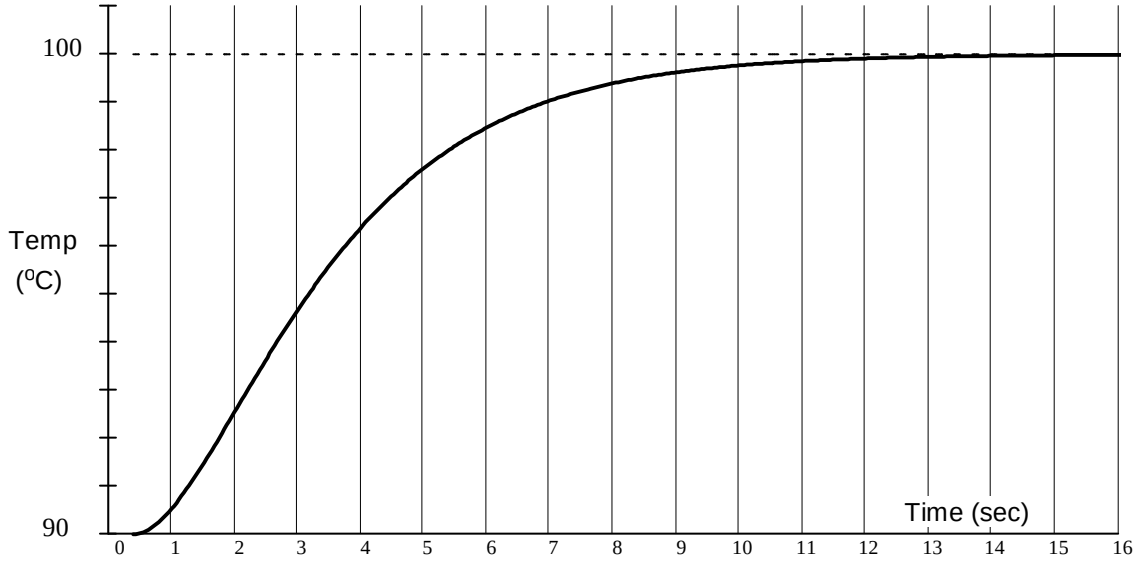
Name_____ ECE 3510 HW FC1 PID Tuning Due: Wed, 3/27/24

1. You are trying to control a process temperature in a nanofabrication lab. The current open-loop response to a temperature adjustment (unit step) is shown below. Use the Ziegler-Nichols tuning method to answer the questions below. A.Stolp



a) Find L and R from the plot above, show your work above and hand in this plot with your homework.

b) Use these values to find the proportional gain of a proportional-only (P) controller in a closed loop.

c) Use these values to find the proportional gain and integral time of a Z-N PI controller.

d) Use these values to find the proportional and integral gains of the PI controller we commonly use in class.

e) Use these values to find the proportional gain integral time and differential time of a Z-N PID controller. See eq. 4.110 in the notes.

