The University of Portland
Donald P. Shiley School of Engineering

EE352
Electronic Circuits II
HOMEWORK 6

Assigned: Wed, Mar 18, 2020
Due: Fri, Mar 27, 2020
Exam: Mon, Apr 6, 2020 (Closed-Book, 2 crib-sheets, calculator)

Problems:

1) Consider the opamp circuit in Fig. P11.106 (pg. 919 in your text). Assume the opamp has an A(s)=((2/3)x1e6)/s. Assume the feedback resistor is 100Ω (not 100kΩ).

   a) Using hand analysis, calculate the PM.
   b) Confirm your PM answer in part a) above in matlab using "margin(LG)" as shown in class. Take a screen shot and hand in with your homework.
   c) Using hand analysis, find the closed-loop transfer function, T(s). In matlab, sketch the the pole-zero plot using "pzmap" as shown in class. In matlab, sketch the bode plots of T(s) using "bode(T)" as shown in class. Take screen shots of both the matlab pzmap and bode plots and hand in with your homework.
   d) In matlab, sketch the step response using "step(T)" as shown in class. Take screen shot and hand in with your homework.

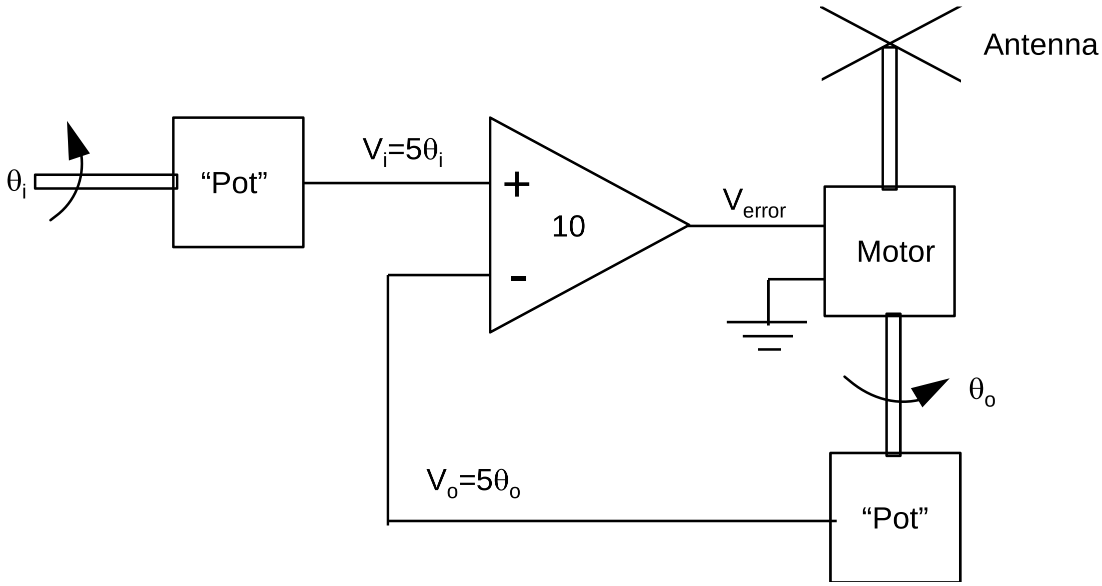
2) A negative feedback servo-system used to rotate a roof-top antenna is schematically shown in the Figure on the reverse page. This is a "position-sensitive" feedback system as discussed in class. The two potentiometers convert the angular positions, θ_i and θ_o, to corresponding voltages, V_i and V_o, through the transfer function, $V=K_p\theta$ where K_p=5V/rad. The output voltage, V_o, is subtracted from the input voltage, V_i, and the result is multiplied by 10V/V through a gain stage yielding $V_{error}=10(V_i-V_o)$. V_{error} then drives the motor. Assume the following: (1) the total Moment of Inertia of the entire output mechanism (antenna, antenna shaft, motor rotor, and potentiometer) is J=2kg-m^2, (2) the torque provided by the motor is G=10N-m/A multiplied by the armature current, I_a (i.e. $\tau=GI_a=10I_a$) and, (3) the motor can be modeled as an armature resistor, R_a=10Ω, in series with an ω-dependent voltage generator known as the "Back-EMF Voltage" where $V_{BEMF}=G\omega$ as shown in class.

   a) Sketch the closed-loop, negative feedback block diagram which relates θ_o and θ_i. Find the closed-loop Transfer Function, $A_f(s)=\theta_o(s)/\theta_i(s)$.

   b) Determine the Bode Plots of $A_f(s)$ using matlab (bode). What is the "characterisic frequency", ω_n, of this electromechancial servo-system ?

   c) Using matlab (pzmap), plot the location of the closed-loop poles of $A_f(s)$ in the complex plane (σ vs jω). By inspection, is the system stable ?

   d) Calculate the Loop Gain, LG(s) of this servo-system. Determine the system's Phase Margin and Gain Margin using matlab (margin).



Antenna
θi
"Pot"
Vi=5θi
+
10
-
Verror
Motor
θo
Vo=5θo
"Pot"