Laboratory Final Project

The final project will be simulation-based; the idea is to design a simple system and, given that there is no access to a physical lab, to check its behavior using the `LTspice` similator.

Detailed instructions

1) Look at the attached list to find which project you have been assigned and what group code you have; you'll work in groups of two like in the "normal" lab.
2) Find the project attached — the number of the project is stated on the top right of the page.
3) Solve the problem, designing the part that you have to design, and simulate the circuit with `LTspice`; attending the laboratory online classes on April 17th and 24th the instructors will help you.
4) write a report, PDF format, named `groupcode-report.pdf` which must contain:
   a) the full diagram of the circuit;
   b) the theoretical derivation of the values of the components, where appropriate (resistors, capacitors, voltage sources, and so on);
   c) the simulation of the circuit, with a description of how you checked the correct behavior (as a minimum, the simulation of the amplifier and the low-pass filter).

   The part *a* and *b* of the report have a total maximum permitted length of **3 pages**; the simulation report (part *c*, consisting of screenshots of `LTspice` circuits and result) must be at most **4 pages**. The whole file must not exceed 10 Mbytes of size.
5) Prepare a `zip` file (or similar) with the simulation files (the `.asc` files used by `LTspice`, and name it `groupcode-spice.zip`.
6) Submit the report and the zipped `.asc` `LTspice` files on Moodle **before April 30, midnight, Madrid time**.

Evaluation

The final evaluation will be based on the submitted report, on the quality of the simulation tests performed, and on the participation (either on the forum, or in online classes) during the second part of the virtual laboratory course.

Student (alphabetically)	Group Code	Assigned Project	Second member
Achkar , Jean Marc	M2-4	4	Cabrera Capiro, Daniel
Applewhite , Branden J	M1-4	4	Taylor , Talbot C
Ballard , Hannah Grace	M2-2	2	Mazuera , Laura
Banovic , Josip Ante	F0-6	2	Caracciolo , James Timothy
Basak , Debarshi	M2-3	3	Momi , Jaspreet Kaur
Bilow Makler, Elior Abraham	F1-6	2	Paliwal , Anjali
Bryja , Bozena Izabela	F0-1	1	Halleran , Bridget Rose
Burke , Connor P	M2-5	1	Wu , Kevin D
Cabrera Capiro, Daniel	M2-4	4	Achkar , Jean Marc
Caracciolo , James Timothy	F0-6	2	Banovic , Josip Ante
Chiao Bellamy, Rachael	M1-2	2	Veraksa , Darya A
Chrisman , Hannah Belle	F2-3	3	
Davarapalli , Nidhi Sri	F2-5	1	Wagner , Madeline Elizabeth
Davidson Chazen , Zachariah	F0-5	1	Iven , Benjamin
DeGuzman , Taylor	F1-4	4	Ennis , Megan R
DiMarco , Connor Charles	F0-3	3	Hunt , Frances Emily Harriet
Duphiney , Catherine	F1-3	3	Lebrija Huerta, Marcela
Ennis , Megan R	F1-4	4	DeGuzman , Taylor
Esparza , Eliseo	F2-2	2	Ghrayeb , Anan O
Florin , Courtney	F1-1	1	Pulvermacher , Elizabeth
Ghrayeb , Anan O	F2-2	2	Esparza , Eliseo
Gupta , Arnav	M1-5	1	Inirio , Jason David
Halleran , Bridget Rose	F0-1	1	Bryja , Bozena Izabela
Hari , Lucas Benjamin	F1-2	2	Rynne , Josiah Daniel
Herby , Katherine	F2-4	4	Ocampo , Armando
Holder , Sydney	M0-1	1	Siegel , Allison
Hunt , Frances Emily Harriet	F0-3	3	DiMarco , Connor Charles
Inirio , Jason David	M1-5	1	Gupta , Arnav
Iven , Benjamin	F0-5	1	Davidson Chazen , Zachariah
Kathe , Kevin	F0-4	4	Sachdev , Sagar
Kelman , Benjamin	M0-2	2	Nierman , Cory Michael
Lebrija Huerta, Marcela	F1-3	3	Duphiney , Catherine
Mazuera , Laura	M2-2	2	Ballard , Hannah Grace
McGovern , Brigid	M1-1	1	Valdiviezo , Zenia
McLeod , Shane	M0-3	3	Niezyniecki , Gillian
Melsheimer , Trevor A	M0-4	4	Mikulskis , John
Mikulskis , John	M0-4	4	Melsheimer , Trevor A
Momi , Jaspreet Kaur	M2-3	3	Basak , Debarshi
Narayanan , Santhosh	F1-5	1	Rifai , Wesley
Nasir , Aala G	M1-3	3	Strauther , Ethan
Newman , Jewel Ling Diao	F0-7	3	Sander , Allison Michelle
Nierman , Cory Michael	M0-2	2	Kelman , Benjamin
Niezyniecki , Gillian	M0-3	3	McLeod , Shane
Ocampo , Armando	F2-4	4	Herby , Katherine
Paliwal , Anjali	F1-6	2	Bilow Makler, Elior Abraham
Pardo González, Germán Roberto	F0-2	2	Robinson , Grant Everett
Pineiro Gonzalez, Alexandra M	M0-5	1	Ramos Espinoza, Rosangel
Pretti , Caio Ruzene	M2-1	1	Wang , Joanne
Przybylski , Sydney A	F2-6	2	Slowik , Stephanie

