

Assignment 8: Matlab Plots and Functions

Date Due: April 7, 2023

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Problem 1

Figure 1 shows a beam supported on both ends with a single load applied at a distance "a" and "b" from both ends.

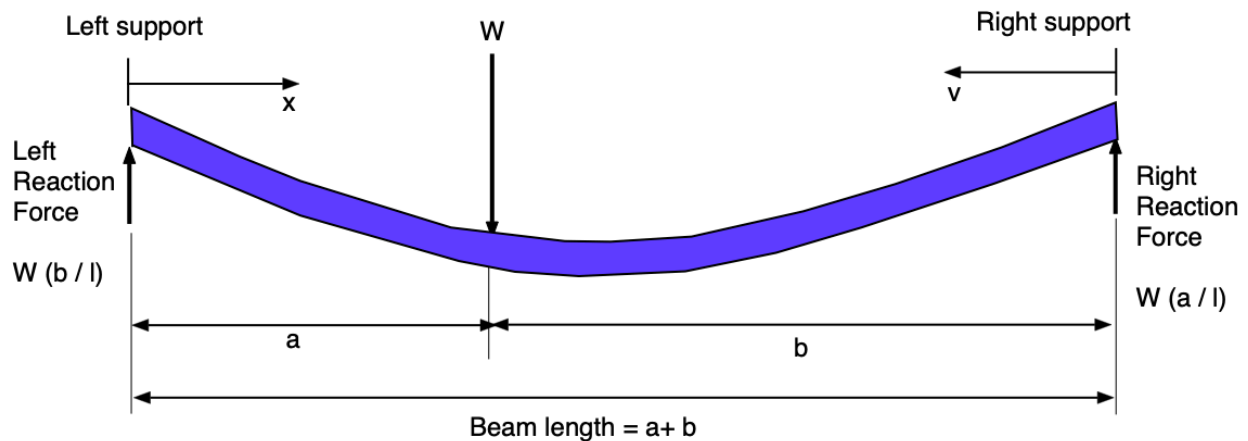


Figure 1. A simple beam supported at both ends with a load W at some known location. Adapted from: http://www.engineersedge.com/beam_bending/beam_bending3.htm. The nomenclature for beam deflection equations are shown below.

W = load (N)

E = Modulus of elasticity (N/m²)

I = Moment of inertia (m⁴)

x = Beam station (or distance) from left side of the beam to the loading point (m)

v = Beam station (or distance) from right hand side beam end point to the loading point (m)

l = beam length (m)

a, b = distances from each beam end point towards the loading point (m)

Let:

$$y_a = \frac{-Wbx}{6EI}(l^2 - x^2 - b^2)$$

$$y_b = \frac{-Wav}{6EI}(l^2 - v^2 - a^2)$$

where:

y_a = deflection of the beam from left support point (section a) in meters

y_b = deflection of the beam from right hand side support point (section b) in meters

Task 1

Create a Matlab **function** to estimate the deflections of the beam (y_a and y_b). The Matlab function should accept as input parameters W , E , I , a , b and vectors x and v . The output of the Matlab function are two vectors with values of deflection (y_a) and (y_b) for the given stations x and v . Your function should be able to handle vector operations.

Task 2

Create a separate Matlab script to test your Matlab function using the following values for the beam model parameters shown below. Clearly state the values of the deflections at the values of the beam stations (x and v) shown below.

$W = 4500$ N
 $E = 180e9$ N/m-m
 $I = 0.0005$ m⁴
 $b = 3.5$ meters
 $a = 2.5$ meters

Find the deflection of the beam (y_a) for values of x ranging from 0 to "a" with step size 0.01 meters. Also, find the deflections of the beam at stations v from 0 to "b" with step size 0.01 meters.

In the calculations for Task 2 define x and v as a vector to produce two output vectors of deflections (y_a) and (y_b).

Task 3

Make a subplot of the beam deflection (y_a) as a function of beam station (x). Make a subplot of the beam deflection (y_b) as a function of beam station (v). Arrange the subplots in a single figure with deflections y_a in the top plot.

Task 4

Combine the two deflection plots of Task 3 into a single plot that shows the deflections along the beam. For this plot, assume the datum point (station zero) of the beam is the left support. Show the y_a deflections in red and the y_b deflections in blue.

Task 5

Create another **Matlab function** to estimate the beam support reaction forces at the two support points. The function should accept as input variables the values of W , I , b , and a to produce two outputs (i.e., two reaction forces).

