**Submission Deadline Policy & Extended Deadline Approval Form**

**(Remove This Page if Not Applicable)**

**Default Deadline:**

The standard submission deadline for lab reports is **one week after the date you performed your experiment**.

**Extended Deadline Cases:**

You may be permitted to submit under a new extended deadline only in specific cases, such as:

* Attending the lab in another section (with valid excuse).
* Being invited by the instructor to resubmit your work.
* Discuss with your instructor for other cases.

**New Extended Deadline:**

If an extension is approved, the new deadline will be **one week after the date you performed the experiment** in the other section or the date you were invited to resubmit. The non-business days will be included in the new deadline.

**Important:**

If you are granted a new extended deadline, **retain this page and fill in all required information**.

If you are not granted a new extended deadline, **remove this page** before submission.

**Student Information**

* Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Student ID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Original Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Original Group Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Date of The Original Experiment: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Extended Deadline Approval**

* Did your lab instructor approve a new extended deadline? Answer with Yes or No (you are not permitted an extended deadline without approval): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Reason for New Extended Deadline: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Experiment Information:**

* Date Performed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Group Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Class Instructor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Additional Comments or Details (if any):**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Write Your Comments Here (If Any) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Experiment Title

Student Name

Affiliation (e.g., Senior, Computer Engineering, ECE department, Missouri S&T)

Email address (must use a domain that match your affiliation)

***Abstract*-This section is called the abstract. The abstract is a summary of your document. You should state the goal (what you intend to do), the methodology, and upper-level comment on the results. The abstract should be short and summarize the entire document. Example: In this experiment, we aim to investigate the characteristics and applications of analog multimeters. To do so, construct various circuits to measure the internal resistance, we designed shunt resistors to extend ammeter range, and we evaluated the sensitivity of the device via** **ohm/volt analysis. The results match the expected theory, while the results show that the methods that rely on decade resistor box for internal resistor have resulted errors compared to the decade box free methods.**

1. Introduction

The Introduction section is the first part of your report and should provide a clear explanation of the fundamental concepts and theory relevant to the experiment. It should establish a strong theoretical foundation, assuming the reader has a basic understanding of the subject (e.g., physics, mathematics, or circuits) but may not be familiar with the specific theoretical details of the experiment (e.g., Thevenin Equivalent). Your explanation should be well-supported with mathematical expressions, figures and references to enhance clarity and comprehension. Including mathematical description is highly recommended. However, you should only use math via Math Mode of MS Word. An example of a proper equation written via the Math Mode of MS word is shown below. Note that it is recommended to insert your equation in a new line rather than within the text of your paragraph.

$$V=IR,$$

After inserting any equation, you must explain the notation if you haven’t done so before. For example, after the previous equation you should start the next paragraph with “where $V$ is the voltage, $I$ is the current, and $R$ is the resistance.” Note that how I used the same notation consistently for explaining my equation (i.e., $V$ not V). If there was a notation that is has been already defined, you don’t need to define it again. For example, consider inserting this second equation, note how I don’t need to define $V$ and $R$ again.

$$P=\frac{V^{2}}{R},$$

where $P$ is the power.

For a formal report, you need to cite at least one reference. You can only cite books, research papers, or web-articles. In professional settings, people will judge you based on the quality of your references! In order to cite a reference, you need to include both (i) in-text citation and (ii) add the reference at the references section. For the “in-text citation” you need to add the number of the reference in square brackets just after the statement you want to cite. For example, “Analog multimeters work by using a moving-coil galvanometer to measure current, voltage or resistances [1]”. In that example, the in-text citation [1] has been added after illustrating the working principle of the analog multimeter. After adding the in-text citation, you need to add the reference at the references section. To do so, you need to take into your consideration that you need choose one “styles” express your reference; there are many “styles” to cite a reference such as the “MLA”, “APA”, “Chicago-style” … etc. In the electrical and computer engineering contexts it is preferable to use the “IEEE style”. Examples of how to cite different kinds of documents via the IEEE style can be found in this link ([ieee-dataport.org/sites/default/files/analysis/27/IEEE Citation Guidelines.pdf](https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf)). In the previous example [1] is a “Single Author Book” which should be cited according to IEEE style as:

[1] A. S. Morris, *Measurement & Instrumentation Principles*. Elsevier, 2001.

You might need to use figures to support your explanation in the introduction section. You will surly need figures in the methodology and results section. When inserting a figure, you need to choose a figure with high-quality if possible.



