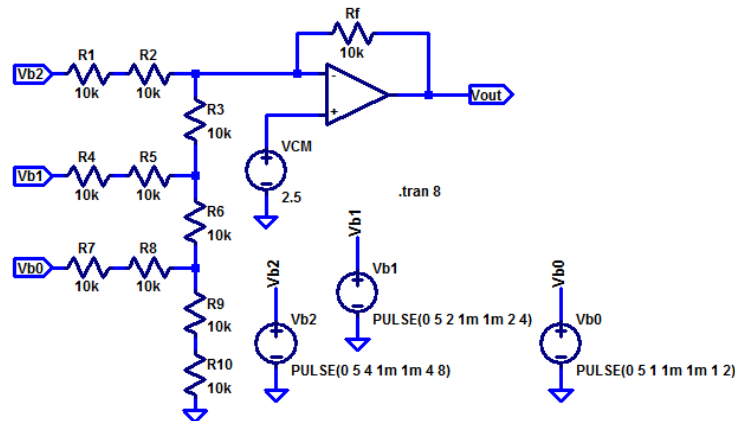
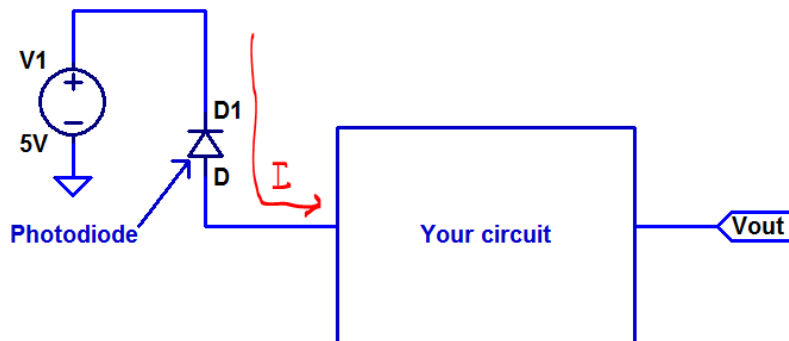


Show your work for credit!

- Find an equation for  $V_{out}$  in terms of  $V_{b0}$ ,  $V_{b1}$ , and  $V_{b2}$ . Pick values for these later voltages and show, using hand calculations and a simulation, that your equation is correct. Please don't focus on, or get confused by, the values I picked for  $V_{b0}$ ,  $V_{b1}$ , or  $V_{b2}$  below when I simulated. You pick a DC value for these in this problem. (6 points)



- An infrared (light at longer wavelengths than the visible spectrum so you can't see it) light-emitting diode (LED) may be used in a remote control to send infrared light to the TV, game console, cable box, etc. to control operation. In these receiving devices there is a photodiode, a device that converts the received light into current. Modeling the diode below as a current source that may vary from 0 to 1  $\mu\text{A}$  in the direction shown, design, using a single ideal op-amp and single resistor, a circuit that converts this current to a voltage that varies from 0 to  $-1\text{ V}$  (0 input current then 0 V output voltage, 1  $\mu\text{A}$  input current then  $-1\text{ V}$  output, 0.5  $\mu\text{A}$  input then  $-500\text{ mV}$  output). Simulate, using a DC sweep of the input current, the operation of your circuit. The circuit you design is often called a transresistance, or transimpedance amplifier, since its output is voltage and its input is current ( $V_{\text{oltage}}/\text{Current} = \text{Resistance}$ ). (3 points)



- Re-design the circuit in problem 2 so that the output varies from  $-1\text{ V}$  to  $-2\text{ V}$ , that is, an input of 0  $\mu\text{A}$  gives  $-1\text{ V}$  output while an input of  $-1\text{ }\mu\text{A}$  gives an output of  $-2\text{ V}$ . Note that you can accomplish this design using the design in problem 2 with an added voltage source (only). Simulate your design as done in problem 2. (2 points)