EE 101: Basic Electronics

BJT Amplifiers

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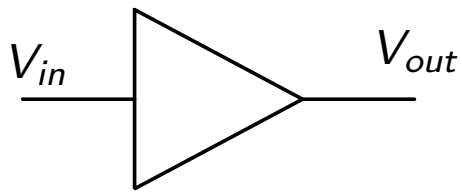
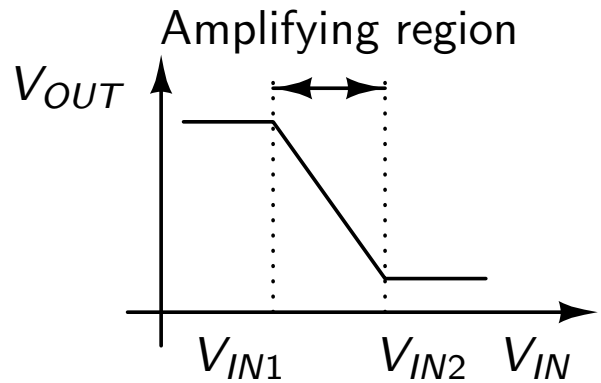
Biasing

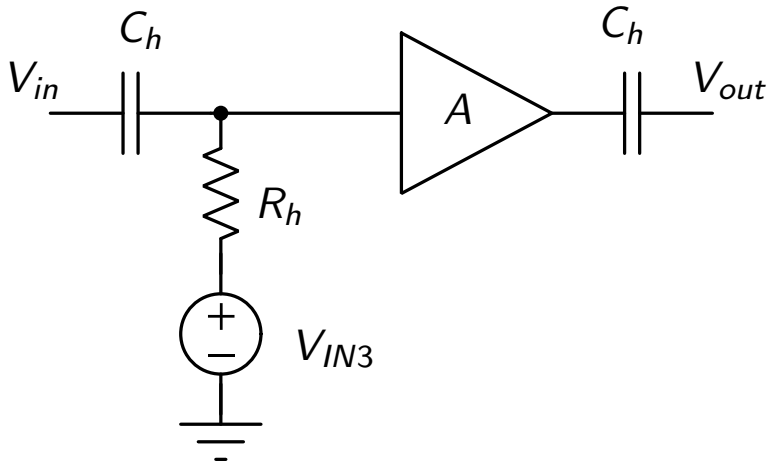




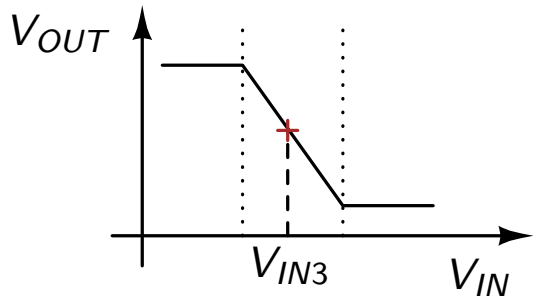
Input should have a DC offset within (V_{IN1}, V_{IN2})

What iff it is not the case?

AC-coupled amplifier



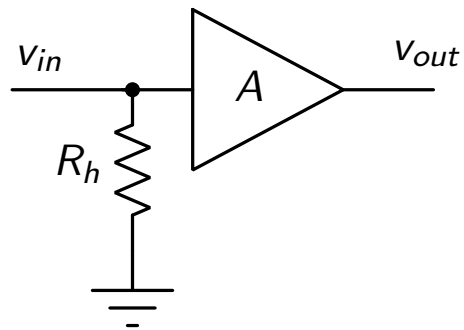
AC-coupled amplifier



C_h at the input blocks the DC in V_{in}

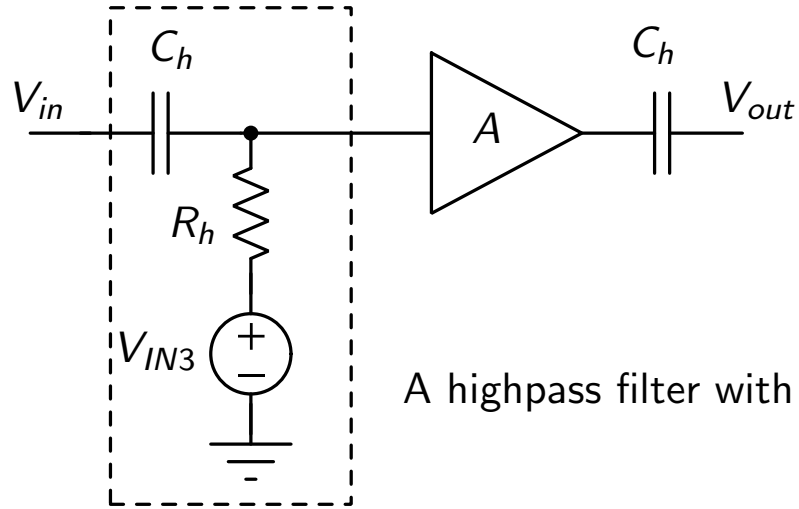
Amplifier can be biased at the max-gain point.

