Laboratory 1

Introduction to the Electrical Circuits Lab

Objectives

1. Introduce **lab safety issues**, lab rules, lab report requirements.
2. Build **lab teams** and **assign lab stations** to each team.
3. Introduce the students to the basic electrical instruments in the lab.
4. Be able to **operate basic lab instruments**, such as multimeters and power supplies.
5. Become familiar with **resistors** and the color codes used to identify them.
6. Learn to use multimeters to **measure voltage and resistance**.

0.1 Lab Safety and Rules

Electrical energy can be hazardous. Even small currents (e.g. 50 mA) can cause death. **Therefore, electrical safety is very important when you are working in the lab**. To protect you from electrical harm, you must:

- Strictly follow the lab instructions and procedures. A detailed list of rules and procedures will be provided to you during the first lab. Read it carefully.
- Carefully check your circuits before turning on power supplies.
    - **Carefully read the lab instructions before attending labs!**
- **Avoid touching electrical circuits if the power supplies are on**.
- Minimize the potential for water or chemical spills on or near electrical equipment.
    - **Do not eat food and drink in the lab room!**
- Dial 911 if someone is seriously injured.

Additionally,

- do not bring people who are not supposed to be in the lab room.
- **Clean up and put everything their original places before leaving labs!**

0.2 Build lab teams and assign lab stations to each team

The students in each lab section will be divided into teams of two or three students. Students will be able to pick their own team members. Students that cannot find a team will be assigned one by the lab instructor.

Each team will be assigned a station. Each team has the responsibility to keep the station clean and organized. Be sure the instruments and other accessories on the station work well so that the next team

can perform the labs smoothly and properly. If anything is broken, please report it to the lab instructor before leaving.

0.2 Lab grading

The lab grade includes three parts: preliminary work (if the lab has), attendance + lab work, and lab reports. The following table describes the lab grading policy.

Table I. Grading policy.

Evaluation Item	Description	Points	Evaluation type
Preliminary work	If a lab requires a preliminary work, then each student must perform this preliminary work before the lab. The work must be checked by the lab instructor within the first 15 minutes of the lab for credit.	25	Individual
Attendance and Lab work	The work required to be completed in the lab must be checked by the lab instructor at the end of the lab. ***Note****: the work is carried out as a team, but each student should keep individual records of the results obtained during the experiments.*	50	Individual*
Lab report	Each team is required to submit one lab report after each lab. The lab report is due a week later after it is assigned. The grade of the report is given to all members of the team.	25	Team-based

* Note: if a student misses or is dismissed from a lab, the student's lab grade will be zero even if the student submits a lab report. Personal/family emergencies will be evaluated case by case.

0.3 Lab report requirements

Each report must be written electronically (e.g. using MS-WORD) and submitted online (PDF file) in CatCourses. Tables, figures, and graphs should be produced electronically and attached to or embedded in the report if necessary. Figures and graphs should have clear captions, units, and labels. Each report must contain the following sections:

- **The cover page,** including lab number and title, the date the lab was performed and the names of the team members.
- **Objectives:** A short description of the purpose of the lab should be provided.
- **Theoretical background:** A brief description of the theory used in the lab should be given, e.g., by explaining the circuit laws and methods used to analyze the behavior of the electric circuits employed in the lab.
- **Lab procedures:** the procedure for each lab should be summarized in the report by using your own words. The measurement and other experimental data should be clearly presented using tables, figures and/or graphs.
- **Analysis of experimental data**:
  - Provide the circuits and simulation models used in the lab.

- Provide the formulas or equations to support your lab results.
- Compare theoretical results with your simulation or experimental ones.
- Explain your results.

- **Conclusions:** Discuss and summarize the lab and the results. You are welcome to provide your suggestions and critical comments on the lab's assignment.

1. Equipment and components of Lab 1

Multimeter: Digital multimeter with manual
Power supply: DC/AC power supply with manual
Resistors: 100 Ω, 270 Ω, 470 Ω, 680 Ω, 1 kΩ, 2.2 kΩ, 3.3 kΩ, 5.6 kΩ, 10 kΩ, 100 kΩ, 4.7 MΩ, 10 MΩ

2. Preliminary Work

1. Read this lab instruction about the lab safety and lab report requirements.
2. Read the attached manuals for the power supply and multimeter. The following videos also provide a good overview of the functionalities offered by these devices:
    1. https://www.youtube.com/watch?v=v8RV3bs1MgQ&ab_channel=MarkFurneaux
3. Familiarize yourself with the color code of resistors; see Appendix and the following video
    - https://www.youtube.com/watch?v=GLD7AgAYqwA&ab_channel=EngineeringTechnologySimulationLearningVideos

3. Lab Procedure

Part1: Voltage Measurement.

1. Read the multimeter and power supply manual. Pay attention to "+" and "-" reference polarity.
2. Turn on the power supply.
3. Adjust the voltage knob at 5 V.
4. Set the multimeter as a voltmeter, measure the voltage value, and write down the measured value (_____)
5. Find the percentage of error for the measured values (_____)
6. Adjust the voltage knob at 10 V and repeat step 4 (_____) and step 5 (_____).
7. State potential reasons for measurement errors.

Part 2: Resistance measurement

1. Check component kit for possible missing parts. The number of the resistors in the kit should be 12 in total (see Equipment and Components of Lab 1, discussed above)
2. Read the color code of resistors.

