Amplifiers

An **ideal** amplifier is a two-port circuit that takes an input signal  and reproduces it **exactly** at its output, only with a **larger** magnitude!













The real value  is the **open-circuit voltage gain** of this ideal amplifier, and has a magnitude much larger than unity ().

**We actually *can* find *g*(*t*) !**

Now, let’s express this result using our knowledge of **linear circuit theory**!

Recall, the output of a linear device can be determined by **convolving** its input  with the device **impulse response** :



**Q:** *Yikes! What is the impulse response of this ideal amp? How can we determine it?*

**A:** It’s actually quite **simple**!

Remember, the impulse **response** of linear circuit is just the output that results when the **input** is an impulse function .

**Every function an Eigen function**

Since the output of an ideal amplifier is just the input multiplied by , we conclude if :



Thus:



**🡪** **Any** and **every** function  is an **Eigen function** of an **ideal** amplifier!!

**And now the Eigen value**

Now, we can determine the **Eigen value** of this linear operator relating input to output:



Recall this Eigen value is found from the **Fourier transform** of the impulse response:



This result, although simple, has an interesting interpretation…

**DC to daylight**

…it means that the amplifier exhibits gain of *Avo* for sinusoidal signals of **any** and **all** frequencies!







BUT, there is one **big** problem with an ideal amplifier:

They are **impossible** to build!!

**Real amplifier have finite bandwidths**

The **ideal** amplifier has a frequency response of .

Note this means that the amplifier gain is ***Avo*** for **all** frequencies  (D.C. to daylight!).

The **bandwidth** of the **ideal** amplifier is therefore **infinite**!

**\*** Since every electronic device will exhibit **some** amount of inductance, capacitance, and resistance, every device will have a **finite** bandwidth.

**\*** In other words, there will be frequencies  where the device does **not work**!

**\*** From the standpoint of an amplifier, “not working” means ** (i.e., **low gain**).

**🡪** Amplifiers therefore have **finite** bandwidths.

**Amplifier bandwidth**

There is a range of frequencies  between  where the gain will (approximately) be *Avo*.

For frequencies outside this range, the gain will typically be small (i.e. ):



The **width** of this frequency range is called the amplifier **bandwidth**:













**Wideband is desirable**

One result of a **finite bandwidth** is that the amplifier impulse response is **not** an impulse function !



therefore **generally** speaking:

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However, if an input signal **spectrum**  lies completely **within** the amplifier bandwidth, then we find that will (approximately) behave like an **ideal** amplifier:

 if  is within the amplifier bandwidth

As a result, **maximizing** the bandwidth of an amplifier is a typically and important **design goal**!