Amplifier gain for DC inputs is zero.

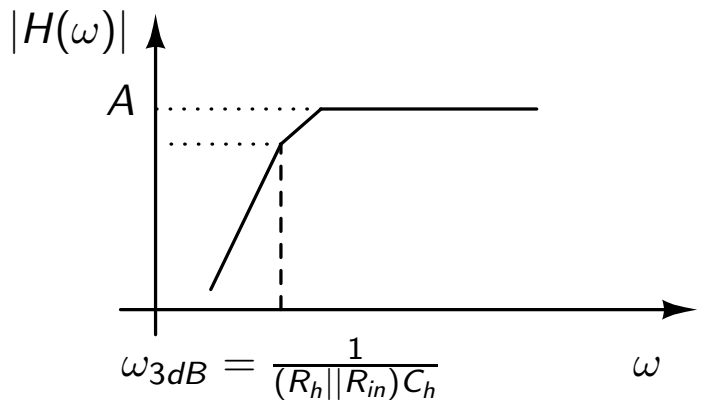


Mid-band equivalent circuit

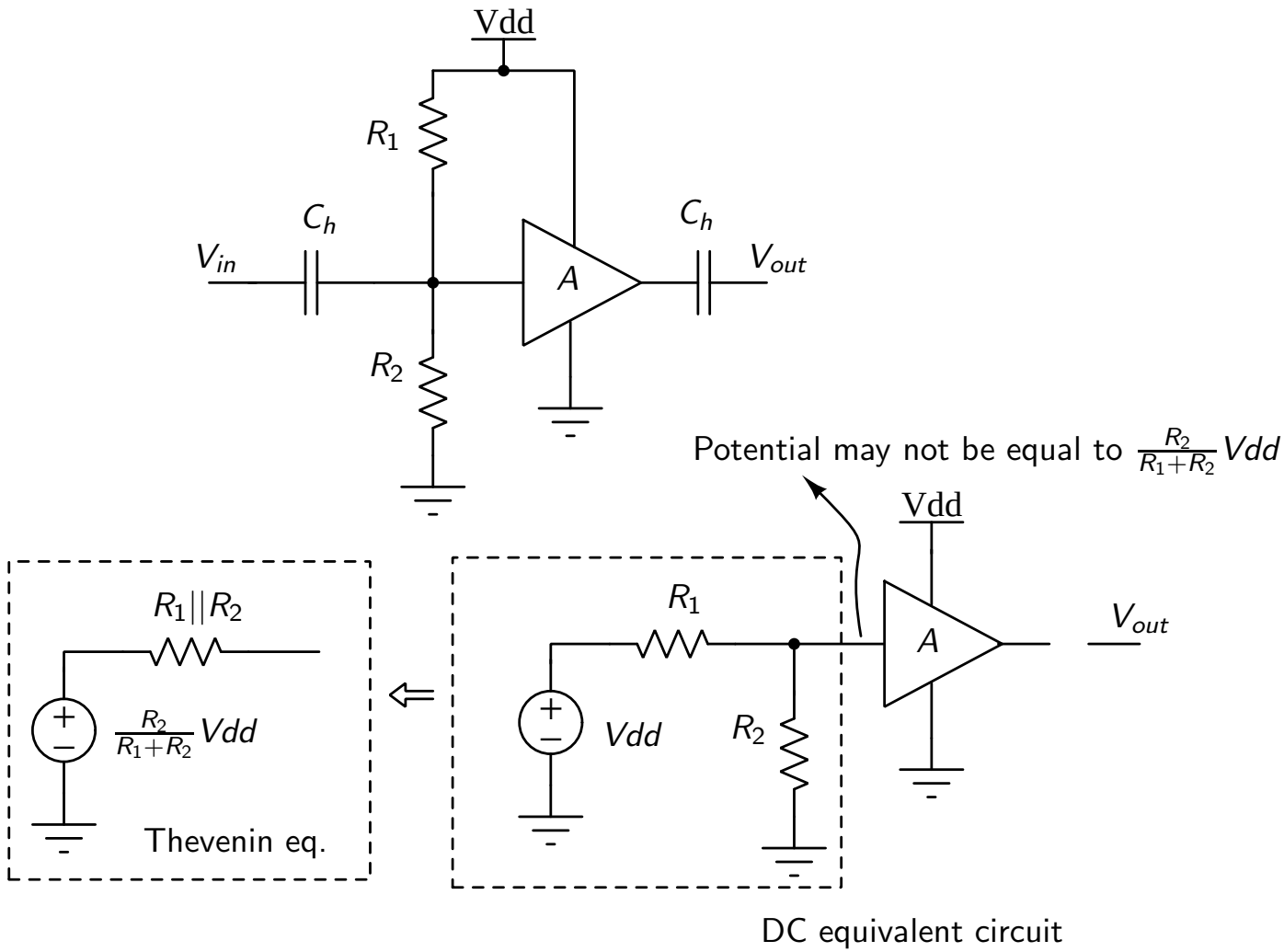
Frequency Response



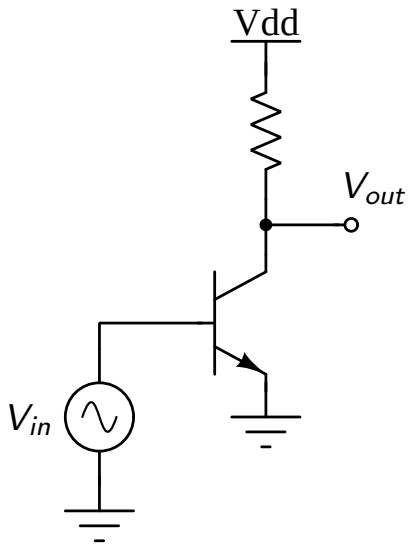
A highpass filter with $\omega_{3dB} = \frac{1}{R_h C_h}$



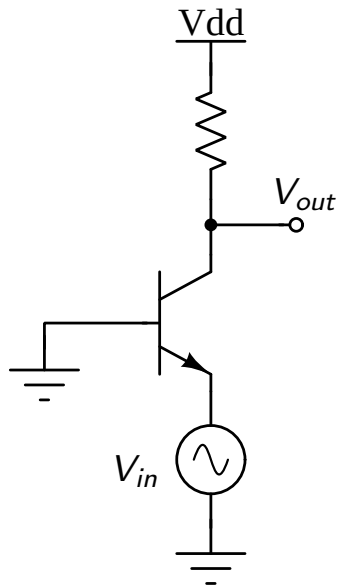
