CEE 3804: Computer Applications in Civil Engineering

Spring 2026

Assignment 4: VBA Programming and Excel Macros

Date Due: February 24, 2026   **Instructor: Trani**

Problem 1

Use the California Bus Company Excel file from assignment 2 to do the problem.

	A	B	C	D
1	City	Bus Type	Odometer (Miles)	Route length (miles)
2	Los Angeles	Gillig Hybrid 40	110,498	35.6
3	San Diego	Van Hool AG500	260,756	10.9
4	Los Angeles	Van Hool AG500	71,010	17.0
5	San Diego	New Flyer Xcelsior Hybrid	132,532	22.2
6	San Luis Obispo	Van Hool AG500	200,620	17.4
7	San Jose	New Flyer Xcelsior Hybrid	208,128	15.0
8	San Diego	New Flyer Xcelsior NG	49,451	35.8
9	Los Angeles	Gillig Hybrid 40	148,989	27.2
10	San Jose	New Flyer Xcelsior NG	91,645	13.0
11	Los Angeles	Van Hool AG500	83,841	25.8
12	San Diego	New Flyer Xcelsior NG	209,616	29.1

Figure 1. California Bus Company File (partial).

The goal is to create a Macro in the California Bus Company file and then apply it to another Excel file (called Virginia Bus Company). Record the macro in the California Bus Company file to do the following tasks:

a) Change the header background to yellow and make the text bold.

b) Changed the numerical values in the column labeled Odometer (miles) to include a comma to separate thousands and make the odometer readings integers.

c) Create a Pivot Table to find the average number of miles for each type of bus in California. Make the city a filter variable in the Pivot Table. Show the results for all cities in California, and also the results for San Luis Obispo. Make a screen capture of the Pivot Table to find the average odometer miles for all four buses in California.

d) Find the average number of odometer miles for the Gillig Hybrid 40. Highlight the answer.

e) Create another Pivot Table to find the average route length for each city in California. Show the results for all cities in California, and also the results for San Jose. Make a screen capture of the Pivot Table to show the results.

f) Show the first 20 lines of the macro created.

g) Apply the macro created in the California Bus Company file to the Virginia Bus Company file.

h) Verify that all procedures work. Report the average number of miles by bus type in all cities in Virginia.

i) Find the average number of odometer miles for the Gillig Hybrid 40 for all cities in Virginia. Highlight the answer. Compare to your answer in part (d).

Problem 2

A simple formula used in highway engineering to estimate the horizontal radius of a road is:

$$R = \frac{v^2}{g(e + f)}$$

Where:

R is the road horizontal radius (in meters)

v is the road design speed (m/s)

g is the gravitational constant (9.81 m/s^2)

e is the superelevation rate of the road (%/100). For example, a road with a superelevation rate of 0.06 implies the road is inclined at a slope of 0.06 meters vertical per meter of horizontal distance traveled.

f is the lateral friction force coefficient developed between the vehicle tires and the pavement. Table 1 provides some values of f for various design speeds.

Table 1. Values of Lateral Friction Coefficient as a Function of Design Speed.

Road Design Speed (m/s)	Lateral Friction Coefficient f (dim)
0	0.190
10	0.162
15	0.150
20	0.135
25	0.120
35	0.090

a) Plot the values of f (in the y-axis) versus design speed (x-axis) in Excel and estimate the best linear regression model to predict f for a given value of design speed.

b) Write down the equation to predict f given design speed. Use the trend function in Excel to do this part.

c) Create a VBA Subroutine to estimate the radius of the curve (R) given the design speed (v) and the superelevation rate (e). The calculation of f using the equation derived in part (c) is performed inside the subroutine according to the linear regression model.

d) Create a simple Excel interface to calculate the horizontal radius of the highway section given the design speed (v) and the superelevation rate (e). The speed values (in meters/second) should be included in a **validation list,** with a low value of 0 and a high value of 40 m/s, in steps of 5.0 m/s. The values of the superelevation rate should also be in a data-validated cell, ranging from 0 to 0.10 at steps of 0.01.

e) Test your VBA code and Excel interface to obtain the horizontal radius for the following design conditions. (See Table 2). Make a screen capture of the horizontal radius for the last value in Table 2.

f)   Improve the VBA code created in part (a) to make a table of horizontal radius of the curve versus speed for speeds ranging from 0 to 40 m/s at steps of 5 m/s. Assume a constant superelevation rate of 0.06. Create a plot in Excel with the appropriate labels for the resulting table (the table should be generated in code). The plot can be done in Excel.

Declare all your variables using Option Explicit.

Table 2. Testing Conditions.

Road Design Speed (m/s)	Road Superelevation Rate (m/m)
16.5	0.03
12.5	0.00
18.5	0.06
17.5	0.05
23.0	0.04
32.0	0.05

G)

Problem 3

The equation to predict the drag (D) of a train moving at speed (v) is given by the formula:

$$D = \frac{1}{2}\rho v^2 A C_d$$

where: ρ is the density of air (1.225 kg/cu.meter at sea level conditions), A is the reference area of the high-speed train (in sq. meters), C_d It is a non-dimensional drag coefficient unique to each train. Typically, the value of C_d is derived empirically from wind tunnel tests. In the formula above, the units of v are meters per second, and the units of D are in Newtons (since drag is a force). Table 2 shows general characteristics for some trains.

Figure 2. High-Speed Train in South Korea (A. Trani).

Table 2. General Characteristics of Some Trains.

Train	Drag Coefficient (dim)	Reference Area (m²)
High-Speed Train	0.27	6.7
Cargo Train	0.46	10.4
Subway	0.31	6.2
Double-Deck Train	0.36	11.3

a) Create a VBA subroutine to estimate the drag force generated by the train while traveling at a speed (v). In your analysis, create a simple Excel interface that allows the user to select the train type (a string from a data validation list) and then calculate the drag force (Newtons) for a given speed (meters/second). Display the drag force in the Excel interface.

b) Test the VBA code and the Excel interface showing the drag for a Cargo Train (show a screen capture). Repeat for the High-Speed Train (show a screen capture).

c) Add VBA code to part (a) to calculate the power required to overcome the drag force. The power required is:

$$P = Dv = \frac{1}{2}\rho v^3 A C_d$$

Write the calculated Power required in another cell in the Excel spreadsheet. Label the cell and also show the units of power.

d) Add **code to the VBA program** created in parts (a-c) to estimate the drag and power required for speeds ranging from 0 to 60 m/s. Display three columns with speed, drag, and power required in the Excel spreadsheet. Included headers and show the units of each column. Make a screen capture of the three columns and the program inputs for a subway train.

Declare all your variables using Option Explicit.