

Name: _____

CVEN 458 – Hydraulic Engineering of WDS
 Spring Semester 2011
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Exam #1

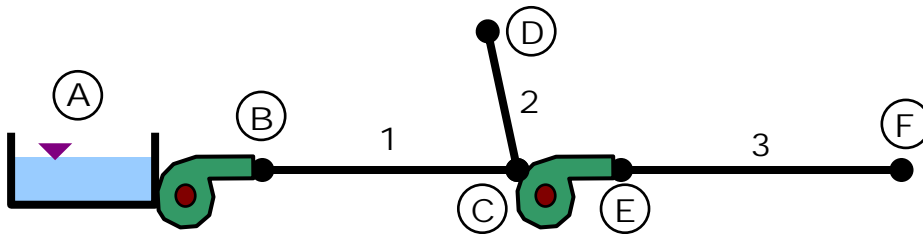
Open-book, Open-notes (5 pages, 3 questions); Time allowed: 75 minutes

1. Drawn below is a small water distribution system. Relevant data is given in the tables below. In all calculations of pipe head loss, use the Hazen-Williams equation:

$$Q = 0.281 C D^{2.63} \left(\frac{H_f}{L} \right)^{0.54} \quad \text{or} \quad H_f = \frac{10.47 L}{C^{1.85} D^{4.87}} Q^{1.85}$$

where $[Q]$ = gpm, $[D]$ = in, $[L]$ = ft, and $[H_f]$ = ft.

Determine the flowrates (gpm) in pipes 1, 2, and 3, and the pressures (psi) at nodes B, C, D, E, and F. (45 points)



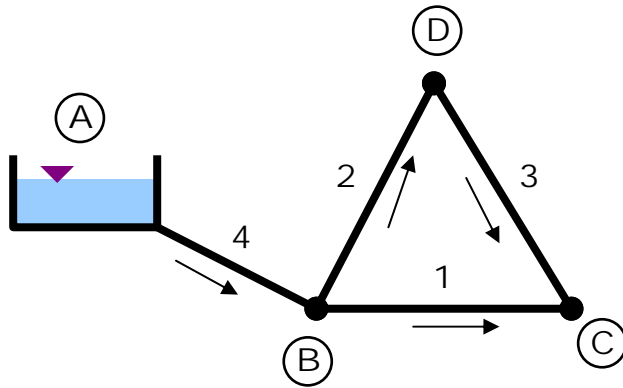
Node	Elevation (ft)	HGL (ft)	Demand (gpm)
A	200	215	0
B	205		300
C	230		400
D	220		345
E	230		150
F	255		360

Pipe	Length (ft)	Diameter (in)	Roughness
1	2000	12	105
2	750	8	135
3	2000	12	105

Both pumps have characteristic curve: $E_p = (-0.000\ 018) Q^2 + (-0.015\ 7) Q + 170$, where $[E_p]$ = ft and $[Q]$ = gpm.

{ Work space for #1 }

2. You are working at a firm developing software for modeling of water distribution systems. The new software will use the Gradient Method to solve pipe networks. Another employee has coded the algorithm, and you are responsible for checking the code to make sure that it is correct. For the system diagrammed below, the code has produced the following matrix equation:



$$\begin{bmatrix}
 2K_1|Q_1|^{0.85} & 0 & 0 & 0 & 1 & 1 & 0 \\
 0 & 2K_2|Q_2|^{0.85} & 0 & 0 & 1 & 0 & 1 \\
 0 & 0 & 2K_3|Q_3|^{0.85} & 0 & 0 & 1 & -1 \\
 0 & 0 & 0 & 2K_4|Q_4|^{0.85} & 1 & 0 & 1 \\
 \hline
 1 & 1 & 0 & 1 & 0 & 0 & 0 \\
 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
 0 & 1 & -1 & 1 & 0 & 0 & 0
 \end{bmatrix}
 \times
 \begin{bmatrix}
 \Delta Q_1 \\
 \Delta Q_2 \\
 \Delta Q_3 \\
 \Delta Q_4 \\
 \Delta H_A \\
 \Delta H_B \\
 \Delta H_C
 \end{bmatrix}
 =
 \begin{bmatrix}
 -(-H_B + H_C + K_1Q_1|Q_1|) \\
 -(-H_B + H_D + K_2Q_2|Q_2|) \\
 -(-H_D + H_C + K_3Q_3|Q_3|) \\
 -(0 + H_B + K_4Q_4|Q_4|) \\
 \hline
 -(-Q_1 - Q_2 + Q_4 - D_B) \\
 -(Q_1 + Q_3 - D_C) \\
 -(Q_2 - Q_3 - D_D)
 \end{bmatrix}$$

Find any errors in the equation. (35 points)

(Hints: There are 14 specific matrix elements that are incorrect, but many elements are incorrect because of common mistakes in the code.)

{Work space for #2}

3. Explain the purpose and common conditions of use for the following hydraulic appliances in water distribution systems. Use descriptive sketches where appropriate. (20 points)

a. Butterfly Valves

b. Blowoffs

c. Hydropneumatic Tanks