Biasing using a single supply



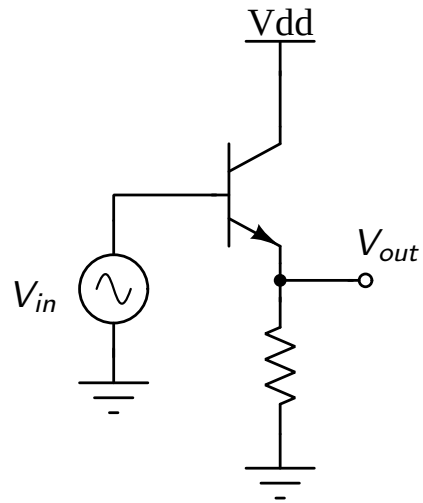
BJT configurations



CE configuration



CB configuration

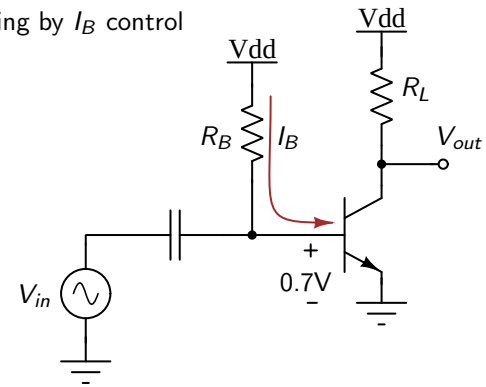


CC configuration

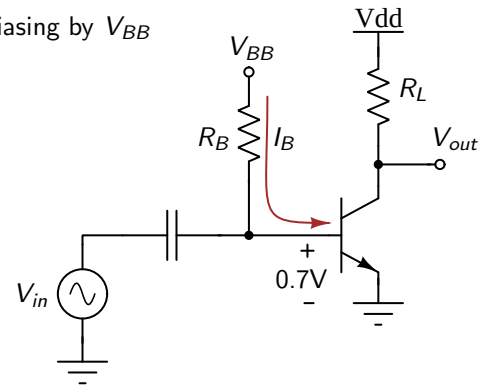
(Biasing is not shown in the above circuits)