Figure 2:Exemplary Figure-2

Figure 1: Exemplary Figure-1

A high-quality figure has the following aspects: (i) it should not be pixelated or blurry figure, (ii) the information displayed in the figure (e.g., text, numbers, notations, … etc) should be easily readable, (iii) the background of the figure should match the background of the page (e.g., white page in this case), and (iv) the figure format should be consistent; for example, if one figure use color red to draw the DC power supply, then all your other figures that have DC power supplies should have the same art style; also, if one figure use the notation $V\_{S}$ for the power supply, then all your other figures as well as your equations should use $V\_{S}$ to express power supply voltage. The figure should be placed (positioned in the page) appropriately, it is recommended to place your figures on the top of your page. The top space of your page has the space to hold two to three small square figures or one wide rectangular figure. When placing a figure you must do the following: (i) the figure must always have an identifier and caption. The caption is the description of the figure that appear under the figure. The identifier is a unique name of the figure identifier that procced the caption (e.g., Figure 1: caption) (ii) you must cite your figure in-text. This means that after placing your figure and adding the identifier and caption you must call the figure in-text (e.g., Figure 1 shows this and that). Placing a table on the other hand follow a similar procedure with one noticeable difference that the table identifier and caption appears on the top of the table.

The formatting and presentation are significantly important and can express your professionalism. Your report should be typo-free, no grammar errors, have an appropriate use of the language, have consistent high-quality figures and tables, have appropriate the use of punctuation marks, and have a consistent use of appropriate mathematical notations. When writing your formal report, use the “justify” format on all your paraphs, don’t use “align left”, “center”, or “align right”. The following two paragraphs are examples of appropriate and non-appropriate text alignment:

Exemplary appropriate alignment:

An analog multimeter is a versatile electrical measuring instrument used to measure voltage, current, and resistance. It features a needle that moves across a scale to display readings, offering real-time fluctuations that digital multimeters may not capture. Though less precise than digital models, analog multimeters are valued for their responsiveness and ability to detect transient changes in electrical signals, making them useful in certain applications like tuning circuits and troubleshooting dynamic electrical systems.

Exemplary non-appropriate alignment

An analog multimeter is a versatile electrical measuring instrument used to measure voltage, current, and resistance. It features a needle that moves across a scale to display readings, offering real-time fluctuations that digital multimeters may not capture. Though less precise than digital models, analog multimeters are valued for their responsiveness and ability to detect transient changes in electrical signals, making them useful in certain applications like tuning circuits and troubleshooting dynamic electrical systems.

For formal reports, use should follow the requested template specifically. This means that you shouldn’t change font size, font color, paragraph spacing, page margin, or any other formatting. You should make the appropriate usage of tense and voice. The general rule of thump is that we use the “present tense” in the introduction and conclusion sections, the “past tense” for methodology and results sections, and “future tense” if you have a future work section. Moreover, you should be consistent in the usage of either the “third-person (passive voice)” (e.g., the circuit has been constructed according to Figure 1) and the “first-person (active voice)” (e.g., we constructed the circuit according to Figure 1). The “third-person” is usually more formal and preferable although that the “first-person” is highly popular and acceptable. When using the “first-person”, use the pronoun “we” and never use “I”. When writing your report stick to the “formal professional” language and avoid using “causal language”. Finally, format your report to cover white spaces; your report should be good-looking, symmetrical, consistent, and with minimum white spaces; writing a report is an art! Don’t forget that you must read your report before submission.

The final paragraph of your report should include a summary of what you intend to make in this report. Start with a generic upper-level objective of your report (e.g., In this experiment we intend to investigate the characteristics and applications of analog multimeters) after that, break down your generic upper-level objective into smaller goals, the smaller goals should balance all the aspects of your experiment (recall that Thevenin analysis include both finding the Thevenin circuit as well as conducting the power analysis). The usage of bullets here is really preferable. The following paragraph is an exemplary of how your last paragraph should look like

In this experiment, we aim to investigate the characteristics and applications of analog multimeters. Specifically:

* We examine different methods and techniques for measuring the internal resistance of an analog multimeter.
* To extend its measurement range, we design and implement a shunt resistor circuit.
* We perform an ohm/volt analysis by evaluating the analog multimeter across various load resistances.

The whole introduction section should be at least ¾ of page in length.

1. Methodology

This section is intended to describe the methodology you followed to conduct your experiment. The key concept here is that your description should make the experiment to be “reproducible”. This means that anyone who read your report should be able to conduct the same exact experiment under the same exact settings and use the same exact devices/tools to collect the same exact numerical results.

You must start your methodology section with upper-level description of your procedure. For example, for a Thevenin analysis experiment you can start by “We aim to build and test Thevenin equivalent for a given circuit; to do so, we start by measuring the Thevenin voltage $V\_{TH}$, after that we complete our Thevenin equivalent by measuring the Thevenin resistance $R\_{TH}$ using two methods … etc.” When you finish your upper-level methodology description, break down your methodology into subsections.

1. *Measuring Thevenin voltage practically*

Describe your methodology here to measure Thevenin voltage practically (hint: part-1).