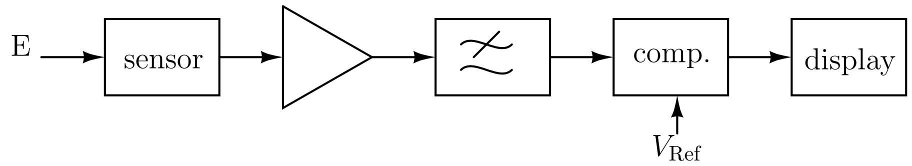
Pulvermacher , Elizabeth	F1-1	**1**	Florin , Courtney
Ramos Espinoza, Rosangel	M0-5	**1**	Pineiro Gonzalez, Alexandra M
Rifai , Wesley	F1-5	**1**	Narayanan , Santhosh
Robinson , Grant Everett	F0-2	**2**	Pardo González, Germán Roberto
Rynne , Josiah Daniel	F1-2	**2**	Hari , Lucas Benjamin
Sachdev , Sagar	F0-4	**4**	Kathe , Kevin
Sander , Allison Michelle	F0-7	**3**	Newman , Jewel Ling Diao
Siegel , Allison	M0-1	**1**	Holder , Sydney
Slowik , Stephanie	F2-6	**2**	Przybylski , Sydney A
Strauther , Ethan	M1-3	**3**	Nasir , Aala G
Taylor , Talbot C	M1-4	**4**	Applewhite , Branden J
Ubeid , Arman A	F2-1	**1**	Yun , Dana
Valdiviezo , Zenia	M1-1	**1**	McGovern , Brigid
Veraksa , Darya A	M1-2	**2**	Chiao Bellamy, Rachael
Wagner , Madeline Elizabeth	F2-5	**1**	Davarapalli , Nidhi Sri
Wang , Joanne	M2-1	**1**	Pretti , Caio Ruzene
Wu , Kevin D	M2-5	**1**	Burke , Connor P
Yun , Dana	F2-1	**1**	Ubeid , Arman A

Name: ____

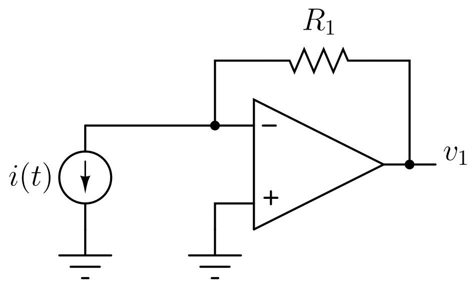
1. Design problem

The light intensity E in a room has two components: a DC and a AC ($100\,\mathrm{Hz}$) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold $E_{\min}$.

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** V_{Ref} (which is related to threshold level $E_{\min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The current source is a model for the light sensor (that is, the current $i(t)$ is proportional to the light intensity E). The amplifier stage is used to convert the current signal $i(t)$ into a voltage signal $v_1(t)$, amplifying the sensor output signal.



Assume that the current source produces a signal with a DC component in the range $[5, 20]\,\mu\mathrm{A}$ and an AC component with an amplitude of $2\,\mu\mathrm{A}$. Then,

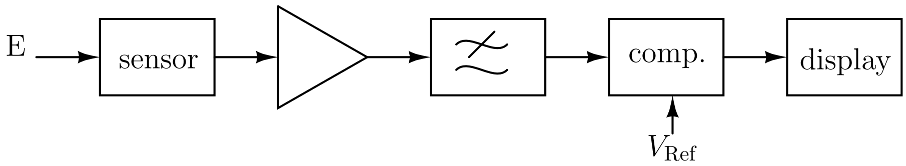
1. Design the amplifier stage so that the DC component of $v_1 = 10\,\mathrm{V}$ when the DC input current is maximum, that is $20\,\mu\mathrm{A}$.
2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the current $i(t)$ is less than $10\,\mu\mathrm{A}$. The current in the diode should be in the $[10, 20]\,\mathrm{mA}$ range.
3. Use SPICE to test the circuit.
4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

Name: ____

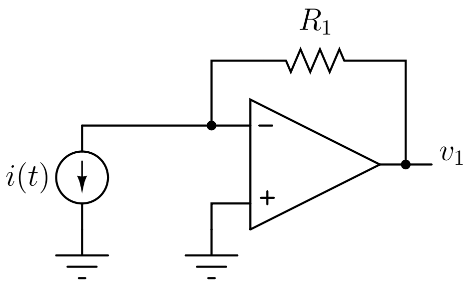
2. Design problem

The light intensity E in a room has two components: a DC and a AC ($400\,\mathrm{Hz}$) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{min}.

