Lab 11: PI feedback control

This week's lab focuses on the use of PI feedback control to stabilize the incident light on a photodiode. We also introduce the Peltier thermoelectric cooler which is frequently used for precision temperature control in electronic circuits.

1. PI feedback control of an LED *(2.5 hours … infinite if you are not prepared)*

Construct the circuit we used in Lab 10, part 4b. Use your circuit design from design exercise 11-1 to regulate the optical power incident on the photodiode. The circuit should be such that the incident optical power can be set with some control resistor.

a. Determine experimentally the integral and proportional gain that you need in order for the feedback to function properly.

b. Use a second LED attached to a square-wave generator to see how fast your circuit can respond and modify the intensity of its LED to keep incident optical power on the photodiode constant. Adjust the integral and proportional gain to optimize the response time of your feedback circuit. What is the fastest response time that you can obtain with your circuit? How does the feedback control respond to a step function change in incident optical power from an external source (an oscilloscope plot will suffice)?

c. If you increase the proportional gain sufficiently, the feedback loop will go into positive feedback and start to oscillate uncontrollably. What is the frequency of this oscillation?

2. Peltier thermoelectric cooler *(0.5 hours)*

A Peltier thermoelectric cooler (TEC) is a two-wire device which consists of two ceramic plates. The TEC will cool one plate by removing heat and dumping it into the other plate (and thus heating it). If the current is reversed, then the cooling plate becomes the heating plate and vice versa.

Attach the your TEC to the variable power supply of your breadboard unit and verify that you can heat or cool either side of the TEC. What is the coldest steady state temperature which you can maintain?