

Assignment 5: VBA Programming

Date Due: March 6, 2020

Instructor: Trani

Problem 1

Equation (1) presents a formula to estimate the runoff (volume of water per unit time) generated by a storm.

$$Q = CIA$$

where:

Q = Volume of water (runoff) in cubic feet per second (1)

C = Runoff coefficient (dim)

I = Rainfall rate intensity (inches/hr)

A = Area in acres

The units of Q (in cubic feet per second) are dimensionally correct because the conversion from inches/hr to acre-foot/hr is 1.008 or close to unity. The value of C varies according to the type of land use (or surface) and the hydrological soil group. The table below shows typical values of C for 4 hydrological soil groups and 5 land-uses.

Hydrological Soil Group					
Land-Use	Sand	Silt	Sandy Clay	Silty Clay	
Cultivated land	0.49	0.67	0.81	0.88	
Pasture	0.38	0.63	0.78	0.84	
Lawns	0.15	0.25	0.51	0.65	
Commercial areas	0.84	0.90	0.93	0.96	
Residential	0.59	0.76	0.86	0.90	

a) Write a **program in** Visual Basic for Applications (VBA) to calculate the value of Q given the values of three variables in the right hand side of Equation (1). The VBA program should produce a single value (Q) as output. Use Option Explicit in this program. Your program should have a simple GUI interface that allows the user to select the hydrological soil group and the land use.

b) Test the program and the interface developed in part (a) using the following parameters:

b1) Area = 10 acres, Rainfall rate = 4 in/hr (equivalent to a 35 minute, 100 year storm), Cultivated land on Silt soil.

- b2) Area = 10 acres, Rainfall rate = 4 in/hr (equivalent to a 35 minute, 100 year storm), Commercial area on Silty Clay soil.
- b3) Area = 10 acres, Rainfall rate = 4 in/hr (equivalent to a 35 minute, 100 year storm), Residential area on Sandy Clay soil.

Comment on the difference in runoff observed for the different scenarios modeled.

- c) Verify the conversion factor in equation (1) to be 1.008.

Problem 2

- a) Improve the program developed in Problem 1. The following table illustrates typical rainfall rates for the 100-year storm at a location near New York City. Improve the program created in Problem 1 to include a data validation list allowing the user to select the duration of the 100-year storm in the Excel interface. The selection of the storm duration should then allow your program to estimate the rainfall intensity rate.

Storm Duration (minutes)	Rainfall Intensity (in/hr) 100-Year Storm
10	8.1
20	6.1
30	4.6
35	4.0
45	3.7
60	3.1

- b) Calculate the total runoff volume (in cubic feet) as the product of Q (runoff) and the storm duration. Display the answer in a message box and also in a cell of the spreadsheet.

Problem 3

A simple equation to predict the so-called basic resistance of a high-speed rail system (R_{basic}) moving at speed (v) is given by Davis' equation and shown below. This equation includes the resistance due to aerodynamic drag and axle load friction resistance (i.e., resistance between train steel tires and the rail track).

$$R_{basic} = A + Bv + Cv^2$$

where: $A, B,$ and C are train-specific coefficients and v is the train speed in meters per second. The values of $A, B,$ and C are determined using wind tunnel testing and actual testing of the trains in test tracks. The values of $A, B,$ and C for a Japanese High-Speed Train of the series Shinkansen 300 (see <http://en.wikipedia.org/wiki/Shinkansen>) are provided below with their corresponding units.

A = 7.91000; % units are kN
 B = 0.10356; % units are kN s/m
 C = 0.01099; % units are kN s-s/m-m

Note that the units of A, B and C are consistent to produce a basic resistance of the train in kiloNewtons.

a) Create a VBA program (i.e., a subroutine) to estimate the basic resistance for the high-speed train for a range of velocities ranging from 1 to 85 m/s (range of speed where the train operates).

In your analysis create VBA code that includes a FOR-NEXT loop to estimate the resistance at various speeds (in meters/second). Create a run button to execute the code from within the Excel interface. The VBA code should write the header for velocity and resistance in the 10th row of the Excel spreadsheet. Make sure you place your name and the time of creation in the Excel spreadsheet. Declare all program variables using the Option Explicit statement.

b) Improve the code created in part (a) by adding a separate worksheet to the problem. In this new worksheet include the description of the problem and add three slider controls to set the values of A, B and C to simulate other versions of the High-Speed Train family of trains. The interface should let the user select the lower and upper bound of the speeds to be computed in the VBA code and also should let the user select the step size of speed to be used in the calculations.

Set limits for these sliders to be:

A - 7.2 (min) and 9.2 (max) in units of kN

B - 0.10 (min) and 0.14 (max) in units of kN (s/m)

C - 0.010 (min) and 0.012 (s²/m²) in units kN s²/m²

c) Test the behavior of the new interface for various Shinkansen train sets shown in the Table below.

Table 1. High-Speed Rail Systems in Japan.

Train Set	A	B	C
Shinkansen 300	7.91	0.104	0.0109
Shinkansen 500	7.50	0.105	0.011
Shinkansen 700	7.92	0.10	0.010

Comment on how do you solve the issue of dealing with non-integer values for parameters A, B and C.