# Su22-ENGR-40M-01 Prelab 1

Jannah Sabic El-Rayess

TOTAL POINTS

**9.7 / 9**

QUESTION 1

1 P1 **3 / 3**

✓ **- 0 pts** Correct

**- 0.3 pts** Missing diode to prevent leakage current

**- 0.2 pts** Missing polarity of voltage converter

**- 0.8 pts** Voltage converter in a way that cannot draw power from the battery (on the wrong side of the diode, or in series, etc.)

**- 0.2 pts** Minor Error

**- 1 pts** Missing voltage converter

**- 0.3 pts** Late submission

**- 0.1 pts** Added unneeded bypass diodes

**- 0.5 pts** Diode / Solar panel in wrong direction

**- 3 pts** No Attempt

**- 1 pts** Missing Solar Panel

QUESTION 2

2 P2 **1 / 1**

✓ **- 0 pts correct- should be around 7V and 100mA (accept anything >6V and >60mA)**

**- 0 pts**
current too low (still >35mA), but gave explanation for discrepancy (had to take indoors, etc.)

**- 0.3 pts** voltage too low (< 6), without explanation for the discrepancy

**- 0.3 pts** current too low even for indoor situation (<35mA), perhaps fingers were blocking part of the solar cell? face pointed directly toward the light source? using DMM incorrectly?

**- 0.3 pts** current too high (>200mA)

**- 0.3 pts** Current too low, without explanation for the discrepancy

**- 1 pts** no work

**- 0.3 pts** Voltage too high >10V

**- 0.3 pts** Late submission

QUESTION 3

3 P3 **1 / 1**

✓ **- 0 pts correct- should be around 800mW**

**- 0 pts** too high/low due to previous measurements (carry-over error), but power calculated correctly

**- 0.1 pts** incorrect units

**- 1 pts** no work

**- 0.2 pts** Arithmetic Error

**- 0.3 pts** Late submission

QUESTION 4

4 P4 **1 / 1**

✓ **- 0 pts Correct - 12 diodes (you can count the strips too!!!)**

**- 0 pts** Correct: 10-12 diodes (you can count the strips too)

**- 0 pts** calculation done correctly, using previous number which was too low/high (carry-over error)

**- 0.1 pts** Need to round up (said 11)

**- 1 pts** no work

**- 0.1 pts** need to give an integer value

**- 0.1 pts** incorrect

**- 0.3 pts** Late submission

**- 1 pts** Incorrect analysis

QUESTION 5

5 P5 **1 / 1**

✓ **- 0 pts Correct -- blocking the strip should bring the current near zero (at least a factor of 10 lower than short circuit current readings)**

**- 0 pts** current was too high (>10mA)-- but they mentioned only partially blocking it or the drop was at least 10x compared to their short circuit current

**- 0.2 pts** current was too high (>10mA). Try blocking the strip completely.

**- 1 pts** no work or incorrect

- **0.3 pts** Late Submission
- **0.2 pts** Missing units

QUESTION 6

## 6 P6 - extra credit **1 / 0**

- **0 pts** no attempt, incomplete, or incorrect explanation

✓ **+ 1 pts** **Explains how current sources in series limited by smallest current and that extra current flows through diode in parallel**

+ **0.5 pts** draws diagram to explain, but doesn't explain where current flows for the other higher current sources

+ **0.5 pts** Explains how current sources in series are limited by smallest current but doesn't explain where current flows for higher current sources

QUESTION 7

## 7 P7 - extra credit **0 / 0**

✓ **- 0 pts** **Not attempted / Incorrect**

+ **2 pts** Extra Credit -- Complete with graph + data

+ **1 pts** Extra credit-- suggested a proper method to measure this, but did not collect data

+ **1 pts** Extra credit -- method didn't work, but collected data

+ **0.5 pts** A partial method was described, but could not be used to recreate a proper IV curve. (Also no data)

+ **0.5 pts** Data given but method not described

+ **0.5 pts** A partial method was described. no data collected.

