CM3215 Assignment 6:

System-head Curves for a *Proposed* Piping System
Under Conditions of Different Needle-Valve Positions

Due: **Wednesday 23 March 2:05pm** in Homework Box A
This is an **individual** assignment. Note the due time.

Complete all calculations described below; you may verbally consult with any of your classmates, but you must submit individual assignments that represent your own work; you may not exchange papers or electronic files. Deliver your submission with a memo of transmittal that clearly lists where to find your submitted answers to the assigned objectives. You must submit only your own work.

Overall objective: Determine the system-head curves (each will be function of flow rate) for a flow loop under three different operating conditions (three different needle valve settings) The three different systems are described below. Plot these curves as instructed.

In a future laboratory, you will predict the performance of a particular pump (the laboratory Lossy® pump) when it is installed to provide the flow energy to overcome the losses in the three systems described here. Week 12 you will "build" this system, "install" the Lossy® pump, and check the accuracy of your Assignment 6 predictions by measuring the actual performance of the Lossy® pump against the three systems.

1. Sketch the following system using Visio or by hand (make the sketch 8.5 by 11 inches, approximately). The system is a subset of our laboratory station.

   The systems:
   The three systems are three different metering valve settings for a flow loop containing:
   - Source tank: 12.5 inch inner diameter; discharge through the bottom to 1" nominal copper tubing, type L
   - 36.25 inches of 1" nominal, type L copper tubing; this tubing leads from the bottom of the source tank to the suction side of where the pump will be installed.
   - Three, 90^o elbows, 1" nominal, copper tubing
   - A position for a constant-speed pump (1" connection available on suction side, ½" connection available on the discharge side)
   - 98.5 inches of ½" nominal, type L copper tubing; this tubing conducts water from the discharge side of the pump through the rest of the system until exiting to the air above the destination tank.
   - Two, ½ inch, 3-way ball valves
   - Six 90^o elbows, ½" nominal, type L copper tubing

- Destination tank: 12.5 inch inner diameter; receives efflux from the discharge of ½″ nominal type L copper tubing discharging to air; the discharge point is 5" above the surface of the water in the tank. The tank is open to air.
- One Swagelock Integral-Bonnet Needle Valve,18 series needle valve, regulating stem, 0.375" orifice, set to the three different positions described in note 2 (note: the valve orifice size is part of the specifications of the needle valve and identifies the valve model; the valve is not an orifice meter and has nothing to do with an orifice meter).

2. We are interested in three positions of the needle valve, ½ turns open (180^o rotation), 1 turn open (360^o rotation), and 2 turns open. For the Swagelock needle valve in brand-new condition, you need to determine the friction coefficient K_f for the three requested valve positions: ½ turn open, 1 turns open, and 2 turns open. Dr. Morrison's handout shows how this calculation is done, and the answer at one valve position is given in her notes: www.chem.mtu.edu/~fmorriso/cm3215/Cv_control_valves_2013.pdf

3. Calculate system head versus capacity for the three flow systems. Determine equations (curve fits) for the system-head curves $H_{system}(Q)$ for the flow loop metered by the Swagelock Needle Valve in the following three positions: ½ turn open, 1 turns open, 2 turns open. Give a table indicating the values of friction coefficients K_f you used for each of the fittings you included in your calculations. Give *head* in units of ft and capacity in units of gpm.
4. On a single graph, plot the three system-*head* curves from item 3 as a function of capacity (volumetric flow rate in gpm, which is gallons per minute). When choosing your plotting limits, for the flow rate use $0 \leq Q \leq 4gpm$ and use enough points to get a smooth curve. As always, include appropriate captions in your figures and tables. We are interested in system head of at most $100\ ft$; limit your y-axis to $100\ ft$.

Deliver your submission with a memo of transmittal that clearly lists where to find your submitted answers to the four assigned objectives.