ECE 450 - Homework #12

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1 ECE 450 - Homework #12

1.0.1 Package Imports

In [2]:
```
import numpy as np
import seaborn as sns
import pandas as pd
import matplotlib.pyplot as plt
from scipy import signal as sig
from control import margin, tf
import warnings
warnings.filterwarnings('ignore')
```

1.0.2 Generic function to plot the responses of a system

In [4]:
```
# Color list for multiple lines on each subplot
colors = ["red", "blue", "green", "gray", "purple", "orange"]
step_size = 0.005

# Generic Function to create a plot
def create_plot(x, y, xLabel=["X-Values"], yLabel=["Y-Values"],
                title=[("Plot", )], num_rows=1, size=(18, 14), logx=False):
    plt.figure(figsize=size, dpi=300)
    for c, (x_vals, y_vals, x_labels, y_labels, titles) in enumerate(zip(x, y, xLabel, y
        for c2, (y_v, t) in enumerate(zip(y_vals, titles)):
            plt.subplot(num_rows, 1, c + 1)
            # Add a plot to the subplot, use transparency so they can both be seen
            plt.plot(x_vals, y_v, label=t, color=colors[c2], alpha=0.70)
            plt.ylabel(y_labels)
            plt.xlabel(x_labels)
            plt.grid(True)
            plt.legend(loc='lower right')
            if logx:
                plt.xscale("log")

    plt.show()
```

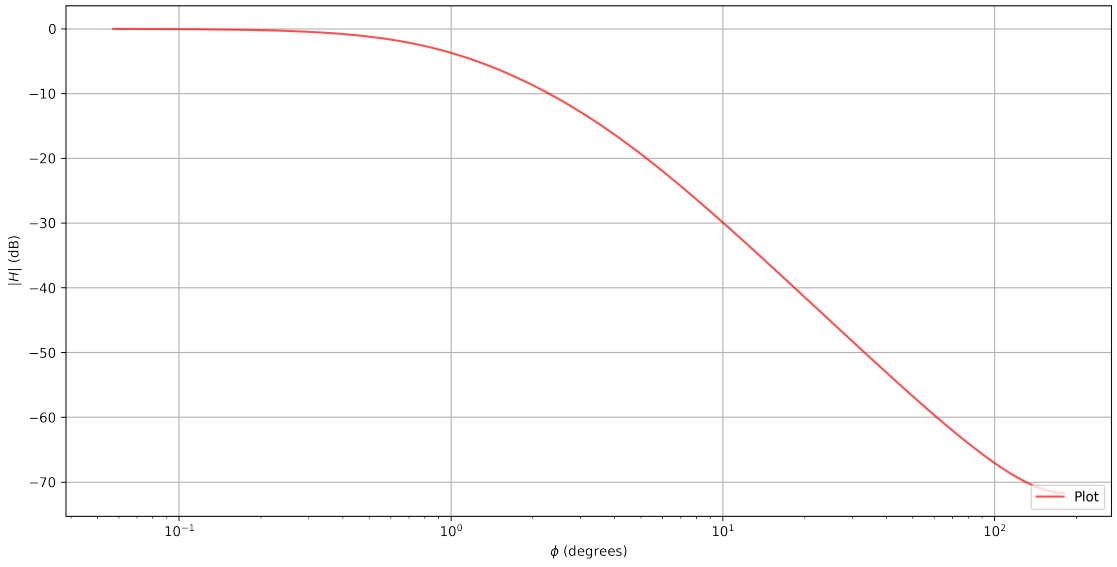
1.0.3 Generic function to generate the $|H|$ and ϕ values of a $H(z)$ function

```
In [42]: def z_plot(num, den, T):
             phi = np.arange(0.001, np.pi, T)
             angles = angles = [np.exp(complex(0, angle)) for angle in phi]

             # Loop through all angles, calculate that angles H(z)
             h_z = []
             for z in angles:
                 num_sum, den_sum = 0, 0
                 for z_pow, num_val in enumerate(num):
                     num_sum += num_val * z ** (len(num) - z_pow)
                 for z_pow, den_val in enumerate(den):
                     den_sum += den_val * z ** (len(den) - z_pow)
                 h_z.append(num_sum / den_sum)

             return np.multiply(180 / np.pi, phi), 20 * np.log10(h_z)
```

1.1 Problem 9.1.1

$$H(z) = \frac{0.001z}{z^2 - 1.921z + 0.922}$$

```
In [43]: num = [0.001]
         den = [1, -1.921, 0.922]
         T = 0.001

         hz_x, hz_y = z_plot(num, den, T)
         create_plot([hz_x], [(hz_y, )],
                     ["$\phi$ (degrees)"], ["$|H|$ (dB)"], logx=True, size=(14, 7))
```



1.2 Problem 9.1.2

Design a hardware implementation of Equation 9.1.15

$$H(z) = \frac{0.001z^{-1}}{1 - 1.921z^{-1} + 0.922z^{-2}}$$