1. Do Problem 4.1–1. The header for this table should be

| theta (in degrees) | s1(theta)-s2(theta) | s3(theta)-s4(theta) |

2. I think that the sine, cosine, and tangent functions get too much attention in the world, so we are going to play around with the secant, cosecant, and cotangent functions. However, we don’t want the curves to blow up because all we will see are some vertical lines. Instead, we will use some “funny” variations of them.

(a) However, first, plot sec x, csc x, and cot x for $x \in [0, 2\pi]$.

(b) Plot the three functions

\[
\begin{align*}
    f_1(x) &= \frac{1}{1 + 2\sec(\cot x)} \\
    f_2(x) &= \frac{1}{1 + 2\csc(\sec(\cot x))} \\
    f_3(x) &= \frac{1}{1 + 2\sec x \csc(\sec(\cot x))}
\end{align*}
\]

in separate plots for $x \in [0, 2\pi]$. Put all six plots in one figure.

3. Do Problem 4.2–3.


5. In this problem we will play around with some functions and their inverses.

(a) We begin with $y = \sin x$.

(i) Plot $y = \sin x$ for $x \in [-\frac{1}{2}\pi, +\frac{1}{2}\pi]$. Label the axes $x$ and $y$ and put “$y = \sin(x)$” at the top.

(ii) Flip the entire plot about the $45^\circ$ line so that the $x$ is now the vertical axis and the $y$ axis is now the horizontal one. Include the labels on the axes and put “$x = \arcsin(y)$” at the top.

(iii) Finally, generate a new plot by switching “$x$” and “$y$” in the previous plot, and put “$y = \arcsin(x)$” at the top. Put all three plots side by side.

(b) Next, we focus on $y = \cos x$.

(i) Plot $y = \cos x$ for $x \in [0, \pi]$. Label the axes $x$ and $y$ and put “$y = \cos(x)$” at the top.

(ii) Flip the plot about the $45^\circ$ line again, and put the appropriate labels on the plot.

(iii) Finally, switch “$x$” and “$y$” in the previous plot.

(c) And last, we focus on $y = e^x$.

(i) Plot $y = e^x$ for $x \in [-4, +4]$. Label the axes $x$ and $y$ and put “$y = e^x$” at the top.

(ii) Flip the plot about the $45^\circ$ line again, and put the appropriate labels on the plot, ending with “$x = \log(y)$”.

(iii) Finally, switch “$x$” and “$y$” in the previous plot.
Note: All 9 plots should be put in one figure.

6. (a) Plot the surface

\[ f(x, y) = (16 - x^2y^2) \left( 1 - 0.4 \sin(\frac{1}{2} \pi x) - 0.2 \sin^2(\pi x) \right) \]

for \( x, y \in [-2, +2] \).

(b) Plot the surface

\[ g(r, \theta) = (20 + 4r^2 - r^4) \left( 1 - 0.05r^4 \cos(3\theta - 5r) \right) \]

for \( r \leq 2 \).

Hint: (For this part only) The script m-file coner.m is very similar.

Note: Choose \( \Delta x \), \( \Delta y \), \( \Delta r \), and \( \Delta \theta \) small enough that the surface is easy to view, but not so small that it seems like a solid mass.

7. The MATLAB function \texttt{randperm} permutes the numbers 1 to \( n \), so let’s see how far it “moves” the numbers. That is, it begins with the vector \( \mathbf{v} = (1, 2, 3, \ldots, n)^T \) and permutes it to \( \mathbf{w} \) which is some reordering of the elements in \( \mathbf{v} \) (including not changing anything at all, whose probability is \( 1/n! \)). So do a Monte Carlo simulation by repeatedly doing this reordering, say \( m \) times, and storing \( |w_i - v_i| \) in an \( m \times n \) matrix. Convert this matrix to a vector and use \texttt{hist} to generate a nice histogram. Do this for \( n = 10 \), then \( n = 20 \), and finally \( n = 30 \). Put all four below each other using \texttt{subplot} and put the mean and standard deviation on each plot using \texttt{title}.

Warning: Make sure that the width of each bin is 1.

8. Last week in Problem 3.4–1 you converted a permutation of the integers in \( \mathbb{N}[1, 26] \) to the letters of the alphabet. This week, continue your previous code to do the following.

(a) Print out the alphabet again, both lower and upper case. However, there should a comma following each letter — except for the last one.

(b) Print out the alphabet again, both lower and upper case. However, there should a comma and a space following each letter — except for the last one.

Hint: If you are having trouble following letters by another character, consider

\[
\begin{align*}
&>> n = 5; \\
&>> r(2:2*n) = 2; \quad >> r
\end{align*}
\]


Homework rules:

1. All parts of a problem must be together — not spread out throughout all the problems.
2. All the problems must be held together by a staple or clip so that they don’t fall apart.
3. The MATLAB code for each problem must be included, and it must be at the end of \texttt{THAT} problem — not anywhere else!