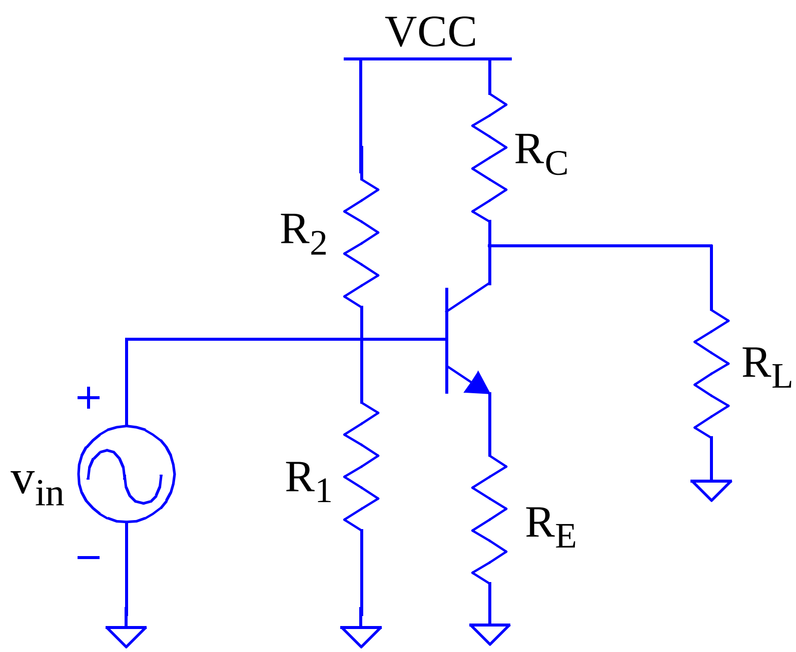
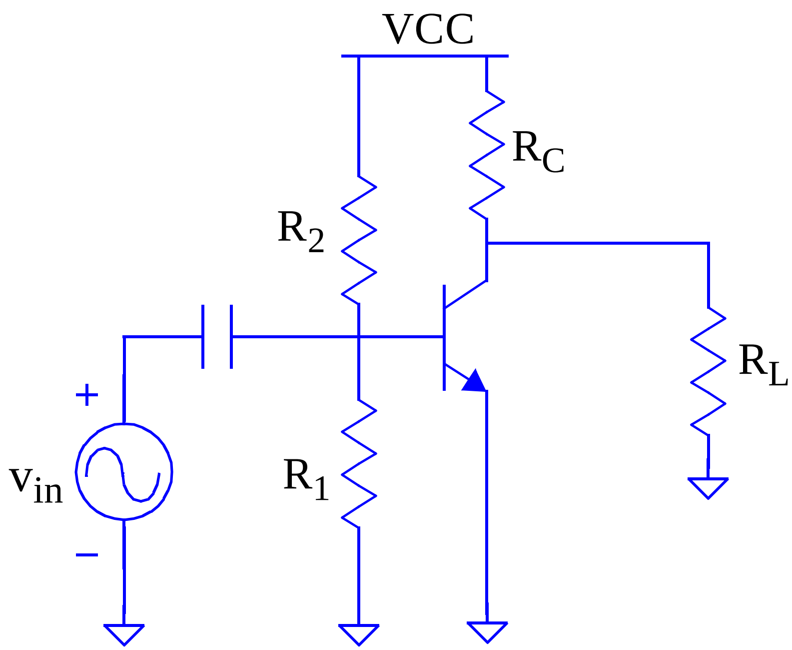
dc Bias Point Calculations

- Instead of supplying two dc voltages, the V_{BE} is generally established by a voltage divider using the VCC supply
- But then the ac input cannot be attached as shown. Why?



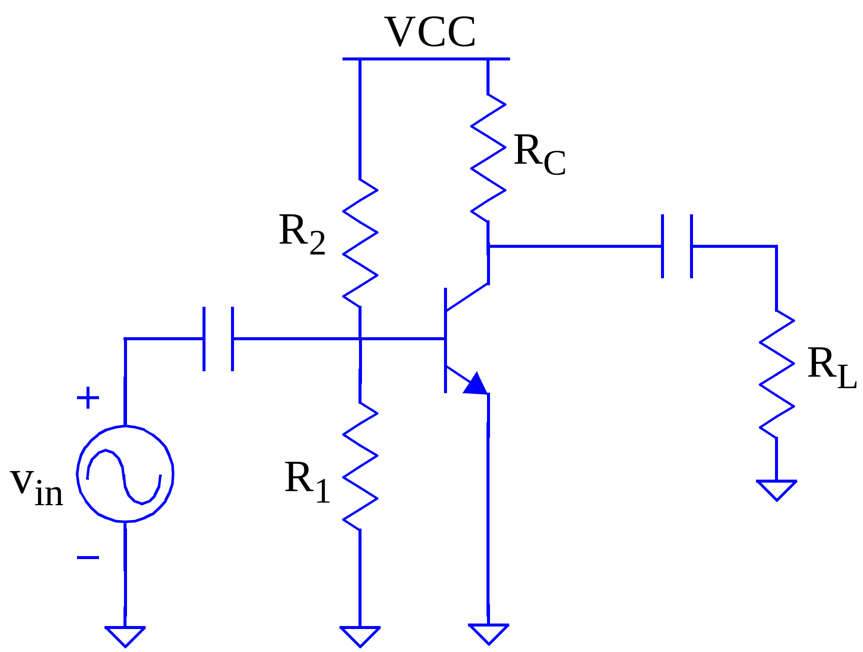
Decoupling

- What is the advantage of adding decoupling to this circuit?



