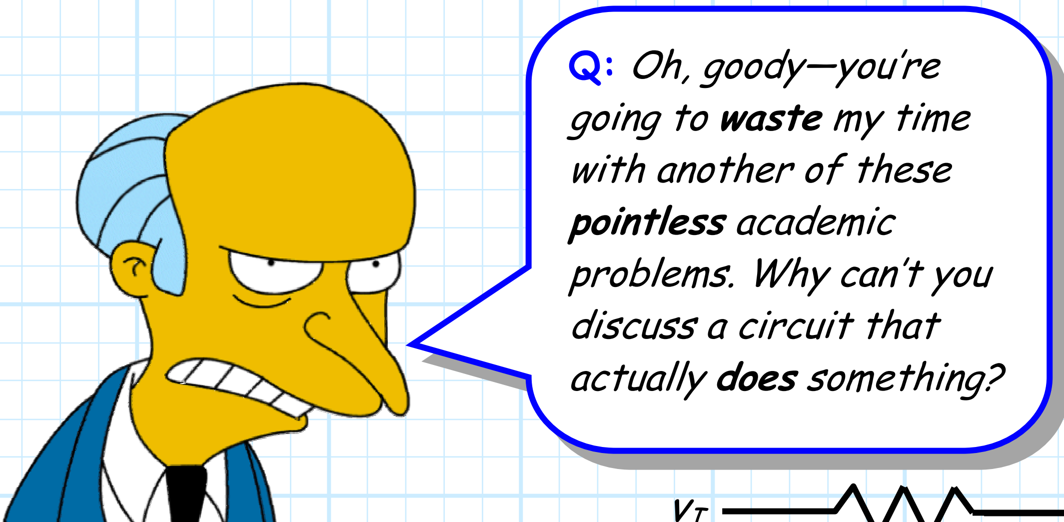
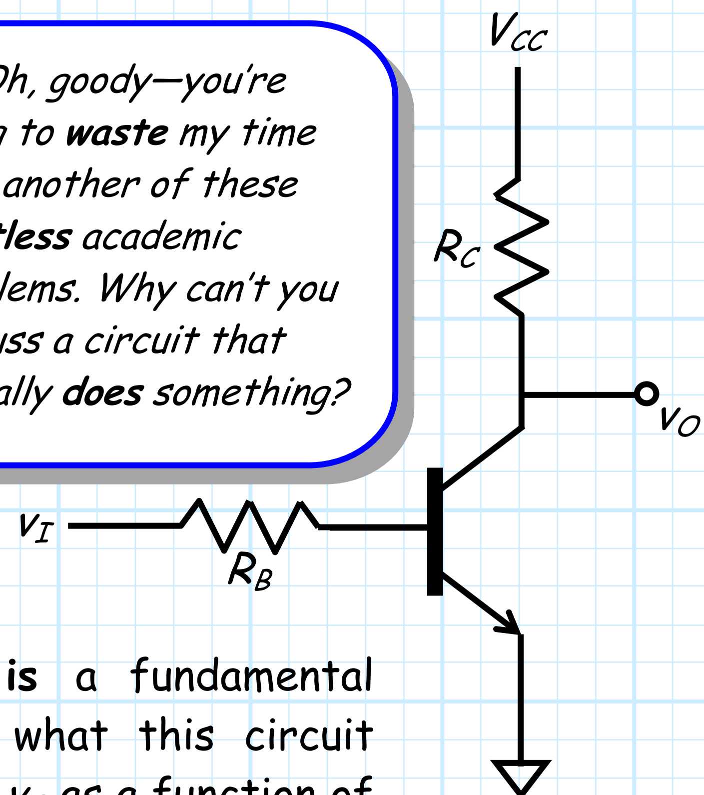
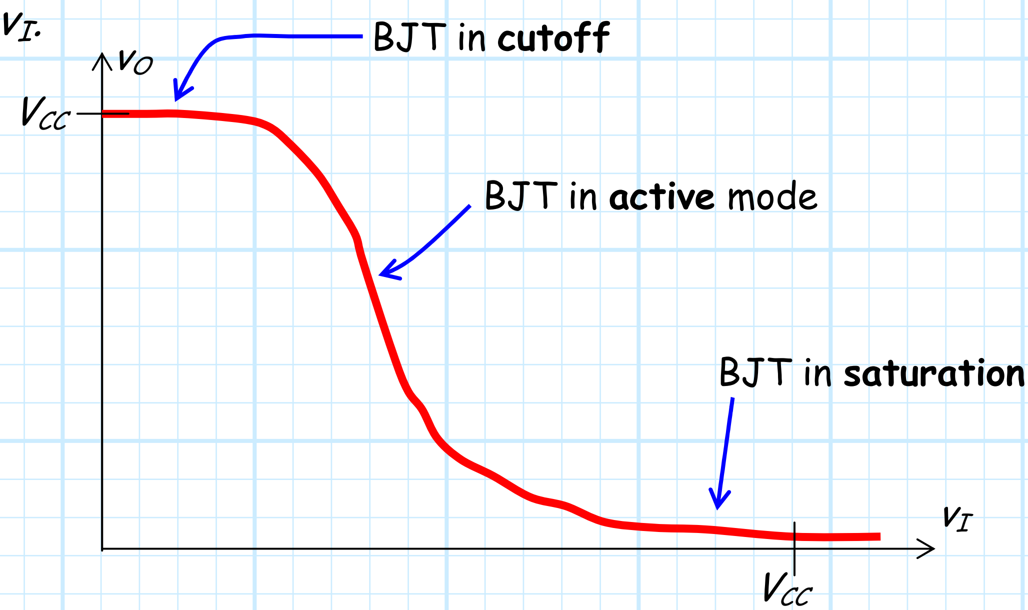
BJT Amplifier Gain and the Active Region

