

RoboJackets Electrical Training Week 0 Worksheet

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1 What is this worksheet? What's so special about it? Why should you read it?

This worksheet contains all **the knowledge we expect you to already know when you walk into Week 1** electrical training session. If there are any concepts in this worksheet you feel uncomfortable with, please come to Week 0 training session on [Location, Time].

RoboJackets build robots and we are going to help you understand how we built them so you can do it as well. The electrical training focuses on the idea of "Prototyping" and that would require a basic understanding of electricity. We therefore prepared Week 0 session for those have little knowledge in electricity so you'll walk in week 1 less confused.

There are three documents in the week 0 training. A worksheet, its answer sheet and an informational sheet that explains everything in this document. This document is the worksheet.

2 Intro to Electricity

1. Resistance is measured in _____. (Unit)
2. If the two terminals of a resistor are measured to be -3.3V and -5V with reference to some arbitrary pre-defined ground. The potential difference across the resistor is _____.
3. To measure current, Ammeter is connected in _____(parallel / series) with the desired path. To measure voltage, Voltmeter is connected in _____(parallel / series) with the desired path.
4. 5V is applied across a resistor and the resultant current is 0.2A. The resistance across the resistor is _____.
5. The resistor in the previous question is dissipating energy at _____W.
6. With reference to the color coding diagram (Figure 1), a resistor of yellow, violet, brown and gold color code has a resistance of _____.

3 Capacitors and Inductors

3.1 Capacitors

1. Capacitors are measured in _____. (Unit)

Color	Digit value	Multiplier	Multiplied Out	Tolerance
Black	0	10^0	1	
Brown	1	10^1	10	
Red	2	10^2	100	
Orange	3	10^3	1,000	
Yellow	4	10^4	10,000	
Green	5	10^5	100,000	
Blue	6	10^6	1,000,000	
Violet	7	10^7	10,000,000	
Gray	8	10^8	100,000,000	
White	9	10^9	1,000,000,000	
Gold				$\pm 5\%$
Silver				$\pm 10\%$

Figure 1: Resistor Coding Chart

2. 0.0025 coulomb of charge accumulates across a capacitor when 5V is applied, its capacitance is _____.
3. There are two types of capacitors: ceramic and electrolytic. Both of them do not have polarity (True / False).
4. Electrolytic capacitors usually have a lower value than ceramic capacitors (True / False).
5. Capacitors are used in circuits for what purposes related to power?

3.2 Inductors

1. Inductors are measured in _____(Unit).
2. Inductors can typically be found in electro-mechanical parts on a robot (True / False).
3. An ohmmeter is connected across an inductor and the meter reads zero ohms. The inductor is definitely broken (True / False).

4 Diodes and FETs

1. LEDs are a type of diode and they're very delicate. We need to apply additional resistors in series to an LED to prevent too much current. If the supply voltage is 5V and the LED is rated at 20mA maximum. What's the minimum resistance of the additional resistor?
2. FETs are used to help low voltage logic circuits to control high voltage and current-drawing motors. (True / False)
3. For the Figure 2, assume the two transistors are functioning properly with respect to Vdd and Vss levels, what's the voltage level of Q when voltage at A equals Vdd?

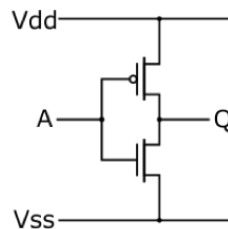


Figure 2: Transistor Operation Schematics

5 Circuit Analysis

5.1 Parallel and Series

1. Two $1.2k\Omega$ resistors are in series and this combination is in parallel with a $3.3k\Omega$ resistor (Left circuit in Figure 3). The total resistance is _____.
2. Consider the right circuit in Figure 3. Assume ECHO_5V is actually 5V. What's the voltage at ECHO_OUT.
3. A $10\mu F$, $20\mu F$, $22\mu F$, and $100\mu F$ capacitor are in parallel. The total capacitance is _____.
4. Now the capacitors in Q3 are in series. Their capacitance is _____.

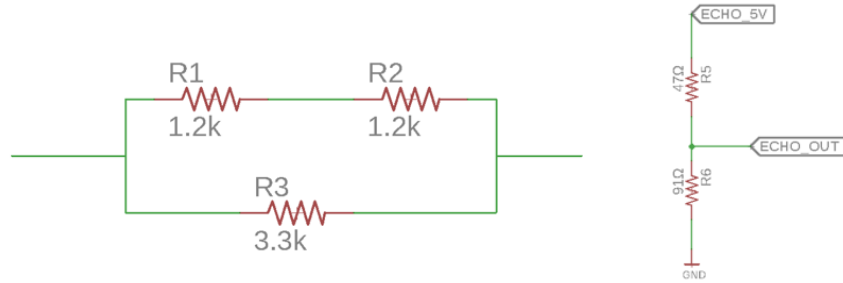


Figure 3: Parallel and Series Analysis

5.2 Kirchhoff's Law

1. In Figure 4, $R_1 = 4\Omega$, $R_2 = 3\Omega$, $R_3 = 2\Omega$. $\varepsilon_1 = 12V$, $\varepsilon_2 = 8V$. What's the current through R_2 .

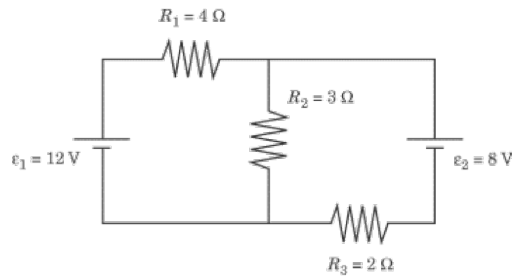


Figure 4: Kirchhoff's Circuit Analysis

6 Prototyping

1. Breadboards are very useful during prototyping. If the breadboard in front of you is oriented so that the longer side faces you (See Figure 5). Holes in the same rows are _____ and those in the same column are _____. Columns on the two sides of the middle trench are _____ (Fill in with Connected or Not connected).
2. When prototyping with breadboard, you should use _____ (Single-core / multi-core) for a signal line. When crimping a multi-core wire, one (should / should not) twist the wire to make it more solid.
3. Is R1 in Figure 5 acting as a pull-down resistor or pull-up resistor? What does it do?

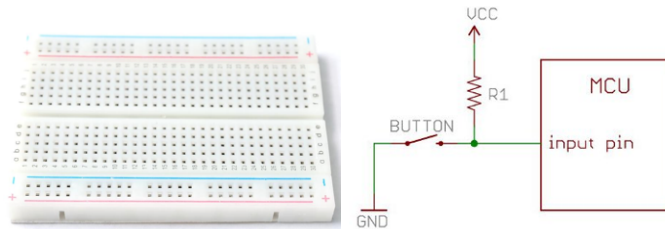


Figure 5: Example breadboard and pull-up resistor network

4. Fuse is the most fragile part of your circuit. Replace it with a wire to make your circuit more robust (True / False).