NAME: ______________________ **ROLL #:** __________ **Sec #:**____

ESO212 Fluid Mechanics & Rate Processes **July-Nov 2011**

Quiz 2 Paper **B** **30 minutes; 10 points**

• 2.5 marks for a correct answer. *Negative marking*: One point will be deducted per wrong answer.

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1. Consider the steady, fully-developed flow of a very viscous Newtonian fluid (viscosity μ, average velocity V) in a tube (radius R, length L) such that viscous forces dominate the flow, and the density ρ is ***not*** a relevant parameter in the problem. The non-dimensional group that correctly represents the pressure difference $\triangle P$ across the length L of the pipe is:

   (a) $\triangle P/(\mu VL/R^2)$ (b) $\triangle P/(\mu V/R)$ (c) $\triangle P/(\mu V/L)$ (d) $\triangle P/(\mu VR^2/L)$

2. Consider the flow in the annular region formed between two concentric cylinders (see figure 1) of inner diameter D_i and outer diameter D_o. If $D_i = 3/4D_o$, the hydraulic diameter for flow in the annular region is:

   (a) $D_o/2$ (b) $2D_o$ (c) $4D_o$ (d) $D_o/4$

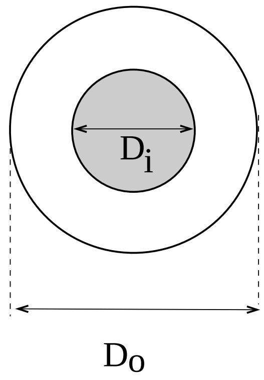

Figure 1: **Problem 2**

3. Consider the fully-turbulent flow of water in a very rough pipe, where the friction factor is independent of the Reynolds number. The pressure difference across the ends of the pipe $\triangle P$ and the length L of the pipe are kept constant. If the diameter of the pipe is ***decreased*** by two times, i.e., $D_2 = D_1/2$, the volumetric flow rate Q_2 (for pipe with diameter D_2) is related to the flow rate Q_1 (for pipe with diameter D_1) as:

   (a) $Q_2 = Q_1\sqrt{32}$ (b) $Q_2 = Q_1/\sqrt{32}$ (c) $Q_2 = Q_1/2$ (d) $Q_2 = 2Q_1$

4. A large pump is to deliver $1.5\,m^3/s$ of water from a $40\,cm$ dia impeller with a pressure rise of $400\,kPa$. To design this, a lab-scale model with an $4\,cm$ dia impeller is to be used with water as the fluid with identical properties as in the prototype. The

pressure rise $\triangle P$ in the pump is related to the volumetric flow rate Q, density of fluid ρ, viscosity μ, diameter of the impeller D. Using dimensional analysis, the flow rate Q_m (in m^3/s) and pressure rise $\triangle P$ (in kPa) to be expected in the model are respectively given by:

(a) $Q_m = 10.5$, $\triangle P = 4$

(b) $Q_m = 0.15$, $\triangle P = 4$

(c) $Q_m = 10.5$, $\triangle P = 4 \times 10^4$

(d) $Q_m = 0.15$, $\triangle P = 4 \times 10^4$