# ECE 461 / 661 Homework #3

Structured Text,LaPlace Transforms, 1st and 2nd Order Approximations

Due Monday, September 14th

## PLC Structured Text

- Will accept problems 1-3 any time before December 1st (so you can use the Micro810 PLC's)

Option #1: If using Allen Bradley PLC's write a structured text program (i.e. a Pascal program) to implement the automated watering system of homework #2.

Option #2: Write a C program (for an Arduino, PIC processor, Rasberry PI) to implement the automated watering system of homework #2

A soil moisture sensor measures the ground moisture

- 0V = dry
- 10V = wet

Start the watering process if

- You press button #0, or
- The moisture sensor reads less than 4.00V for more than 10 seconds,

When watering starts

- Relay #0 turns on for 5 seconds
- One second later, Relay #1 turns on for 5 seconds,
- One second later, Relay #2 turns on for 5 seconds.

1) Write a strtuctured test program to implement the same program

2) Test your program (collect data on its timing)

3) Demo your program (in person or with a video)

## LaPlace Transforms

4) Assume Y and X are related by

$$Y = \left( \frac{10(s+2)}{(s+1)(s+7)} \right) X$$

a) What is the differential equation relating X and Y?

b) Find y(t) assuming

$$x(t) = 2 + 3\sin(4t)$$

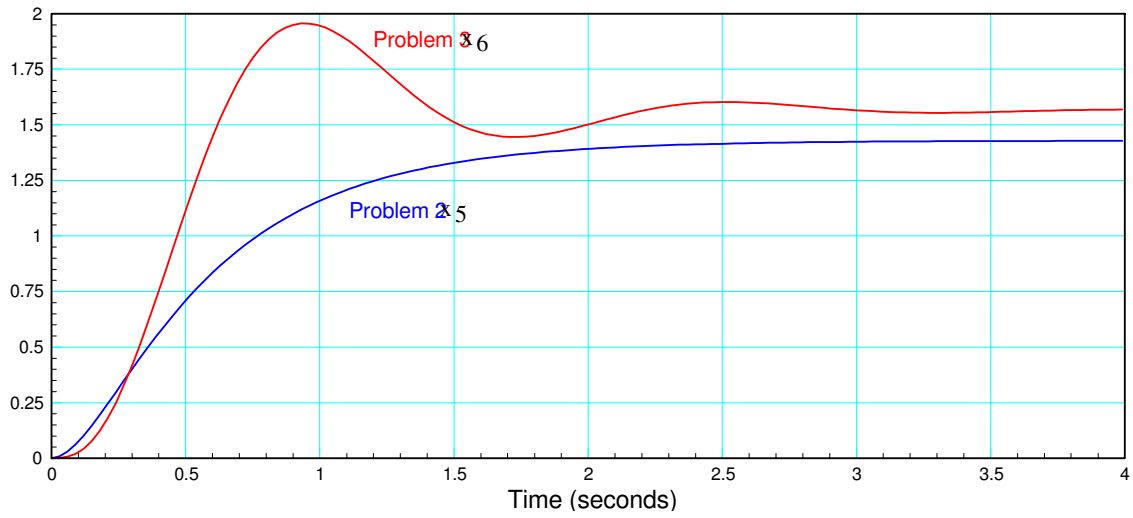
c) Find y(t) assuming

$$x(t) = 2u(t)$$

## 1st and 2nd Order Approximations:

5) Determine the transfer function for a system with the following step response

6) Determine the transfer function for a system with the following step response




Problem 2 (blue - no oscillations) & Problem 3 (red - oscillations)

7) Find a 2nd-order approximation for G(s). Plot the step response of both G(s) and its second order approximation

- $G(s) = \left( \frac{2000}{(s+0.5)(s+2)(s+5)(s+10)} \right)$
- $G(s) = \left( \frac{200{,}000}{(s+2+j10)(s+2-j10)(s+8+j20)(s+8-j20)} \right)$