

## Assignment 2: Excel Functions

Date Due: September 11, 2013

Instructor: Trani

Show all your work including VBA code and results of your computation in the spreadsheet as screen captures.

### Problem 1

A classical problem in civil engineering hydraulics is the estimation of draining time for a tank with diameter  $D_t$  as shown in the figure. The equation to estimate the time to drain the tank between two heights  $h_1$  and  $h_2$  is given by the equation:

$$\Delta t = \frac{2(A_t / A_j)}{\sqrt{2g}} (h_1^{1/2} - h_2^{1/2})$$

where:

$\Delta t$  is the draining time in seconds

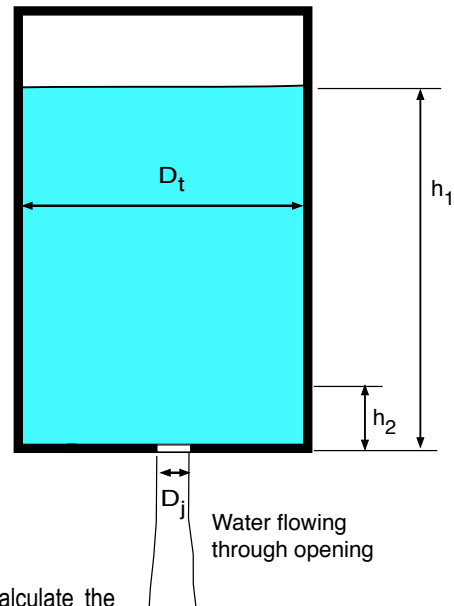
$A_t$  is the area of the tank (square meters)

$A_j$  is the area of the open nozzle (square meters)

$g$  is the gravitational constant ( $9.81 \text{ m/s}^2$ )

$h_1$  is the initial height (meters)

$h_2$  is the drained height (meters)



- Create an **Excel Function** (using Visual Basic For Applications) to calculate the draining time for a cylindrical tank with a diameter of 3 meters and with an initial height of 10 meters. Assume the tank drains completely. The diameter of the circular nozzle opening ( $D_j$ ) is 14 centimeters. Your Excel function should have four inputs: 1) the diameter of the tank, 2) the diameter of the tank opening, 3) the initial height of the tank and 4) the lowest height of the tank for draining time computations. The function should produce the time to drain to height  $h_2$ .
- Use the function created in part (a) to estimate the draining times of the tank when the circular nozzle diameter varies from 1 to 20 centimeters at intervals of 1 centimeter. Create a table of results in the spreadsheet.
- Plot the draining time data obtained in part (c). Comment on the results observed.

**Note:** You will get no credit if you just do regular Excel computations in a spreadsheet and do not show your VBA code.

## Problem 2

The empirical equation derived by Hazen-Williams to estimate the flow of water through a pipe as a function of the physical properties of the pipe is given by:

$$v = kC_{hw}R^\alpha S^\beta$$

where:

$v$  is the speed of the water in the pipe (m/s)

$C_{hw}$  is the friction factor of the pipe (dimensionless)

$R$  is the hydraulic radius of the pipe (m)

$S$  is the head loss per unit length of the pipe (m/m)

and  $k, \alpha$  and  $\beta$  are constant determined empirically

$$k = 0.85$$

$$\alpha = 0.63$$

$$\beta = 0.54$$

The typical values for the friction factor ( $C_{hw}$ ) of pipes used in Civil Engineering design are: a) 120 for concrete, b) 130 for copper and c) 100 for steel pipes. For circular pipes the hydraulic radius is the diameter divided by 4 (note: 4 is correct and not a typo).

- Create an **Excel Function (using Visual Basic For Applications)** to calculate the velocity of the water flow inside the pipe. Your Excel function should have as inputs: 1) the pipe diameter (m), 2) the head loss per unit length (m/m), and 3) the friction factor. The function should produce the velocity inside the pipe (in m/s).
- Use the function created in part (a) to estimate the velocity profiles inside a 0.3 m diameter pipe with the following values:  
 $S = 10$  m/m, a concrete pipe.
- Repeat the calculations for a copper and steel pipes. Comment on the results obtained.
- Use the function created in part (a) to estimate the velocity of the water inside the pipe when  $S$  varies from 0.1 to 20 m/m. Plot the results in Excel.

**Note:** You will get no credit if you just do regular Excel computations in a spreadsheet and do not show your VBA code.

### Problem 3

Use the construction company assets file provided in class and use your knowledge of **Excel Pivot tables** when appropriate to answer the following questions. Show your Pivot table.

- Find the average value for the Caterpillar 775F vehicles at the Richmond construction site.
- Find the average number of miles for Caterpillar Cat 160H equipment at the Raleigh office.
- Find the total number of miles for all Cat 775F vehicles owned by the company.
- Find the number of Cat 725 that are active at the Richmond site.
- Make a Pivot Plot showing the average value of each vehicle for all sites.

### Problem 4

In order to evaluate the efficiency, energy, environmental, and safety impacts or traffic signal re-timing, a number of floating-car runs were conducted using vehicles that were equipped with a Global Positioning System (GPS) that measured the vehicle's speed at increments of 1 or 2 seconds. Floating-car runs are runs in which a vehicle is driven in the general traffic at typical driving speeds. The worksheet enclosed includes the speed for a sample of GPS runs that were conducted along the Scottsdale/Rural Road in Phoenix, Arizona. This data is smoothed to facilitate the evaluation of the traffic signal re-timing. The smoothed speed is:

$$S_i = \alpha X_i + (1 - \alpha) S_{i-1}$$

Where:

$X_i$  = Observation at time ( $i$ )

$S_i$  = Smoothed data at time ( $i$ )

$\alpha$  = Exponential Smoothing factor

- Create a column that computes the smoothed speed based on the value of alpha selected. Initially use a value of the exponential smoothing factor of 0.5.
- Create a column that calculates the acceleration based on the smoothed speed in  $m/s^2$  (note units) as follows:

$$a = \frac{S_i - S_{i-1}}{t_i - t_{i-1}}$$

- Use Conditional Formatting to set the background colors of the accelerations cells based on the following table.

Condition	Cell Shading
Decelerations	Green
Minor Accelerations (between 0.00 and 0.3 $m/s^2$ )	White
Moderate Accelerations (between 0.3 and 1.50 $m/s^2$ )	Light yellow
Major Accelerations (greater than 1.5 $m/s^2$ )	Red

- Plot time versus smoothed speed and time versus raw speed. Observe changes in the smoothed speed data when  $\alpha$  is changed. Suggest the best value of  $\alpha$  to produce a realistic speed profile. Comment.

## Problem 5

In the construction of a new runway at the Atlanta International Airport, the airport authority and the local government requested a 1.2 billion dollar loan to be paid in bonds after 20 years. Assume the interest rate of the load is 5% at 20 years.

- a) Estimate the monthly payments of the airport to repay the bonds over 20 years. Use the appropriate Excel function to estimate monthly payments.
- b) If the airport receives an average of 470,000 landings per year, estimate the average landing fee (a fee charged to every aircraft landing at the airport) if 40% of the bond payments are expected to be charged in landing fees. By the way airports charge tenants (airlines and companies with stores at the airport) other fees like rentals of gates and terminal space. The airport also collects revenue in parking costs and other services at the airport.