottom plate stationary. The fluid is pumped in the same direction in which plate is moving.

c) Flow between two vertical plate with left plate moving with constant velocity in upward direction and right plate stationary. The fluid is pumped in the same direction in which plate is moving.

d) Flow between two vertical plate with left plate moving with constant velocity in upward direction and right plate stationary. The fluid is moving due to left plate movement only.

Q 3 **[9+6]**

a) Explain the Reynolds decomposition and discuss the physical interpretation of the Reynolds stress using Prandtl Mixing length model.

b) What is the reason for failing of Euler equation in predicting the velocity profile near boundary? How this problem is addressed in Prandtl Boundary layer theory?

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Q. 1 **[20]**

The truncated cone is of circular cross section with a diameter that varies along its length according to $d(x) = a \exp(x)$ where a = 0.8 and x is in meters. The cone has a length L = 1.8 m, and a thermal conductivity, k = 8 W/m K, and is shown in Fig Q1. It also exhibits a uniform volumetric rate of heat generation, $\dot{q}$= 1993 W/m^2 K. The sides of the cone are insulated and one end surface (x = 0) is hold at T_0 = 300 °C and has a heat flow rate, q = 500 W.

Determine the temperature at the other end surface ($x = L$) and the heat transfer rate there.

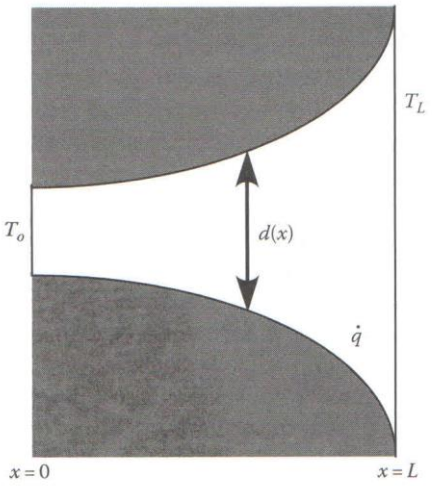

Fig Q1

Q 2 **[10]**

For a turbulent flow in a circular tube the time-smoothed velocity has the following distribution:

$$\frac{v_z}{v_{z,max}} = \left(1 - \frac{r}{R}\right)^{1/7}$$

Show that the cross-sectional average velocity is around 0.8 times of the maximum velocity.

Q 3 **[15]**

As shown in Fig Q3, assume two cylinders separated by a thin film of liquid are rotated in the same direction. Each has a radius R and rotated at a constant angular velocity Ω, giving a linear velocity ΩR at its surface. The minimum gap half height $h_0 << R$.

Determine the variation of v_x. In literature, it is reported that pressure drop in the x direction has to be zero. Please write briefly your agreement/disagreement with proper justification on the same.

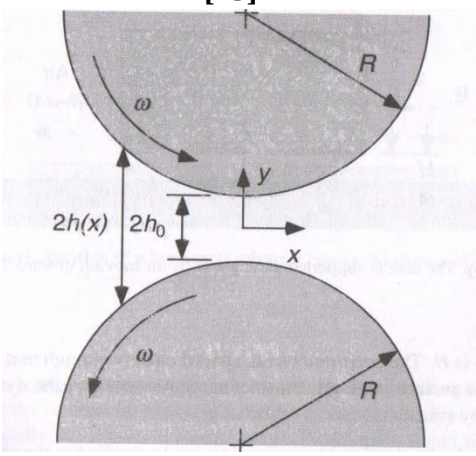

Fig Q3