Duke University
Department of Physics

Physics 271 Spring Term 2017

WUN2K FOR LECTURE 14

These are notes summarizing the main concepts you need to understand and be able to apply.

- The I_c vs V_{ce} curve of a typical bipolar transistor shows a sharp turn-on followed by a fairly flat plateau in the BE forward-biased regime. This flat region is the normal operation regime, and the near-constant value of I_c in that region depends on I_b in a nearly-linear way: $I_c = h_{FE} I_b = \beta I_b$ to a good approximation, where $h_{FE} = \beta$ is called the *static forward current transfer ratio*. This behavior is the key to transistor action: one can control I_c by changing I_b. The circuit can be modeled by a current source in series with a forward-biased diode, in which the current is proportional to base current entering the + side of the doide.

- Transistors are often used as *switches*: in the simple configuration with a control voltage V_1 through R_B to the base, supply voltage V_{cc} at the collactor, and the emitter at ground, the current I_c is large (ON state) when V_1 is large and positive (and V_{ce} is small). In this case, the transistor is said to be operating in the "saturation region" with both pn junctions forward-biased, and the I_c current large for small V_{ce}. The OFF state corresponds to V_1 small, $V_{ce} = V_{cc}$ and $I_c = 0$.

- One can make four-terminal circuits out of three-terminal transistors in three configurations (all of which have the base in the input terminal): common emitter, common collector and common base. "Common" refers to a terminal being shared at the input and the output of the four-terminal circuit.

- In general, one needs to consider both DC and AC operation. For AC operation, under the assumption of small signals, we have $i_c = h_{fe} i_b + h_{oe} v_{ce}$, $v_{be} = h_{ie} i_b + h_{re} v_{ce}$, where the h's are "hybrid parameters"

characterizing the transistor: h_{fe} is the forward current ratio, h_{ie} is the input impedance, h_{oe} is the output admittance and h_{re} is the reverse voltage ratio.