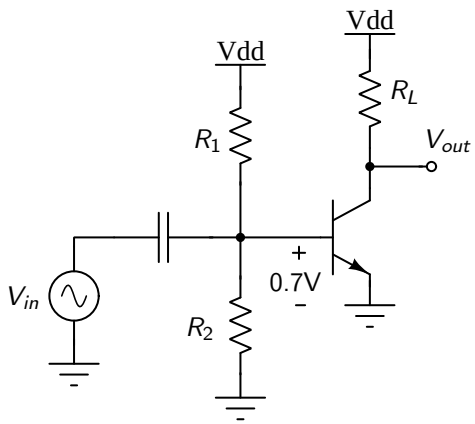
Biasing a discrete CE amplifier

Biasing by I_B control

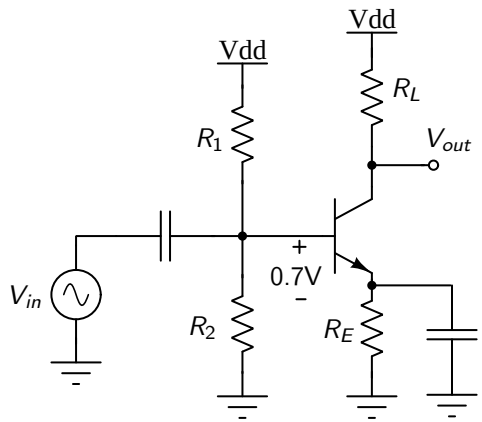


Biasing by V_{BB}



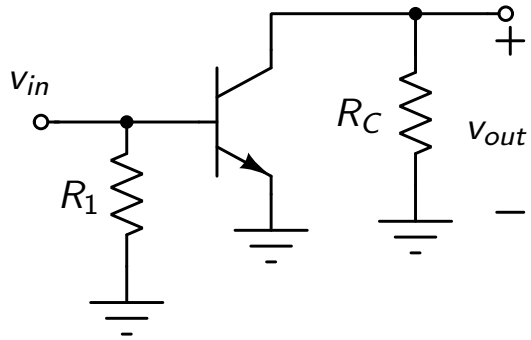


Biasing using a resistive divider

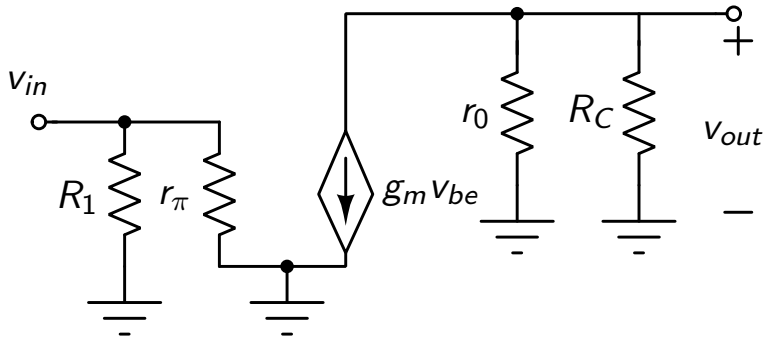


Biasing using an emitter degeneration resistor R_E

CE amplifier



Typical AC equivalent circuit



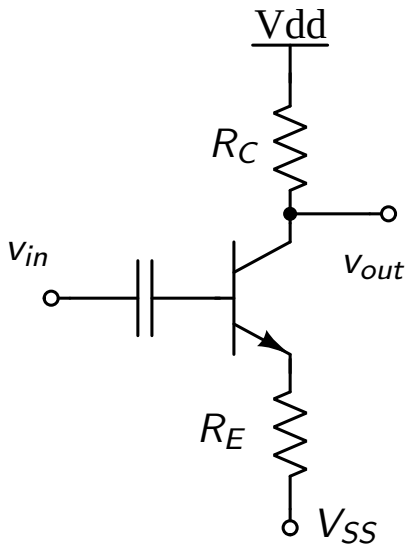
Small-signal model

Input impedance $\approx R_1 || r_\pi$

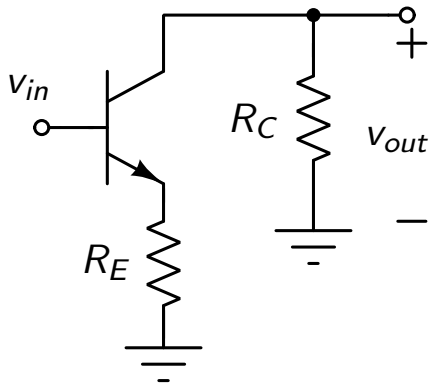
Output impedance $\approx r_0 || R_C$

Voltage gain $\approx$ -$g_m(r_0 || R_C)$

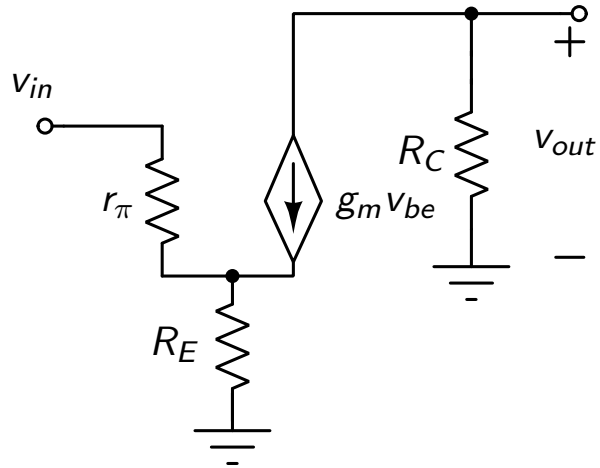
CE amplifier with emitter degeneration



Circuit



AC equivalent circuit



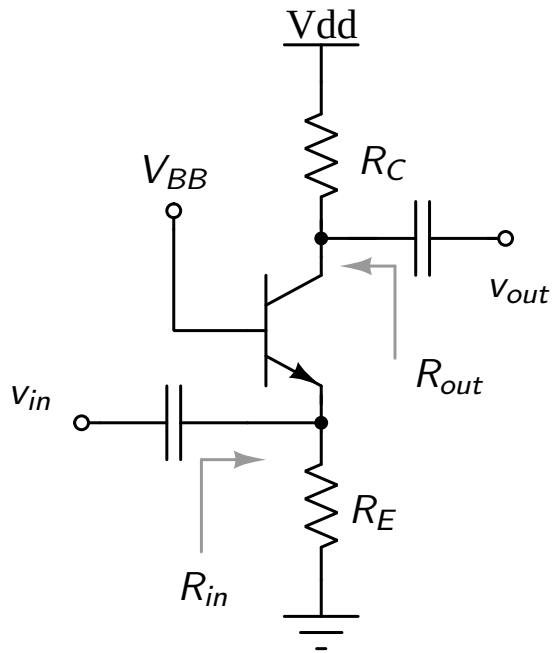
Small-signal model

Input impedance $\approx r_\pi + (\beta + 1)R_E$

