Name: _____

CVEN 458 – Hydraulic Engineering of WDS
Spring Semester 2009
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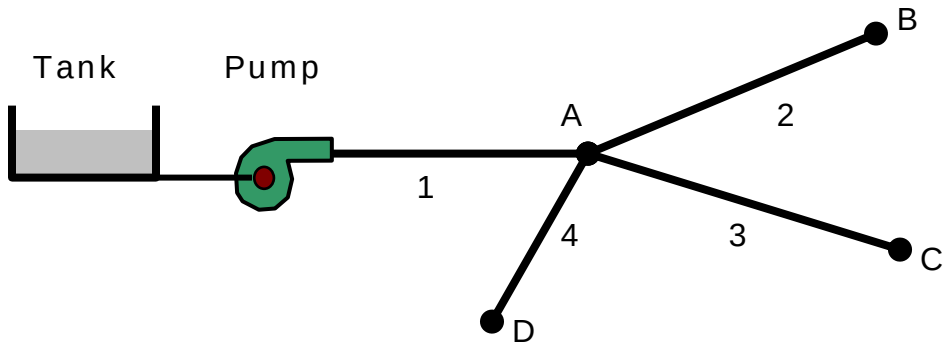
Exam #1

Open-book, Open-notes (4 pages, 2 questions); Time allowed: 75 minutes

1. Drawn below is a small water distribution system. *Determine the flowrate in each pipe (gpm) and the pressure at each node (psi).* Use the Hazen-Williams equation in your calculations. Explicitly state all assumptions and reference sources for parameter values not written here. (50 points)

Hazen-Williams Eqn:

$$Q = 0.285\, C\, D^{2.63} \left(\frac{H_f}{L} \right)^{0.54}$$, for [Q] = gpm, [D] = in, [H_f, L] = ft



HGL_{Tank} = 75 ft
Z_A = 62 ft Dem_A = 10 gpm
Z_B = 63 ft Dem_B = 26 gpm
Z_C = 82 ft Dem_C = 15 gpm
Z_D = 93 ft Dem_D = 55 gpm

Pipe 1: 550 ft, cast iron, 4 in
Pipe 2: 400 ft, galvanized iron, 1.5 in
Pipe 3: 300 ft, galvanized iron, 1 in
Pipe 2: 200 ft, PVC, 3 in

Pump characteristic curve: $E_p = -0.0012\, Q^2 - 0.125\, Q + 175$; [$E_p$] = ft, [$Q$] = gpm

{Work space for #1}

2. For the WDS in problem 1, *do all necessary work to setup the first iteration of the Gradient Method solution for flows and heads in this network.* Your final answer should be the matrix equation:

$$\begin{bmatrix} n\underline{A_{11}} & \underline{A_{12}} \\ \underline{A_{21}} & \underline{0} \end{bmatrix} \times \begin{bmatrix} \underline{\Delta Q} \\ \underline{\Delta H} \end{bmatrix} = \begin{bmatrix} -\underline{dE} \\ -\underline{dq} \end{bmatrix}$$

with all matrices fully written out including numerical values where possible. That is, your final answer should look something like:

$$\begin{bmatrix} 3 & 0 & 0 \\ 1 & 2 & -1 \\ 0 & 1 & 1 \end{bmatrix} \times \begin{bmatrix} \Delta Q_1 \\ \Delta Q_2 \\ \Delta H_1 \end{bmatrix} = \begin{bmatrix} 21.3 \\ -9.6 \\ -0.53 \end{bmatrix}$$

You should continue to use the Hazen-Williams equation for pipe flow head loss.

(50 points)

{Work space for #2}