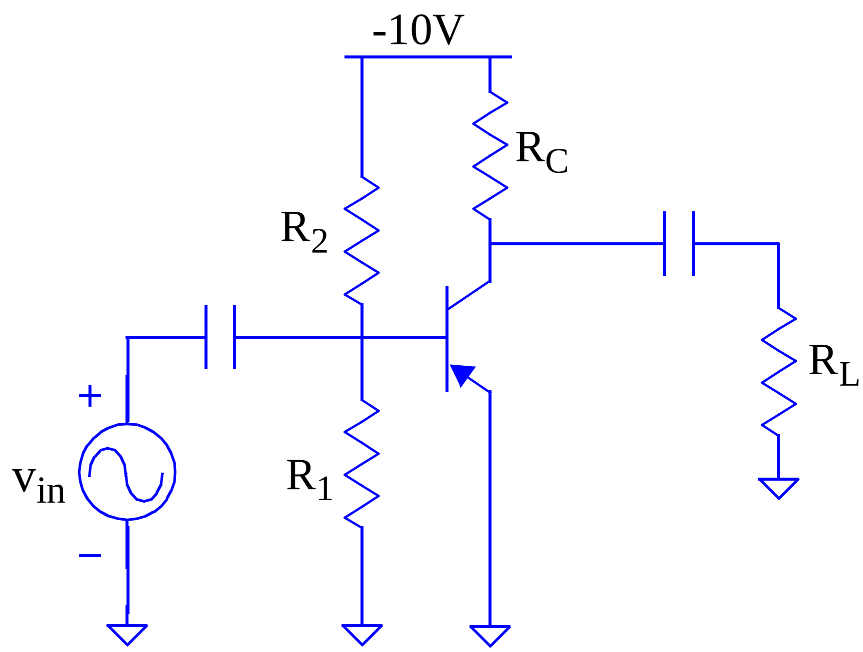
Output Decoupling

- What would be the ideal values for these capacitors?
- How do we select the capacitor values?



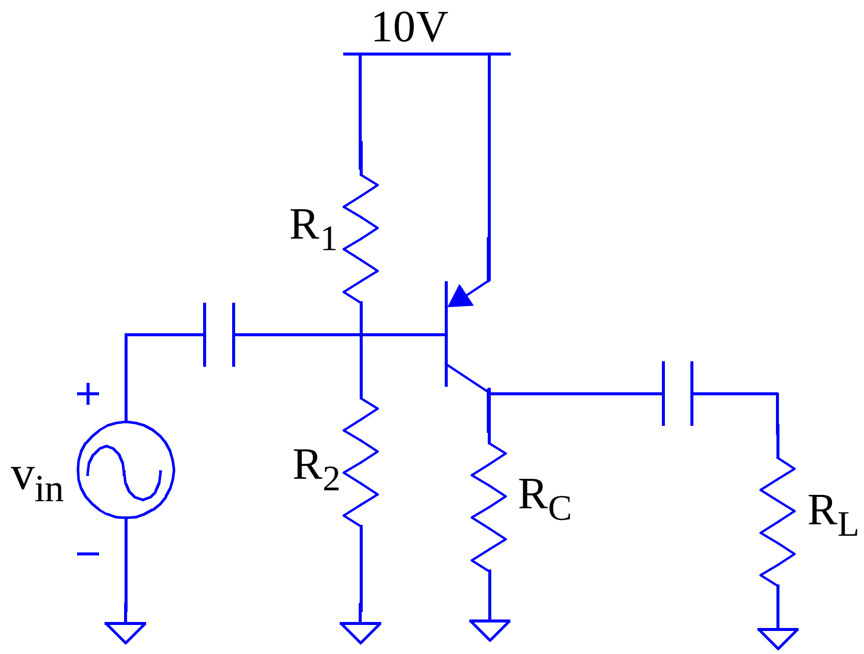
PNP Amplifiers

- dc bias voltages are negative



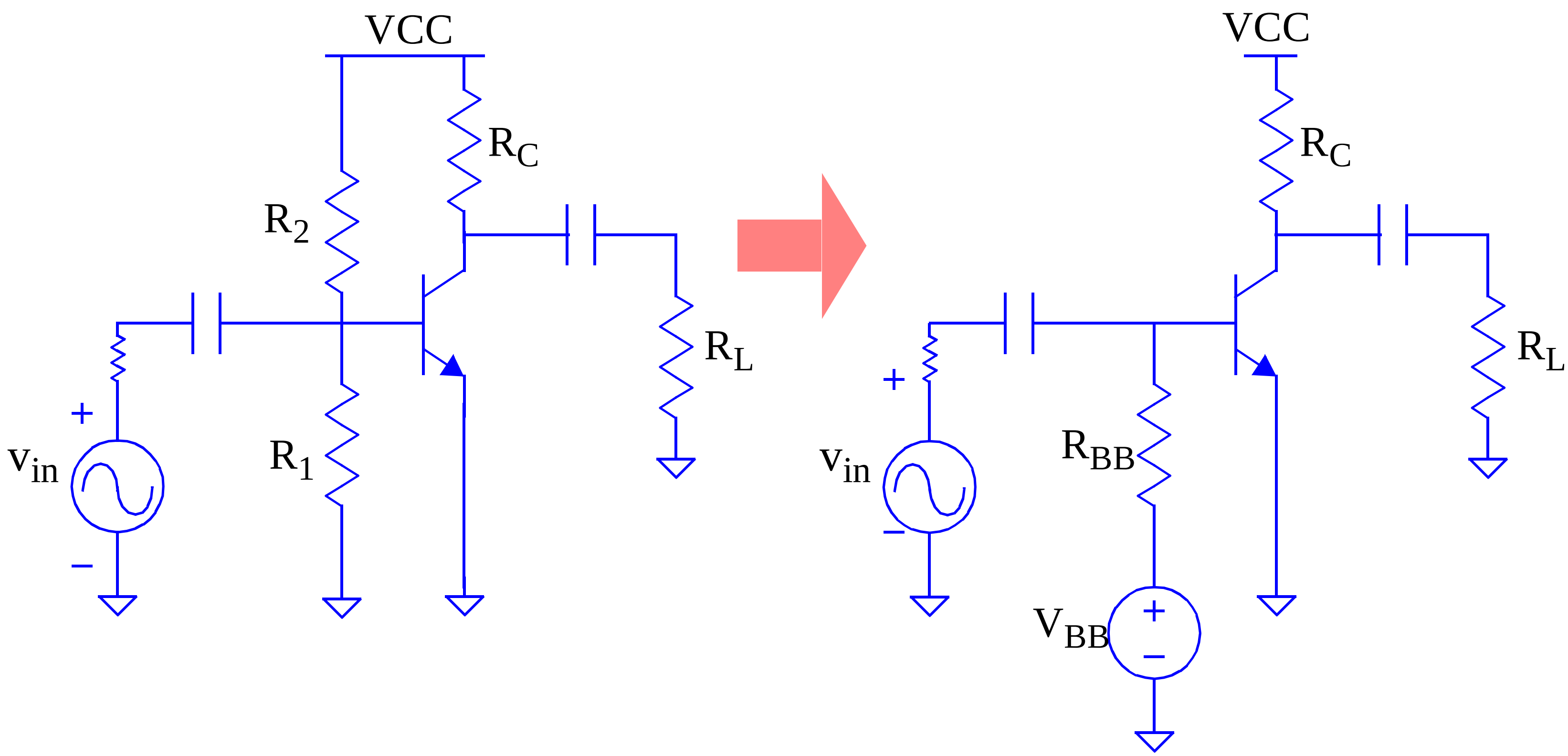
PNP Amplifiers

- Which can also be designed by shifting all of the dc voltages by the same potential:



Decoupling and Biasing

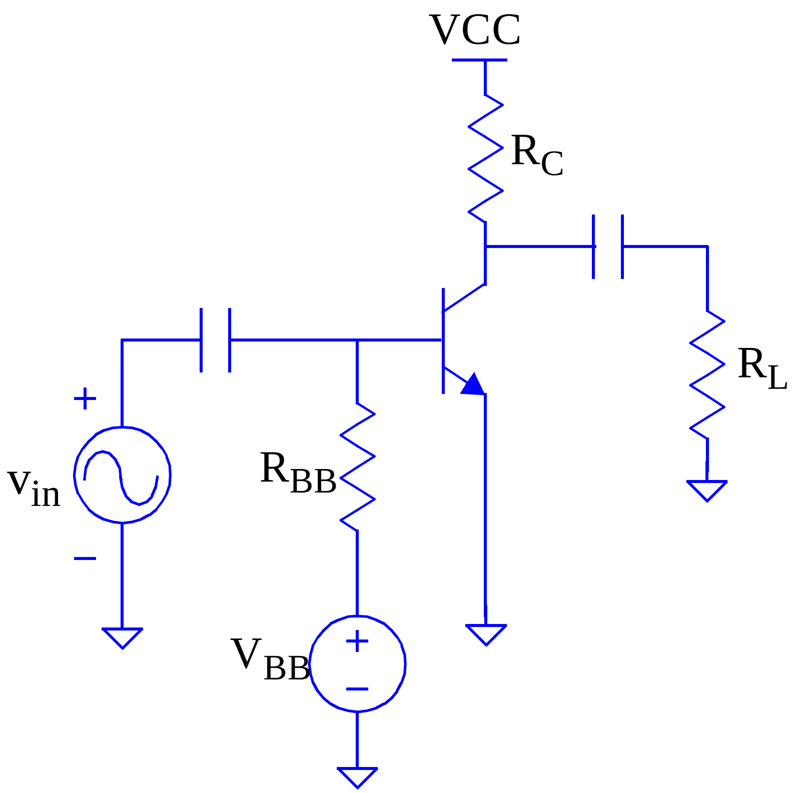
- Decoupling also allows us to specify the effective base resistance, R_{BB}, independent of V_{in}



Decoupling and Biasing

- We'd like to have $V_{BB} >> V_{BE}$ so that the currents are not overly dependent on V_{BE}. Why is this dependency undesirable?

- But what is the problem with a large V_{BB}?



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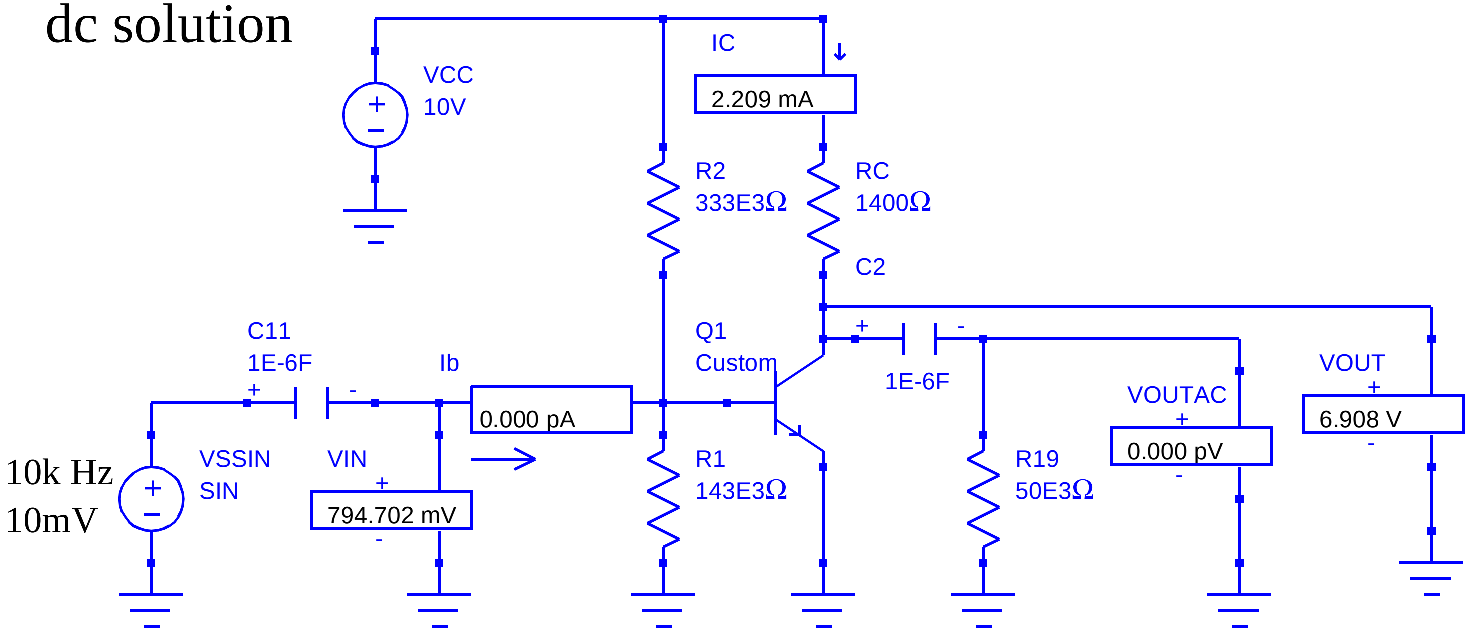
- Discrete amplifier design rules of thumb: select bias point so that the expected ac signal can swing from max to min without clipping at the supply or forcing the transistor into saturation