QUESTION 8

## 8 P8 **0.7 / 1**

- **0 pts** Correct - current should be in the single-digits in mA.

✓ **- 0.3 pts** **Current is too high**

- **0.2 pts** Current is not zero.
- **1 pts** No answer / no work
- **0.3 pts** Late submission

QUESTION 9

## 9 P9 **1 / 1**

✓ **- 0 pts** **Correct: 2800 mA-h / leakage current (mA)**

- **0 pts** calculation done correctly, using the previous number which was wrong (carry-over error)
- **0.3 pts** incorrect.
- **1 pts** no work
- **0.3 pts** Late submission
- **0.2 pts** Arithmetic Error

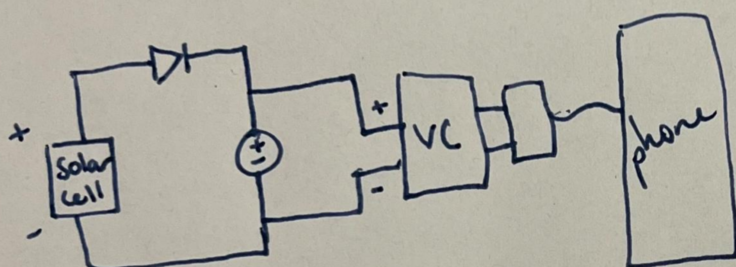
## 2 Prelab

Each lab in ENGR 40M will have a prelab. We'll sometimes do parts of prelabs as in-class exercises.

**Prelab logistics:** You must submit your prelab on Gradescope 24 hours before your lab section, or at the time designated by your TA (if different). Your TA will grade it before your lab starts.

It's very important that you understand the prelab thoroughly—our experience is that students who don't take much longer to do the lab.

**P1:** Given what you know about the solar panel, diodes, battery, and voltage converter, draw a circuit diagram for a solar charger circuit. The battery must charge when the solar panel is exposed to the sun, and not discharge when it's in the dark. The voltage converter should always be able to draw power, regardless of whether the device is in the sun or not. Please use the standard symbols for the battery and diode.




### 2.1 Characterizing your solar cell in light

In the lab you will solder wires to your solar panel, but for now, you should use two of your clip leads to connect to the panel. Clip one onto the silver-colored positive connection on the back of the panel, and the other onto the negative connection.

**P2:** On a sunny day, the sun is about 1000 times brighter than indoor lighting, so it's best to characterize your solar cell in the sun. Go outside when the sun is shining (you're in California, so no excuses about not having a chance to), and use your multimeter to measure the *short-circuit current* and the *open-circuit voltage* of the solar cell. Remember to orient the solar cell to catch as much light as possible, *i.e.*, cast the largest shadow possible.

1 P1 **3 / 3**

✓ **- 0 pts** Correct

**- 0.3 pts** Missing diode to prevent leakage current

**- 0.2 pts** Missing polarity of voltage converter

**- 0.8 pts** Voltage converter in a way that cannot draw power from the battery (on the wrong side of the diode, or in series, etc.)

**- 0.2 pts** Minor Error

**- 1 pts** Missing voltage converter

**- 0.3 pts** Late submission

**- 0.1 pts** Added unneeded bypass diodes

**- 0.5 pts** Diode / Solar panel in wrong direction

**- 3 pts** No Attempt

**- 1 pts** Missing Solar Panel

6.8V
0.15A

**P3:** From these measurements, can you estimate an upper bound on the amount of power the solar panel can provide? *Hint: Have a look at the V–I characteristic of a solar cell. How can you represent the power $P = VI$ provided by the solar panel at some given voltage and current, graphically?*

$6.8V \cdot 0.15A = 1.02W$

If you look carefully at your solar cell (bright light is best) you will see it is not one monolithic piece, but rather a large number of strips, each about 10 mm wide. So far we have characterized the solar panel when the same light falls on all the different solar cells diodes that make up the panel. Now we're going see what happens when some cells are blocked.

