# EE342 Lab-2 Preliminary Report

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## 1. Introduction

This preliminary work consists of two different parts. In the first part we are given a transfer function for a DC motor and are asked to draw bode plots for both the magnitude and the phase of the transfer function.

In the second part, we are asked to input 10 different sinusoidal signals to the system whose transfer function is from part 1. We obtain 10 different outputs and find the transfer functions from the input/output relations for different frequencies. Then, we compare the analytical dataset with the initial transfer function.

We use the properties of LTI systems and complex sinusoidals. Also, we use the FFT operation for extracting the magnitude and phase in the analytical part.

## 2. Laboratory Content

### 2.1. Part 1

At the lab manual we were given an example transfer function for a DC motor as the following **(1)**.

$$G(s) = \frac{20}{0.5s+1} \quad \textbf{(1)}$$

Here you can see the magnitude and the phase bode plots of the DC motor with the transfer function in **(1)**.

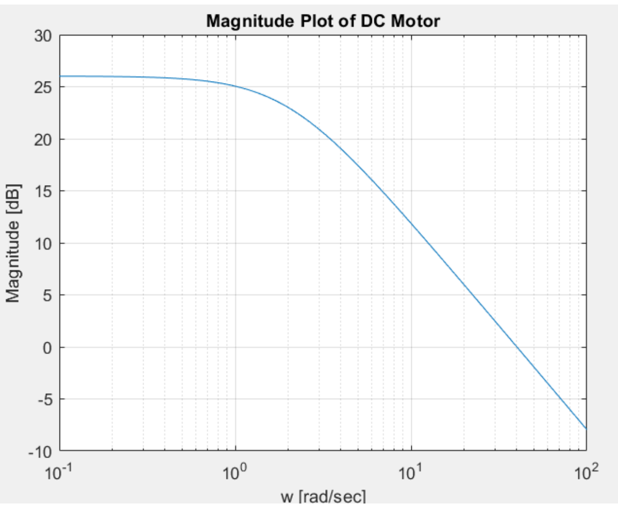


**Fig. 1:** Magnitude Plot of DC Motor

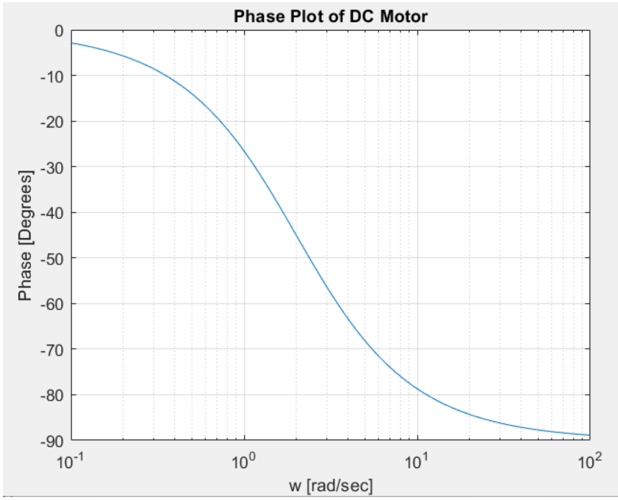


**Fig. 2:** Phase Plot of DC Motor

### 2.2. Part 2

In this part we used 10 sinusoidal inputs to the system to obtain outputs with different frequencies. For the sake of simplicity, we chose the following function as the input of the system **(2)**.

$$x(t) = \cos(\omega t) \quad \textbf{(2)}$$

Since complex sinusoidals are eigenfunctions of LTI systems, the output function becomes as the following **(3)**.

$$y(t) = |G(jw)| \cdot \cos\big(\omega t + \angle G(jw)\big) \quad \textbf{(3)}$$

We picked 10 different frequency points by logarithmically scaling the points between 0.1[rad/s] and 100[rad/s].

We found the corresponding output for 10 each frequencies using **(3)**. Then, we obtained analytical results for the magnitude and the phase of each 10 points.
Here you can see the original transfer function and our datapoints, which we obtained by inputting complex sinusoidals to the system, plotted together.

