ENGR 231 – Linear Engineering Systems Spring 2016-17
Lab 8

The objective of this lab is to review functions and introduce homogeneous coordinates. These concepts will be continued next week when we implement a subset of PACMAN in Matlab.

Create a ".m file" called: **lastname_initials_lab6.m**. The mfile MUST contain cells and must be published as a PDF. Upload correct solution to bblearn. All figures must be annotated, all cells named.

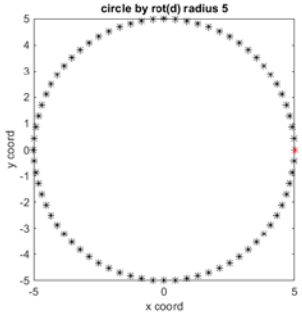
Perform the following tasks (label cells as task numbers). Note the first cell (unnumbered) should be your Name, section number and the version of this Assignment. Tasks follow:

1. Create a function called trans(dx,dy). The function should return the matrix: $\begin{bmatrix} 1 & 0 & dx \\ 0 & 1 & dy \\ 0 & 0 & 1 \end{bmatrix}$. Make sure any intermediate results are suppressed. Test you function by typing in at the command line `trans(5,-5.2)* [1;1;1]` the result should be [6; -4.2; 1]. The function MUST be in its own mfile named as the function. To print out the function in a cell include the command type trans.m Then follow this commands to show the test vector.

2. Do the same as cell 1 but Make another function called rot(ang_deg). The function should return the matrix: $\begin{bmatrix} \cos(d) & -\sin(s) & 0 \\ \sin(d) & \cos(d) & 0 \\ 0 & 0 & 1 \end{bmatrix}$. Make sure sin and cos handle degrees. Test using `rot(-45)*[1;0;1]` result should be [0.7071; -0.7071; 1]

For now suffice it to say that these functions operate on **homogeneous coordinates** vectors [x; y; 1], i.e. the last element is a "1". This is vector space with different {+, .}

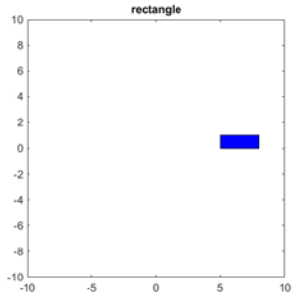
3. We will now use rot(d) to plot a circle centered at (0,0) and with a radius of 5. Think about it this way there is a vector from the origin to x = 5 and as we rotate it ccw, the tip traces the perimeter of the circle.
   - Define p = [5; 0; 1] a vector at x=5 y=0 in homogeneous coordinates
   - Plot the x, y coordinates of p with a red star
   - Then compute p = rot(5)*p; and plot the x, y coordinates as a blue star.
   - Use a for loop and create a circle as shown below do not go past zero – red *
   - Hint: use the command **axis square** at the end so it looks like a circle.



4. The power of homogeneous coordinates and rot() and trans() is that they allow us to operate on figures defined as a set of vertex points. Copy the following code into cell 4 and execute it. The x and y coordinates define the corner points of the rectangle. The variable **rectf** are the coordinates in homogeneous coordinates

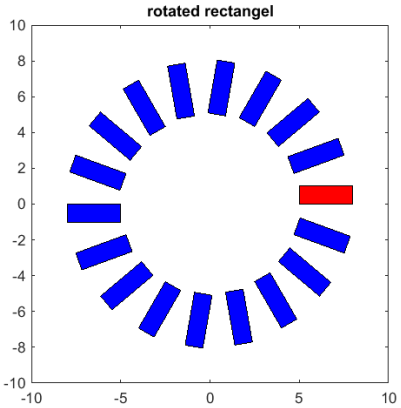
```
x_coords = [5 8 8 5];
y_coords = [0 0 1 1];
rectf = [x_coords; y_coords ; 1
1 1 1];
figure
fill(rectf(1,:),rectf(2,:), 'b')
axis square
title('rectangle')
axis([-10, 10, -10, 10])
```

You should get the following result:



5. Use the trans(dx,dy) operator to find the points of rectf if all the points are translated by 10 units in the x direction. Using that result, translate 5 units in the y direction. Plot the original figure plus both translation results on same plot in different colors.

6. Create a plot that shows the rotation of rectf about the origin in increments of 20 degrees. The first one should be red followed by blue or another color. See part 3 for hints remember to use a loop.



Next week we will learn how to rotate an object about a point other than the origin.

7. Create a square using vertex points (see sample code). Make sure you use homogeneous coordinates. The center of the square should be at (0,0) and the width and height should be two units. Plot the figure to check your work. Then rotate the square 30 degrees and plot in another color.