Duke University
Department of Physics

Physics 271 Spring Term 2017

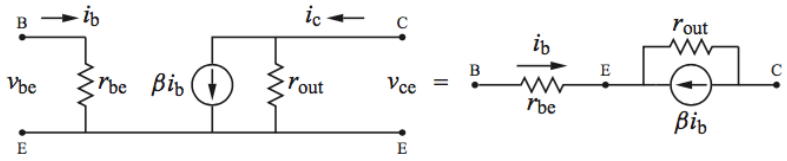
WUN2K FOR LECTURE 15

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

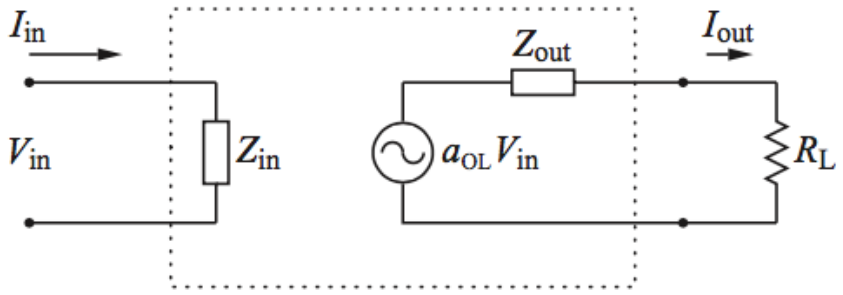
- Equivalent names and notations for the hybrid parameters are:

Eggleston Name	Eggleston Symbol	Alternate Names	Alternate Symbols	Typical Values
Input resistance	r_{be}	Input impedance	h_{ie}	few $k\Omega$
Output resistance	r_{out}	Output admittance	$1/h_{oe}$	$2 \times 10^{-5}\ \Omega^{-1}$
Current gain	β	Forward current ratio, forward transfer ratio	h_{fe}	10^2
Voltage feedback ratio	not used	Reverse voltage ratio	h_{re}	10^{-4}

- A common and useful simplification of the "h-parameter" small-signal AC transistor model is:

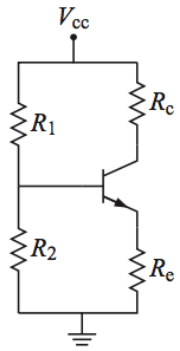


- A four-terminal amplifier (and more generally many four-terminal circuits) can be modeled as
  - The gain is $a = \frac{V_{\text{out}}}{V_{\text{in}}}$. The "open loop" gain (open circuit at output) is $a_{OL} = \frac{V_{\text{out}}(R_L=\infty)}{V_{\text{in}}}$.



  - The current gain is $g = I_{out}/I_{in}$.
  - The input impedance is $Z_{in} = V_{in}/I_{in}$.
  - The output impedance is $Z_{out} = \frac{V_{out}(R_L=\infty)}{I_{out}(R_L=0)}$.

- Transistor amplifiers need to be "DC biased" in order to ensure the transistor is always in its linear active region. A "universal DC bias circuit" looks like:



  This can be analyzed using Kirchoff's rules, Ohm's Law, and $I_c = \beta I_b$ in order to choose appropriate resistors.

- Transistor amplifiers can be analyzed for AC signals (as "AC equivalents") by the following steps (which can be used in other cases too):

1. Treat coupling capacitors as shorts (assuming they are large enough).
2. Short the supply to ground.
3. Insert the AC transistor model.
4. Simplify the circuit where possible.
5. Draw the following quantities on the circuit: v_{in}, v_{out}, i_{in}, i_{out}, i_b.
6. Draw B, E, C at the locations of the base, emitter and collector.
7. Compute a, g, Z_{in} and Z_{out} by writing v_{in}, v_{out}, i_{in}, i_{out} in terms of i_b.

You will then have a full characterization of the amplifier behavior.

- A basic transistor circuit is the *common emitter amplifier*, which can be analyzed using the method above.