1. *Measuring Thevenin resistance practically via method-1*

Describe your methodology here to measure Thevenin resistance practically using method-1 (hint: part-2).

1. *Measuring Thevenin resistance practically via method-2*

Describe your methodology here to measure Thevenin resistance practically using method-2 (hint: part-3).

1. *Comparing the constructed Thevenin equivalent with the given circuit*

Describe here what methodology you have conducted to compare your Thevenin equivalent with the given circuit (hint: part-4, part-5, part-6, and part-7).

1. *Thevenin equivalent power analysis*

Describe here what methodology you have conducted to conduct the power analysis on the Thevenin equivalent (hint: part-8 and part-9).

In any of these subsections, you need to “generalize” in your description. For example, the given circuit in the experiment is just an arbitrary example. You need describe generally how each part is to be conducted for any arbitrary circuit then state how does that apply for your specific exemplary circuit. For each part, you might need to insert figures to illustrate the given exemplary circuit. Finally, you as the author should understand the goals and objectives of each part of the methodology, and design your methodology accordingly (e.g., why did we conduct parts 4 to 7? What was the goal? Write subsection II.D accordingly).

1. Results and Discussion

In this section you should (i) illustrate your collected numerical results, (ii) evaluate your results against theoretical expectations, (iii) comment on your results and evaluation, and (iv) to post process collect data if needed. Start this section by stating your experiment tools; what tools have you used to conduct this experiment (breadboard, jumpers, resistors, measurement devices, … etc)? Moreover, state what experiment parameters have you used (i.e., what are the values of the resistors that you used?) You can used tables if needed to state what value of component have been used for each part of the experiment. You must use proper measurement units for your parameters and results; ohm is $Ω$, kilo if $k$ not $K$, volt is $V$ not $v$ … etc. Finally, you must define your evaluation formula(s) that you will use to evaluate your measurements. Remember that there are many mathematical definitions of errors (e.g., root-mean-square error, absolute error, percent error, … etc), you need to state what error definition you are specifically using and insert the equation of that error definition. For example, you prefer to use the percent error you can write

We rely on percent error to evaluate the performance; percent error is defined as

$$error=\frac{\hat{y}-y}{y},$$

Where $\hat{y}$ is the measured value and $y$ is the actual theoretical value.

You might also need to state how did you calculate the actual theoretical value $y$. You might include your math here for this purpose if not have been already done in the introduction section. When you are done defining the experiment settings, used parameters, and error definitions, breakdown your results into sections where each section showcase results and evaluation of a specific part of the experiment. For example, you might use the following:

1. *Thevenin voltage results*

In this subsection you need to compare the measured numerical Thevenin voltage with the actual theoretical Thevenin voltage. You also need to comment on the error.

1. *Thevenin resistance*

In this subsection you need to compare the measured numerical Thevenin resistance via both method 1 and method 2 with the actual theoretical Thevenin resistance. You also need to comment on each error. Finally, you need to comment on which method works better and why

1. *Comparing the constructed Thevenin equivalent with the given circuit results*

In this subsection you need to compare the performance of the constructed Thevenin equivalent with the given circuit for the two resistance options. Comment on the errors, does the load resistance affect the performance of the Thevenin equivalent?

1. *Thevenin equivalent power analysis results*

In this subsection you need to perform power analysis. Make three figures for the load power $P\_{L}$ the total power $P\_{T}$ and the efficiency $η$ against the load resistance. What did you notice? Does that match the theory? [Optional and bonus over the report, prove mathematically that the circuit will deliver the maximum power to the load resistance $R\_{L}$ when $R\_{TH}=R\_{L}$].

The raw numerical results should be always in tables. These tables don’t necessarily contain results of specific part only; as you can make on table that combine results of multiple parts of the experiment. It is also possible to make tables of results that contain single element if needed (e.g., a table in subsection III.A that contains one result only of the measured Thevenin voltage). When evaluating, you should always comment on what if the results match the theory or not; if not, you need to justify the error. In this template, the required evaluations has been given to you, but in actual professional settings it will be your responsibility to conduct the necessary evaluation methods that prove that your experiment really work.

1. Conclusion

This section should include one paragraph that include the following: (i) Summary of Key Findings – briefly restate the main results of this experiment. (ii) Limitations – mention any constraints or factors that may have affected the results. (iii) Future Work – suggest possible improvements.

##### Acknowledgment

This section is optional, you might use it if you want to acknowledge any support or help you received to make this experiment, process the data, or gain the necessary theory. The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”.

##### References

Put your results here. It is preferable to follow IEEE style. One reference is enough, but you can place more if needed.

1. A. S. Morris, Measurement & Instrumentation Principles. Elsevier, 2001.