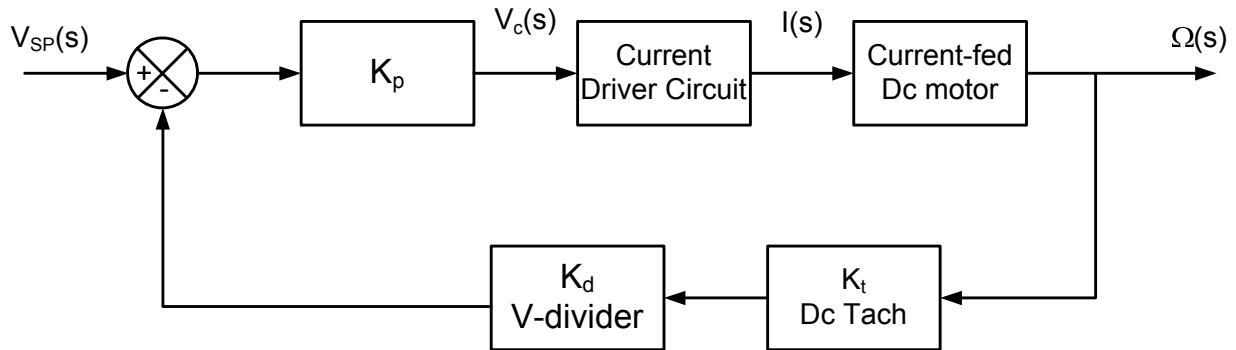


ET 438A
Dc Motor Control Homework

A proportional controller is applied to a current-fed permanent magnet dc motor. The objective is to maintain a constant speed on the output. The speed can be changed by adjusting the set point voltage V_{sp} . The block diagram for this system is shown below.



A dc tachometer measures the motor speed. The tachometer sends an output to a scaling circuit to bring the voltage into the set point input range.

The parameters defining the feedback circuit are:

$$K_T = 0.064 \text{ V-s/rad}$$

$$K_d = 0.1 \text{ V/V}$$

The controller drives a transistor circuit that is the current source for the dc motor. The current source takes the voltage from the controller and produces a current based on the following function

$$i(t) = (5.5 \times 10^{-4} V_c(t)) h_{fe} \text{ A/V}$$

$$h_{fe} = 100$$

The dc motor and load parameters are:

$$K_e = 0.064 \text{ V-s/rad}$$

$$K_t = 0.064 \text{ N-m/A}$$

$$L_a = 0.10 \text{ H}$$

$$R_a = 22.6 \text{ ohms}$$

$$J_m = 1.1 \times 10^{-4} \text{ N-m-s}^2/\text{rad}$$

$$B_m = 9.204 \times 10^{-6} \text{ N-m-s/rad}$$

$$J_L = 8.2 \times 10^{-4} \text{ N-m-s}^2/\text{rad}$$

$$B_L = 0.15 \times 10^{-5} \text{ N-m-s/rad}$$

The load is directly coupled to the motor.

For the system described above:

- 1.) find the closed loop transfer functions when $K_p = 1, 10, 100$. Assume that the offset of the proportional controller is zero. This is required for all transfer function models.
- 2.) Find the poles and zeros of the transfer functions found in 1. Evaluate the poles and determine if the system is stable of each of the gain values given in 1.
- 3.) Use Matlab's control tool box functions to generate bode plots for each of the transfer functions given in 1. Turn in the graphs with the other calculations.

ET 438a
Using Matlab to Generate Bode and Step Responses

- 1.) Start any of the computers in D106 and find the student version of Matlab under the program menu.
- 2.) Start Matlab. After Matlab loads, click on the file menu and select New m-File. This will start a text editor for making Matlab script files.
- 3.) Enter the following lines of code and save the file.

```
clear all;
close all;
n=input('enter the numerator coefficients: ');
d=input('enter the denominator coefficients: ');
kp=input('enter the value of Kp: ');
sys=tf(n,d);
sys
bode(sys);
grid on;
G=kp./n;
sys=sys*G
sys
figure;
step(sys);
```

- 4.) From the Matlab prompt, EDU>>, type the filename that you give to this script file. This will run the script file. You can also use the run script command and browse for the script file.
- 5.) Follow the program prompts. Enter the numerator coefficients in decreasing powers of s (e.g. s^2 , s^1 , s^0).
- 6.) Enter the denominator coefficients in decreasing powers of s .
- 7.) The program will automatically produce the Bode and step responses of the defined transfer function.
- 8.) Cut and paste the graphs into Word for printing or print the results directly from Matlab. Use the copy figure command to make copies of the Matlab figures.