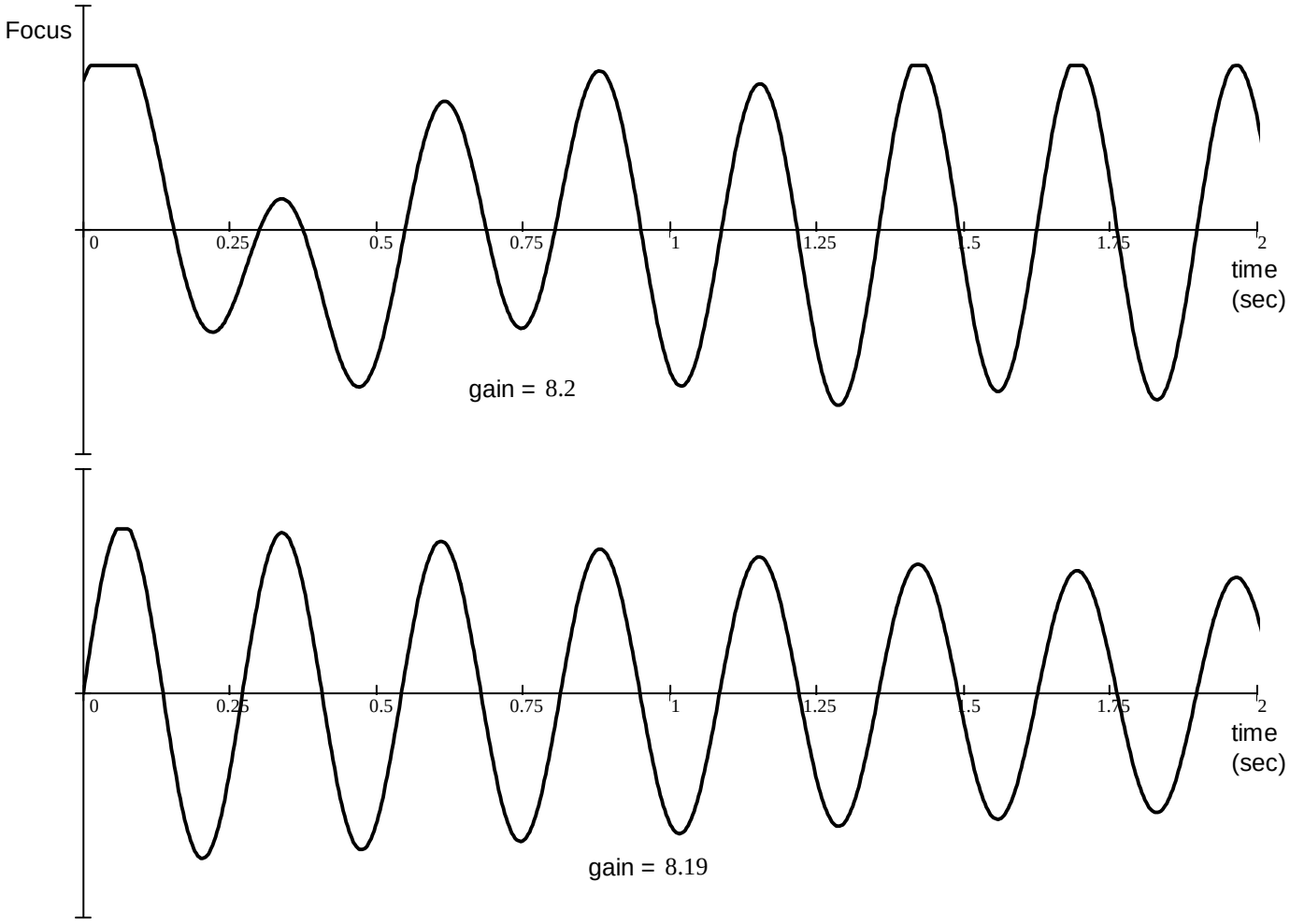
f) Draw a block diagram of this Z-N PID controller, showing the gains.

g) Use these values to find the 3 gains of the PID controller we commonly use in class.

2. Next, you are trying to control a photographic focus mechanism in a nanofabrication lab. The mechanism uses a DC motor to control the position of the focusing lens. Use the Ziegler-Nichols tuning method to answer the questions below on another sheet of paper.

   a) Can you use the method of problem 1 to find the controller parameters? If not, why not?

   You've created a simple proportional-gain feedback loop to control the focus and are playing with the gain to get the responses below at the gain settings shown.



Find the values you need from these plots (show work on plots) to answer the following on another sheet:

b) Find the proportional gain of a proportional-only (P) controller.

c) Find the proportional gain and integral time of a Z-N PI controller.

d) Find the proportional and integral gains of the PI controller we commonly use in class.

e) Find the proportional gain integral time and differential time of a Z-N PID controller.

f) Find the 3 gains of the PID controller we commonly use in class.

g) The overshoot turns out to be too high, but you like the speed. What should you try to do first?, second?, third?

Answers

1. a) Approximately 0.8 & 2.08
   b) 0.6
   c) 0.54 2.67
   d) 0.54 0.202
   e) 0.72 1.6 0.4
   g) 0.72 0.45 0.288

2. a) No answer the "why" yourself
   b) 4.1
   c) 3.69 0.208
   d) 3.69 17.7
   e) 4.92 0.125 0.031
   f) 4.92 39.4 0.154

g) 1st, Try turning up the differential gain
   2nd, Try turning down the integer gain, but keep an eye on the steady-state error
   3rd, Try turning down the proportional gain, but this could slow down the system