**P4:** A silicon diode has a forward voltage of about 0.6 V. Given the panel voltage you measured, how many diodes must it contain?

$11.3 = \frac{6.8V}{0.6V}$ at least 11 diodes

**P5:** Measure the short-circuit current if you block the sun from one of these strips using a finger or a piece of dark tape.

0.1mA

**P6:** *Extra credit:* Explain your results from P5 using the model of the solar cell as a stack of current sources in parallel with diodes.

Since the strips are in series, the current can't flow when one of the strips gets no light.

## 2 P2 **1 / 1**

✓ **- 0 pts** **correct- should be around 7V and 100mA (accept anything >6V and >60mA)**

**- 0 pts**

current too low (still >35mA), but gave explanation for discrepancy (had to take indoors, etc.)

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- **- 0 pts** Correct: 10-12 diodes  (you can count the strips too)
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+ **0.5 pts** Data given but method not described
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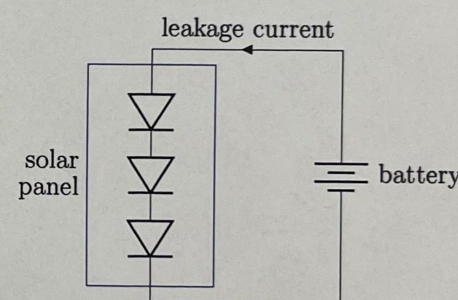
**P7:** *Extra credit:* Find a way to measure the solar panel at points other than open-circuit voltage and short-circuit current, and use this to produce an experimental I–V characteristic plot for the solar cell. (If you do this, submit the plot on a separate sheet. Feel free to use a computer to do the plot, if you like.)

## 2.2 Characterizing the solar cell in the dark

So far we have looked at the current through the solar cell when light is shining on the cell. However, if we are going to connect the solar cell to the battery to charge it, we also need to consider what will happen if the battery remains connected and the sun is no longer shining. When the sun is not shining on the solar panel, it behaves like any other stack of diodes. If the panel is connected directly to the battery, current can flow from the battery through the solar panel.




**P8:** Measure this *leakage current* by measuring the current through the cell when it is connected directly to your battery.

153 mA

**P9:** Your LiPo battery can store up to 2800 mA h (milliamp-hour) of charge, or 10.08 kC. Using your measured leakage current, how long would it take for your battery to fully discharge, if it started full and you stored the circuit above in the dark?

$$\frac{\text{capacity}}{\text{discharge}} = \frac{2800\,\text{mAh}}{153\,\text{mA}} = 18.3 \text{ hours}$$

8 P8 **0.7 / 1**

- **- 0 pts** Correct - current should be in the single-digits in mA.
- ✓ **- 0.3 pts** **Current is too high**
- **- 0.2 pts** Current is not zero.
- **- 1 pts** No answer / no work
- **- 0.3 pts** Late submission

**P7:** *Extra credit:* Find a way to measure the solar panel at points other than open-circuit voltage and short-circuit current, and use this to produce an experimental I–V characteristic plot for the solar cell. (If you do this, submit the plot on a separate sheet. Feel free to use a computer to do the plot, if you like.)

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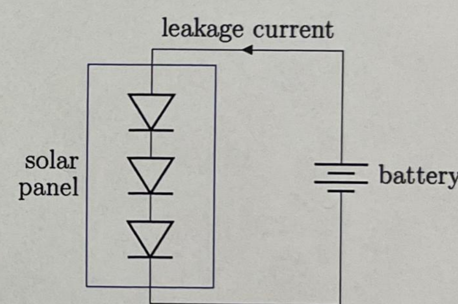


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## 9 P9 **1 / 1**

- ✓ **- 0 pts** **Correct: 2800 mA-h / leakage current (mA)**
- **- 0 pts** calculation done correctly, using the previous number which was wrong (carry-over error)
- **- 0.3 pts** incorrect.
- **- 1 pts** no work
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