Electronics you Migth not Have Learned in College: Introduction to Capacitors

An Online Continuing Education Course for Engineers

Course Number: E-5022

Credit: 5 Hours / 5 PDH / 5 CPD

Electronics you Might not Have Learned in College
Lesson 3: Introduction to Capacitors

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1 INTRODUCTION FOR THOSE WHO HAVEN'T DONE OTHER LESSONS IN THIS COURSE.

"ELECTRONICS YOU MIGHT NOT HAVE LEARNED IN COLLEGE" is a course that is divided into several lessons that are each "stand-alone" with their own quizzes and credit units. Normally, lessons 1 and 2 are taken before this lesson. However, those who are mainly interested in capacitors and have some basic knowledge of electricity can take this as a stand-alone lesson.

If this is your first lesson in this course, there is some introductory information included here that might be useful. **If you have taken other lessons in this course, part 1 is basically repeated in each lesson and may be skipped or skimmed over as a memory refresher.**

2 INTRODUCTION TO THE COURSE

During this course, I will be sharing as much of my 50 years of Electrical Engineering experience as I can. Therefore, there will be many asides that I hope may be of interest to the student as background and general knowledge even though they may not be essential to the basic course and won't be in the course test. Some of the information contained herein is purely to help students who have not been exposed to the electrical world to understand a little better how electricity works. After all, very little of our technology and industry would even exist if it wasn't for the many miracles electricity has brought to us in the short 150 years since Tesla, Edison, Westinghouse, and Faraday first took the novel magic of electricity and put it to work. It now does everything from activating tiny computer microcircuits to powering huge cities. Living in our world without at least some familiarity with electricity is like cooking without knowing how to use a stove. It can be done, but you totally have to rely on others to do the work and know what is going on. I can't imagine any engineer that would be comfortable with that.

Hopefully, the factoids picked up in this course will pique the curiosity of the student enough to search the myriad sources of information on the internet and in the media. There are many videos and lessons in various detail and complexity. This course will provide the student with sufficient background knowledge to build upon by using our amazing information networks that were not available only 40 years ago.

A little knowledge of molecular physics is important to nearly all engineering professions. Civil engineers need a little understanding of atomic structure to understand how concrete works and the strength of materials. Mechanical engineers must understand the atomic structures of metals, alloys, lubricants, and the effects of friction. From the beginning, advances in the electrical world relied on experiments in physics and chemistry done by curious scientists who slowly gained an understanding of the atomic world. Eventually, they learned a lot about how electricity works and can be manipulated to allow humans to do things they never did before.

3 THE WATER ANALOGY

Since the discovery of electricity, water flow has been used to try to help students understand the invisible world of electrons, charges, and magnetics. Water is observable, and its effects are easily explained, while much of the electrical world remains magical and confusing.

The water analogies seemed intuitive because there are many similarities and even similar terminologies used when describing water or electric systems. In a water system, we have liquid flowing through pipes, while in an electrical system, we have electrons flowing through wires.

The similarities notwithstanding, there are some differences between such dissimilar worlds which require a little imagination to compensate. However, for too many who find many of the terms and the workings of electric systems to be confusing, a comparison to a more comfortable and familiar water analogy can be helpful.

Instructors time and again sketch water systems on chalkboards when trying to explain electrical circuitry in beginning electronics courses. It always proved to be instructive and aid to an understanding despite its flaws. Hopefully, this course that heavily makes use of water analogies will further your understanding of the seemingly magical world of electronics.

4 FIRST LESSONS STUDY DIRECT CURRENT CIRCUITS

The first part of this course concentrates on DIRECT CURRENT (DC) components and circuitry, which are much easier to understand than the more complex world of ALTERNATING CURRENT (AC) circuits. Nearly all electronic circuits used in everything from flashlights to computers and electric cars are powered by DC. Even most devices that are plugged in to AC outlets contain AC to DC CONVERTERS to provide DC power to internal components. A basic understanding of the main components used in DC circuits and the way the power that drives them is measured is extremely useful to anyone working in any engineering profession. Electronics are essential in instrumentation, measurement, and control for any design or construction project.