Output impedance $\approx R_C$

Voltage gain $\approx -\frac{g_m R_C}{1+g_m R_E}$

CB amplifier

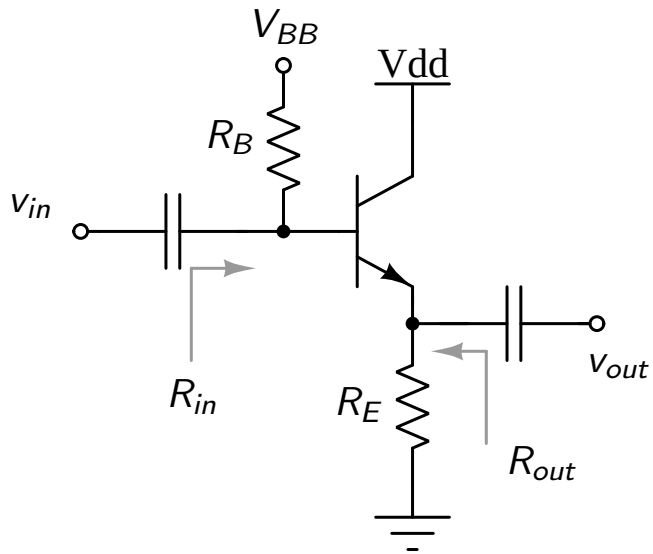


$$R_{in} \approx \frac{1}{g_m} || R_E$$

$$R_{out} \approx r_0 || R_C$$

$$A_v \approx +g_m R_C$$

CC circuit



$$R_{in} \approx R_B||(r_\pi + (1+\beta)R_E)$$

$$R_{out} \approx \frac{1}{g_m}||R_E$$

$$A_v \approx +\frac{g_m R_E}{1+g_m R_E}$$

Summary

- DC and AC coupled amplifiers
- Biasing and frequency response of AC coupled amplifiers
- CE, CB and CC configurations
- CE amplifier: biasing, gain, input and output impedances
- CB amplifier: biasing, gain, input and output impedances
- CC buffer: biasing, gain, input and output impedances

Reference Book

[1] A. Sedra and K. C. Smith, "Microelectronic Circuits," 6th Ed., Oxford university press, 2011.