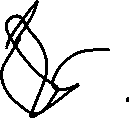
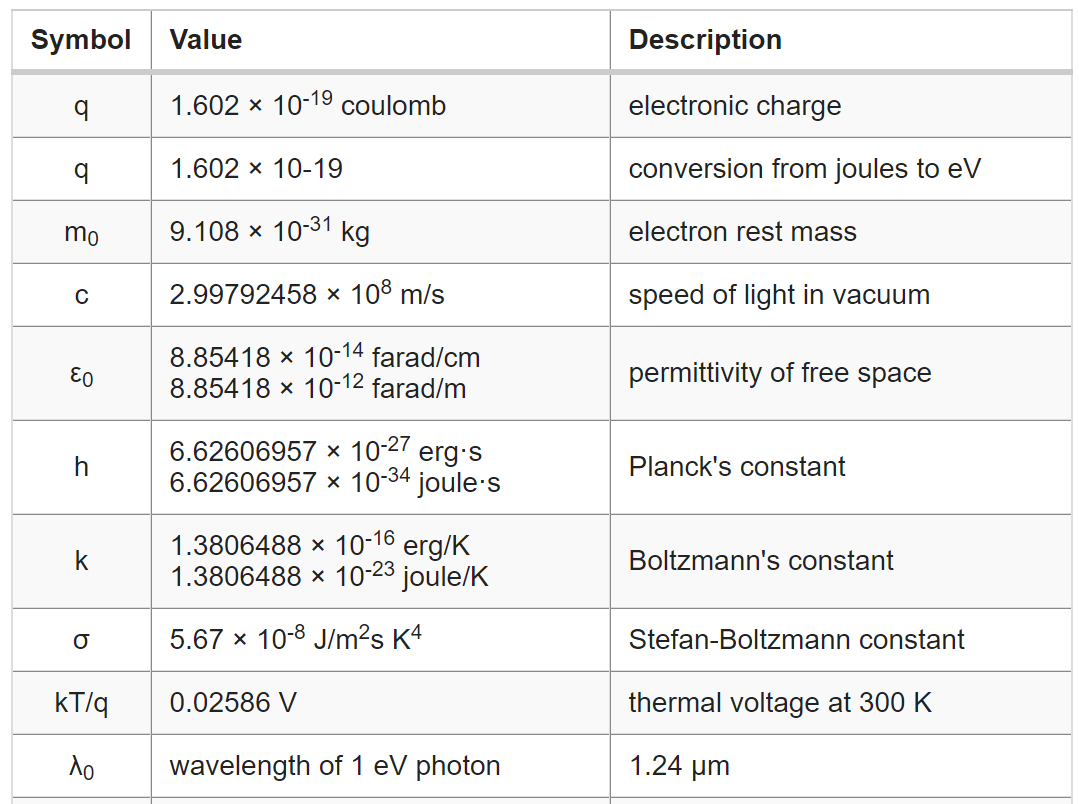
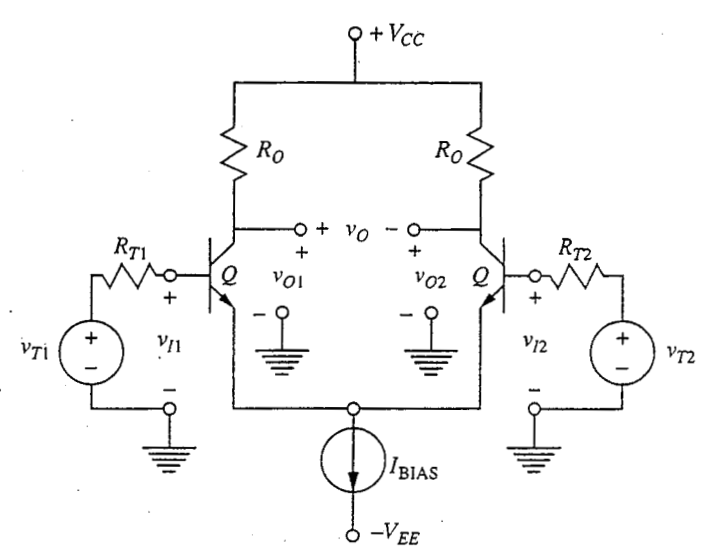
We want to set , such that the green times the red is equal to 1.

We want to set the term outside tanh to 1:





So far things seem to be not so complicated. A bit more effort will be needed with the tanh activation. Luckily, the differential amplifier stage {fig} follows the tanh characteristic. I will provide the required equations to design an analogue tanh activation here, but if you are interested in the analysis of the circuit {ref} has an excellent explanation.



The inputs to output relationship of the circuit above is:

Where is the electronic charge, is Boltzmann's constant and is the temperature of the device. The expression is known at the thermal voltage and its value at (approx. room temperature) is . This value will be used below for simplicity.

The first step of converting the circuit above into a activation is to connect to ground (make it ). The differential output voltage then becomes:

One of the problems with the expression above is that - the input to the function - is scaled by . This can be solved by adding a potential divider to the base pin of {fig} – the reason for this will become apparent below.

Fig: Potential divider figure.

The value of becomes:

Which means that the differential output voltage is now a function of the new input voltage :

If and are now set to be such that the expression is equal to , both terms will cancel out, resulting in:

Next, the term should be set to 1. This can be done by adjusting and . The values of both are arbitrary, so any sensible values can be picked. A concrete example with suggested values is shown in the notebook.

You might have noticed by now, that is a constant current source (i.e. not a real-life component). This current source can be implemented with the circuit in {fig}.

Fig: …

Lastly, the differential voltage should be converted to a single-ended output. …