dc solution



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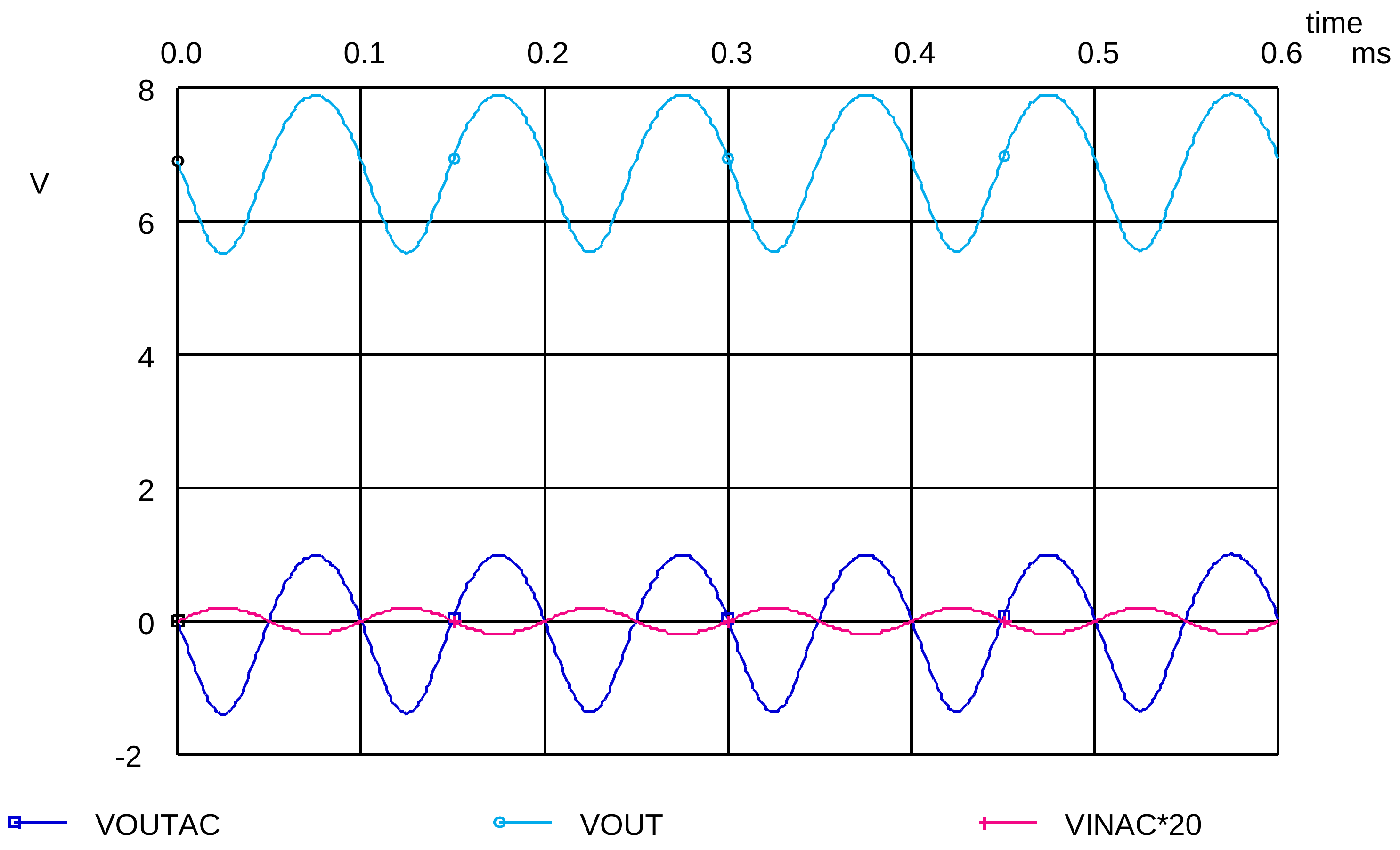
- The 1µF capacitors are nearly perfect at decoupling the input and output dc signal components at this 10kHz frequency



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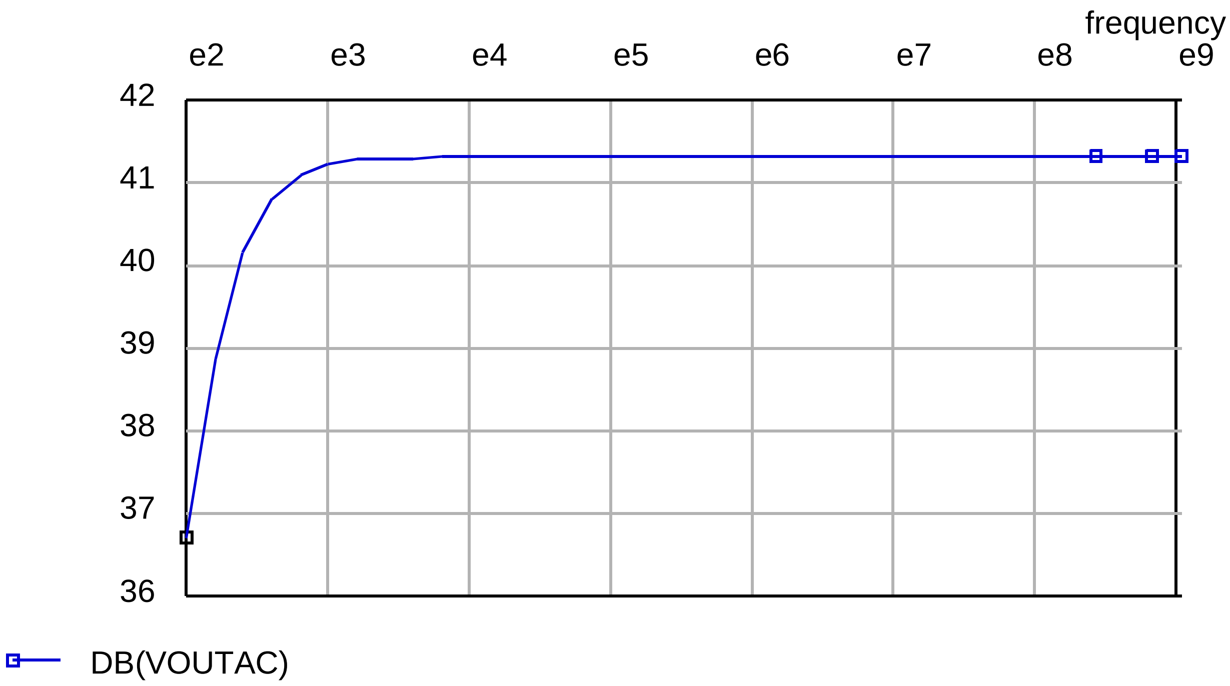
- Decoupling is evident from the frequency response
- Decoupling would cause distortion at low frequency