3. Measure the resistance of each resistor by clipping the test leads of the multimeter (set to measure resistance) to the resistor leads (Note: the multimeter should be configured to work as an ohmmeter).
    - Fill out the table below.
4. Calculate the tolerance of each resistor. Hint: The measured tolerance can be calculated by using the formula given below.

    Ra = actual resistance (measured)
    Ri = indicated resistance (based on color code)

    Measured Tolerance (%)= 100*(Ra-Ri)/Ri

Indicated Value	Color Code	Measured Value	Indicated Tolerance	Measured Tolerance
100 Ω	Brown, Black, Brown	99.7 Ω		0.3%
270 Ω				
470 Ω				
680 Ω				
1 kΩ				
2.2 kΩ				
3.3 kΩ				
5.6 kΩ				
10 kΩ				
100 kΩ				
4.7 MΩ				
10 MΩ				

Note: The first row shows an example. The indicated tolerance of the resistance is based on the resistance's color code (see Appendix)

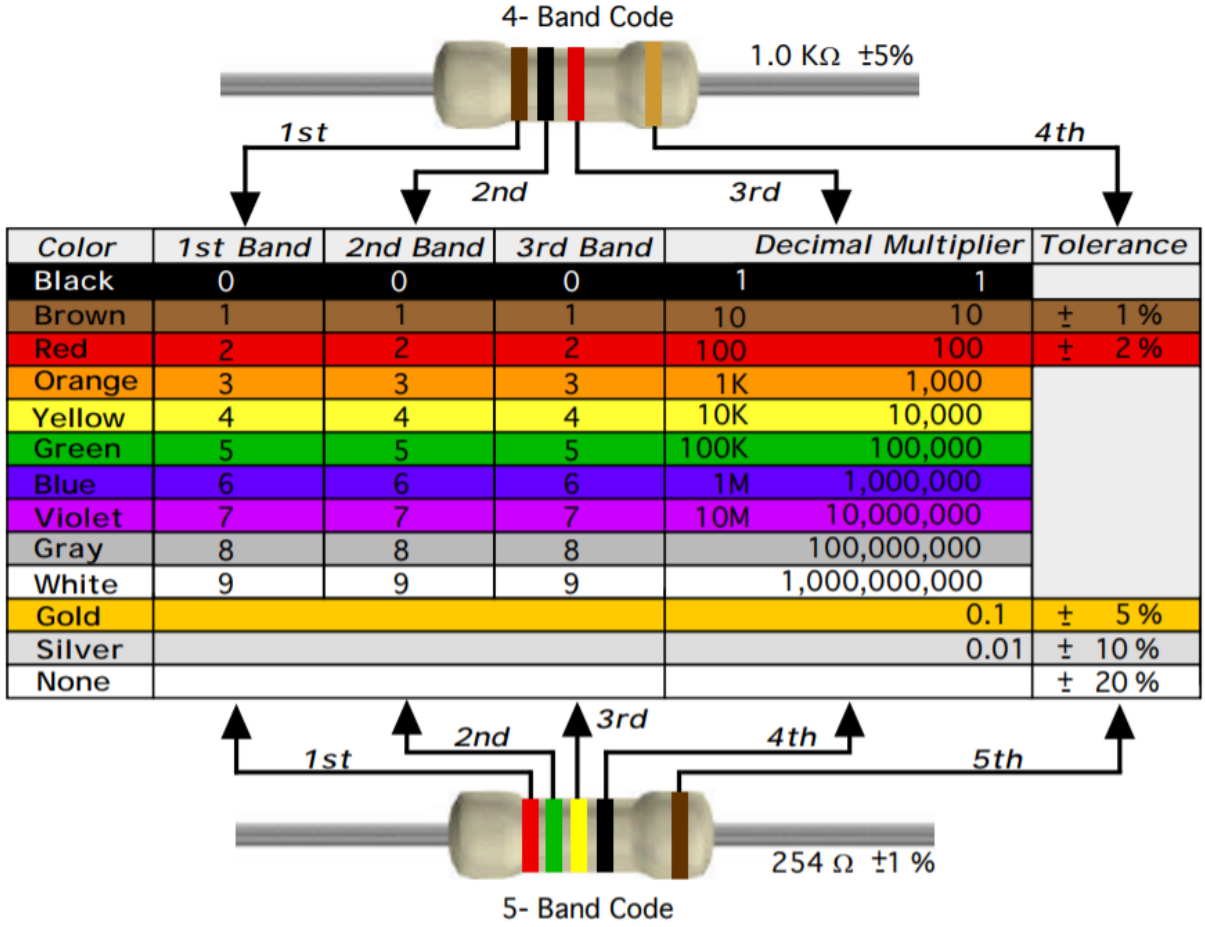
Discussion and Conclusions

1. Compare the indicated values with your measured values.
2. Give plausible reasons for the discrepancies.

4. Lab Report

Complete the lab report and submit it before start of next lab.

Appendix 1 - The color code of resistors



Color	1st Band	2nd Band	3rd Band	Decimal Multiplier	Tolerance
Black	0	0	0	1	
Brown	1	1	1	10	± 1 %
Red	2	2	2	100	± 2 %
Orange	3	3	3	1K	
Yellow	4	4	4	10K	
Green	5	5	5	100K	
Blue	6	6	6	1M	
Violet	7	7	7	10M	
Gray	8	8	8		
White	9	9	9		
Gold				0.1	± 5 %
Silver				0.01	± 10 %
None					± 20 %

To probe further: https://eepower.com/resistor-guide/resistor-standards-and-codes/resistor-color-code/#