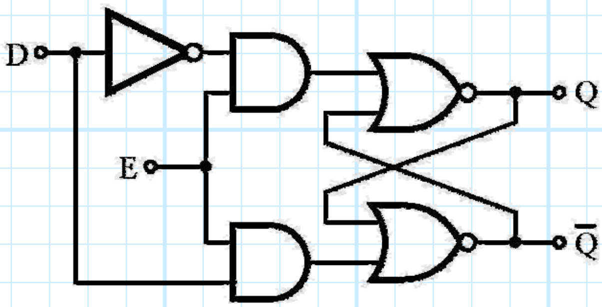
EECS 412 Introduction

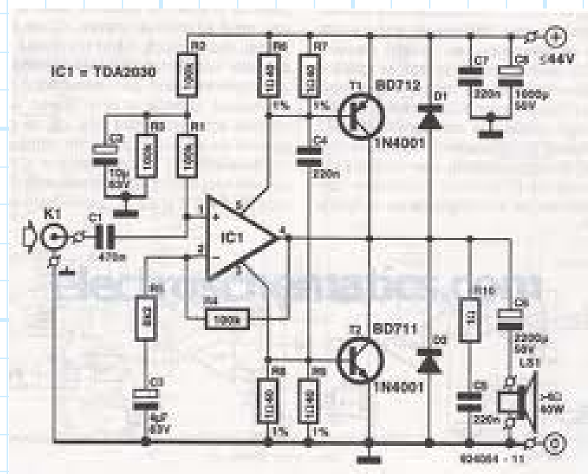
Q: *So what's this class all about? What is its **purpose**?*

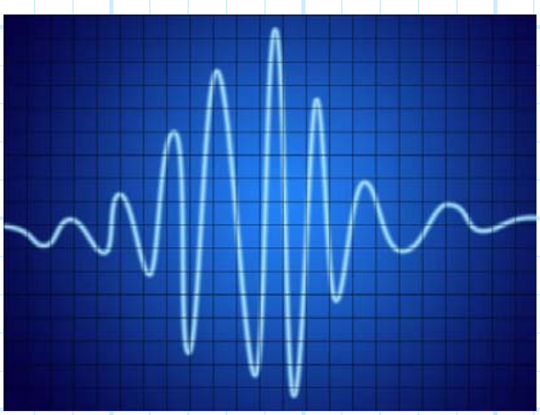
A: In EECS **312** you learned about:



* Electronic **devices** (e.g., transistors and diodes)
* How we use transistors to make **digital** devices (e.g., inverters, gates, flip-flops, and memory).

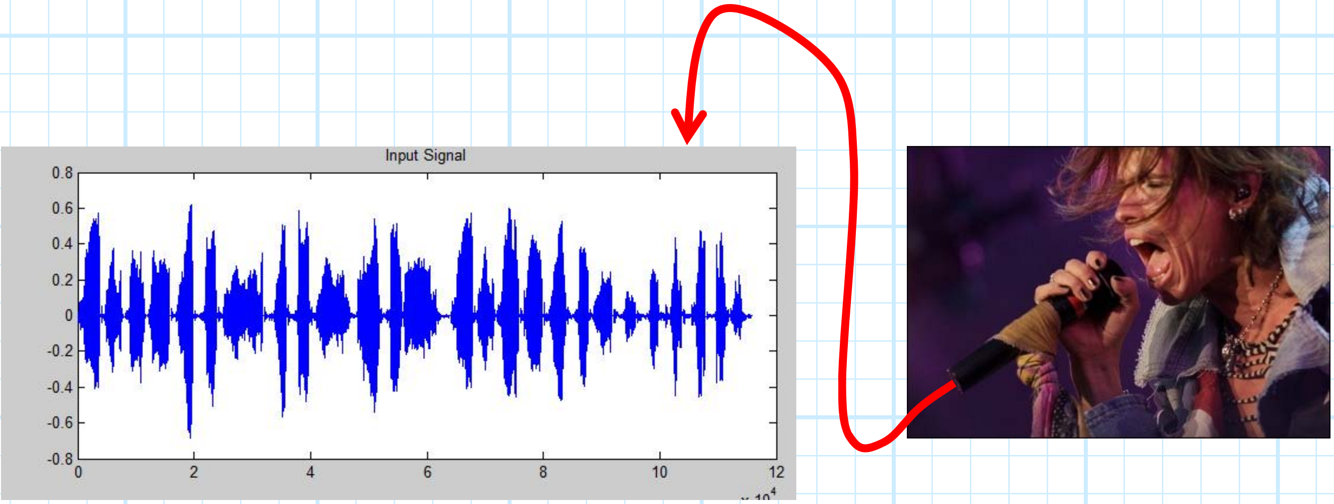
In contrast, EECS 412 will teach you how we use transistors to make **analog** devices (e.g., amplifiers, filters, summers, integrators, etc.).

