**CMPE 1380**

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**Lab Assignment 3**

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**Learning Objective: If Then Else**

**Date due: February 7, 2014**

**Flow in pipe**

For [flow in a pipe](http://en.wikipedia.org/wiki/Flow_conditioning) or tube, the Reynolds number is generally defined as:[[6]](http://en.wikipedia.org/wiki/Reynolds_number" \l "cite_note-Engineeringtoolbox-7)

 \mathrm{Re} = {{\rho {\mathbf v} D_H} \over {\mu}} = {{{\mathbf v} D_H} \over {\nu}} = {{{\mathbf Q} D_H} \over {\nu}A} 

where:

* {D_H} is the [hydraulic diameter](http://en.wikipedia.org/wiki/Hydraulic_diameter) of the pipe; its characteristic travelled length, {L}, (m).
* {\mathbf Q} is the volumetric [flow rate](http://en.wikipedia.org/wiki/Flow_rate) (m3/s).
* {A} is the pipe *cross-sectional* area (m²).
* {\mathbf v} is the mean velocity of the fluid ([SI units](http://en.wikipedia.org/wiki/SI_units): m/s).
* {\mu} is the [dynamic viscosity](http://en.wikipedia.org/wiki/Dynamic_viscosity) of the [fluid](http://en.wikipedia.org/wiki/Fluid) (Pa·s or N·s/m² or kg/(m·s)).
* {\nu} is the [kinematic viscosity](http://en.wikipedia.org/wiki/Kinematic_viscosity) (\nu = \mu /{\rho}) (m²/s).
* {\rho}\, is the [density](http://en.wikipedia.org/wiki/Density) of the fluid (kg/m³).

Ref: Assignment taken from Nyhoff and Leestma.

**Write a program to compute the flow of fluid through a pipe is either laminar, turbulent or unstable.**

**Explanation:** The flow of fluid through a pipe is either laminar, turbulent or unstable (switches between the two), depending on certain characteristics of the flow and the pipe. In laminar flow the fluid travels the pipe in concentric layers called laminae, with little mixing between the layers. Turbulent flow is much less structures with considerable mixing.

Experiments have shown that a combination of four factors determines the type of flow. This combination is referred to as the Reynold’s number, the formula is given below:

Reynold’s Number = (density x velocity x diameter) / viscosity.

Once the Reynold’s number is calculated, we can apply the cutoff values to determine if the flow is turbulent or laminar. within circular pipes the critical Reynolds number is generally accepted to be 2300, where the Reynolds number is based on the pipe diameter and the mean velocity *v*s within the pipe, but many engineers will avoid any pipe configuration that falls within the range of Reynolds numbers from about 2000 to 3000 to ensure that the flow is either laminar or turbulent. So, we will apply the low cutoff value of 2000 and a high cutoff value of 3000.

If the Reynold’s number is less than the low cutoff value then the program will display “Flow is laminar”. If the number is greater than the high cutoff value then the program will display “Flow is turbulent”. If the number falls between the cutoff values then it will display “Flow is unstable.”

A good program should first calculate density, velocity and diameter from known values. However, for this program the user will directly input the density, velocity and diameter.

Here is an example of the program run:

|  |
| --- |
| Enter the density of the fluid: 1.0  Enter the viscocity of the fluid: 0.0125  Enter the average forward velocity of the fluid: 10.0  Enter the diameter of the pipe: 1.0  For the values entered, the Reynold' number calcualted is: 800  Flow is Laminar  Enter the density of the fluid: 1.2  Enter the viscocity of the fluid: 0.013  Enter the average forward velocity of the fluid: 35  Enter the diameter of the pipe: 1.1  For the values entered, the Reynold' number calcualted is: 3553.85  Flow is turbulent  Enter the density of the fluid: 1.0  Enter the viscocity of the fluid: 0.0125  Enter the average forward velocity of the fluid: 30  Enter the diameter of the pipe: 1.0  For the values entered, the Reynold' number calcualted is: 2400  Flow is unstable |