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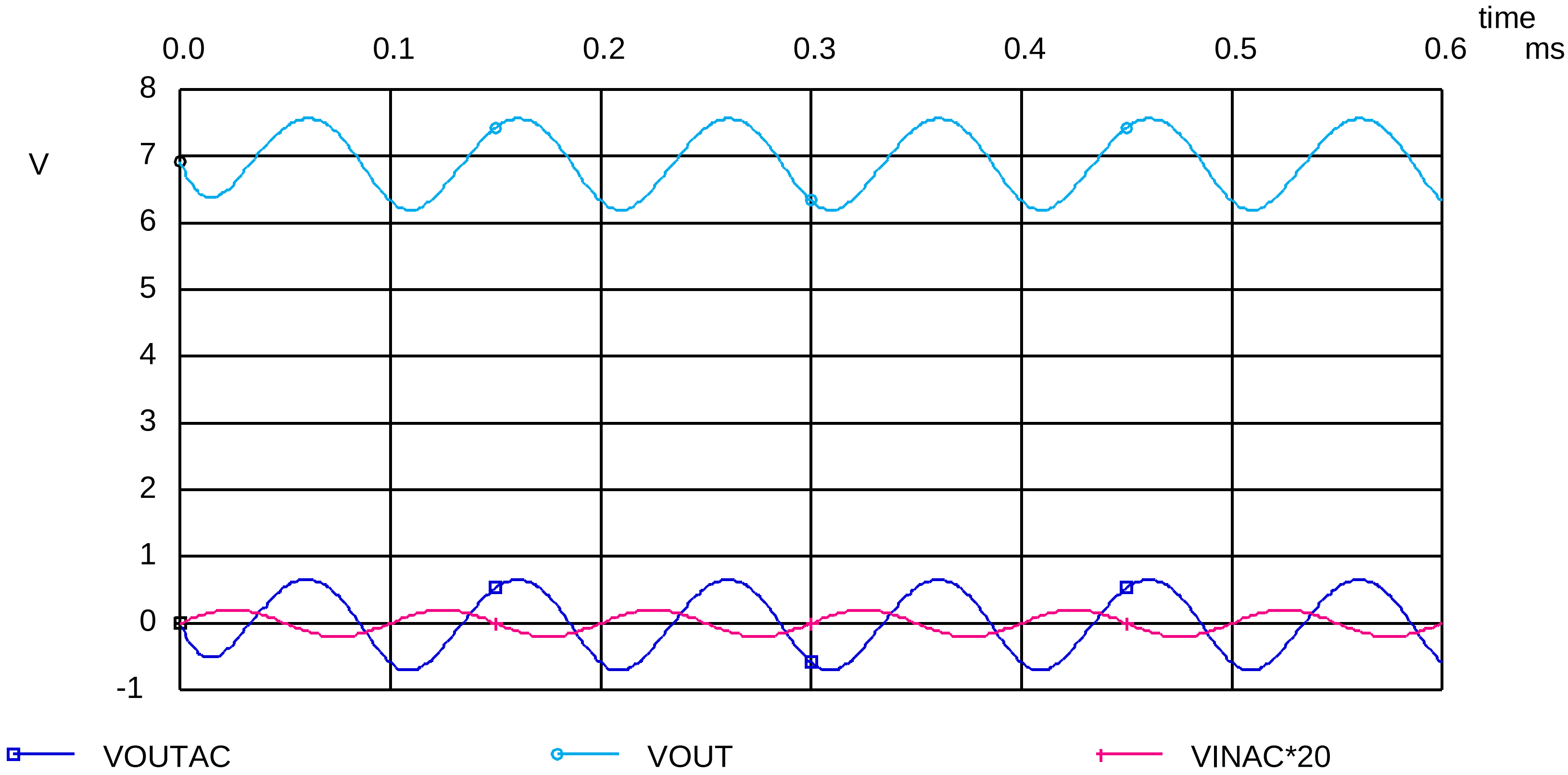
- For smaller decoupling C's (10nF) we will see some distortion even at 10kHz



