H.W. #13 EE 220 Fall 2023
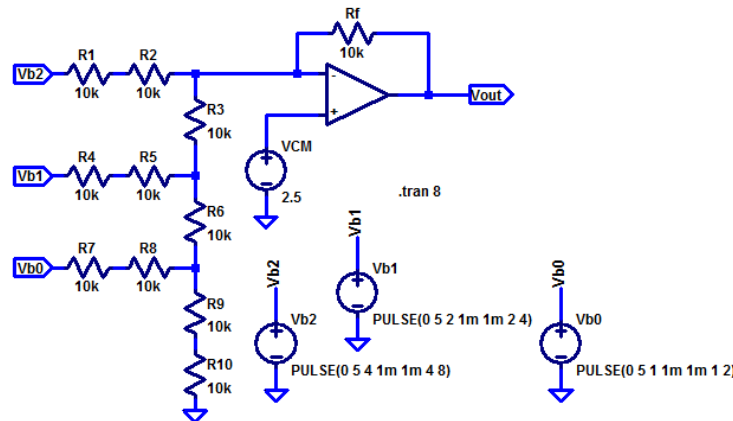
Show your work for credit!

1. Find an equation for Vout in terms of Vb0, Vb1, and Vb2. 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 Vb0, Vb1, or Vb2 below when I simulated. You pick a DC value for these in this problem. (6 points)

2. 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 uA 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 V (0 input current then 0 V output voltage, 1 uA input current then −1 V output, 0.5 uA input then − 500 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 (Votlage/Current = Resistance). (3 points)
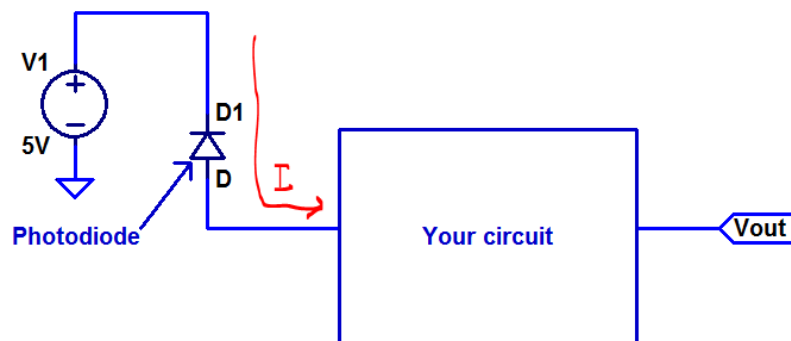
3. Re-design the circuit in problem 2 so that the output varies from −1 V to −2 V, that is, an input of 0 uA gives −1 V output while an input of 1 uA gives an output of − 2 V. Note that you can accomplish this design using the design in problem 2 with an added voltage source (only). Simulate your design as done in problem 2. (2 points)