Branching Pipe Systems
(Definitions and Concepts)

Branching Pipe System: a pipe network containing one junction which usually connects a number of reservoirs.

The Classic Three Reservoir Problem: (see figure below)
Given: Water elevations, pipe mat'ls, sizes, and lengths
Find: Q_1, Q_2, and Q_3.

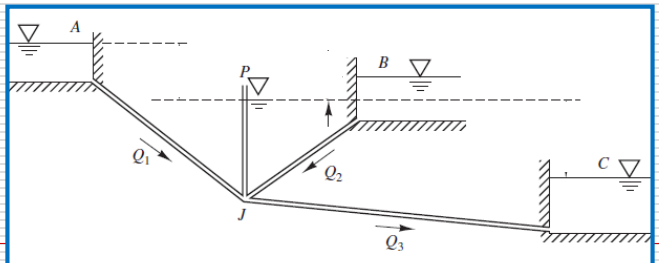


Figure 4.4 Branching pipes connecting three reservoirs

Branching Pipe Systems
(Active Learning Exercise)

Q: What equations would you use to solve for the 3 Qs.

Q: What additional equation can be used in the solution?

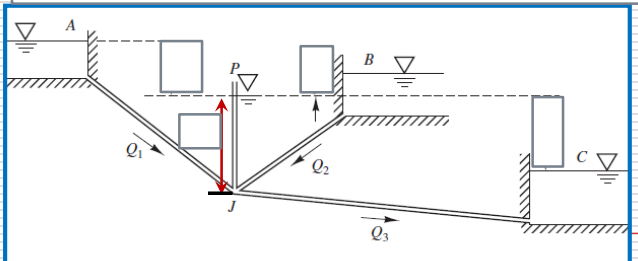


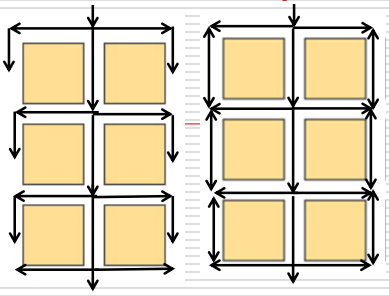
Figure 4.4 Branching pipes connecting three reservoirs

Note: Velocity head is ignored at the junction and minor losses are ignored in pipes.

Pipe Networks
(Municipal Water Delivery)

Q: Which system is better for delivering water to customers?

Water Distribution – City Blocks



Dendritic System (tree structure) **Grid System (loop structure)**

Q: Which path should I take?

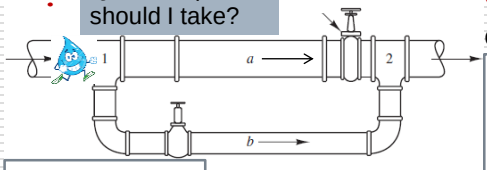


Figure 4.6

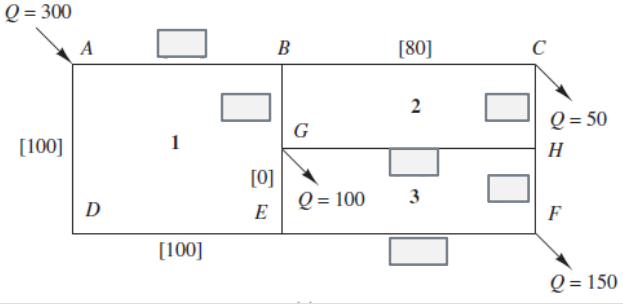
Q: What principles (eq'ns.) are available to find Q_a & Q_b?

Pipe Networks
(Initiation of the Hardy Cross Method)

Q: Starting with the Darcy-Weisbach equation, determine the value of K for friction loss expressed as $h_f = KQ^2$.

A:

Q: Estimate all Q's in the pipe network depicted below.



Principle: Conservation of Mass (i.e., mass balance of flows at all nodes)

Pipe Networks
(Analysis by the Hardy Cross Method)

Q: Determine the total friction loss (clockwise and counter clockwise) for loop 1 based on $h_f = KQ^2$ (Darcy-Weisbach)

Q: The clockwise and counter-clockwise head losses do not balance. What does this mean and what should be done?

A:

Pipe	Q (m^3/sec)	K (sec^2/m^5)	h_f (m)
AB	0.200	194	
BG	0.120	678	
GE	0.000	2,990	
AD	(0.100)	423	
DE	(0.100)	1,630	

Principle: Conservation of Energy (head loss balance in all of the loops)

Pipe Networks
(Flow Corrections)

Homework Problems:

Hardy-Cross Method: If $\sum K_c Q_c^2 \neq \sum K_{cc} Q_{cc}^2$ around a loop (subscripts refer to clockwise and counterclockwise flow), losses are equalized by adjusting the flow rates by ΔQ, then $\sum K_c (Q_c - \Delta Q)^2 = \sum K_{cc} (Q_{cc} + \Delta Q)^2$

Based on mathematics, the flow correction ΔQ is ➔

$$\Delta Q = \frac{(\Sigma h_{fc} - \Sigma h_{fcc})}{2\left(\Sigma \frac{h_{fc}}{Q_c} + \Sigma \frac{h_{fcc}}{Q_{cc}}\right)}$$

A second iteration uses this correction to determine a new flow distribution. A successive computation procedure is used until the entire network is balanced (mass and energy).

Team Activity: Review Ex. 4.8. Identify one or two points of confusion. How can the pressure at F be increased?