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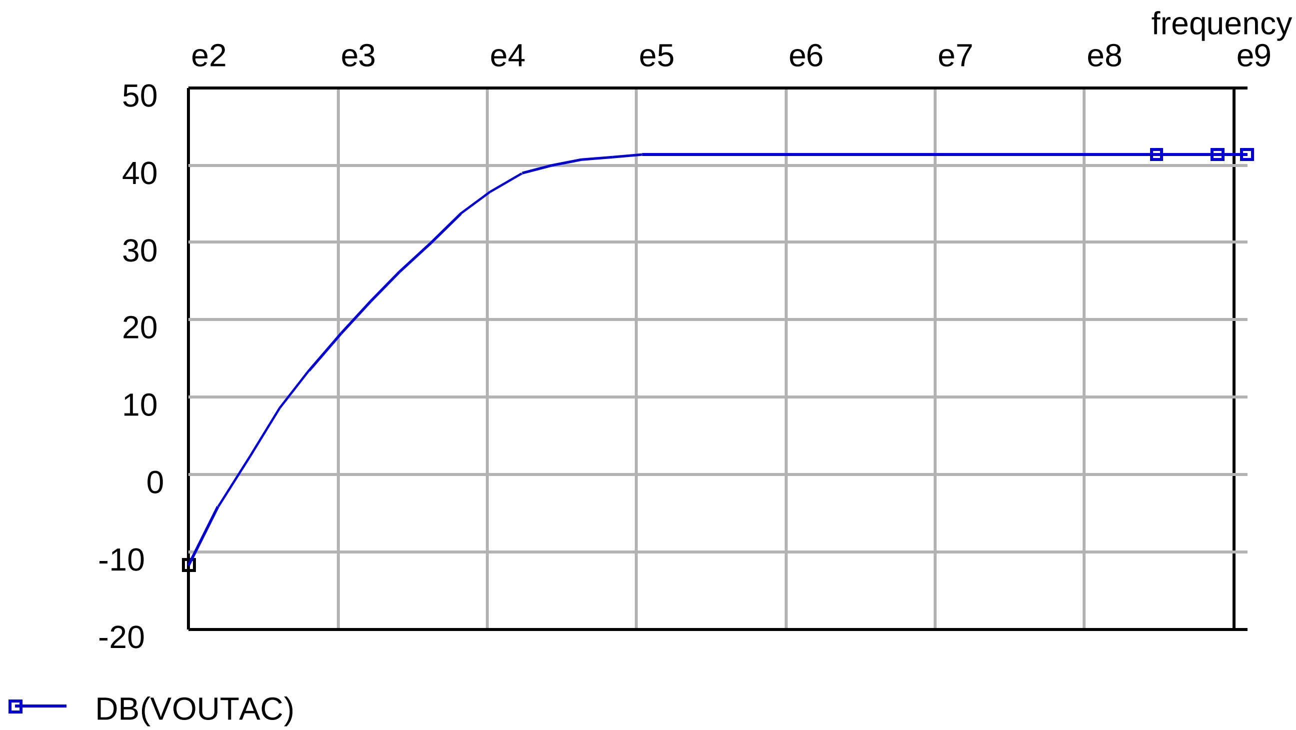
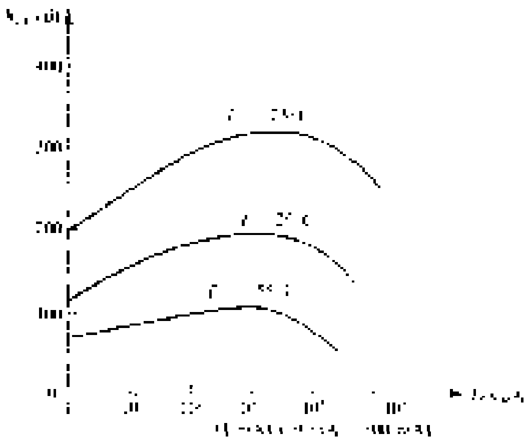
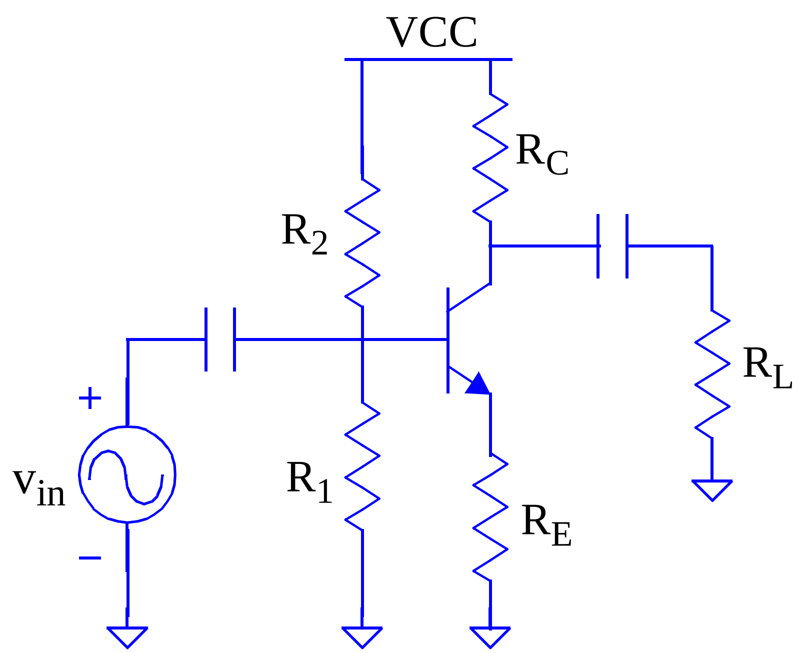
- Frequency response with 10nF decoupling C's



Controlling Parameter Variations

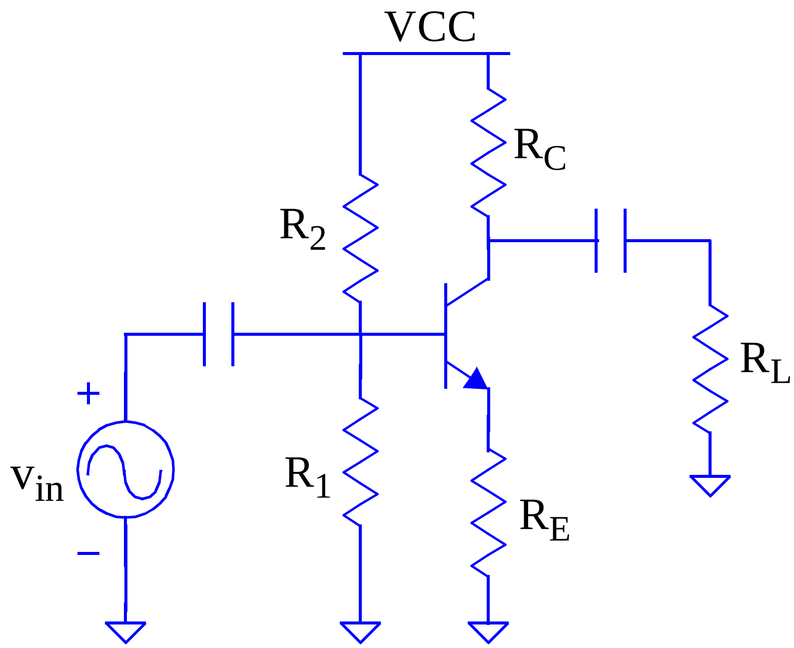
- The current gain, β,varies with temperature
  - *Recombination greatly depends on temperature*
- Recombination also depends on the *injection level* (magnitude of current)
- An emitter resistor, R_E is used as negative feedback to reduce the β-variation effect on I_C





Controlling Parameter Variations

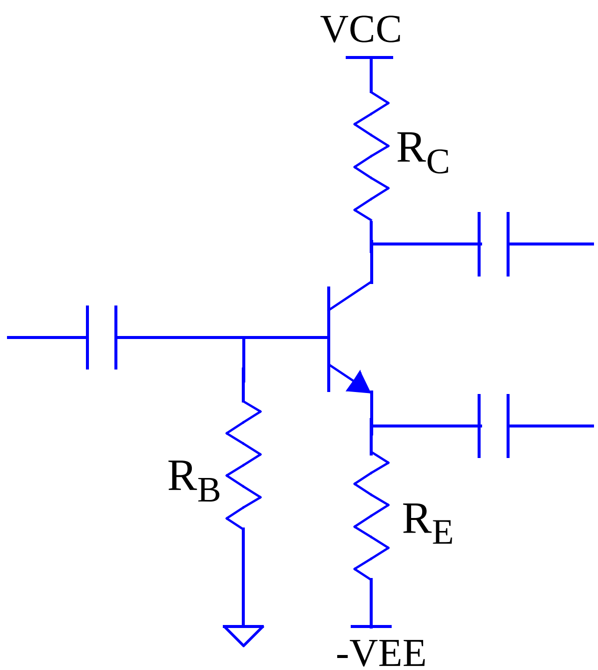
- Make R_{BB} small enough that the base voltage is roughly independent of base current so that R_E feedback can be most effective
  - But why not too small?



