Name: ____

CVEN 458 – Hydraulic Engineering of WDS
Spring Semester 2014
Dr. Kelly Brumbelow, Texas A&M University

Exam #1 – Part A

<u>Closed-book, Closed-notes (2 pages, 3 questions in this part); Time allowed: 20 minutes</u>
All work for Part A must be written on the Part A pages.

1. Explain the function, operation, and common uses of hydropneumatic tanks. Use sketches and drawings as appropriate. *(10 points)*

2. Explain the function and typical application of a pressure sustaining valve. *(6 points)*

3. Rank the following types of valves in order from lowest to highest expected minor losses: (i) butterfly, (ii) ball, and (iii) globe. Explain your rankings. Use drawings and sketches as appropriate. *(6 points)*

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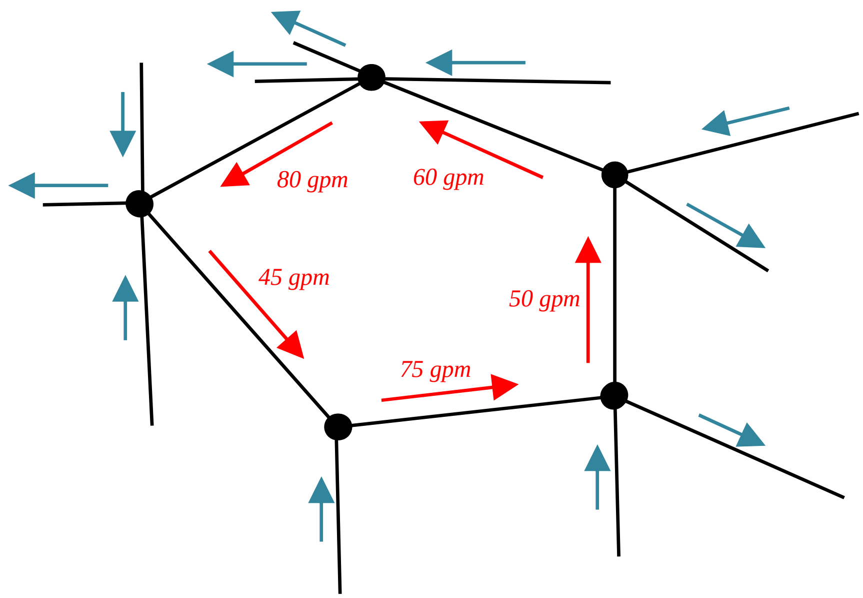
Exam #1 – Part B

<u>Open-book, Open-notes (2 pages [+ ref sheets], 2 questions); Time allowed: 55 minutes</u>
All work for Part B must be written on separate pages with your name written on each page.

1. A portion of a water distribution system is sketched below. A colleague has calculated flows for a set of pipes forming a loop as shown below. Is this solution possible? Why or why not? *(10 points)*



2. A small WDS is diagrammed and relevant parameters are defined below. Attached to the exam are look-up tables and reference material that you may find helpful.

(a) <u>Ignoring the check valve</u> (i.e., pretend it is not there), *do all necessary work to setup the first iteration of the Gradient Method solution for flows and heads in this network using the **Hazen-Williams** equation for all pipe head losses.* 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:

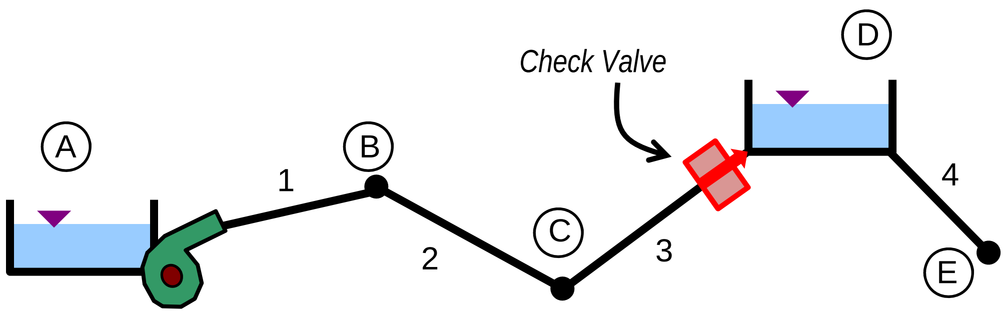
$$\begin{bmatrix} 3 & 0 & 0 \\ 1 & 2 & -1 \\ 0 & 1 & 1 \end{bmatrix} \times \begin{bmatrix} \Delta Q_1 \\ \Delta Q_2 \\ \Delta H_1 \end{bmatrix} = \begin{bmatrix} 21.3 \\ -9.6 \\ -0.53 \end{bmatrix}$$

Explicitly state all assumptions made in preparing the matrices.

(b) Including the check valve in your analysis, *determine flows (gpm) in the 4 pipes and pressures (psi) at nodes B, C, and E* using the **Hazen-Williams** head loss formula. (Hint: This is actually not that hard. If you are doing long systems of equations, you have missed some circumstances that greatly simplify the problem.)

(c) Discuss how you could repeat part (a) with the check valve included. I.e., how would you mathematically formulate the problem to include the check valve?

(68 points)



Check valve allows flow from node C to D only.

HGL_A = 420.0 ft; HGL_D = 600.0 ft

Z_B = 435.0 ft; Z_C = 455.0 ft; Z_E = 487.0 ft;

Dem_B = 45 gpm; Dem_C = 255 gpm; Dem_E = 80 gpm

Pipe 1: L = 625 ft, D = 16 in, PVC
Pipe 2: L = 540 ft, D = 10 in, PVC
Pipe 3: L = 470 ft, D = 8 in, PVC
Pipe 4: L = 440 ft, D = 6 in, PVC

Pump characteristic equation: $E_p = -0.0001Q^2 - 0.05Q + 140$, [Ep] = ft, [Q] = gpm