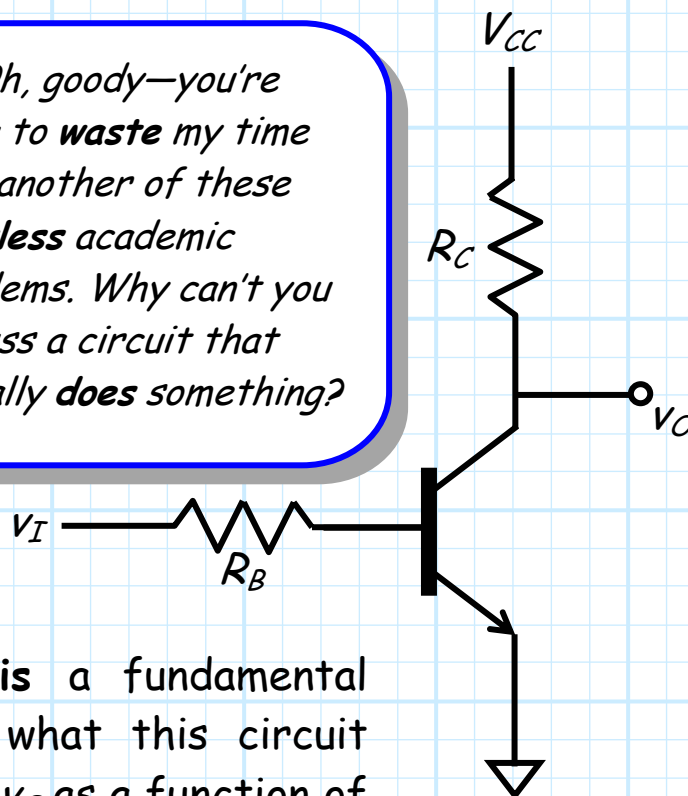


BJT Amplifier Gain and the Active Region

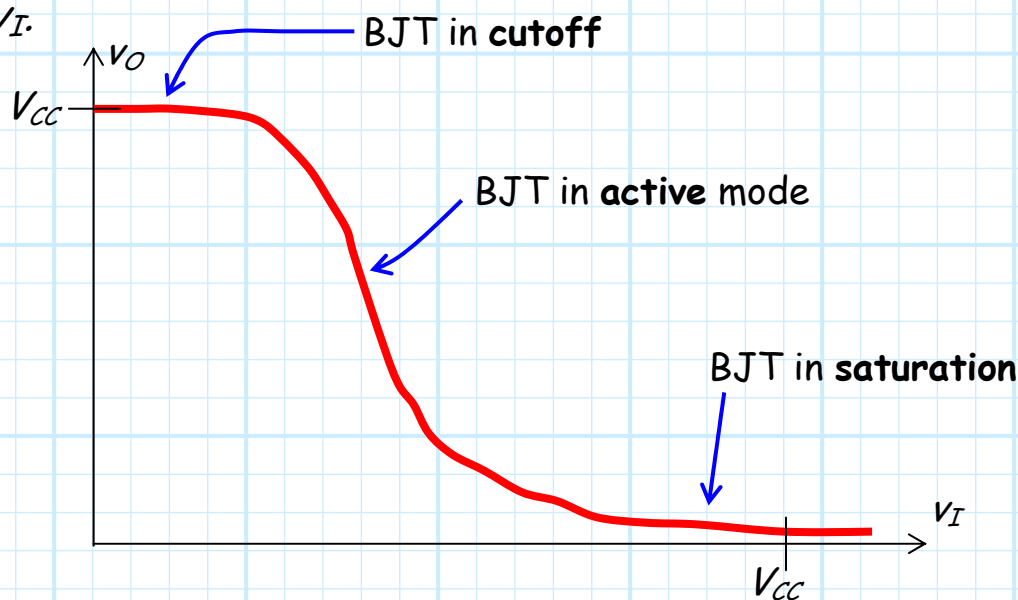
Consider this simple BJT circuit:



Q: Oh, goody—you're going to *waste* my time with another of these *pointless academic problems*. Why can't you discuss a circuit that *actually does something*?



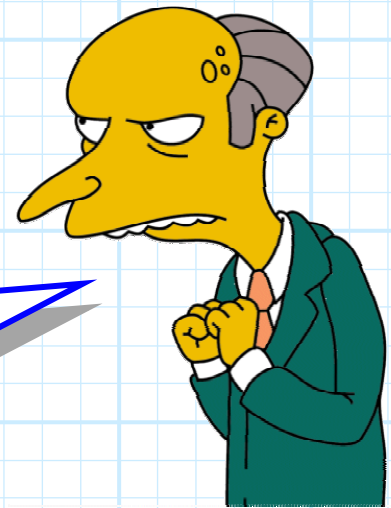
A: Actually, this circuit is a fundamental electronic device! To see what this circuit does, plot the output voltage v_O as a function of the input v_I .