- If base voltage is nearly constant, an increase in current due to β-variation will tend to decrease V_{BE} because of R_E

Universal Amplifier Configuration

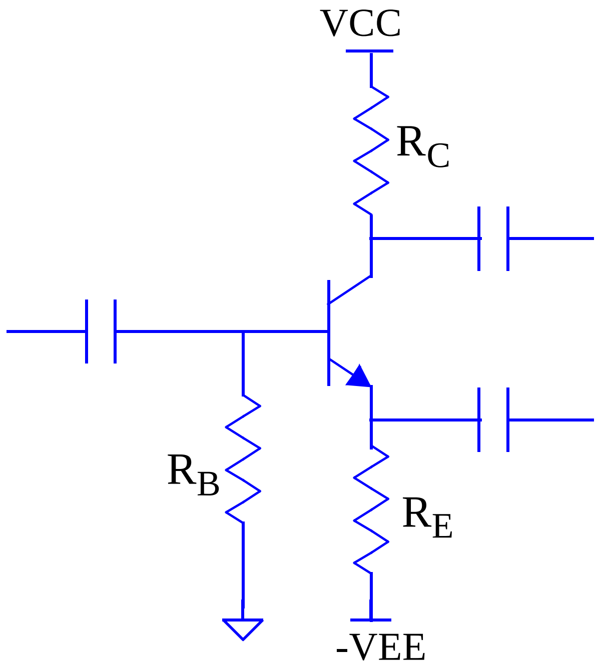
- Dual supplies for generality, makes base biasing simpler



- Use decoupling for input and output signals
- But what does the capacitor at the emitter do?

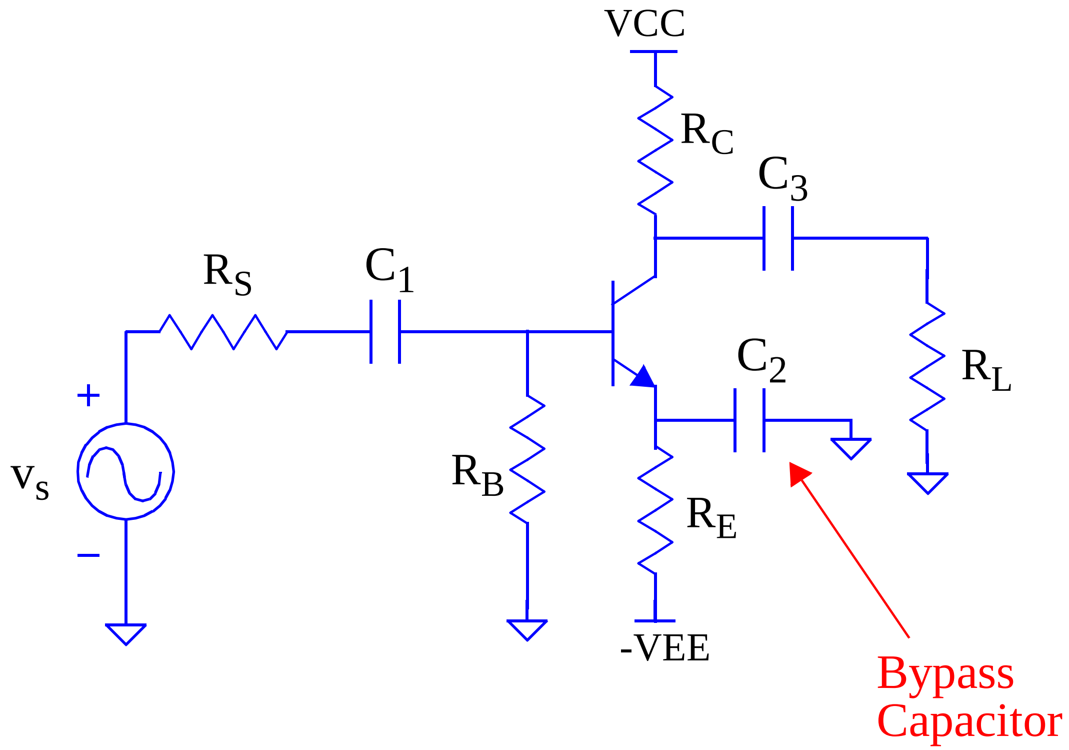
Decoupling Capacitors

- Decoupling C's are generally used only for discrete design since it is difficult to build a large capacitor on a chip
- Direct coupled amplifiers are generally used on ICs, but they are similar in form to the amplifiers that we will study here



