Name: _____

CVEN 458 – Hydraulic Engineering
Spring Semester 2007
Dr. Kelly Brumbelow, Texas A&M University

Exam #1

Open-book, Open-notes (4 pages, 3 questions); Time allowed: 90 minutes

1. You are designing a 1220 mm (48 inch) water transmission line. It will be 20.3 km long. The starting point for the pipeline is a reservoir at elevation 17 m and adjacent pump station, and the ending point will be an input point to a distribution network at elevation 35 m. Static pressure in the flow at the pipeline end point must be 550 kPa. The expected flowrate in the pipeline will be 170 000 m^3 per day.

You are evaluating different pipe materials and are considering steel (uncoated), cast iron, PVC, and prestressed concrete. Part of the evaluation process is determining the differences in pumping energy needed for pipe of each material. *What will be the daily energy consumption of the pump station (in kWh) for each pipe material under consideration assuming gross efficiency of the pump and motor to be 48%?* Use the Hazen-Williams equation for your head loss calculations. (35 points)

(Work space for #1)

2. How would you expect the calculated energy consumption values in problem 1 to change if you used the Darcy-Weisbach equation for head loss calculations? Which formula is considered to be "conservative"? (5 points)

3. Diagrammed below is a simple pipe network. *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:

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

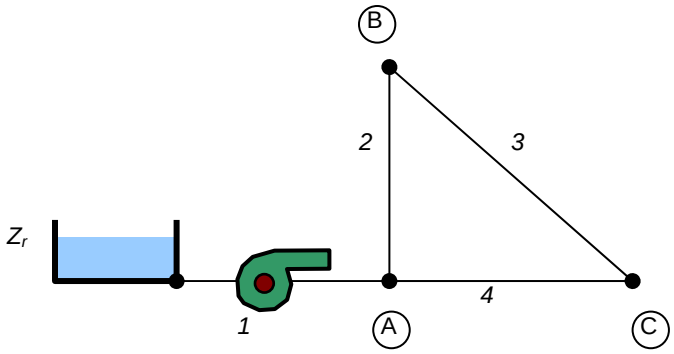
with all matrices fully written out including numerical values where possible. That is, your final answer should look something like:

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

(60 points)

Z_r = 200 ft
Z_A = 202 ft
Z_B = 210 ft
Z_C = 208 ft

Pipe 1: 200 ft, cast iron, 36 in
Pipe 2: 2000 ft, PVC, 12 in
Pipe 3: 4000 ft, PVC, 18 in
Pipe 4: 3000 ft, cast iron, 18 in



Dem_A = 2.2 cfs
Dem_B = 1.3 cfs
Dem_C = 1.2 cfs

Pump 1: $E_p = -Q^2 - 5Q + 210$; [Q] = cfs, [E_p] = ft

(Work space for #3)