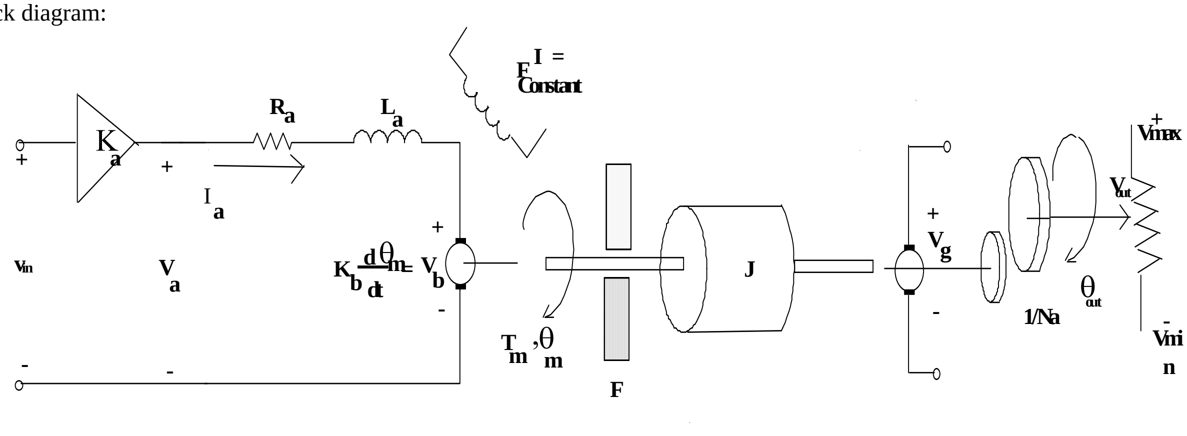
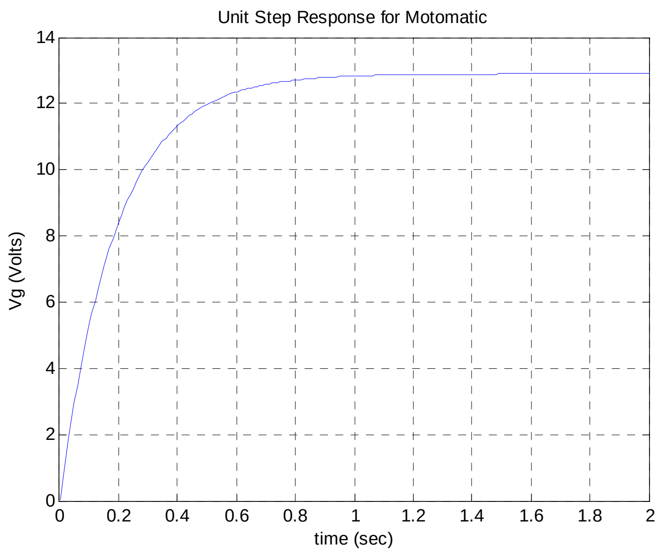
In our controls system lab, we have a DC Servo motor called the Motomatic®. We would like to design a controller for this DC servo using the following block diagram:



We can operate the Motomatic in either velocity mode or position mode. If we operate in velocity mode, the Motomatic is approximately a first order system. The open-loop unit step response of the Motomatic in velocity mode is given below




1.a) Find the transfer function, G(s), then find the value of Kp, Kv, and ess due to a step and ess due to a ramp

b) Design a PI compensator, $G_{PI}(s)$ to meet the following specs:
1) $t_s < 0.4$ seconds
2) $M_p < 5\%$
3) $e_{ss}$ due to a step = 0

c) Simulate your closed-loop design on Matlab

d) If your step response does not meet all the specifications, comment on why

2. a) Design a PID compensator to meet the following specs:
1) $t_s < 0.2$ seconds
2) $M_p < 5\%$
3) $e_{ss}$ due to a ramp = 1/50