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** V_{Ref} (which is related to threshold level E_{min}). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The current source is a model for the light sensor (that is, the current $i(t)$ is proportional to the light intensity E). The amplifier stage is used to convert the current signal $i(t)$ into a voltage signal $v_1(t)$, amplifying the sensor output signal.



Assume that the current source produces a signal with a DC component in the range $[5, 20]\,\mu\mathrm{A}$ and an AC component with an amplitude of $2\,\mu\mathrm{A}$. Then,

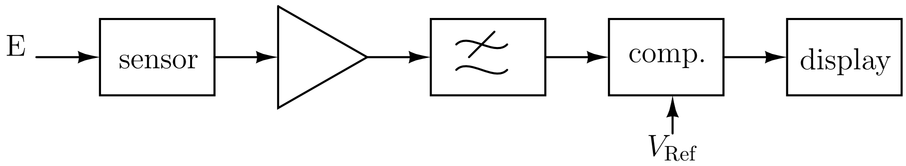
1. Design the amplifier stage so that the DC component of $v_1 = 10\,\mathrm{V}$ when the DC input current is maximum, that is $20\,\mu\mathrm{A}$.
2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the current $i(t)$ is less than $15\,\mu\mathrm{A}$. The current in the diode should be in the $[10, 20]\,\mathrm{mA}$ range.
3. Use SPICE to test the circuit.
4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

Name: ____

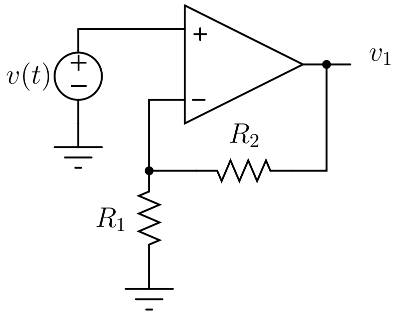
3. Design problem

The light intensity E in a room has two components: a DC and a AC ($200\,\mathrm{Hz}$) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold $E_{\min}$.

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** V_{Ref} (which is related to threshold level $E_{\min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The voltage source $v(t)$ is a model for the light sensor (that is, the voltage $v(t)$ is proportional to the light intensity E). The amplifier stage is needed because the signal $v(t)$ is weak.



Assume that the voltage source produces a signal with a DC component in the range $[50, 200]\,\mathrm{mV}$ and an AC component with an amplitude of $20\,\mathrm{mV}$. Then,

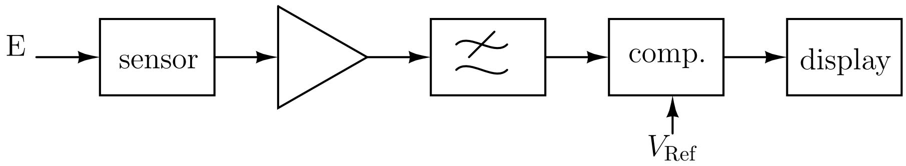
1. Design the amplifier stage so that the DC component of $v_1 = 10\,\mathrm{V}$ when the DC input current is maximum, that is $200\,\mathrm{mV}$.
2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the voltage $v(t)$ is less than $100\,\mathrm{mV}$. The current in the diode should be in the $[10, 20]\,\mathrm{mA}$ range.
3. Use SPICE to test the circuit.
4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

Name: ____

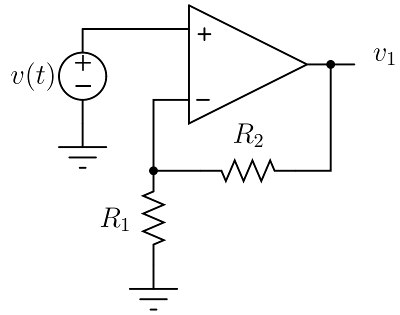
4. Design problem

The light intensity E in a room has two components: a DC and a AC ($1000\,\mathrm{Hz}$) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{min}.

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** V_{Ref} (which is related to threshold level E_{min}). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The voltage source $v(t)$ is a model for the light sensor (that is, the voltage $v(t)$ is proportional to the light intensity E). The amplifier stage is needed because the signal $v(t)$ is weak.



Assume that the voltage source produces a signal with a DC component in the range $[50, 200]\,\mathrm{mV}$ and an AC component with an amplitude of $20\,\mathrm{mV}$. Then,

1. Design the amplifier stage so that the DC component of $v_1 = 10\,\mathrm{V}$ when the DC input current is maximum, that is $200\,\mathrm{mV}$.
2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the voltage $v(t)$ is less than $150\,\mathrm{mV}$. The current in the diode should be in the $[10, 20]\,\mathrm{mA}$ range.
3. Use SPICE to test the circuit.
4. Write up a brief report explaining your work. Include the final circuit design and simulation results.