Lab 3 Instructions

Dr. Bing Han

Email: Bing.Han@xjtlu.edu.cn

Office: EE220

Components

- Transistor BJT 2N3904
- Resistor $R_L = 3.9\ \mathrm{k\Omega}$
- Resistor R_c, R_e, R_1 and R_2
  - According to calculations
- Capacitors
  - $2 \times 1\ \mu\mathrm{F}$
  - $2 \times 47\ \mu\mathrm{F}$

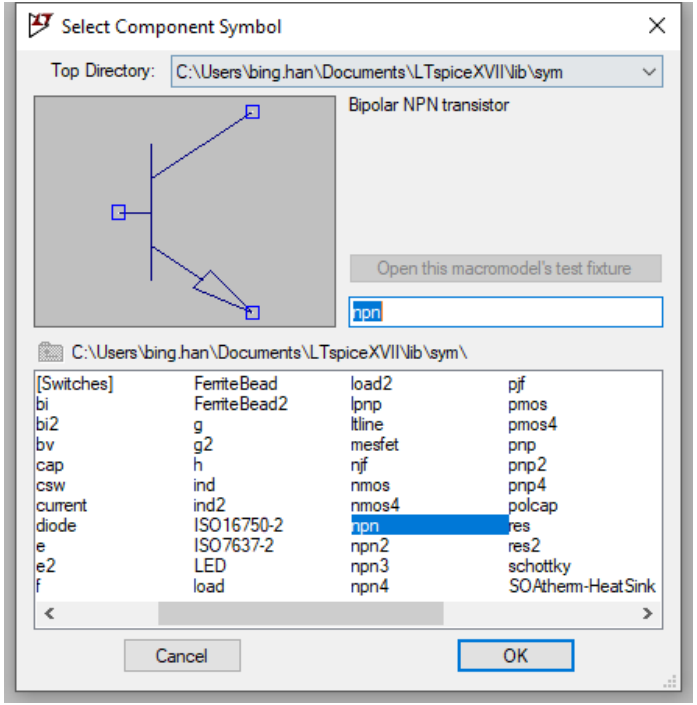
Objectives

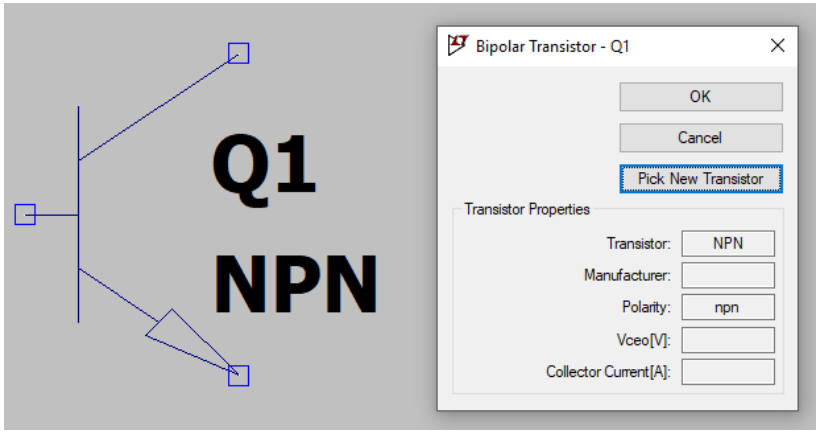
- Find β of the Transistor
- Simulate frequency response of a common emitter amplifier
- Simulate frequency response of a common collector amplifier

