**Grading Rubric**

***Lab 2 – RC Circuit***

***( /46)***

Recall that your goal is to teach them through inquiry-based teaching, and therefore you should encourage discussions, and make them understand the concepts (and achieve the best marks possible) as opposed to strictly evaluating them. You should try and assess their understanding in the last 30 mins of the lab session, or before they leave.

Points are distributed in four parts: **Pre-lab**, **Log book structure**, **Session A** and **Session B**. For the latter two, there’s always a **Conceptual questions and Critical thinking** and sometimes **bonus points**. Only during Session B will there be a **Data presentation** subsection.

**Pre-lab (/2)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Unsatisfactory (0) | Minimally satisfactory (1) | Satisfactory (2) | Exceeding Expectations (3) |
| Pre-lab Activity | Did not attempt any of them | Gave an answer to all of them. Made some mistakes. | Gave an answer to all of them. Made no mistakes | - |

**Log book Structure (/4)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Unsatisfactory (0) | Minimally satisfactory (1) | Satisfactory (2) | Exceeding Expectations (3) |
| Session a | Did not write any introduction or conclusion | Introduction and conclusion sections are present. Made no effort in evaluating their sources of error, and potential follow-up. | Introduction and conclusion sections are present. Made some effort in evaluating their sources of error, and potential follow-up. | Introduction and conclusion sections are present. Put in a lot of effort in evaluating their sources of error, and potential follow-up. |
| Session b | Did not write any introduction or conclusion | Introduction and conclusion sections are present. Made no effort in evaluating their sources of error, and potential follow-up. | Introduction and conclusion sections are present. Made some effort in evaluating their sources of error, and potential follow-up. | Introduction and conclusion sections are present. Put in a lot of effort in evaluating their sources of error, and potential follow-up. |

**Session A**

**Conceptual questions and Critical thinking (/10)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Unsatisfactory (0) | Minimally satisfactory (1) | Satisfactory (2) | Exceeding Expectations (3) |
| Answered step 10 | Did not explain it. | Incorrectly explained it. | Correctly explained it. | - |
| Answered step 11 | Did not explain it. | Incorrectly answered it. | Correctly answered it. | - |
| Answered step 12 | Did not explain it. | Incorrectly answered it. | Correctly answered it. | - |
| Answered step 13 | Did not explain it. | Incorrectly answered it. | Correctly answered it. | - |
| Answered step 14 | Did not explain it. | Incorrectly answered it. | Correctly answered it. | - |

**Bonus points:**

* Engage in a discussion about measuring larger time constants **(+2)**.
  + For larger time constants, square wave inputs are too quick, and one should use a DC source.
  + The internal impedance of the PASCO unit may be insufficient to allow larger time constant measurements.

**Session B**

**Conceptual questions and Critical thinking (/14)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Unsatisfactory (0) | Minimally satisfactory (2) | Satisfactory (4) | Exceeding Expectations (6) |
| Measured the time constant from the effective resistance and capacitance of the circuit. | Did not obtain the correct time constant and was not able to justify the cause of this discrepancy. | See Satisfactory conditions but made some computational mistakes and/or didn’t measure correctly the time constant. | Correctly constructed their circuit by calculating the effective resistance and capacitance and measured the time constants using the PASCO. | Offered and executed another way to provide evidence that they correctly constructed the right RC circuit with the demanded time constant. |
| Incrementally increased the resistance and capacitance to obtain the slope and re-verify the time constant. | Did not perform this test. | Incorrectly connected the additional component such that the fit is not linear. | Correctly connected resistors and capacitors to obtain graphs with linear fits. | See Satisfactory conditions and explained the discrepancy between these two methods of measurement |
|  | Unsatisfactory (0) | Minimally satisfactory (3) | Satisfactory (6) | Exceeding Expectations (9) |
| Presented their conclusion in an argumentative form by referencing correctly their data. | Provided unconvincing arguments. | Obtained a decent time constant measurement, compared using less useful measures than percentage error, showed graphs of linear fit | Obtained a good time constant measurement, compared using percentage error, showed graphs of linear fits. | Offered experimental alternatives to improve the accuracy of the time constant measurement. |

**Data presentation (/16)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Unsatisfactory (0) | Minimally satisfactory (1) | Satisfactory (2) |
| Appropriate algebra (includes appropriate error propagation calculations) | Overwhelming number of mistakes | Roughly half the calculations are wrong | Most calculations are correct |
| Units (results and graphs) | Missing | Incorrectly used | Correctly used |
| Standard deviation  and significant figures | Missing | Incorrectly used | Correctly used, or did not include it after noticing that the PASCO fit parameter gives an infinitesimal standard deviation. Must be able to explain why that happened. |
| Standard deviation  and significant figures | Missing | Incorrectly used | Correctly used |
| Title (figures and tables) | Missing | Incorrectly used | Correctly used |
| Axes labels | Missing | Incorrectly used | Correctly used |
| Fit equation for graphs | Missing | Incorrectly used | Correctly used |
| value for graphs | Missing | Incorrectly used | Correctly used |

**Bonus points:**

* Engaged in a discussion of a mixed circuit, one where the resistors are coupled to the capacitors instead of having two separate sub-circuits **(+2)**.
  + For mixed circuits, one must use complex analysis to understand the impedance of the circuit, and therefore the equations for equivalent resistance and capacitance cannot be applied. We do not expect them to understand these concepts but understanding well enough the effective resistance/capacitance equations would entice certain students to think beyond the scope of the course. You should engage in such discussions when possible.