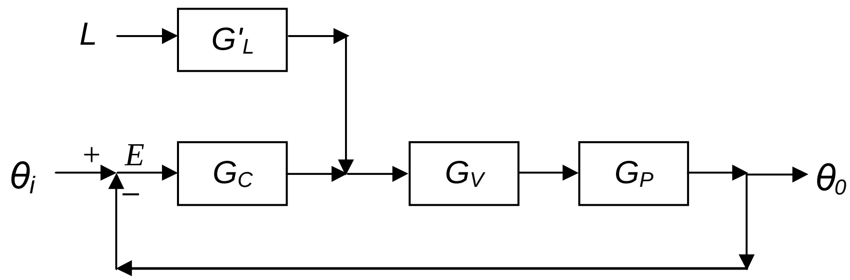
MINE 432
Robotics and Industrial Automation

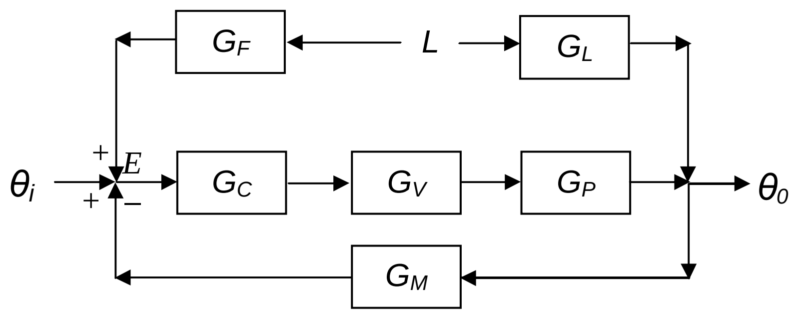
Assignment 2
Classical Process Control Theory

1. Draw a simple conventional feedback control system operating under servo control.

2. For the following control system, redraw the system into the form we have used in class to represent a load input (i.e. regulator mode) and define the Load Block in terms of the control blocks used in the diagram.

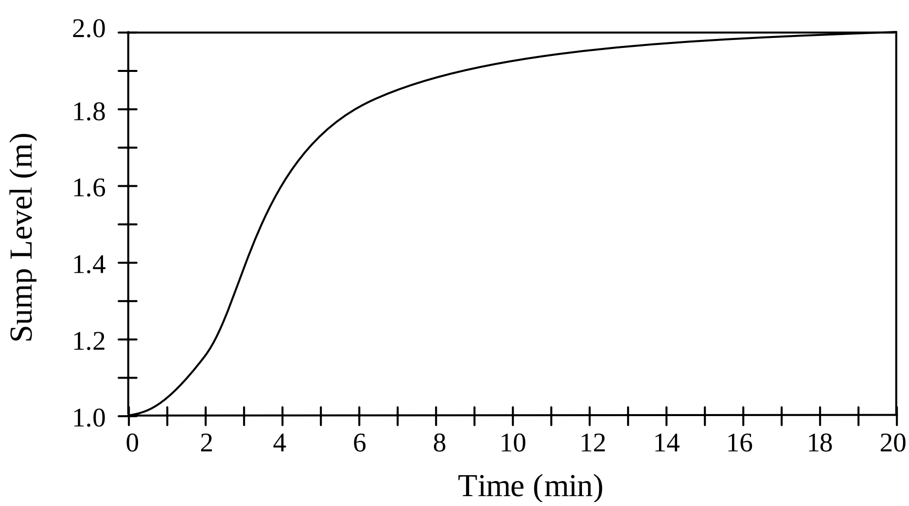


3. Determine the system transfer function for the following control diagram



Define a term to describe this control system.

4. Pulp flows into a sump under steady state conditions at 2,200 L/min and is pumped out to a cyclone at the same rate in order to maintain a set sump level. To compensate for pulp flowrate changes, water is added to the sump to maintain a constant level in response to a float valve. A reaction curve was obtained for the open-loop sump level control system when the water flow was stepped up by 370 L/min as follows:



a. What are the parameter values for T_d, T_p and K_p for this sump, assuming it can be modelled as a pure time lag and a first order process?
b. For a PID controller to adjust the water flow control valve, what K_c, T_I and T_D parameters will achieve quarter decay ratios in the control system response?

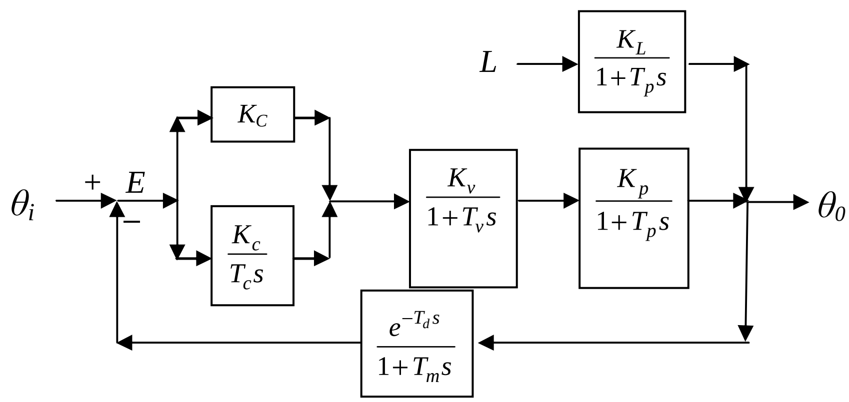
Zeigler-Nichols Rules for PID Control: $K_c = 1.2\ R / K_p$ where $R = T_d / T_p$
$T_I = 2.0\ T_d / K_c$
$T_D = 0.5 T_d K_c$

c. For a digital equation of the form: (assume time between t and t-1 is 0.1 seconds)

$$p(t+1) = p(t) + K_1 * \varepsilon(t) + K_2 * \varepsilon(t-1) + K_3 * \varepsilon(t-2)$$

what values for K_1, K_2 and K_3 should be used? (If you are unable to obtain a numerical answer for this question, you may simply express K_1, K_2 and K_3 as functions of T_d, T_p and K_p.)

5. For the following system, develop the generic equation to calculate the transient response of the system to a set point change for the critically damped case.



Assume $T_p >>>> T_m$
$T_m = 10 * T_d$
$T_v = 0.01 * T_p$
$K_v = 1.0$