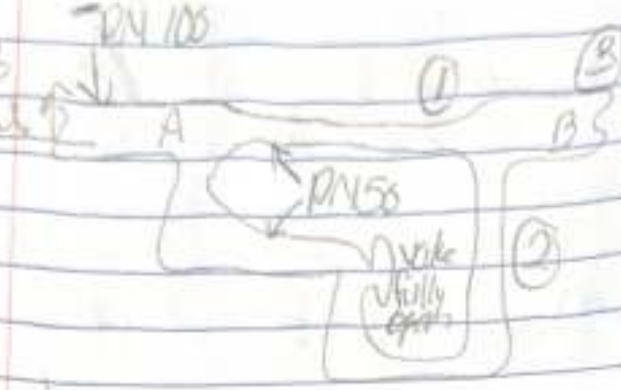

Assumptions
Incompressible
Isothermal
Steady state

Data
$L_1 = 30m$
$L_2 = 16m$
Water at 0°C
$Q_A = 850 L/m = 0.0147 m^3/s$
$\gamma = 9.81 kN/m^3$
$\nu = 1.3 \times 10^{-6} m^2/s$
$\varepsilon = 4.6 \times 10^{-5} m$

$D_1 = 0.1023m$
$D_2 = 0.0525m$

roughness $= \frac{D}{\varepsilon} = \frac{.1023}{4.6 \times 10^{-5}} = 2223.9$

$\frac{.0525}{4.6 \times 10^{-5}} = 1141.3$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{LAB}$$

$$A_1 = \frac{\pi D^2}{4} = \frac{\pi}{4}(.1023)^2 = 8.2 \times 10^{-3} m^2$$

$$A_2 = \frac{\pi}{4}(.0525)^2 = 2.2 \times 10^{-3} m^2$$

$$Q = VA \quad V_1 = \frac{Q}{A_1} = \frac{0.0147}{8.2 \times 10^{-3}} = 1.6 m/s$$

$$Re = \frac{VD}{\nu} = \frac{(1.6)(0.1023)}{1.3 \times 10^{-6}} = 125907.7$$

Branch 1 $h_L = f\frac{L}{D}\frac{V^2}{2g}$

Branch 2 $h_L = f\frac{L}{D} + \frac{V^2}{2g} + 3L_{elbow} + L_{valve}$

$$Q_1 = \sqrt{\frac{\Delta P}{\frac{Y}{f\left(\frac{L_1}{D}\right)\frac{8}{g\pi^2 D^4}}}}$$

$$Q_2 = \frac{\Delta P}{\frac{Y}{f\left(\frac{L_2}{D_2} + 3\frac{L_C}{D}\text{elbow} + \frac{L_e}{D}\text{valve}\right)\frac{8}{g\pi^2 D^4}}}$$

$$Q = V_A A_A + V_B A_B$$

$$V_B = \frac{Q}{V_A A_A + A_B} = \frac{.001417}{1.6(.0022) + .0022} = 2.6 \text{ m/s}$$

$$Q = 1.6 + (2.6) = 4.2 \text{ m/s}$$

$$Q_1 = .00196 \text{ m}^3/\text{s}$$

$$Q_2 = .000519 \text{ m}^3/\text{s}$$

$$\Delta p = f \frac{L}{D} \frac{V_a^2}{2g} \gamma = 2.3 \left(\frac{60}{.0525}\right) \left(\frac{2.6^2}{2(9.81)}\right) 9.81$$

$$\Delta p = 855 \text{ kPa}$$

specific weight	9.81	kn/m3
viscosity	1.30E-06	m2/s
Pressure A	1000	kpa
Pressure B	900	kpa
L1	30	m
L2	60	m
D1	0.1023	
D2	0.0525	
Q	0.01417	m3/s
Le/Dvalve	150	
Le/d elbow	30	
g	9.81	
roughness 1	2223.9	
roughness 2	1141.3	

Q1

iteration	f1	Q1	V1	Re1	f	%difference
1	0.1	0.002093	2.78846E-05	1.13	0.032287	-22.2872
2	0.11	0.001995	2.65869E-05	1.07	0.032283	-18.3486
3	0.12	0.00191	2.54551E-05	1.03	0.03228	-14.8999
4	0.13	0.001835	2.44564E-05	0.99	0.032276	-11.8281
5	0.14	0.001769	2.35668E-05	0.95	0.032273	-9.0523
6	0.15	0.001709	2.27677E-05	0.92	0.03227	-6.51339
7	0.16	0.001654	2.20447E-05	0.89	0.032267	-4.16691
8	0.17	0.001605	2.13865E-05	0.86	0.032264	-1.97891
9	0.18	0.00156	2.0784E-05	0.84	0.032261	0.077049

Q2

iternation	f2	Q1	V1	Re2	f	%difference
1	0.1	0.00249	2.07355E-06	8.37E-02	8.37E-02	-83.5978
2	1.049706	0.000768	6.40002E-07	0.025846	0.052233	-3.92623
3	2.301945	0.000519	4.32183E-07	0.017454	0.04561	0.320593
4	5.303215	0.000342	2.84738E-07	0.011499	0.039862	4.551553
5	14.81223	0.000205	1.70375E-07	0.006881	0.034166	14.58157
6	72.63946	9.24E-05	7.69359E-08	0.003107	0.027487	72.60162
7	101022.9	2.48E-06	2.06303E-09	8.33E-05	0.012737	101022.9
8	86.52462	8.46E-05	7.04929E-08	0.002847	0.026875	86.49356
9	25.1119	0.000157	1.30851E-07	0.005284	0.031701	24.98566

12.5

design
incompressible
isothermal
steady state

data
1 = 1 comm x 5.5
2 = 100 x 3.5
3 = 50 x 1.5
L = 30m
water @ 15°C
500 L/min
ν = 1.3x10⁻⁶
ε = 1.5x10⁻⁴

K elbow = 30
K tee = 60
K reducer = .04 @ 35°
K expansion = 0.41 @ 35°

D1 = 1.6
D2 = 3.17

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L\,1\text{-}2}$$

$$\frac{\Delta P}{\gamma} = h_L$$

1-2A $h = h_{L\,tee\,thru\,reducer} + 2h_{L\,elbow\,thru\,pipe\,thru\,valve\,thru\,exp}$

$$= 2K_{tee}\frac{V^2}{2g} + K_{red}\frac{V^2}{2g} + 2K_{elbow} + f\frac{L}{D}\frac{V^2}{2g} + K_{valve}\frac{V^2}{2g} + K_{ex}\frac{V^2}{2g}$$

1-2B $h = 2h_{L\,tee} + 2h_{L\,elbow} + 2h_{exp} + h_{L\,pipe\,thru\,exp\,valve}$

$$= 2K_{tee}\frac{V^2}{2g} + 2K_{elbow}\frac{V^2}{2g} + K_{red}\frac{V^2}{2g} + f\frac{L}{D}\frac{V^2}{2g} + K_{exp}\frac{V^2}{2g}$$

$K_{valve} = 2h_{L\,tee} + h_{L\,reducer} + 2h_{L\,elbow\,thru\,pipe\,thru\,exp} - 2h_{L\,tee} + h_{L\,red} + h_{L\,elbow\,thru\,pipe\,thru\,exp}$

$\frac{V^2}{2g}$