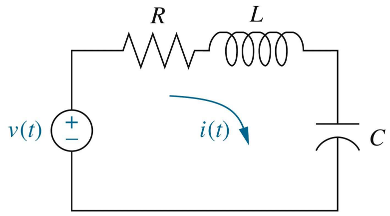
ELEC301
Systems,Control and Communication

1. Given the electric network shown in Figure 1. Assume $R = 4\Omega$, $L = 3H$ and $1/LC = 50$.



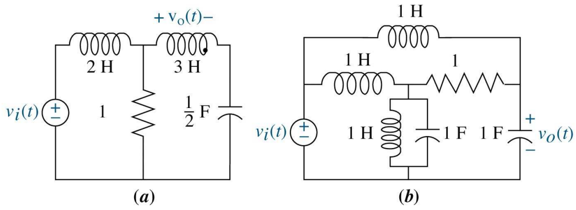
   (a) Write down the differential equation for the network if $v(t) = u(t)$, a unit step.
   (b) Solve the differential equation for the current, if there is no initial energy in the network.
   (c) Make a plot of your solution.

2. For each of the following transfer functions, write the corresponding differential equation.

   (a) $\frac{X(s)}{F(s)} = \frac{9}{s^2+7s+12}$
   (b) $\frac{X(s)}{F(s)} = \frac{7}{(s+10)(s+11)}$
   (c) $\frac{X(s)}{F(s)} = \frac{s+2}{(s+1)(s+3)}$

3. Find the transfer function $G(s) = \frac{V_o(s)}{V_i(s)}$, for each of the network shown in Figure 3. Solve the problem using

   (a) nodal analysis.
   (b) mesh analysis.



4. *Our prototype control problem*

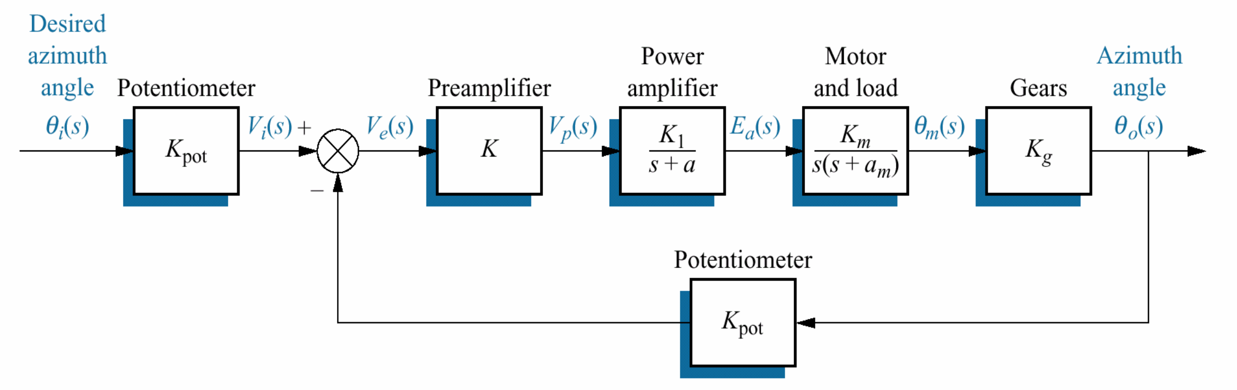
Figure 4, at the end of the homework, shows the prototype control problem that we'll use throughout the control section of the course. Here the goal is to design a system where the user determines the angle of a huge radioantenna by turning a potentiometer. The basic functionality is illustrated by the top image in Figure 4,(a) and more detailed version is provided in Figure 4.(b).

To describe this system:

- Potentiometer on the left gets the user input and converts it to an electrical signal
- Potentiometer on the right is used to measure the actual angle of the antenna (that we want to control) and convert it into electrical signal
- Differential amplifier measures the difference between the user input angle and the actual angle of the antenna which is the error
- This error signal is used to rotate a DC motor.

We'll concentrate on how's and why's of this system in more detail. For the time being our goal is to simulate this system in Simulink to enter into the real world of control engineering.

Figure 4 shows the transfer function based block diagram of this antenna angle control system. You are asked to implement this system in Matlab's Simulink. In the block



diagram,

- Desired Angle is a unit step function in time with initial value 0 and final value 1.
- $K_{pot} = 0.318$
- $K_1 = 100$
- $K_m = 2$
- $a = 100$

- $a_m = 2$
- $K_g = 0.1$

Place a scope at the input to monitor the input. Place a scope at the output of the system. Connect the antennatvisualization block diagram provided in our blackboard site (Make sure that antenna.m and antenna-s-function.m provided in blackboard function.m should be in your working directory)