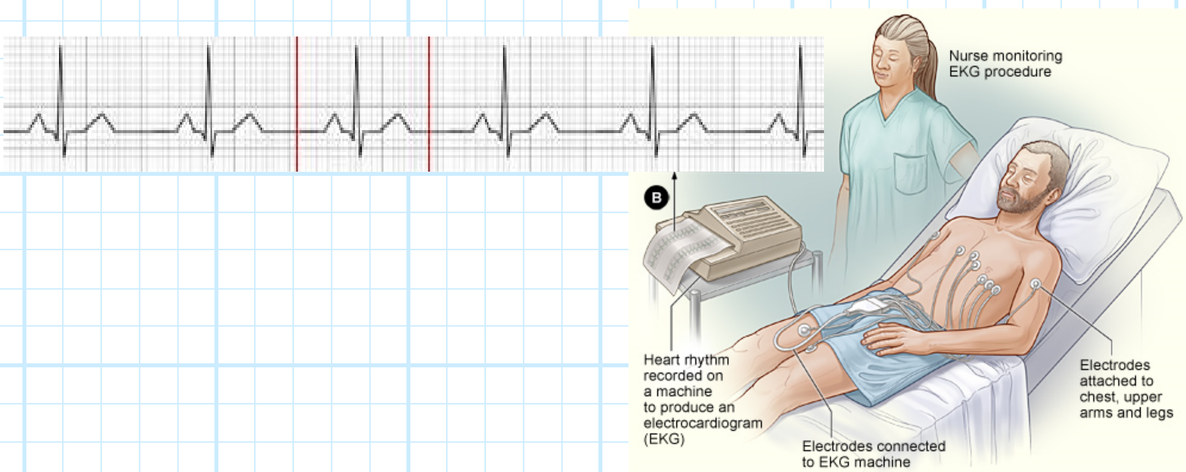




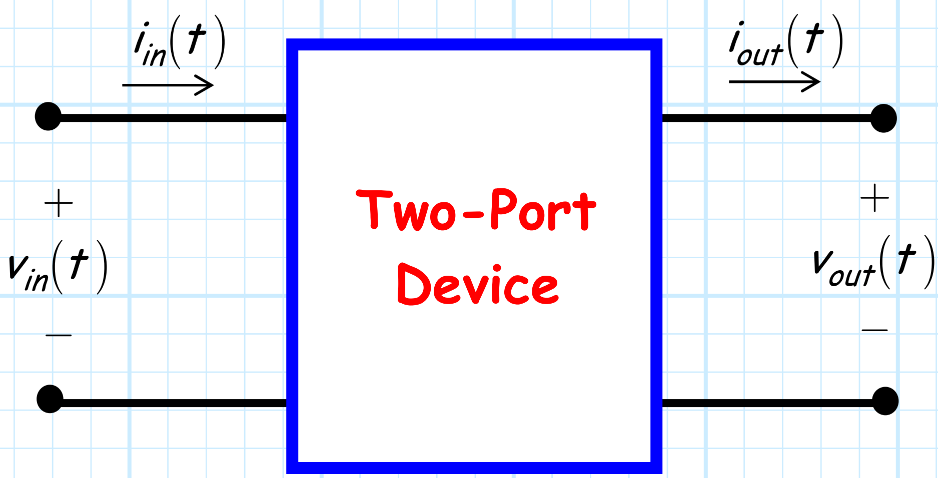
Analog circuits and devices operate on analog signals—usually voltage signals—that represent a **continuous**, time-varying analog of some physical function.

For **example**, the analog voltage signal $v(t)$ can represent an audio pressure wave (i.e., sound), or the beating of a human heart.





Quite often, an analog device has two ports—an **input** port and an **output** port:



A fundamental question in electrical engineering is **determining** the **output** signal $v_{out}(t)$ when the input signal $v_{in}(t)$ is known.

This is frequently a difficult question to answer, but it becomes significantly easier if the two-port device is constructed of **linear**, time-invariant circuit elements!

HO: THE LINEAR, TIME-INVARIANT CIRCUIT

Linear circuit behavior would be not at all useful except for the **unfathomably important** concept of signal expansion via **basis functions**!

HO: SIGNAL EXPANSIONS

Linear systems theory is useful for electrical engineers because most **analog devices and systems are linear** (at least approximately so!).

HO: LINEAR CIRCUIT ELEMENTS

The most powerful tool for analyzing linear systems is its **Eigen function**.

HO: THE EIGEN FUNCTION OF LINEAR SYSTEMS

Complex voltages and currents at times cause much **head scratching**; let's make sure we know what these complex values and functions **physically** mean.

HO: A COMPLEX REPRESENTATION OF SINUSOIDAL FUNCTIONS

Signals may **not** have the explicit form of an Eigen function, **but** our linear systems theory allows us to (relatively) easily analyze this case as well.

HO: ANALYSIS OF CIRCUITS DRIVEN BY ARBITRARY FUNCTIONS

If our linear system is a linear **circuit**, we can apply **basic** circuit analysis to determine all its **Eigen values**!

HO: THE EIGEN SPECTRUM OF LINEAR CIRCUITS

A more general form of the Fourier Transform is the **Laplace** Transform.

HO: THE EIGEN VALUES OF THE LAPLACE TRANSFORM

The numerical value of **frequency** ω has tremendous practical ramifications to us EEs.

HO: FREQUENCY BANDS

A set of **four** Eigen values can completely characterize a two-port linear system.

HO: THE IMPEDANCE AND ADMITTANCE MATRIX

A really important linear (sort of) device is the **amplifier**.

HO: THE AMPLIFIER

The two most important parameter of an amplifier is its **gain** and its **bandwidth**.

HO: AMPLIFIER GAIN AND BANDWIDTH

Amplifier circuits can be quite complex; however, we can use a relatively simple **equivalent circuit** to analyze the result when we connect things to them!

HO: CIRCUIT MODELS FOR AMPLIFIERS

One very useful application of the circuit model is to analyze and characterize types of amplifiers.

HO: CURRENT AND VOLTAGE AMPLIFIERS

It turns out that amplifiers are only **approximately linear**. It is important that we understand their **non-linear** characteristics and properties.

HO: NON-LINEAR BEHAVIOR OF AMPLIFIERS