b) Simulate your design on Matlab

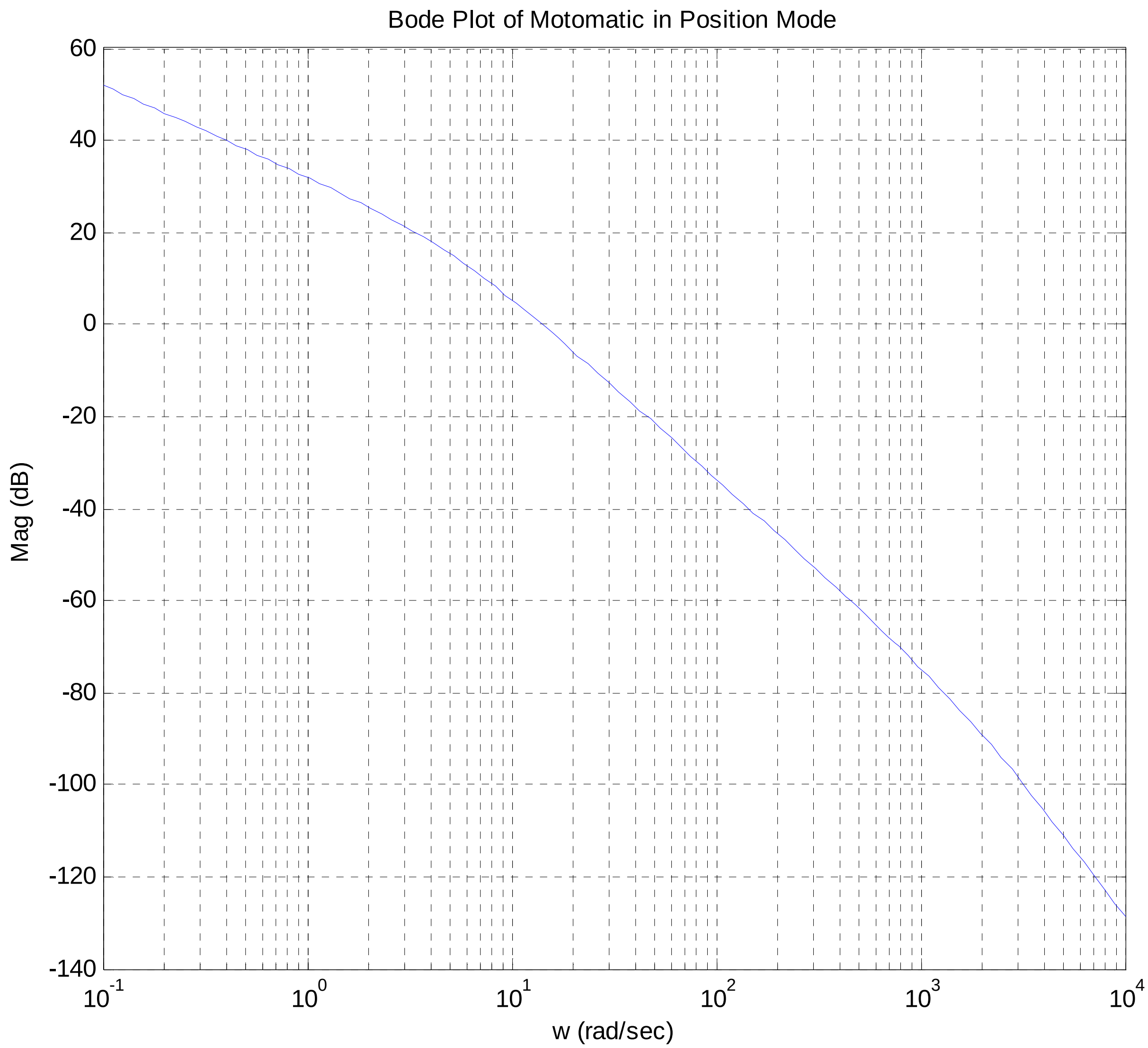
c) If your step response does not meet all the specifications, comment on why

The Bode Plot for the Motomatic in Position mode is given on the next page.

d) Find the new transfer function, G(s), then find the value of Kp, Kv, and ess due to a step and ess due to a ramp

e) Use the 2nd Ziegler-Nichols method described in class to tune a PID controller for this system (i.e., find the gain K0 that makes the closed-loop system marginally stable then record this gain and the period of oscillation)

f) Simulate your design on Matlab



Bode Plot of Motomatic in Position Mode
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
Mag (dB)
$10^{-1}$
$10^{0}$
$10^{1}$
$10^{2}$
$10^{3}$
$10^{4}$
w (rad/sec)