Assignment 2: Excel Functions

Date Due: February 7,2020   Instructor: Trani

Show all your work including VBA code and results of your computation in the spreadsheet as screen captures.

Problem 1

A set of formulas to calculate the deflection (y) of a beam at a given station and the maximum deflection (δ_{max}) of the same cantilever beam subjected to a tapering load applied through the length of the beam are shown below. The beam diagram showing the situation is shown in Figure 1.

$$y = \frac{W_0 x^2}{120l(EI)}(10l^3 - 10l^2 x + 5lx^2 - x^3)$$

$$\delta_{max} = \frac{W_0 l^4}{30EI}$$

and $W = \frac{W_0}{l}(l - x)$ as the formula to estimate the tapering load at any station (x).
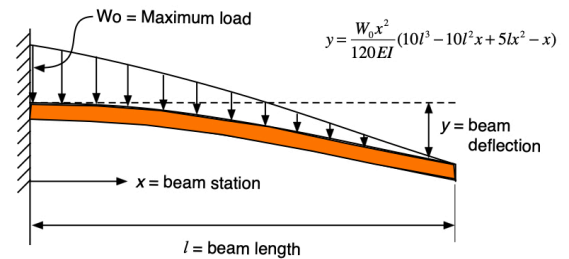

Figure 1. Beam Configuration.

where:

y is the deflection at any point along the beam (meters)

x is the distance from the support point of the beam to any point in the beam (meters)

l is the length of the beam (meters)

W_0 is the maximum load applied at the end point (N/m)

E is the Young's modulus of elasticity (N/m²)

I is the beam moment of inertia (m⁴)

a) Create an Excel Function (using Visual Basic For Applications) to calculate the deflection of a beam. The function should take the characteristics of the beam shown above and produce a single value output: the deflection (y). The function created in Excel needs to have the following arguments in the function list: x, l , W_0 , E and I . These are inputs needed to estimate the deflection y.

b) Use the function created in part (a) to estimate the deflections of a 9 meter steel beam at points along the beam spaced every 0.1 meters. Use the following numerical values: W_0 = 6000 N/m, E = 200e9 (N/m²) and I = 0.0001 (m⁴).

c) Plot the solutions obtained in part (c) and label accordingly.

d) For the beam described in part (b) estimate the maximum deflection at the end point of the beam.

e) Create a second Excel Function to calculate the maximum deflection (δ_{max}) of the beam of the type described above. This new function needs to have the following arguments: l , W_0 , E and I . Find the maximum deflection for the beam described in part (a).

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

Problem 2

The equation to predict the drag D or resistance force (in Newtons) acting on a high-speed 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/m^3 at sea level conditions), A is the reference area of the high-speed train (in sq. meters) and C_d 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).

A modern high-speed train has the following characteristics:

A = 6.3 square meters

C_d = 0.28 (dimensionless)

The power required (P) by the train is:

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

a) Create an Excel function to calculate the drag force as a function of various model parameters (ρ, v, A, C_d). All model parameters are input arguments to the function.

b) Use the function created to calculate the train drag (in Newtons) at 75 m/s.

c) Repeat part (b) for speeds ranging from 0 to 90 m/s.

d) Plot the results obtained in part (c) and label accordingly.

e) Create a second function to calculate the power required by the engine of the high-speed train.

f) Estimate the power required for speeds ranging from 30 to 90 m/s.

g) Plot the results and label accordingly.

Problem 3

An earthquake engineer derives a mathematical formula to predict the horizontal displacement of a building subject to an initial displacement of 3 cm. This horizontal displacement simulates a static force induced by an earthquake. The formula to calculate the horizontal displacement of the building (x) in centimeters over time (t) is:

$$x = e^{-k_1 t}(k_2 \cos(\omega t) + k_3 \sin(\omega t))$$

where: k_1, k_2, k_3 and ω are constants specific to each building and t is the time in seconds. The values of the constants k_1, k_2, k_3 and ω are: 0.025, 3.00, 0.238 and 0.315, respectively.

a) Create a VBA function to estimate the horizontal displacement (x) of the b uilding as a function of time (t).

b) Using the function created in part (a) calculate the building displacement for the first 100 seconds after the earthquake hits (from zero to 100 seconds every second). Display the values of displacement and time in two columns in the worksheet.

c) Plot the displacement (x) as a function of time in the worksheet. Label the axes accordingly.

d) Using the solution obtained in part (a) find the displacement of the building 60 seconds after the simulated earthquake strikes.

Problem 4

Use the file US airports that contains information about airports in the US. A sample of the data is shown below.

	A	B	C	D	E	F	G
1	Airport ID	Name	State	Air Carrier Passengers	Commuter Passengers	Latitude (seconds)	Longitude (seconds)
2	00V	MEADOW LAKE	CO	0	0	140204.6960N	376451.6160W
3	01G	PERRY-WARSAW	NY	0	0	153868.8480N	280987.4900W
4	02A	GRAGG-WADE FIELD	AL	0	0	118261.7400N	311801.1700W
5	02C	CAPITOL	WI	0	0	155115.0360N	317440.3290W
6	02G	COLUMBIANA COUNTY	OH	0	0	146423.9260N	290309.0630W
7	04Y	HAWLEY MUNI	MN	0	0	168781.7550N	346860.9350W
8	05C	GRIFFITH-MERRILLVILLE	IN	0	0	149471.4276N	314638.2287W
9	05U	EUREKA	NV	0	0	142575.0000N	417618.2150W
10	06A	MOTON FIELD MUNI	AL	0	0	116857.6980N	308448.1300W
11	06C	SCHAUMBURG REGIONAL	IL	0	0	151161.6270N	317164.4740W
12	06D	ROLLA MUNI	ND	0	0	175983.6280N	358635.1570W
13	06N	RANDALL	NY	0	0	149155.0580N	267809.7410W
14	07F	GLADEWATER MUNI	TX	0	0	117103.8268N	341898.2877W

a) Using the Excel "find" and "len" functions, identify the position of the letters (N, S, W and E) and length of data contained in each cell in the latitude and longitude columns.

b) Use Excel functions (such as "right" or "left") to read the numerical part of the latitude and longitude. Write the new values in a separate columns.

c) Use a pivot table to create a summary of the airports by state. How many airports listed are in California?

d) Use Excel pivot table to count the total number of air carrier passengers in the state of Virginia.

Problem 5

Fresno is building a new airport to replace the 46-year old facility. The local Government obtains financing for 356 million dollars needed for phase 1 of the airport design and construction. The loan has an interest rate of 4.2% per year.

a) Estimate the monthly payments to pay the loan over 30 years. Show all your Excel formulas and work.