Yusuf Ziya Dilek
Electrical and Electronics Engineering Department, Bilkent University, 06800 Ankara, Turkey

1. Introduction

In this lab we were tasked with identifying the properties of a physical DC motor in frequency domain. We will be inputting sinusoidal signals with varying angular frequencies to the hardware.

2. Laboratory Content

Q.1

In this question we need to generate and draw the bode plot of the estimated transfer function that we have found in previous lab. Which was:

$$T(s) = \frac{14}{(0.1022)s + 1}$$

We used this Matlab code:

```
w = logspace(-1,2,100);
for k = 1:100
    s = 1i * w(k);
    G(k) = 14 / (0.1022*s+1);
end

subplot(2,1,1)
semilogx(w,20*log10(abs(G)));
title("Magnitude");
xlabel("Hz");
ylabel("dB");
grid on

subplot(2,1,2)
semilogx(w,angle(G)*180/pi)
title("Phase");
xlabel("Hz");
ylabel("degrees");
grid on
```

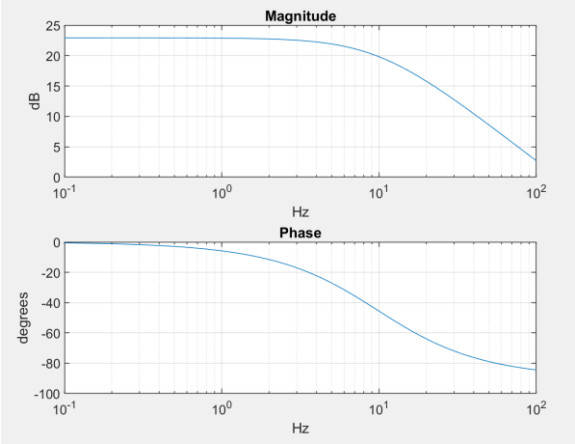

Figure 1. Bode plot of estimated transfer function

Q.2

For this part we have used this as input:

```
angular_frequency=0.1;
duration=70;
t=0:0.01:duration;
input=10*sin(angular_frequency*t);
output=vel_0_1.data;
```

where the angular_frequency is set to = 0.1, 0.3, 1, 3, 10, 30, 100 rad/s

First 3 frequencies (0.1, 0.3, 1 rad/s) vs. output:

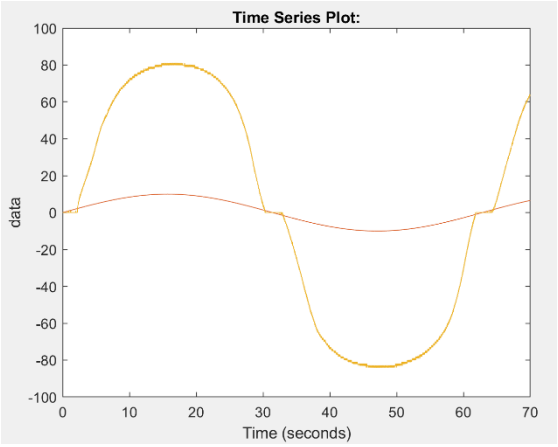

Figure 2. Frequency is 0.1 rad/s T ~ 60

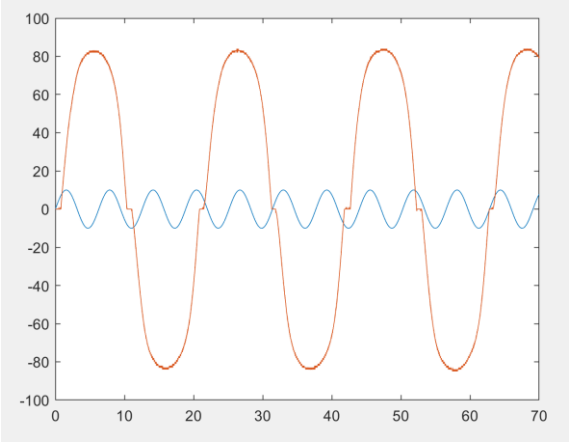

Figure 3. Frequency is 0.3 rad/s T ~ 20

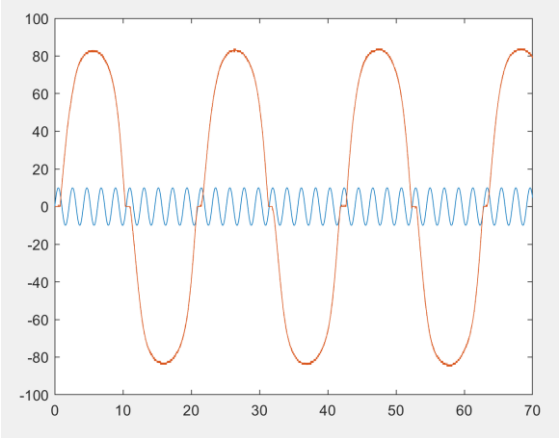

Figure 4. Frequency is 1 rad/s

K and the phase values are marked in approximation bode plot:

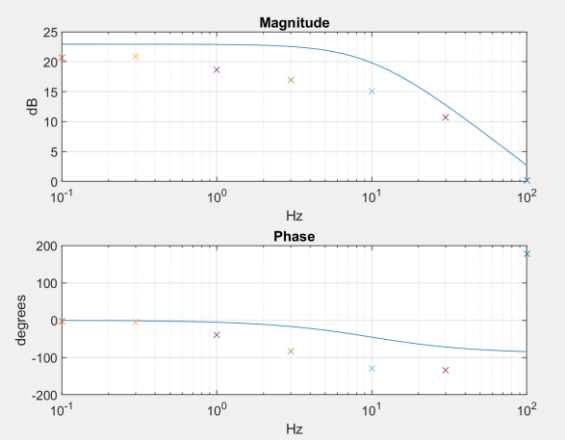

Figure 5. Values are marked (100 rad/s phase is need to be subtracted 360, I did not see it in the lab)

Magnitude results are follows similar pattern but phase is becomes very inconsistent as the frequency increases.

Q.3

We add this transfer function to compensate for the delay (10 ms):

$$G_{delayed}(s) = G(s)\frac{1 - 0.005s}{1 + 0.005s}$$

Now we can plot 3 different bode plots in the same figure, this plot is better looking compared to figure 5 I have adjusted the scales for phase graph:

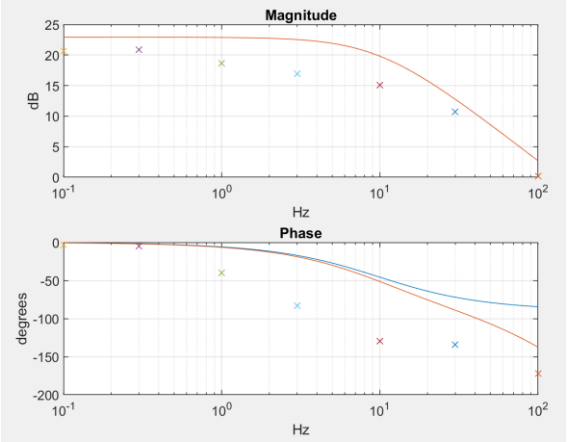

Figure 6. 3 bode plots

3. Conclusion

In conclusion, we can say that the magnitude values of hardware results are very close to the approximation. However, the phase values drops significantly faster as we increase the frequency. This situation is surely caused by the 10ms delay in the motor which can be approximated with the transfer function in the question 3.