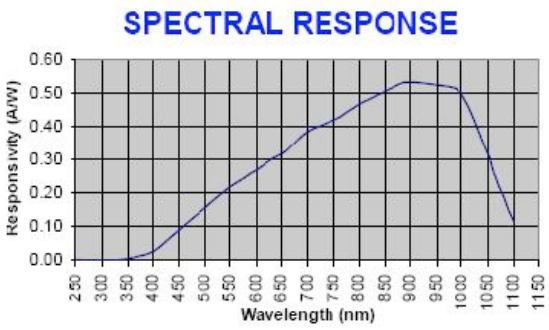
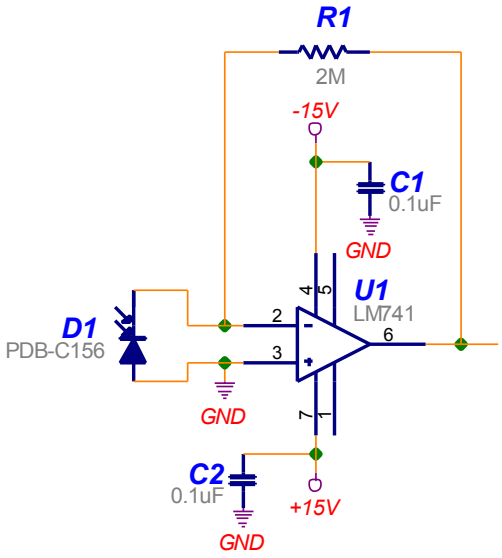
Homework #8 Photodiode Current to Voltage Converter

1) Design a circuit to amplify the signal from a photodiode. The output should be **1V/µW** at **850nm**. You decide to base your design on a PDB-C156 photodiode and a LM741 op-amp with +/-15V supplies. Note: The light intensity doesn't change quickly so don't worry about filtering out high frequencies or reverse biasing the diode.



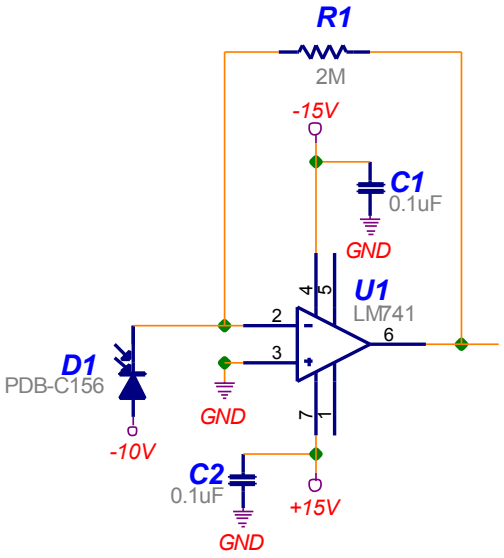
At 850nm the photodiode puts out 0.5A/W (0.5uA/uW). We'll use a LM741 configured as a current to voltage converter. To get an output of 1V/uW from a current of 0.5uA/uW we'll need a 2MΩ feedback resistor (0.5A/uW*2MΩ = 1V/uW). In this circuit the output voltage will go positive when light hits the photodiode. If the photodiode polarity is reversed the output would go negative when light hits the photodiode.



2) You need to do a new experiment and the photodiode must respond faster so you put a **10V** reverse bias on the photodiode.

a) Redraw the circuit with the reverse biased diode.

The circuit is shown to the right. Since the diode can handle a 50V reverse bias you could safely connect it to -15V instead of -10V. I used -10V because the datasheet lists specs for a 10V reverse bias. Again, the output will be positive with the given diode polarity.



b) About how large will the **dark current** be and what will the **output voltage** be when no light is hitting the photodiode (use the same feedback resistor as above)? You may assume an ideal op-amp (i.e. the input offset voltage and bias currents are zero).

The datasheet lists the dark current as typically 2nA (15nA max) with a 10V reverse bias. With the 2MΩ feedback resistor the dark current would cause the output to be 4mV (30mV max).

c) Make a guess at the **response time** of your amplifier design with this photodiode and feedback resistor. You may assume an ideal op-amp (i.e. the input capacitance is zero).

The datasheet lists the diode capacitance with a 10V reverse bias as 10pF (15pF max). With a 2MΩ feedback resistor the response time would be about 20us (30us max).
Note: The LM741 is a poor choice for a photodiode amplifier because of the high bias currents and input offset voltages. A FET input op-amp such as OPA128 would be a better choice with 30fA bias current.
http://www.ti.com/lit/ds/symlink/opa128.pdf