Problem 2

Table 1 contains dams in the Continental United States. The file contains the geo-location of each dam in terms latitude and longitude (in degrees). This file is slightly different than the file used in Assignment 7.

Table 1. United States Dams.

Name	DamID	Longitude_deg	Latitude_deg	County
ANZALDUAS DIVERSION	TX83301	-98.334	26.137	HIDALGO
DELTA LAKE UNIT NO 2 LEVEE	TX03790	-97.9367	26.43	HIDALGO
FALCON	TX00024	-99.167	26.559	STARR
STRUCTURE 79	FL00310	-81.7126	26.7255	LEE
G-90	FL00440	-81.41	27.34	HIGHLANDS
LAKE CASA BLANCA DAM	TX02267	-99.4483	27.5333	WEBB

Task 1

Create a Matlab script to read the data. You can reuse or modify the script created in Assignment 7.

Task 2

Add to the script created in Task 1 code to read a US map coastline (US_coastline.xlsx). This file contains latitude and longitude coordinates of the continental US (see Table 2). Plot the US coastline and also plot the locations of the US dams in the same map. You can use the "hold on" function in Matlab to keep a plot active to plot multiple data sets. Label the locations of US dams using blue circles with marker size 7. This last operation can be done outside the Matlab script if needed.

Table 2. United States Coastline File. File Contains Latitude and Longitude Points of the US Coast.

	Latitude_deg	Longitude_deg
1		
2	25.97	-97.13
3	25.95	-97.22
4	25.97	-97.27
5	25.93	-97.28
6	25.93	-97.33
7	25.92	-97.35
8	25.85	-97.35
9	25.83	-97.37
10	25.87	-97.4

Task 3

Add to the script created in Task 2 code to create a **separate plot** with the locations of the US dams with high (H) and significant (S) hazard levels (look for labels H and S in the Excel data). This plot should have the US map and the dams that meet the desired hazard level. Label de high hazard level dams using red circles and the significant hazard level in blue. The contour US map should be black.

	A	B	C	D	E	F
1	Longitude_deg	Latitude_deg	Station_Code	County	State	Station_Type
2	-82.440842	38.415405	HUN	Huntington	WV	RAIL
3	-97.930061	38.055859	HUT	Hutchinson	KS	RAIL
4	-85.469925	43.395729	HWC	Howard City	MI	BUS
5	-116.23317	33.714752	IDO	Indio	CA	BUS
6	-94.429298	39.086975	IDP	Independence	MO	RAIL
7	-86.160309	39.762154	IND	Indianapolis	IN	RAIL
8	-117.759193	33.674767	IRV	Irvine	CA	RAIL
9	-90.190598	32.300644	JAN	Jackson	MS	RAIL

Problem 3

Task 1

The negative exponential function is a continuous distribution that represents many Civil Engineering phenomena. For example, negative exponential distribution can be used to model times between arrivals at a traffic intersection. Similarly, a negative exponential distribution can be used to model the life-span (or years of survival) of bridges and highways.

Create a **Matlab function** to estimate the negative exponential function defined as:

$$f(x) = \frac{1}{\beta} e^{-\frac{x}{\beta}}$$

β is the parameter of the function

x is a random variable.

$f(x)$ is the negative exponential probability density function. The function requires two input parameters: β and x . The function returns the value of $f(x)$.

Task 2

Create a second **Matlab function** to estimate the cumulative negative exponential function ($F(x)$) defined as:

$$F(x) = 1 - e^{-\frac{x}{\beta}}$$

β is the parameter of the function

x is a random variable.

$F(x)$ is the cumulative value of the negative exponential probability density function. The function to estimate $F(x)$ requires two input parameters: β and x . The function returns the value of $F(x)$.

Task 3

Create a Matlab script to test the functions created in Tasks 1 and 2. Use the following parameters:

$x=0$ to 75 at steps 0.1

$\beta = 20$ (the parameter that represents the mean "survival" life of the system)

Plot the values of x versus $f(x)$ in a subplot at the top. Plot $f(x)$ in the y-axis). Plot $F(x)$ on a second subplot as a function of x .

Task 4

If the random variable $F(x)$ represents the cumulative probability of failure (opposite of survival) of a concrete highway pavement, and x is the number of years of life, estimate the probability of failure of a concrete pavement after 15 years of use.