CVEN 339 “Water Resources Engineering”

**H O M E W O R K  2**

*Assigned 7/14/14  
Due 7/21/14*

Problems 1-12 will be graded on effort alone. You may collaborate freely with others to work these problems.

1. Problem 4.25, p. 239, Wurbs and James. Assume that the given pump characteristic data was determined for N=1300 rpm and you will operate the pump at N=800 rpm. Use multiple stages if necessary.

2. Problem 4.1, p. 234, Wurbs and James. Solve it 3 times: once as written (using Darcy-Weisbach $f$); once using Manning’s equation for friction loss, a roughness value of $n = 0.013$, and culvert slope of 0.001 ft/ft; and once assuming inlet control with depth of headwater equal to 12 ft (this is not head above entrance centerline).

3. A culvert is shown in the sketch below (elevation view). You have surveyed the culvert and found the elevations at the entrance and exit inverts to be 307.65 ft and 305.83 ft, respectively. The pipe material is corrugated metal. (The “invert” is the lowest point in the pipe cross-section.) Solve for flow through the culvert for the following combinations of headwater and tailwater elevations:

   a. HW = 318.80 ft, TW = 312.30 ft  
   b. HW = 325.35 ft, TW = 312.30 ft  
   c. HW = 318.80 ft, TW = 303.90 ft  
   d. HW = 325.35 ft, TW = 303.90 ft
4. Problem 4.30, p. 241, Wurbs and James. Determine the set of equations to be solved and submit them. You may then use the Excel solver to determine the solutions. That is, you should submit the system equations written out on one sheet of paper; then, you may submit a printout from Excel with the solutions for flow in each pipe and pressure at each node.

5. Redo problem 4 assuming that pipes 2 and 6 have ruptured and been removed from service. Comment on the importance of closed loops in water distribution systems for purposes of maintaining system pressures. When commenting, keep in mind that minimum allowable service pressure is 35 psi according to Texas Commission on Environmental Quality (TCEQ) guidelines.

6. Redo problem 4 using the Linearized Equations method to determine the solution. Again, you should submit the system equations that you determine on one sheet, and you may then submit a computer printout from Excel (or Matlab, if you prefer) with the solutions for flows and pressures.

7. Problem 2.1, p. 102, Wurbs and James.

8. Problem 2.7, p. 102, Wurbs and James.

9. Problem 2.12, p. 102, Wurbs and James.

11. Determine the boundaries for the watershed whose outlet is indicated by the red star in the map below.

12. The area of a watershed is 5,000 square miles. It receives 42 in. of precipitation per year. Average annual evapotranspiration is 20 in., and 12 in. per year recharges a 2,200 square mile aquifer underlying the watershed. The remainder of the precipitation becomes runoff into the watershed’s principal river. There are no other inflows or outflows into or out of the aquifer. A farmer wishes to drill an irrigation well into the aquifer. If 60% of the irrigation water goes to evapotranspiration, 25% to runoff into the watershed’s main river, and the rest infiltrates and recharges the aquifer, how much water per year can the farmer pump without depleting the storage of the aquifer? What is the annual flow of the river at the watershed outlet? Express your answers in terms of acre-feet.
Problem 13 will be graded for accuracy. You are to work on this problem individually.

13. A simple pipe network is drawn below, and relevant physical properties and technical data are given.

(a) Determine flow rate (cfs) and direction (e.g., “from node X to node Y”) in all pipes.
(b) Determine pressure (psi) at node C.

Pump characteristic function: \( E_p = -0.3125 Q^2 - 3.75 Q + 50 \), \( [E_p] = \text{ft}, [Q] = \text{cfs} \)