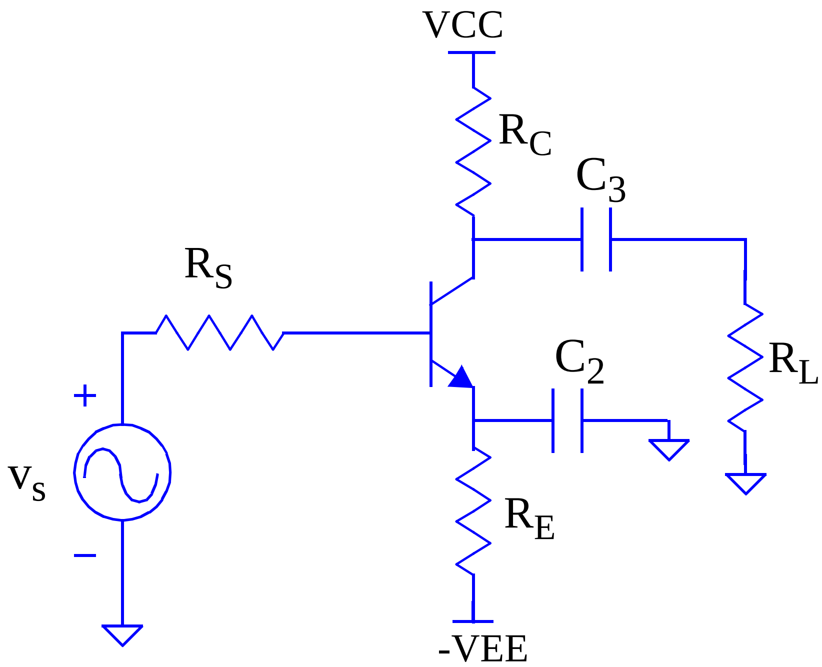
Common Emitter Amplifier

- Popular discrete-component amplifier configuration

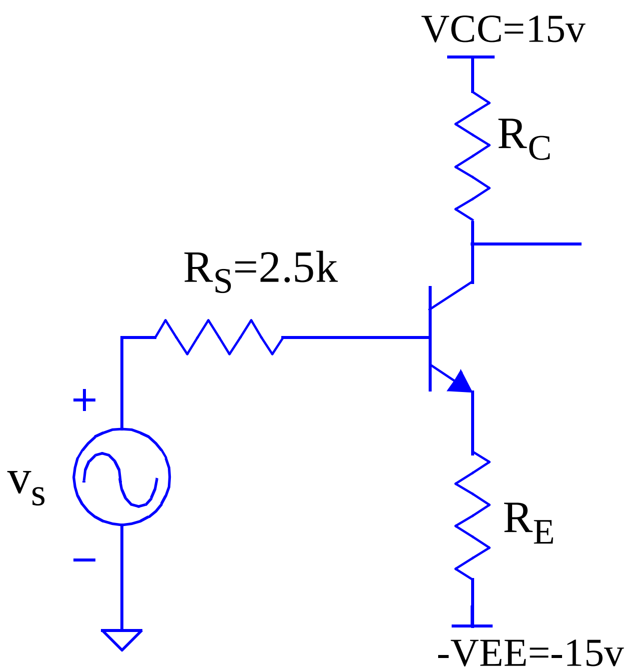


Common Emitter Design Example

- If there is no dc component in v_{in}, then we don't need C_1 or R_B with -VEE.



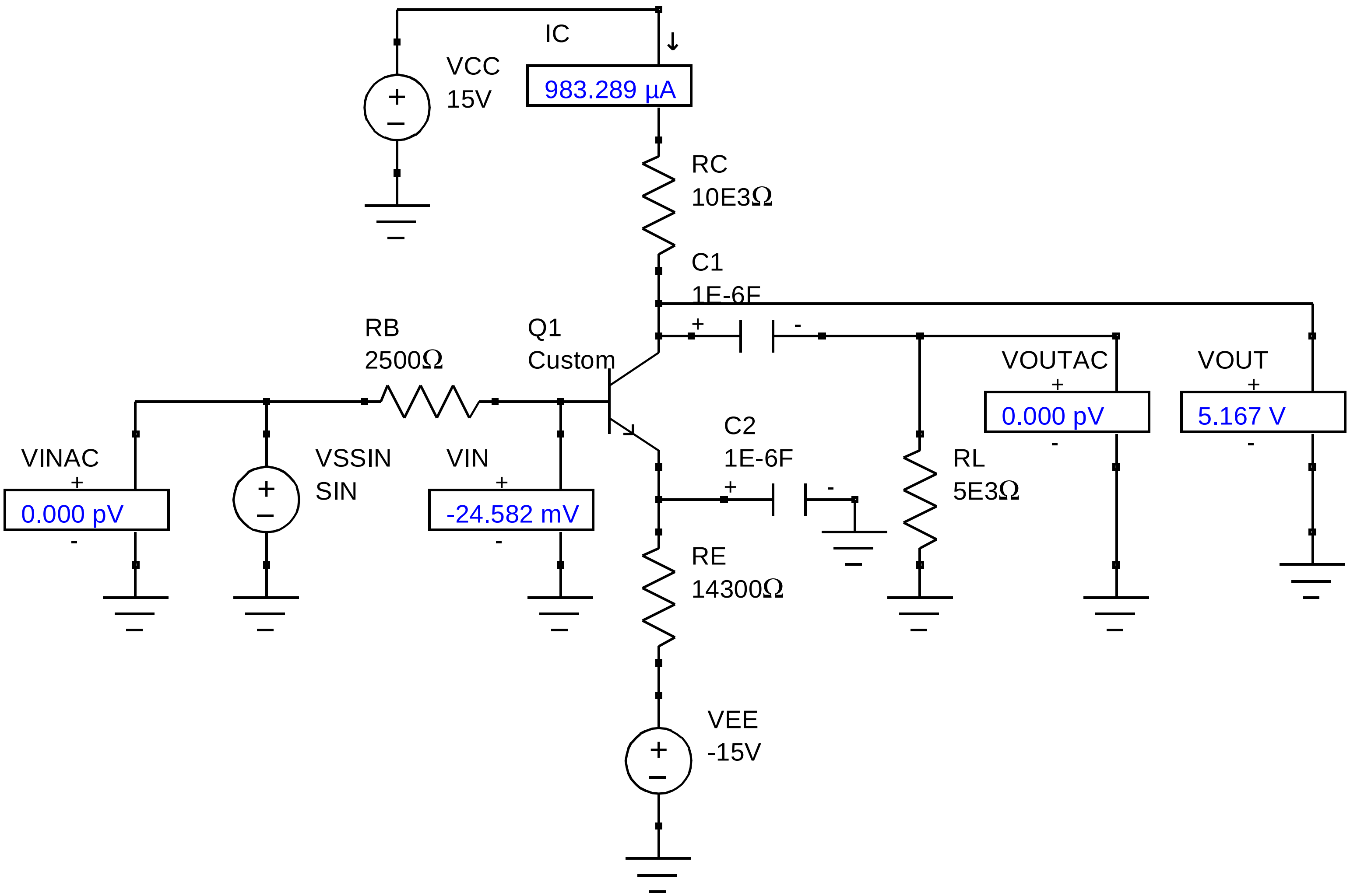
Common Emitter Design Example



Common Emitter Design Example

Common Emitter Design Example

SPICE dc Analysis



SPICE ac Analysis