Assignment 3: VBA Programming

Due Date: February 16, 2026 (midnight)
Instructor: Trani

Problem 1

Improve the example Excel file to calculate the flexible pavement thickness demonstrated in class. The example discussed in class used the file named **loopConcatenate.xls** (see Figure 1).

	A	B	C	D	E	F	G
1							
2	Loop + concatenation Demo			Formula t = sqrt (load / (8.1 * CBR) + Area / PI)			
3	Prorammer: A. Trani						
4	Date: 02/14/07						
5			Units	Calculation			
6	Area	234.00	sq. inches				
7	CBR	10.00	dim				
8	Repetitions	6.00	dim				
9	Load (lb)	Pavement Thickness (in)					
10	35000	22.51					
11	36000	22.78					
12	37000	23.05					
13	38000	23.32					
14	39000	23.58					
15	40000	23.84					

Figure 1. Original Excel Program to Estimate Pavement Thickness under Various Tire Load Conditions.

1) Add a cell in Excel to place the lower bound (i.e., lowest value) of the applied load. Read the value in the cell and use it in VBA to start the loop.

2) Add a cell in Excel to place the upper bound (i.e., highest value) of the applied load. Read the value in the cell and use it in VBA to end the loop.

3) Add VBA code to calculate the applied load change needed consistent with the number of repetitions.

4) Add VBA code to query the value of CBR using an input box.

5) Test the changes in parts (A-D) and show me the answers in Excel and your new VBA code. Test the improved program with 10 load repetitions and a starting applied load of 30,000 lbs. and ending at 45,000 lbs.

6) Use the answers generated in columns A and B to make a plot (do that in Excel for now).

Problem 2

Raising atmospheric temperatures are a concern to Civil and Environmental Engineers. Climate models developed by the National Oceanic Atmospheric Administration - NOAA (U.S. Climate Resilience Toolkit) provide a glimpse at future temperatures in the United States for many cities. The Climate Explorer data can be accessed at:

https://crt-climate-explorer.nemac.org/

According to a US temperature forecast produced by NOAA, an approximation of rising temperatures for US cities can be estimated according to a quadratic (2nd-order polynomial) equation of the form:

$$T = A(year^2) + B(year) + C$$

where:

T is the Average Daily Max. Temperature (degrees F) for a given year at a city in the United States

A, B, C are coefficients of the equation above

$year$ is the year in question

The coefficients of the quadratic model for three cities in the US is presented in Table 1.

Table 1. Coefficients of Quadratic Model to Predict Temperature at Three Cities in the US.

City	Coefficient A	Coefficient B	Coefficient C
El Paso, Texas	0.00035415	-1.34558	1353.699
Washington, DC	0.00044905	-1.73891	1749.969
Anchorage, AK	0.00048901	-1.87050	1818.800

1) Create an Excel/VBA program (Subroutine or Sub) to estimate the value of temperature at a city selected by the user in Excel for a given year. The Excel interface should allow the user to select a city (by name) in the Excel interface using a Data Validation List as demonstrated in class for the pavement design example (see VBA notes). The Excel interface also provides a cell to select the year of the prediction. The values of the coefficients shown in Table 1 can be contained in the VBA code directly and must be selected via an IF-ELSEIF-END statement. The Excel interface must include a "Calculation" button to link the execution of the VBA program.

2) Improve the program in part (a) by adding a loop in VBA to calculate the temperatures of the city selected from 1970 to the year 2090 (at steps of five years). Use column A to write the year and column B to write the temperature in degrees Fahrenheit. Add labels to the top of the table including units.

3) Use Excel to enhance your program and make a plot (in Excel not VBA) of the temperature profile over time.

4) What city in the US may be more affected by rising temperatures in the future?

5) Give an example of a civil engineering infrastructure that may be affected by rising temperatures.

Problem 3

The formula presented below, is used by Civil Engineers to Stopping Sight Distance (SSD) on level grade. The value of *SSD* is an important parameter in the design of highways.

$$SSD = 1.47Vt + 1.075V^2/a$$

Where:

SSD is the stopping sight distance (feet)

V is the highway design speed (miles per hour)

t is breaking reaction time (seconds)

a is the vehicle design deceleration rate (ft/s^2)

Table 2 shows typical values of vehicle deceleration for various pavement design conditions.

Table 2. Typical Values of Deceleration Rate for Various Pavements.

Pavement Condition	Deceleration Rate (ft/s^2)
Dry Concrete - Grooved	11.2
Dry Asphalt	10.8
Wet Concrete - Grooved	8.2
Wet Asphalt	7.7

1) Create an Excel/VBA program (Sub) to calculate the value of *SSD* given three inputs: V, a, t. The program reads the three inputs using Excel as a simple interface and produces one output (*SSD*). The Excel interface allows the user to select the type of pavement condition in the form of a data validation list and then selects the appropriate deceleration rate in the calculation of *SSD* in VBA. Your program should the user to specify the value of design speed and reaction time in the Excel interface. Include the units of each parameter in Excel.

2) Test the program created in part (a) to estimate the stopping sight distance (SSD) for a vehicle traveling at 65 miles per hour on dry (grooved) concrete pavement. Repeat for wet concrete (grooved). Use a 2.5 second breaking reaction time in your calculations. Compare the two solutions and comment on the additional stopping distance needed when the concrete pavement is wet.

3) Add more code to the program in part (a) creating a table to estimate the values of *SSD* for speeds 10 to 70 mph at intervals of 10 mph. The table is created in another section of

the Excel spreadsheet. Create a table with design speed in column A and *SSD* in column B. Label your table appropriately. In your solution, show two tables with your solution: 1) SSD for dry asphalt and 2) SSD for wet asphalt.