MEE383
Exam 1
Free response

3) **What trends do you observe in the data results from the plots? (i.e. what are functional shapes?)**

   The curves of change in internal force seem to follow a polynomial function. The slope of the functions seems to be quite small this is probably because the change in loading is relatively small compared to the total loading.

   How does this identify the extrema conditions that could be considered in the design evaluation?

   By identifying features of the different curves such as its nth derivative or integral or min/max values. One example is that it is easy to tell from the graph that the EG member will never experience any loading.

5) **Which dimension condition(s) allow for nearly equal distribution of tension values?**

   Large values of T and V minimize the maximum change in tension.

   How is the dimensional condition similar or different for the most equal distribution of compression forces?

   The graph shows that the minimum change in compression is experienced when V = 1 and T = 2.

   Which link(s) change between tension and compression values depending on the geometry?

   From the code, we see that CH and DH change from compression to tension or vise versa.

   offer a general principle one would suggest for strut dimensions R → W that would benefit design.

From the analysis above it seem that Increasing the values of R and W would result in the tensions and compressions being more uniform, benefiting the design.

6) **Using the activities from Problems #1 through #5 above as examples, explain whether the inverse should be included within every for loop calculation or if greater efficiency can be implemented doing the inverse a single time**.

   Calculating the inverse every time is unnecessary. It would be more efficient to compute if instead, we decomposed the matrix into upper and lower triangles. We can then increment those appropriately and multiply them together to get the inverse of the matrix we had in the loop.

7) **Explain why the values in the graph are increasing or decreasing during the evaluation period.**

   The values that I got oscillated between 65 and 66 minutes. The actual delta t between 180-degree occurrences is greater than 65 minutes and less than 66 minutes. However, the code is discrete, meaning it can only register an integer delta t, causing the value to switch between being registered as 65 and 66.

8) **Explain your process to compare hand locations to obtain angular values and how the conditional statements of the search were applied.**

   I made arrays of the angular displacement. Looping the values to keep theta between 0 and 360 degrees. By iterating through all the indices and running two consecutive if statements I was able to find the values where the minute, second, and hour hand are 120 degrees apart.

10) **What important features do you see when $z \to 0$?**

   The forces approach infinity as z approaches 0.

   How might one predict this behavior before having the calculate the solution to the system of equations?

By calculating the determinant before we solve the system we can know if there is a value that returns NAN. We can do this because the determinant will return 0 if the solution doesn't have a valid solution. We can also predict this result by looking at the vector forces in the truss.

11) **compare the forces in the links that have z-components versus those links that only point in the bottom plane**

I can't find a strong correlation between the forces with z components and those without a z component. However, the magnitude of the slope seems to be significantly larger for the links without a z component.

13) **How does the magnitude of the determinant correlate to the magnitude of force calculations from the matrix inverse?**

As the determinant gets larger the magnitude of the forces approaches zero.

What is the approximate location of B when the distinct behavior of the determinant can be observed?

B is approximately at (0.5,6.372) when the determinant flips between positive and negative values.

Why does linear algebra math support the mechanical intuition for that critical case?

As we know the determinant represents the extent of a system. As the extent of the system shrinks some of the forces have to grow in order to keep the system in static equilibrium. Because of this, the forces grow exponentially as the determinant approaches zero.

14) **How does the determinant correlate with the conditions for extremely large forces?**

As seen in question thirteen the forces get exponentially larger as the determinant approaches zero