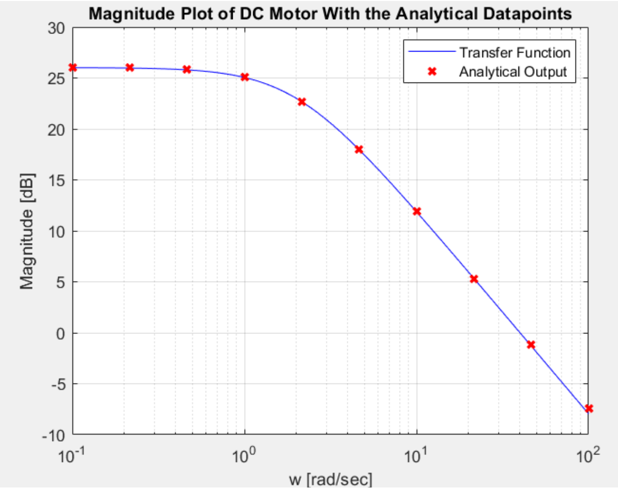


**Fig. 3:** Magnitude Plot of DC Motor with the Analytical Datapoints

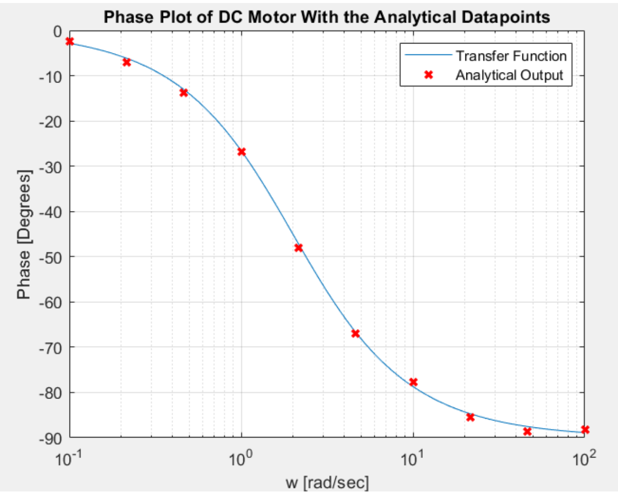


**Fig. 4:** Phase Plot of DC Motor with the Analytical Datapoints

As it can be seen on the graphs, the analytical findings and the initial transfer function model fits each other almost perfectly.

## 3. Conclusion

This preliminary work consisted of two different parts. In the first part we were given a transfer function for a DC motor and were asked to draw bode plots for both the magnitude and the phase of the transfer function.

In the second part, we were asked to input 10 different sinusoidal signals to the system whose transfer function was from part 1. We obtained 10 different outputs and found the transfer functions from the input/output relations for different frequencies. Then, we compared the analytical dataset with the initial transfer function.

This preliminary work was a total success. We had some errors in the final section, but they are caused from decimal rounding errors by Matlab, and they are very insignificant and small.

## 4. Appendices

Matlab Code:

```
w = logspace(-1,2,100);
g=nan(1,100);
for k = 1:100
s = 1i * w(k);
g(k) = 20 / (0.5*s+1);
end
% semilogx(w,20*log10(abs(g)));
% grid on;
% xlabel('w [rad/sec]');
% ylabel('Magnitude [dB]');
% title('Magnitude Plot of DC Motor');
% semilogx(w,angle(g)*180/pi)
% grid on;
% xlabel('w [rad/sec]');
% ylabel('Phase [Degrees]');
% title('Phase Plot of DC Motor');
w = logspace(-1,2,100);
w_m = logspace(-1,2,10);
x = nan(100,10);
y = nan(100,10);
A = 1;
for m = 1:10
for t = 1:100
x(t,m) = A * cos(w_m(m) * t);
y(t,m) = A*abs(20 / ((1i * 0.5 * w_m(m)) +
1)) * cos(w_m(m) * t + angle(20 / ((1i *
0.5 * w_m(m)) + 1)));
end
end
fftx = nan(100,10);
ffty = nan(100,10);
g_yx = nan(100,10);
index_x=nan(1,10);
index_y=nan(1,10);
expmag=nan(1,10);
expphase=nan(1,10);
px=nan(1,10);
py=nan(1,10);
for i = 1:10
fftx(:,i) = fft(x(:,i));
ffty(:,i) = fft(y(:,i));
[kx,index_x(i)] = max(abs(fftx(:,i)));
px(i) = angle(fftx(index_x(i),i));
[ky,index_y(i)] = max(abs(ffty(:,i)));
py(i) = angle(ffty(index_y(i),i));
expmag(i) = 20 * log10(abs(ky / kx));
expphase(i)     =     -abs(mod(py(i),2*pi)-
mod(px(i),2*pi));
end
% semilogx(w,20*log10(abs(g)),'b-');
% hold on;
% semilogx(w_m,expmag,'rx','LineWidth',2);
```

```
% grid on;
% title('Magnitude Plot of DC Motor With
the Analytical Datapoints');
% xlabel('w [rad/sec]');
% ylabel('Magnitude [dB]');
%  legend('Transfer  Function','Analytical
Output');
% hold off;
% semilogx(w,angle(g)*180/pi)
% hold on;
%  semilogx(w_m,expphase*180/pi,'rx','Lin-
eWidth',2);
% grid on;
% xlabel('w [rad/sec]');
% ylabel('Phase [Degrees]');
% title('Phase Plot of DC Motor With the
Analytical Datapoints');
%  legend('Transfer  Function','Analytical
Output');
% hold off;
```