What's the Difference Between Electrical and Computer Engineering?

Electrical engineering (EE) can be a difficult field to actually understand, especially when many universities have broken EE down into two branches: EE and Computer Engineering (CompE). If the two are separated, then it would seem intuitive that they are two distinct majors with only some minor overlap, but the truth is far from this. As a student in the college of Electrical and Computer Engineering, eventually you will have to commit to either one track or another, but do not be too hasty in making your decision. Just because you feel as if CompE is your destiny your freshman year, it doesn't mean you are committed just yet. Similarly with EE, you might find CompE to be the most stimulating field to study, but until you have an understanding of both fields, it's difficult to make a decision.

What is Electrical Engineering?

One simplified way of differentiating EE from CompE is to say that EEs work with curvy waves (analog), and CompEs work with sharp, square waves (digital or binary). In some regards, this could be true. EEs in fields such as electromagnetics work almost exclusively with "curvy waves," as they are the fundamentals of electric and magnetic theory. EEs are also the only field of the two to encounter analog circuit. Any exposure to E&M could give you a feel for this sort of EE work where you build up concepts from Ohm's Law, Kirchoff's Circuit Laws, and Maxwell's Equations. From an analog perspective, you can study wireless communications like cell phones, energy efficiency and power generation, how to design various types of circuits, or even semiconductors which are the building blocks of most electronics. Some of EE is akin to a very applied physics degree, communications could deal with electromagnetics for wave propagation or antenna design, and semiconductors work with applications of quantum mechanics, thermodynamics, and solid state physics. Circuit design is a new concept entirely, and power systems span across many different fields within EE. From a mathematics perspective, the equations and work you deal with will be continuous, much like most math before high school and will likely use a lot of calculus.

Then what is Computer Engineering?

If we restrict EE to curvy waves, then CompE deals with square waves, or, in most cases, binary data. CompEs span a very vast region of study from the lowest level of computer architecture where they design hardware at levels as low as the processor in computer to the highest level where they deal primarily with writing software, and everything in between. More often, however, computer engineers strikes a good medium between the two. CompEs learn how computers work at the lowest level, and then they translate that understanding into code for computers, often at very low levels. Working with assembly code (individual computer instructions) is common for CompEs, which is often more direct than what Computer Scientists deal with in regular programming languages. Other CompEs will do higher level coding as well, working on projects similar to what Computer Scientists would. In Computer Engineering, the math is different than what most people have seen before; it is discrete, and it is used to figure out problems such as program efficiency or to discover new methods for implementing an idea.

Is there any Digital Electrical Engineering?

To label EEs as only dealing with curvy waves only covers part of the field, however. Some EEs will work with digital information just like CompEs, but in a very different manner. EE can include topics such as signal processing or embedded systems. Signal processing often uses math to convert an analog signal into a digital signal, and from there EEs study how to manipulate the signal, transform it, and convert it back to analog (sound and image processing fall under this)., and much of this work is done at the digital level. Embedded systems strikes a balance between EE and CompE, and pulls elements from both; often in embedded systems, the engineer will use both analog and digital design techniques to build a circuit or system that can run on its own and do something specific.

Of course, it is also possibly for an EE to take the digital hardware and software classes alongside the CompEs, and many indeed do - it is perfectly possible to get into the digital hardware industry with either major, either coming from the CompE digital logic perspective (ECE 411), or by taking the EE circuits classes (ECE 342 and ECE 482), or possibly even doing both.

How do I decide?

If you're unsure which branch interests you more, the curriculum provides plenty of opportunity to gain exposure before you need to commit (around your Junior year). ECE 110 will introduce some basic concepts from both EE and CompE, and ECE 190 introduces programming, which will likely be common across both fields. The real exposure sets in around ECE 210/ECE 290. These are the first purely EE or CompE courses respectively. 210 teaches analog circuit analysis and introductory signal processing, which gives students a feel for what much of EE focuses around, and ECE 290 teaches digital hardware design. Depending on how your experiences go with these courses, students typically begin to feel an affinity towards one branch or the other. If you are still indecisive after 210 and 290, expanding to take CS 225 or ECE 385 for CompE and ECE 329 and ECE 310 for EE will give a better feel for both fields and should help pinpoint which direction is most appealing.

Don't worry about choosing EE or CompE immediately; many students will take courses in both fields and find that one is much more suited to them, sometimes contrary to what they had expected. The curriculum is very accommodating of exploration of different fields in both EE and CompE - the main differences between the two really lie in upper-level requirements and technical electives, so you really don't need to choose before the end of your sophomore year. There's nothing wrong with taking a path that runs somewhere in between the two - there are plenty of EEs who like to program, and plenty of CompEs who enjoy tinkering with circuits every once in a while, and one of the great things about ECE is it accommodates both groups well.