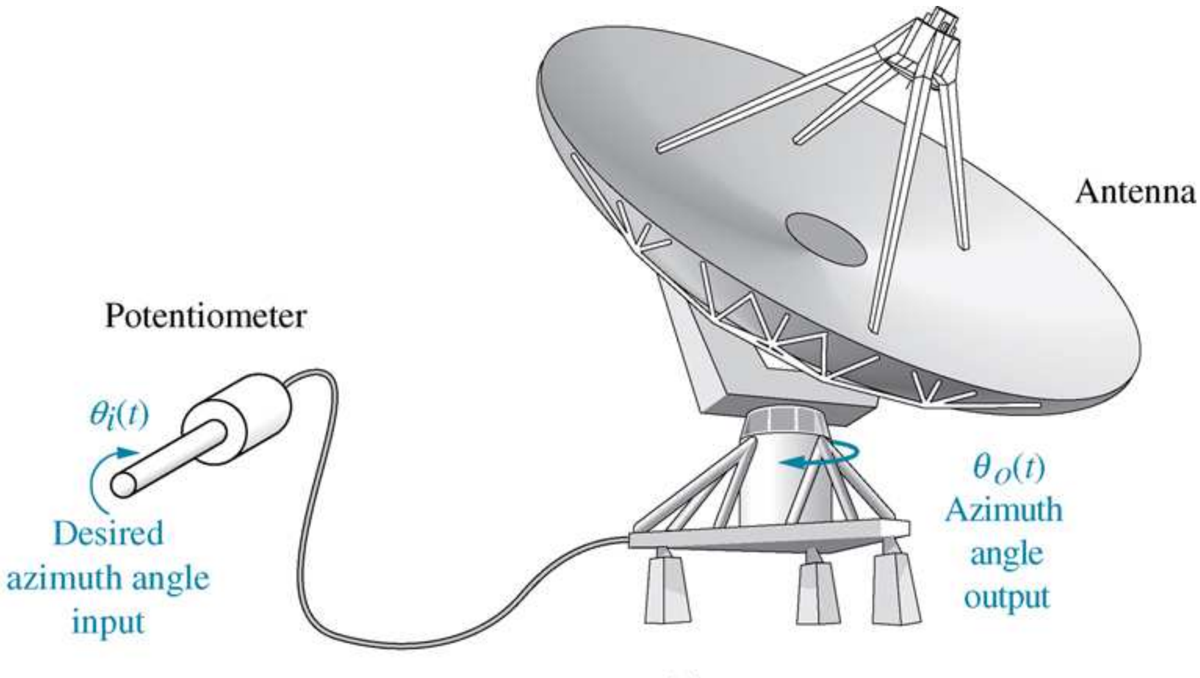
Monitor the time response between simulation times 0 and 15 for

(a) $K = 20$.

(b) $K = 110$.

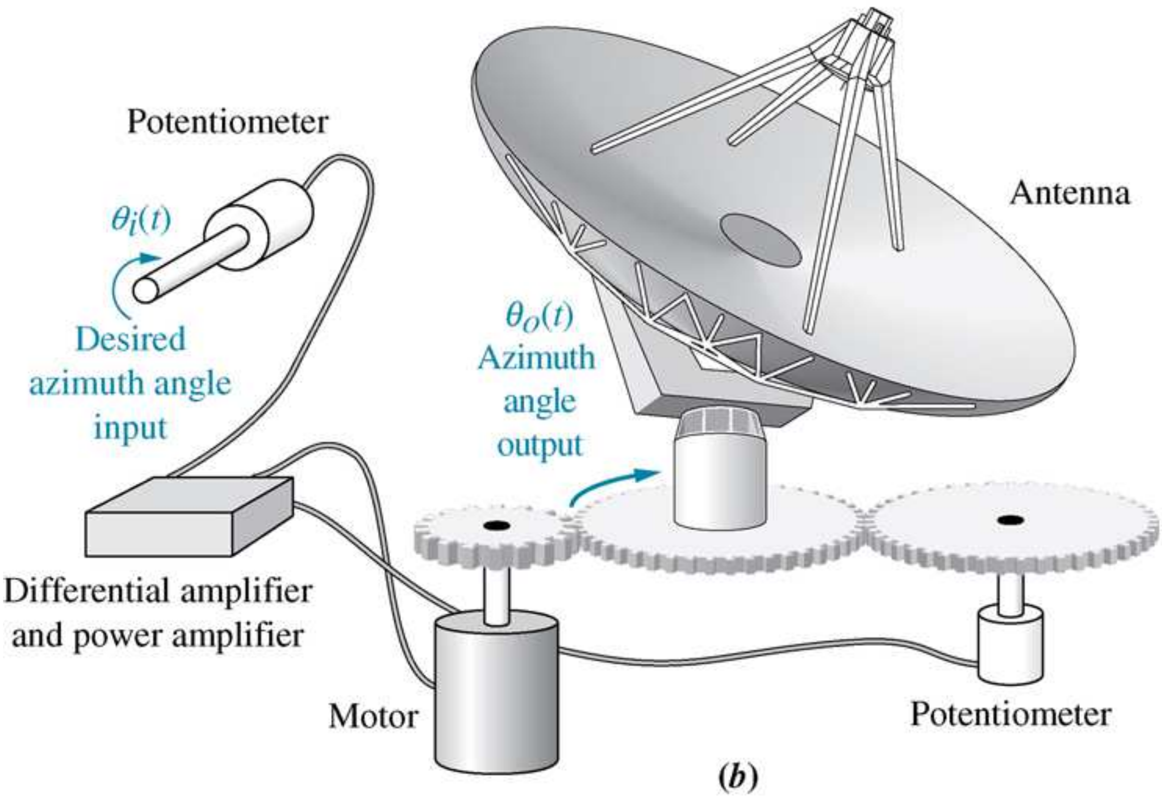
Print your output plots for both cases and comment on the time behavior of the output. Name your simulink file as *lastname.slx)*.

Attach simulink block diagram picture and all time response plots to your homework solutions in your pdf file for homework solutions. Submit this solution pdf file and simulink file separately.



Antenna
Potentiometer
$\theta_i(t)$
Desired
azimuth angle
input
$\theta_O(t)$
Azimuth
angle
output

(*a*)



Potentiometer
$\theta_i(t)$
Desired
azimuth angle
input
Antenna
$\theta_O(t)$
Azimuth
angle
output
Differential amplifier
and power amplifier
Motor
Potentiometer

(*b*)