Duke University
Department of Physics

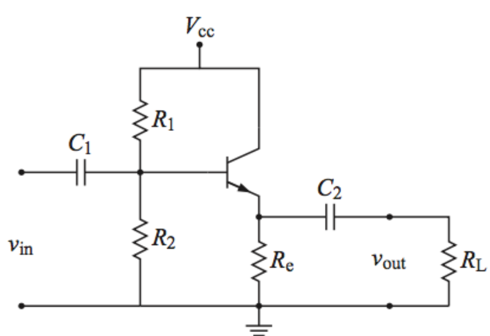
Physics 271 Spring Term 2017

WUN2K FOR LECTURE 16

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

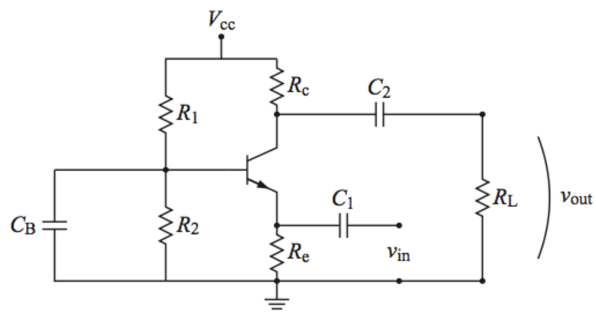
The following amplifiers can be analyzed and their relevant parameters calculated using the method from Lecture 15.

- *Common collector amplifier:* in this configuration, output voltage is taken between the emitter and ground. The gain is near unity, so that this is known also as an "emitter follower". (There can be large current gain though.) The input impedance is high and the output impedance is low, making this device act like a *buffer*.



- *Common base amplifier:* in this configuration, output voltage is taken between the collector and ground, and input is between emitter and ground. There is no current gain, but there can be large voltage gain.

- In practice, amplifier frequency response must be considered. There will be loss of gain at low frequency due to the capacitors at input



and output (which give large Z_C at small ω). There will also be loss of gain (roll-off) at high frequency due to stray capacitance of components creating a low-paas filter situation.

- Here is the table from Eggleston giving the relevant parameters for all of these amps, as well as useful approximations for many cases.

Table 4.2 Summary of results for the bipolar transistor amplifiers

	Common-emitter	Common-collector	Common-base
a	$\frac{-\beta(R_c\|R_L)}{r_{be}+(\beta+1)R_e}$ $\to -\left(\frac{\beta}{\beta+1}\right)\frac{R_c\|R_L}{R_e}$	$\frac{(\beta+1)R_0}{r_{be}+(\beta+1)R_0} \to 1$	$\frac{\beta(R_c\|R_L)}{r_{be}}$
g	$\frac{-\beta R_B}{R_B+r_{be}+(\beta+1)R_e}\left(\frac{R_c}{R_c+R_L}\right)$ $\to -\beta\left(\frac{R_c}{R_c+R_L}\right)$	$\frac{(\beta+1)R_B}{R_B+r_{be}+(\beta+1)R_0}\left(\frac{R_0}{R_L}\right)$ $\to (\beta+1)\frac{R_e}{R_e+R_L}$	$\frac{\beta R_e}{r_{be}+(\beta+1)R_e}\left(\frac{R_c}{R_c+R_L}\right)$ $\to \frac{\beta}{\beta+1}\left(\frac{R_c}{R_c+R_L}\right)$
Z_{in}	$\frac{R_B[r_{be}+(\beta+1)R_e]}{R_B+r_{be}+(\beta+1)R_e}$ $\to (\beta+1)R_e$	$\frac{R_B[r_{be}+(\beta+1)R_0]}{R_B+r_{be}+(\beta+1)R_0}$ $\to (\beta+1)R_0$	$\frac{r_{be}R_e}{r_{be}+(\beta+1)R_e} \to \frac{r_{be}}{\beta+1}$
Z_{out}	R_c	R_e	R_c

$R_c\|R_L$ is the parallel combination of R_c and R_L.
$R_B = R_1\|R_2$.
$R_0 = R_E\|R_L$.
The arrow shows the limit when r_{be} is small and R_B is large.

- Here is a table summarizing these amplifiers, with even more simplified properties for typical parameters and choices of resistors for common usage.

Table 1: Summary of single-bipolar-transistor amplifiers.

	CE	**CC**	**CB**
Typical choices	$R_c >> R_e$	R_e small	R_c large
Voltage gain	large, inverting	~ 1	large
Current gain	$-\beta$	β	~ 1
Input impedance	small	large	small
Output impedance	moderate	small	moderate
Note	versatile	buffer-like	less common use