Fundamentals and Applications of Matlab Summer 2021

Homework #1 (100)

Problem #1 (30)

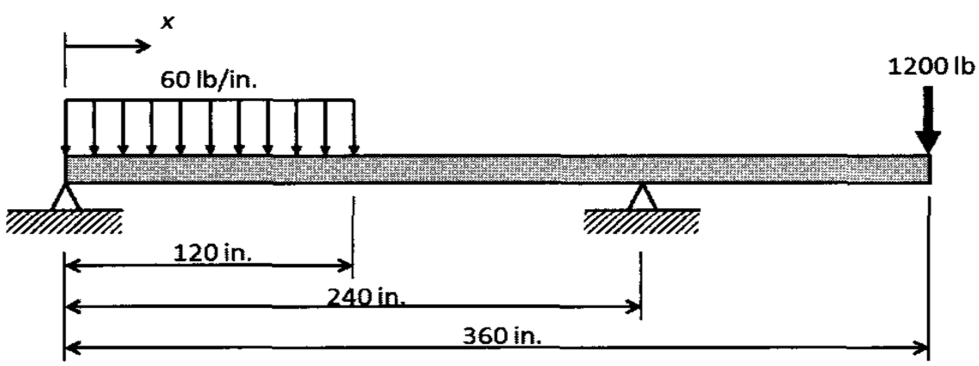
In a mechanics of materials course, you will learn how to calculate the deflections of beams. The use of *discontinuity functions* allows the equation for the deflection of a beam with multiple loadings to be written as a single equation. The definition of a discontinuity function is as follows:

$$\langle x-a\rangle^n = \begin{cases} (x-a)^n \text{ if } x \geq a \\ 0 \text{ if } x < a \end{cases}$$

For the steel beam shown in Figure, the deflection in inches of the beam can be shown:

$$v = \frac{1}{3.190e9}\left(800x^3 - 13.68e6x - 2.5x^4 + 2.5\langle x-120\rangle^4 + 600\langle x-240\rangle^3\right)$$

where is also expressed in inches.



Write a MATLAB script to plot the deflected shape of the beam and find the maximum absolute value of the deflection and its location from the left end in inches. Use ½-inch increments for calculating the deflections.

Problem #2 (35)

For Arbitrary convex polygon

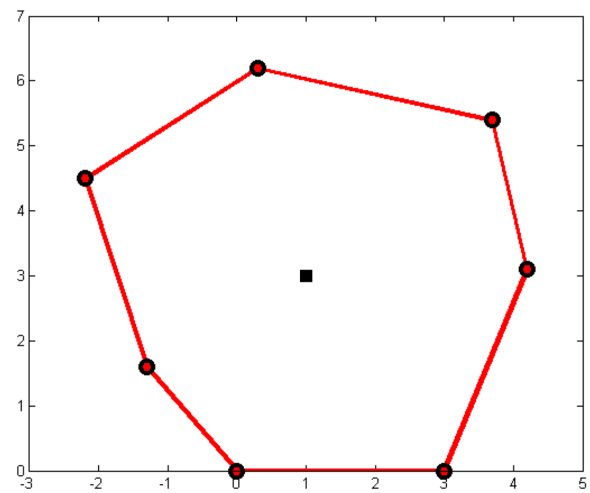
1. Calculate the area of an irregular convex polygon. The polygon is given by the set of points with coordinates x and y (see file Points.txt).
2. Calculate the coordinates of the centroid of an irregular convex polygon.

Write a Matlab script file, which should

1. Enter data from file Points.txt to Matlab workspace;
2. Draw the polygon;
3. Calculate the area of the polygon, print the answer to the Command Window;
4. Calculate the coordinates of the centroid of the polygon, print the answer to the Command Window.

You will get 10 extra points if you write functions to calculate the area and the coordinates of the centroid.

X	Y
0	0
3	0
4.2	3.1
3.7	5.4
0.3	6.2
-2.2	4.5
-1.3	1.6



Centroid of polygon (from Wikipedia)

The centroid of a non-self-intersecting closed polygon defined by n vertices (x_0,y_0), (x_1,y_1), ..., (x_{n-1},y_{n-1}) is the point (C_x, C_y), where

$$C_x = \frac{1}{6A}\sum_{i=0}^{n-1}(x_i + x_{i+1})(x_i\ y_{i+1} - x_{i+1}\ y_i)$$

$$C_y = \frac{1}{6A}\sum_{i=0}^{n-1}(y_i + y_{i+1})(x_i\ y_{i+1} - x_{i+1}\ y_i)$$

and where A is the polygon's signed area,

$$A = \frac{1}{2}\sum_{i=0}^{n-1}(x_i\ y_{i+1} - x_{i+1}\ y_i)$$

In these formulas, the vertices are assumed to be numbered in order of their occurrence along the polygon's perimeter, and the vertex (x_n, y_n) is assumed to be the same as (x_0, y_0). Note that if the points are numbered in clockwise order the area A, computed as above, will have a negative sign; but the centroid coordinates will be correct even in this case.

Do not use special Matlab functions to get the answers. You have to develop your own code.

Problem #3 (35)

Home loans are usually made for 15- or 30-years periods, with payments made monthly. An amortization table is often useful for a borrower to see how much interest is being paid each month, and the remaining balance of the loan each month. Consider a 30-year $200000 loan at an annual interest rate of 6.0% (360 payment periods, interest is 0.5% per month). From economic formulas, we can calculate that the monthly payment should be $1199.10. Write a Matlab program to create a text file containing an amortization table for this loan. For each month, show the balance before the payment is made (the previous balance times 1.005), the payment, and the new balance after the payment is subtracted. Format the table similar to shown on the figure (only 12 of 360 lines shown). Use a while loop to determine when the balance goes below zero and add a formatted statement at the end of the file to show the overpayment that will be refunded to the borrower, as shown on the figure.

The $1199.11 payment was rounded up to the nearest cent, resulting in a slight overpayment over the 360 months. If the payment had been rounded down to $1199.10, then there would be a small balance remaining after 360 payments).

Month	Beginning Balance	Payment	Ending Balance
=====	==========	=======	=======
1	201000.00	1199.11	199800.89
2	200799.89	1199.11	199600.78
3	200598.79	1199.11	199399.68
4	200396.68	1199.11	199197.57
5	200193.55	1199.11	198994.44
6	199989.42	1199.11	198790.31
7	199784.26	1199.11	198585.15
8	199578.07	1199.11	198378.96
9	199370.86	1199.11	198171.75
10	199162.61	1199.11	197963.50
11	198953.32	1199.11	197754.21
12	198742.98	1199.11	197543.87
359	2383.31	1199.11	1184.20
360	1190.12	1199.11	-8.99

Final balance to be refunded = 8.99