MATLAB HW #1:

Submit your solution documents on Canvas (see end for submission checklist).

1) Create a MATLAB function for the ^ operator that takes a $3x1$ unit vector, $\omega \in \mathbb{R}^3$, as the input and creates the skew-symmetric matrix defined in equation 2.4 of the textbook. To create the function, create an M-file that looks like this (***you will need to modify this function (it is incorrect as shown!) and use your own initials instead of mine***):

```
function [ w_hat ] = hatCKB( w )

w_hat = [ w(1) w(2) w(3) w(1) w(2)];
```

Here's how an example of calling this function and the correct output:

```
hatCKB([1 2 3]')

ans =

   0    -3     2
   3     0    -1
  -2     1     0
```

2) Create a MATLAB m-file function that calculates the matrix exponential of $\hat{\omega}\theta$ using Rodriguez' formula. The function should return:

$$e^{\hat{\omega}\theta} = I + \hat{\omega}\sin(\theta) + \hat{\omega}^2(1 - \cos(\theta))$$

for a given rotation axis ω and angle θ. Name your function **exprCKB.m** *(this function should call your* **hatCKB.m** *function)*. Verify that your function works correctly by comparing the output from expm in MATLAB.
Here's how an example of calling this function and the correct output (and the same calculation using expm) :

```
exprCKB([0 1 0]',pi/2)

ans =

   0.0000         0    1.0000
        0    1.0000         0
  -1.0000         0    0.0000

     expm(hat([0 1 0]'*pi/2))

ans =

   0     0     1
   0     1     0
  -1     0     0
```

3) Use your created **expr.m** function in a separate M-file to rotate a square. The corners of the un-rotated square have the coordinates (x, y, z): {1,1,0}, {1,2,0}, {2,2,0}, {2,1,0}. To plot this square shape, create a matrix of points where the first row is x values, the second row is y values, the third row is z values, so that each column is a point on the square. With the points in a matrix in this way they can all be rotated at the same time. Put them in the order required to make the square, and repeat the first point to close the loop. To plot the points in 3-dimensional space, use the command:

```
plot3(square(1,:),square(2,:),square(3,:),'b-') %plot in 3-D using blue lines ('b-')
```

4) Using a for-end loop, plot the square rotated about three separate axes at steps of 10° (all on the same figure). The first should be about the z-axis, using blue lines, the second should be about the line $y=-x$ (careful that $\|\omega\|=1$) using green lines, and the third should be about an axis of your choosing using red lines. Plot all in the same figure, and make sure grid lines are visible using the grid on command. Also, use the view(3) command to create an isometric view. Be sure to label your axes (x, y, and z) and save the figure. Don't add a legend, as it will make the plot smaller. To create a for-loop, use the following syntax:

```
figure(1)
grid on
view(3)
for th=10:10:360        % this syntax creates a loop from theta=10, with a step
                                      % size of 10 to the final value of theta=360. Commands between
                                      % the 'for' and the 'end' will be repeated at each step value
end
```

MATLAB HW #1: WHAT TO SUBMIT

Complete the above and submit ***the following individual files*** (*do not zip*!) on Canvas (use the name format provided):

A. **HW01_Lastname_plot.pdf**: A single PDF document of the assigned plot *(use your last name, not mine!)*. Use "Copy Figure" from the "Edit" figure menu and paste it into a Word document or similar. Do not include figure windows, menus, etc. Avoid shrinking the plot when inserting it into Word (or similar) and set the fonts to 12 pts. or higher.

B. **HW01_Lastname_main.m:** your main m-file *(use your last name, not mine!)*

C. **exprCKB.m:** your function file *(use your initials, not mine!)*

D. **hatCKB.m:** your function file *(use your initials, not mine!)*