Consider this **simple** BJT circuit:



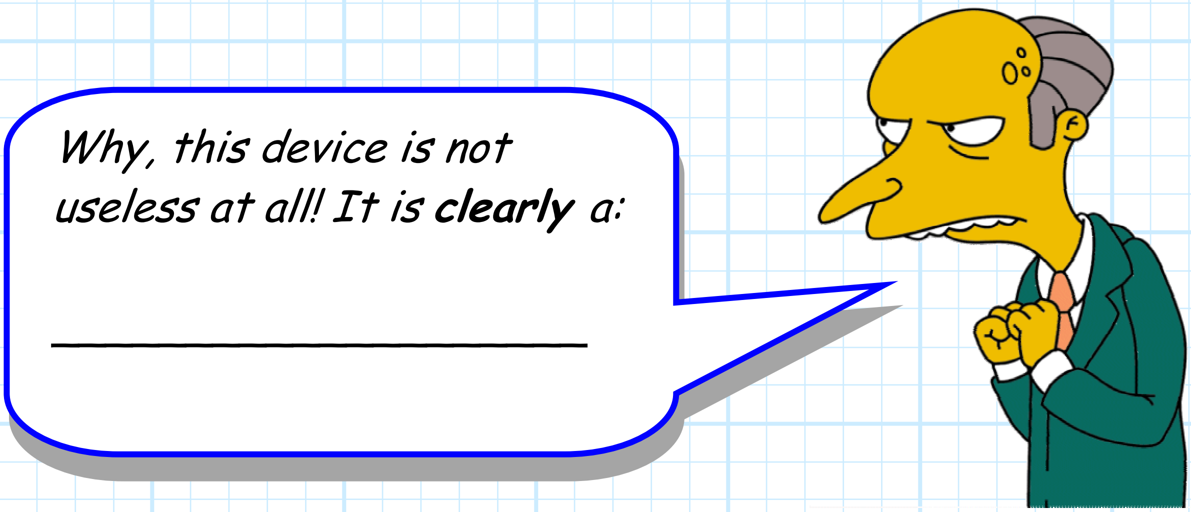


A: Actually, this circuit **is** a fundamental electronic device! To see what this circuit does, plot the output voltage v_O as a function of the input v_I.