5 PURPOSE OF THIS COURSE.

Electronics are ubiquitous in the modern world, especially in engineering. Most engineers in all specialties have taken at least some basic electronics courses but might need a refresher course. Even engineers working in Information Technologies and with computers and measurement instruments could use more understanding of the basic electronic components used in their equipment.

This course is designed for engineers in professions that don't require a lot of electronics knowledge, but they would still like to round out their technical understanding. So many electronic tools and instruments are used in all professions that even a basic knowledge of the components that make them function is very useful to engineers. We don't have to know how current, resistance, and voltage work to use meters for trouble-shooting problems with power supplies or instrumentation wiring, but it often makes the difference between being able to set up equipment properly or having to call in help.

Even electrical and electronics engineers that have been many years in the profession could use a quick electronics refresher. This course is designed to teach electronics in a little different way that might help those who had a hard time understanding the concepts as they were taught in school. Those who already know most of this information should be able to breeze through the course but still can increase their understanding of many concepts they have forgotten or never

were taught or misunderstood because of the way they were taught.

Those who have had little or no electronics training should be able to pick up an understanding of how electricity is measured and how it is used. They will also learn about electronic components, how they work and what they do. The water analogy is designed for those who have a hard time understanding how things work that they cannot see or feel. It also is helpful to those who misunderstood what they thought they already knew.

6 SUMMARIES OF OTHER LESSONS IN THIS COURSE

This is LESSON 3 in the "**ELECTRONICS YOU MIGHT NOT HAVE LEARNED IN COLLEGE" COURSE,** which is an ongoing series of individual "stand-alone" lessons that are best taken in order to build on progressively advanced information. However, **no lesson is necessarily a prerequisite for the next lesson in the course.** If students already have sufficient background to comprehend any lesson that piques their interest, any lesson can be taken in any order.

7 LESSON 1 –"THE ELECTRICAL TOOLBOX"

Lesson 1, "**THE ELECTRICAL TOOLBOX**," is the first lesson of the "**ELECTRONICS YOU MIGHT NOT HAVE LEARNED IN COLLEGE" COURSE**. It introduces basic knowledge that will help engineers trained in non-electrical disciplines be able to comprehend later lessons in the course.

The first part of lesson 1 focuses on basic electronics, which must be learned before trying to understand specifications for hardware and tools used for low voltage DC circuits installed in electronic equipment such as audio amplifiers and computers and also higher voltage (over 90 volts) AC hardware used for RESIDENTIAL and INDUSTRIAL wiring.

- Basic concepts of VOLTAGE, RESISTANCE, AMPERAGE, AND POWER are introduced because knowledge of these is necessary when learning about conductors and electrical hardware. The specifications for even simple wire cannot be understood without knowing the basics of OHM'S LAW.
- The WATER ANALOGY for a simple series resistance circuit is provided to help understand the basics of electrical measurements and terminology

- CONDUCTORS are discussed in detail because they are the most essential item in the electrical world.
- INSULATORS are reviewed because they are an important item that is often skimmed over in engineering courses
- RESISTANCE, CURRENT, AND VOLTAGE specifications for wire are examined and explained.
- OHM'S LAW that determines the relationship of VOLTS, AMPS, AND OHMS to each other is introduced

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8 LESSON 2: LAW, FUSES, AND MULTIMETERS.

The focus of this lesson is mainly BATTERIES, RESISTORS, terminology, and measurement used in low voltage DC (DIRECT CURRENT) circuits that are common in electronic equipment such as toys, video games, and entertainment systems, measuring and monitoring equipment, and computers.

Basic concepts of VOLTAGE, RESISTANCE, AMPERAGE, and POWER are introduced because knowledge of these is necessary when learning about electronic components and how they work.