Assignment 5: VBA and Matlab

Date Due: March 16, 2022 Instructor: Trani

Show all your work including VBA/Matlab code and results of your computation in the spreadsheet as screen captures. All VBA code needs to use Option Explicit to define the variables.

Problem 1

Reuse the program created in Assignment 4 of the class (Problem 2 of Assignment 4) to create a more user friendly version of the program. Refer to Problems 1 and 2 of Assignment 4 for the full description of the problem.

Review the formulas to estimate the deflection of a uniformly loaded beam at: https://mechanicalc.com/reference/beam-deflection-tables.

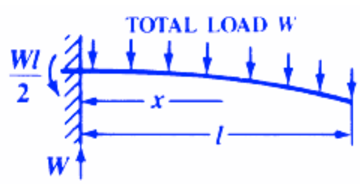

Figure 1. Uniformly Loaded Beam. Source: https://mechanicalc.com/reference/beam-deflection-tables.

W = load (lb)
E = Modulus of elasticity (lb/sq-in)
I = Moment of inertia (in^4)
x = distance from datum point (in). The datum point is the wall.
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:

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

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

L = beam length (inches)

x = beam station (inches) measured from the wall

E = Modulus of Elasticity (lbs/in^2)

I = moment of inertia of the beam (in^4)

W = applied load in pounds

δ = deflection in inches at the beam station (x)

a) Improve the code created in **Assignment 4** by adding a separate worksheet to the problem to act as Graphic User Interface to the program. In this new worksheet include the description of the problem and add a slider control to set the value of W (applied load) allowing the user to specify the value of W to be used in the problem solution. The interface should let the user select the lower and upper bounds of W (from 1000 to 4000 lbs) to be used in the VBA code behind the spreadsheet. Test the solution with values of W = 3000 lbs and W = 2500 lbs and the following beam values.

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

b) Improve the code created in part (a) to add a slider control allowing the user to specify the value of L (beam length) to be used in the problem solution. The new interface should let the user select the lower and upper bounds of L (100 to 250 inches) to be used in the VBA code behind the spreadsheet. Test the solution with values of L = 110 inches and L =200 inches and W = 3000 lbs.

c) Improve the code created in parts (a) and (b) and create a data validation list linked to a cell in your program allowing the user to select among a predefined set of step sizes to calculate the deflection along the beam. The data validation should specify the values of step size as follows: 5, 10, and 25 inches. Test the solution with values of L = 200 inches, W = 3500 lbs, and step sizes of 5 and 10 inches.

Problem 2

Use Matlab to solve this problem.

a) Use the Matlab **Import Data** functions (see Figure 1) to read the **Car_data** file on the Syllabus webpage (week 1). I suggest you import the data using the Output Table format shown in Figure 2.

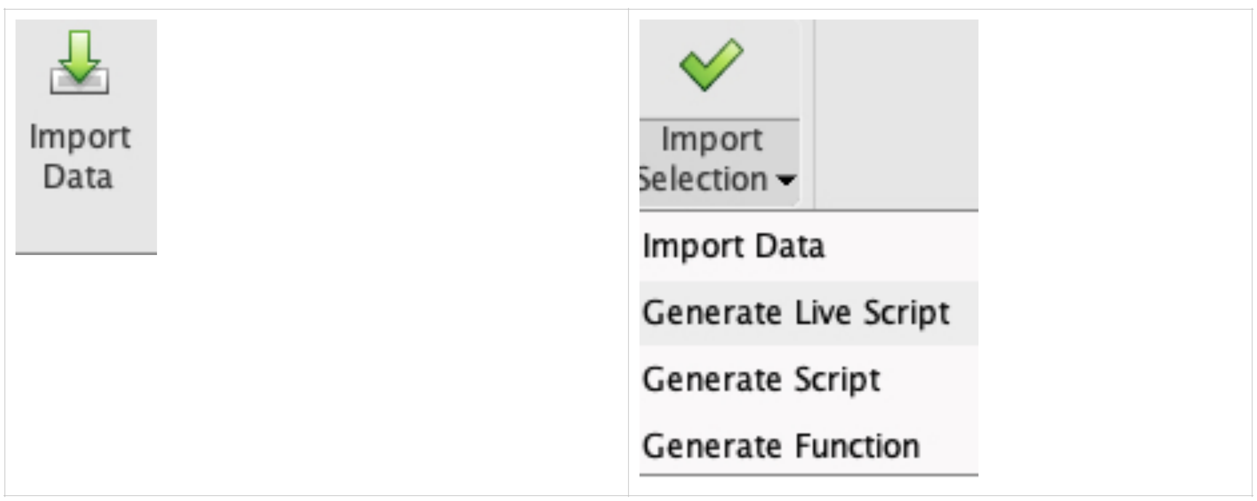

Figure 1. Import Functions in Matlab.

116x8 table

	1 Model	2 Country	3 Type	4 Weight	5 TurningCircle	6 Displacement	7 Horsepower	8 GasTankSize
1	"Acura Inte...	Japan	Small	2700	37	112	130	13.2000
2	"Acura Leg...	Japan	Medium	3265	42	163	160	18
3	"Audi 100"	Other	Medium	2935	39	141	130	21.1000
4	"Audi 80"	Other	Compact	2670	35	121	108	15.9000
5	"Audi 90"	Other	Compact	2790	35	141	130	15.9000

Figure 2. Table Output Format in Matlab.

b) Create an automatic script to import the data using Matlab's Generate script function (see Figure 1 right panel)
c) Improve the Matlab script created by Matlab (part b) to create the following standalone variables in the script: a) carWeight, b) carHorsepower, and c) carTurningCircle.
d) Improve the script in part (c) and plot carWeight versus carHorsepower. Use the following features in the plot:
    a. "o" as marker (no lines since data is not related)
    b. Red markers
    c. Marker size = 10
    d. Label X and Y axis accordingly including units
    e. X and Y labels with font size 20
    f. While plot background (no grey)
    g. Grid
e) Use the plot generated in part (d) to do Basic Fitting (see Figure 3):
    a. Create a linear regression model of carWeight versus carHorsepower
    b. Write down the equation of the line
    c. How good is the curve fit? This is related to the value of R-square (1 = perfect fit, 0 is no fit at all)

    d. For the linear curve fit, plot the residuals as a scatter plot. What is your interpretation of the residuals?
    e. According to the linear fit model and looking at the plot created in part (a), what is the estimated horsepower for a car weighing 3500 lbs?
    f. Will a quadratic polynomial fit improve the R-square statistic? Explain.

Figure 3. Matlab Tools and Basic Fitting.