**LAB #6 Frequency Response of a DC Motor**

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IN FULFILLMENT OF THE REQUIREMENTS FOR:

MTRE 4002L

APRIL 22nd, 2022

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# OBJECTIVE AND BACKGROUND

The goal of this lab is to be able to observe and obtain the frequency domain values of a DC motor and to be able to use the acquired data to create Bode and Nyquist plots which are helpful in the frequency domain analysis and construction of systems and controllers. We know that when we are given a linear system with a sinusoidal input, we can conclude that the steady state response of the system will still be a sinusoidal input with the same frequency but different amplitude and phase angle. Nyquist plots are representations of the vector response of feedback systems that show the relationship between feedback and gain and are used for the frequency response of a system. Bode plots are similar to Nyquist plots in the sense they are used for the frequency response of a system, but are different in the fact that Bode plots use asymptotic approximations for the magnitude of systems on a 20 log(x) scale vs frequency and Phase (in degrees) vs frequency to approximate the steady state stability of responses.

# QUESTION 1

Below in Table 1 shows our values taken from different frequencies of the input signal and the effects they have on the time difference, phase angle, and amplitude of the output angle as well as the magnitude of the output over the input (B/A).

Table 1 Steady-State Response of DC Motor for Sinusoidal Inputs

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Amplitude of the input signal: | Frequency f(Hz) | Frequency (𝛚=2πf) | Amplitude of the output signal: B | ∆t (sec) |  | Phase angle φ(ω)=∆t\*ω/π\*180 (degree) |
| 1 | 0.6 | 2π0.6 | 22.59 | 0.427 | 23.56 | 0.0028 |
| 1 | 0.8 | 2π0.8 | ­16.79 | 0.347 | 16.57 | 0.0031 |
| 1 | 0.9 | 2π0.9 | 13.93 | 0.301 | 14.00 | 0.0030 |
| 1 | 1 | 2π1 | 12.79 | 0.289 | 12.85 | 0.0032 |
| 1 | 2 | 2π2 | 6.46 | 0.157 | 6.49 | 0.0035 |
| 1 | 4 | 2π4 | 2.86 | 0.088 | 2.87 | 0.0039 |
| 1 | 6 | 2π6 | 1.63 | 0.061 | 1.64 | 0.0041 |
| 1 | 8 | 2π8 | 1.05 | 0.049 | 1.05 | 0.0044 |
| 1 | 10 | 2π10 | 0.75 | 0.042 | 0.75 | 0.0046 |
| 1 | 12 | 2π12 | 0.53 | 0.038 | 0.53 | 0.0051 |
| 1 | 15 | 2π15 | 0.35 | 0.033 | 0.35 | 0.0055 |
| 1 | 30 | 2π 30 | 0.00 | 0.020 | 0.00 | 0.0067 |

Diagram, schematic

Description automatically generated

Figure 1 Simulink Model for DC Motor Control

Chart, line chart

Description automatically generated

Figure 2 Response for Frequency of 0.6 Hz

Chart, line chart

Description automatically generated

Figure 3 Response for Frequency of 0.8 Hz

Chart, line chart

Description automatically generated

Figure 4 Response for Frequency of 0.9 Hz

Chart, line chart

Description automatically generated

Figure 5 Response for Frequency of 1 Hz

Chart

Description automatically generated

Figure 6 Response for Frequency of 2 Hz

Timeline

Description automatically generated

Figure 7 Response for Frequency of 4 Hz

Chart

Description automatically generated with medium confidence

Figure 8 Response for Frequency of 6 Hz

Chart

Description automatically generated with low confidence

Figure 9 Response for Frequency of 8 Hz

Chart

Description automatically generated with low confidence

Figure 10 Response for Frequency of 10 Hz

Chart

Description automatically generated

Figure 11 Response for Frequency of 12 Hz

A picture containing timeline

Description automatically generated

Figure 12 Response for Frequency of 15 Hz

A picture containing timeline

Description automatically generated

Figure 13 Response for Frequency of 30 Hz



Figure 14 Bode Plot for Acquired Data



Figure Nyquist Plots for Acquired Data



Figure 16 Bode Diagram for DC Motor at Low Frequencies

Chart

Description automatically generated

Figure Nyquist Diagram for DC Motor at Low Frequencies

# CONCLUSIONS