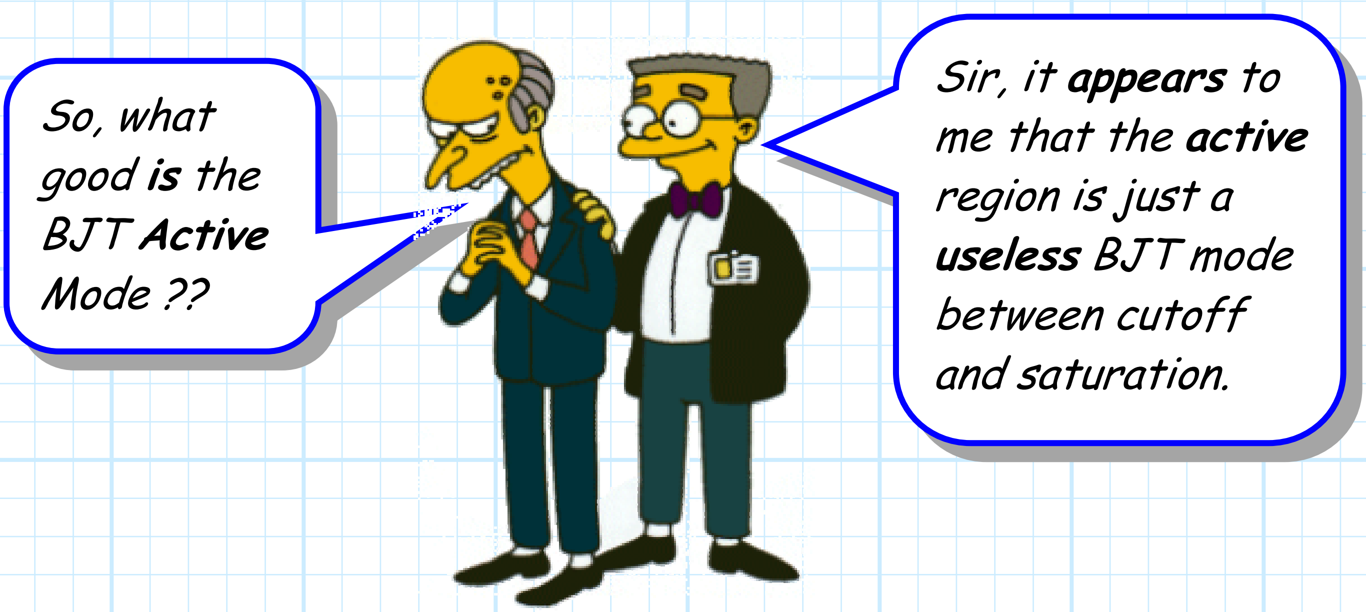


Note that:

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

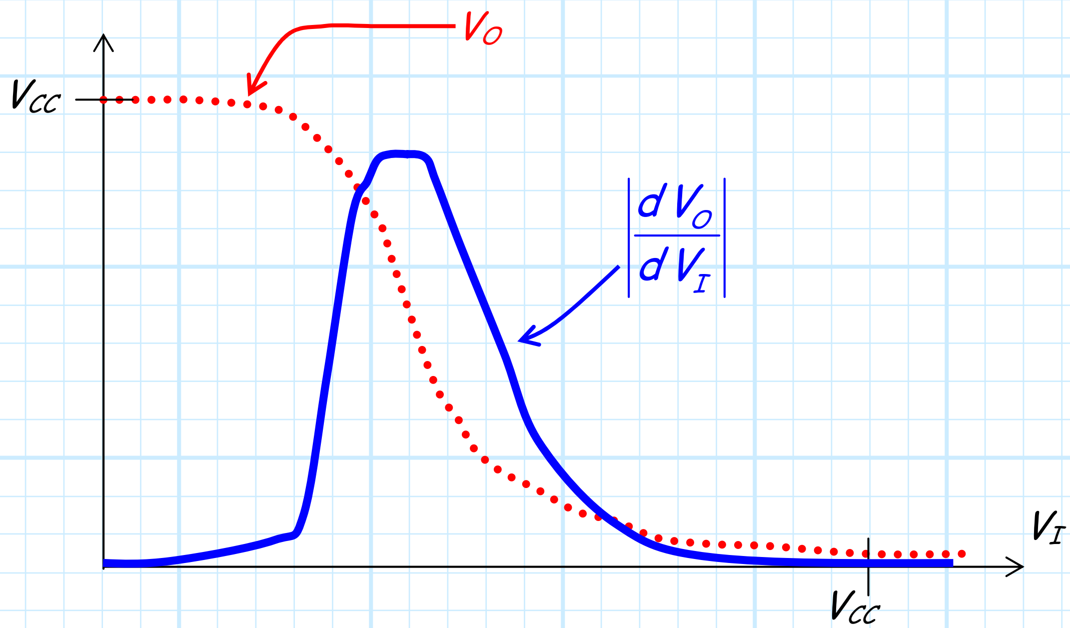


Digital devices made with BJTs typically work in either the **cutoff** of **saturation** regions.



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**:

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

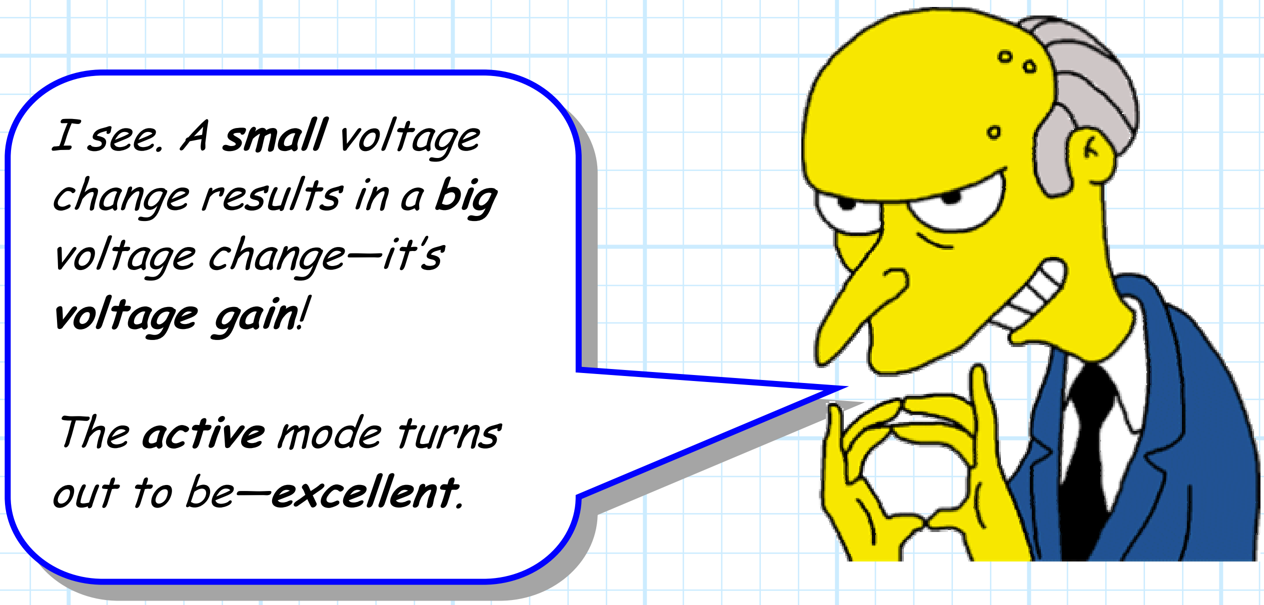
while in the **active** mode:

$$\left|\frac{dV_O}{dV_I}\right| >> 1$$

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 $\left|dV_O/dV_I\right| >> 1$. This means that a **small** change in **input** voltage V_I results in a **large** change in the **output** voltage V_O!



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**!