Note that:

v_I	v_O	Mode
0	V_{CC}	Cutoff
V_{CC}	0	Saturation

Why, this device is not useless at all! It is clearly a:



Digital devices made with BJTs typically work in either the **cutoff** or **saturation** regions.

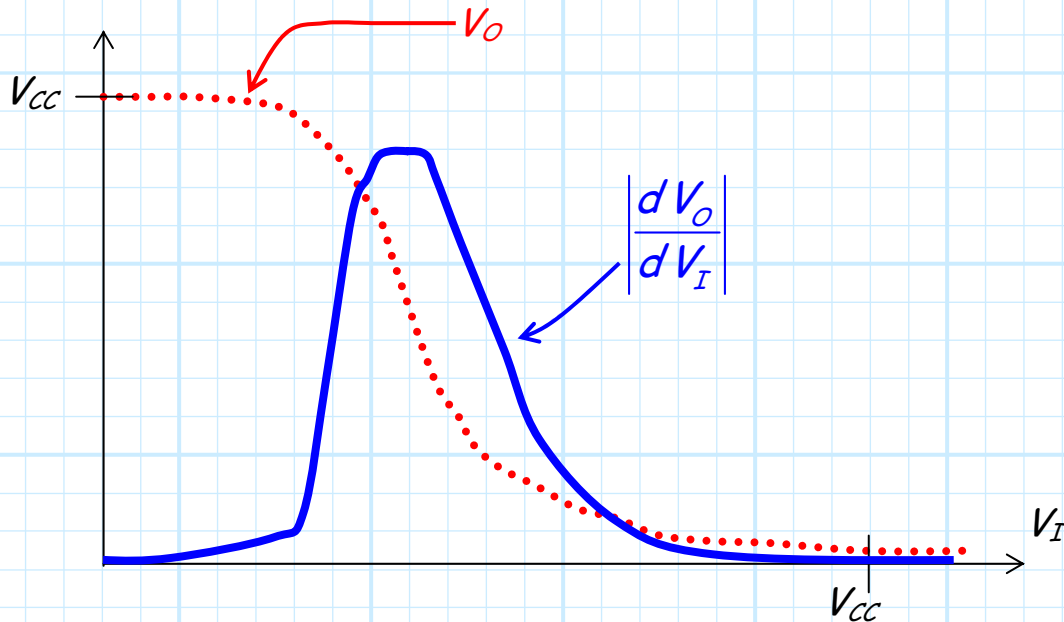
So, what good is the BJT Active Mode ??



Sir, it appears to me that the active region is just a useless BJT mode between cutoff and saturation.

Actually, we will find that the active mode is **extremely** useful!

To see why, take the **derivative** of the above circuit's transfer function (i.e., dV_o/dV_I):



We note that in **cutoff** and **saturation**:

$$\left| \frac{dV_o}{dV_I} \right| \approx 0$$

while in the **active** mode:

$$\left| \frac{dV_o}{dV_I} \right| \gg 1$$

Q: *I've got better things to do than listen to some egghead professor mumble about derivatives. Are these results even **remotely** important?*

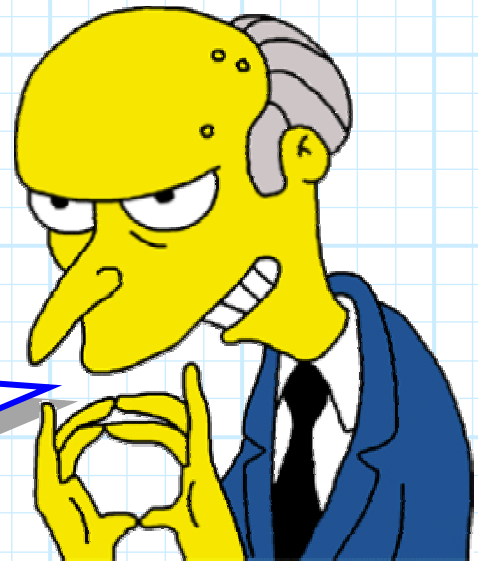


A: Since in **cutoff** and **saturation** $dV_O/dV_I = 0$, a small change in input voltage V_I will result in almost **no change** in output voltage V_O .

Contrast this with the **active** region, where $|dV_O/dV_I| \gg 1$. This means that a **small** change in **input** voltage V_I results in a **large** change in the **output** voltage V_O !

*I see. A **small** voltage change results in a **big** voltage change—it's **voltage gain**!*

*The **active** mode turns out to be—**excellent**.*



Whereas the important BJT regions for **digital** devices are saturation and cutoff, bipolar junction transistors in **linear** (i.e., analog) devices are typically biased to the **active** region.

This is especially true for BJT **amplifier**. Almost all of the transistors in EECS 412 will be in the **active** region—this is where we get **amplifier gain**!