Assignment 4: VBA Programming

Date Due: February 23, 2022   Instructor: Trani

Problem 1

A simple formula used in storm water runoff calculations is presented in the equation below.

$$Q = C_f CIA$$

where:

Q = peak storm water runoff rate (ft^3/s)

C_f = runoff coefficient adjustment factor (dim)

C = runoff coefficient (dim)

I = rainfall rate (in/hr)

A = discharge area (acres)

The runoff coefficient adjustment factors are 1.0 for storm return periods 1-10, 1.1 for 25, 1.2 for 50, and 1.25 for 100. The return period is the probability that a storm will occur in a period of time (i.e., return period).

Table 1. Typical Values of Runoff Coefficients.

Surface	Runoff Coefficient (dim)
Forest	0.12
Asphalt	0.85
Brick	0.80
Concrete	0.86
Shingle Roof	0.88
Farmland	0.22
Pasture	0.21

a) Create a VBA Sub Procedure to estimate the runoff produced (Q) as a function of parameters C, C$_f$, I, and A.

All four parameters will be entered by the user in the worksheet. I suggest column A defines the parameter names, column B defines their numerical values and column C defines the units of each parameter. The output of the VBA Sub is the value of (Q).

The result is sent back to the worksheet and written in column format below the range of cells used to define the input parameters.

b) Test the VBA code created in (a) using the following parameters:

Area = 15 acres
Surface = Asphalt

Storm return period = 50 years
Rainfall intensity = 10 inches/hr

c) Improve the VBA code created in part (a) allowing the user to select the **surface** used in the runoff calculation. Create a separate table in the spreadsheet with "surfaces" and values of runoff coefficient (C). Replace the Excel cell location of runoff coefficient with a list of materials. Refer to the pavement thickness class example.

d) Run the improved code created in part (c) and create a table (see example below) in the spreadsheet with solutions for runoff for various rainfall rate intensities ranging from 0.25 to 10 inches per hour at steps 0.25 inches/hr.

Table 2. Format of your solution.

Rainfall Intensity (in/hr)	Runoff (ft³/s)
0.25	Your solution
0.50	…
…	….
10.0	….

e) Plot the solutions of runoff (Q) versus rainfall intensity (I) obtained in part (d). Label the axes appropriately.

Show sample screen captures of the spreadsheet output and the VBA code.

Problem 2

This problem deals with deflection calculations for a cantilever beam (i.e., a beam supported at one end to a wall) with a total load *W* distributed along the beam (see Figure 1). More information about the equations of the beam can be found at: http://www.engineersedge.com/beam_bending/beam_bending8.htm.
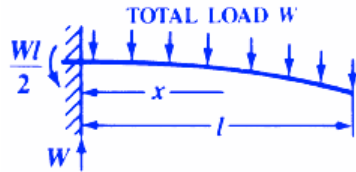

Figure 1. A simple beam supported at one end. Source: http://www.engineersedge.com/beam_bending/beam_bending8.htm

Nomenclature for beam deflection and stress calculation equations.

W = load (lb)
E = Modulus of elasticity (lb/sq-in)
I = Moment of inertia (in^4)
x = distance from datum point (in)
l = beam length (in)
d_N = distance from edge of beam to neutral axis (in)

y = deflection (in)
s = stress at the cross-section being evaluated (lb/in-in)
Z = section modulus of the cross section of the beam

Z is calculated as I / d_N

The stress (in lb/sq. inch) at the cross section of the beam is calculated according to the formula:

$$s = \frac{W}{2Zl}(l-x)^2$$

The deflection of the beam (y) (in inches) at any point along the beam (x distance from datum point) is given by:

$$y = \frac{Wx^2}{24EIl}[2l^2 + (2l-x)^2]$$

a) Create a VBA Sub Procedure to estimate the stress (s) at any station along a beam and the deflection of the beam (y) as a function of known quantities W, E, I, d_N and x. Your VBA subroutine should read the input values: W, E, I, d_N and I from the spreadsheet. These values will be entered by the user in the worksheet as shown in Figure 2. The output of the VBA Sub consist of values of stress (s) and displacement (y). These values should be sent back to the worksheet and written as a function of the beam station length x (see Figure 2). Write a loop inside the Sub Procedure to write the output back to the worksheet. The values of s and y should be calculated every 5 inches along the beam.

	A	B	C	D	E
1					
2	Beam Calculations				
3	Programmer: A. Trani				
4	Date: 02/14/07				
5			Units		
6	W	2000.00	lb	Calculation	
7	E	30000000.00	psi		
8	I	240.00	in-in-in-in		
9	*l*	300.00	inches		
10	dN	12.00	in		
11	Beam Station (in)	Stress (lb/sq.in.)	Deflection (in)		
12	0.000	15000.000	0.000		
13	5.000	14504.167	0.000		
14	10.000	14016.667	-0.001		
15	15.000	13537.500	-0.002		

Figure 2. Worksheet of the Beam Calculation Problem.

b) Test your VBA Sub procedure using the following values for the beam model parameters. Assume a beam is 250 inches in length and that we need to calculate the stress and deflection of the beam at various stations (say every five inches).

W = 1000 lb
E = 30e6 psi (steel)
I = 100 in^4
l = 250 inches
distNeutralAxis = 8 inches

c) Plot the solution of the steel beam deflections obtained in part (b). Label your plot accordingly.

d) Try the analysis for a 250 inch beam made of concrete with a value of E = 15e6.

Show all your screen captures of your code and the output produced by the VBA code.

e) Copy the beam deflections obtained for steel and concrete and compare the deflection profiles. Comment.

Show screen captures of the output produced and the VBA code.

Problem 3

Use two construction equipment files provided in the Syllabus (weekly Planner - see Week 4) to answer the problem. Create a Macro to do the following tasks in the constructionEquiment1_blank file:

a) Change color in the header of the file to light green.

b) Format all columns (individually) using conditional formats using the color scales (green = lowest value, red - highest value).

c) Reduce the number of significant figures to the right of the decimal to zero for the value of the equipment, miles traveled.

d) Reduce the number of significant figures to one for the age of the equipment.

e) Create a pivot table to count the equipment by type and status (two dimensions).

f) Create a pivot chart to plot the average value of the equipment by equipment type.

g) Repeat the macro created to constructionEquiment2_blank

h) Find the average value of the equipment of the two files. Comment.

i) Find the number of loaders active in both files. Comment.