Find β of the Transistor

Find the Transistor

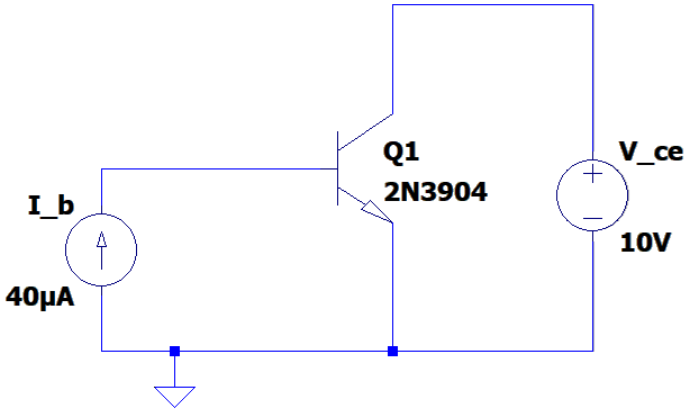
- Find the NPN transistor 2N3904

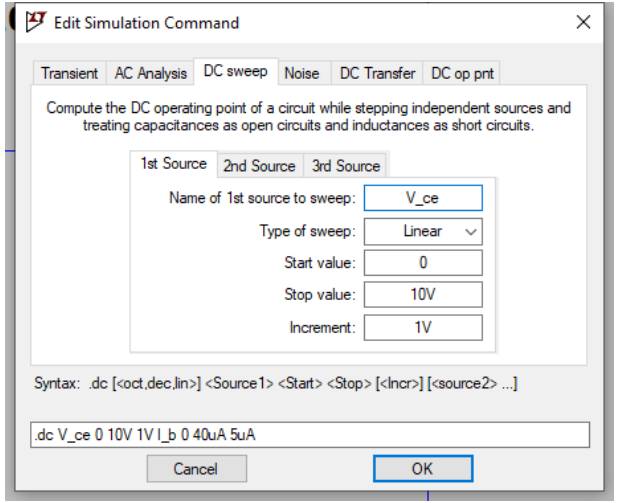


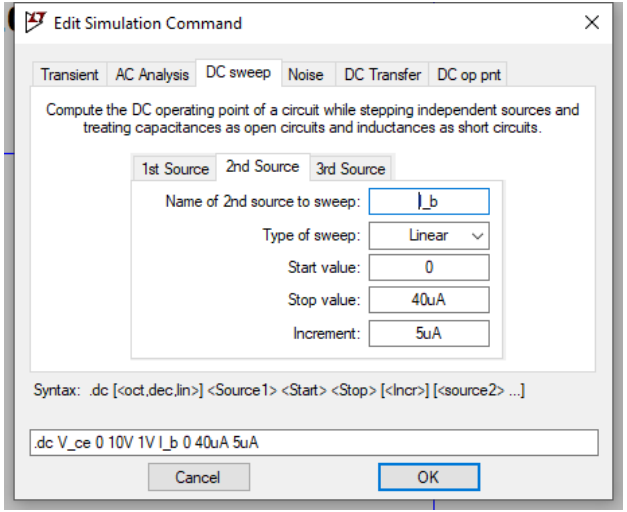


Built the Circuit

- Input the circuit schematic as follows
- Pull down the “Simulate” window, select “Edit Simulation Cmd”



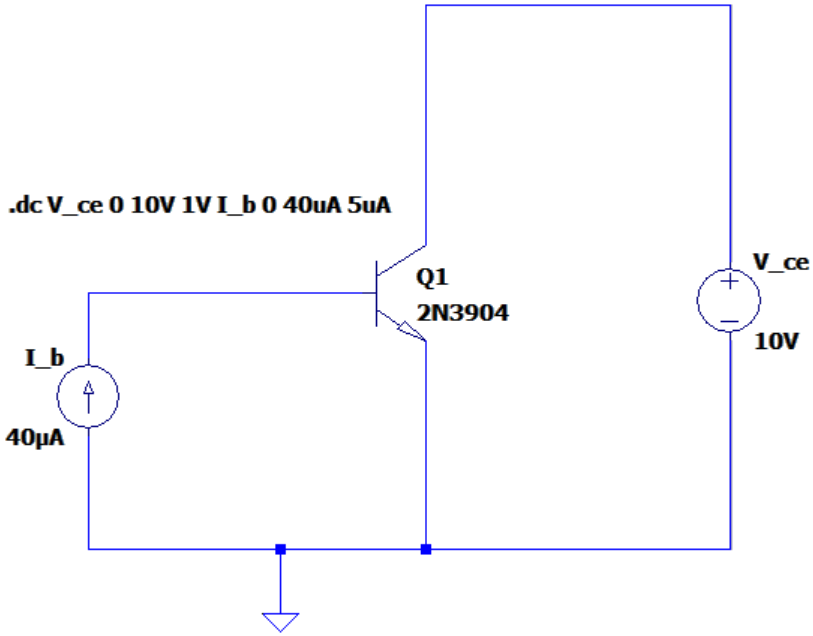




Find β of the Transistor

- Set the value of I_B
  - $0, 5, 10, \cdots, 40\ \mu\text{A}$
- Set the value of V_{CE}
  - $0, 1, 2, \cdots, 10\ \text{V}$
- The unit "μA" is represented by 'uA' in LTSpice

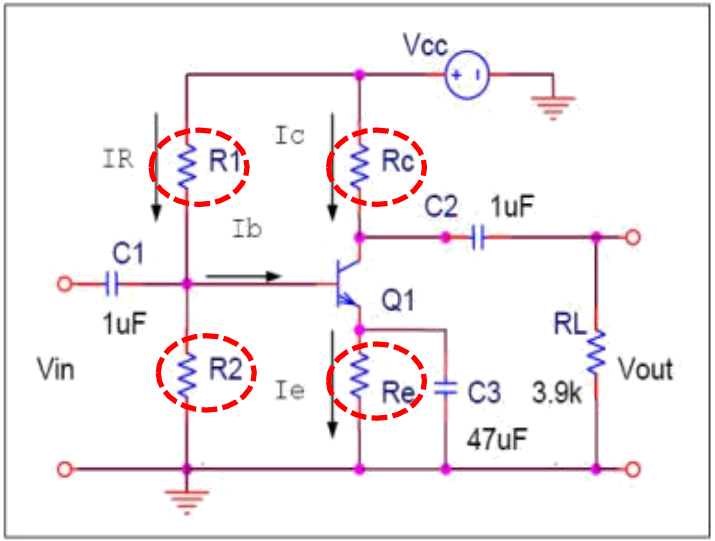
- Calculate the dc current gain β at $I_c = 5\ \text{mA}$



Common Emitter Amplifier

Common Emitter Amplifier

- Calculate the values of R_c, R_e, R_1 and R_2
  - DC Bias: $V_{CC} = 10$ V, $V_{CE} = 5$ V, $I_{CQ} = 5$ mA
- R_1 and R_2 form a potential divider
  - Fix the base voltage of the transistor
- $I_R = 10 I_{BQ}$, $V_{BE} = 0.7$ V
- R_E helps to stabilize the bias
  - If the temperature increases, then extra collector current will flow.
  - If I_{CQ} increases, then I_{EQ} increases
  - V_E increases, and reducing the effective base emitter voltage and therefore stabilizing the collector current.



Calculations

- Assume $V_E = \frac{1}{10}V_{CC}, I_R = 10I_{BQ}, V_{CC} = 10\ \text{V}, V_{CE} = 5\ \text{V}, I_{CQ} = 5\ \text{mA}$
- Determine R_C, R_E, R_1 and R_2

$$V_{CC} = I_{CQ}R_C + V_{CE} + I_{EQ}R_E$$

$$I_{CQ} \cong I_{EQ}$$

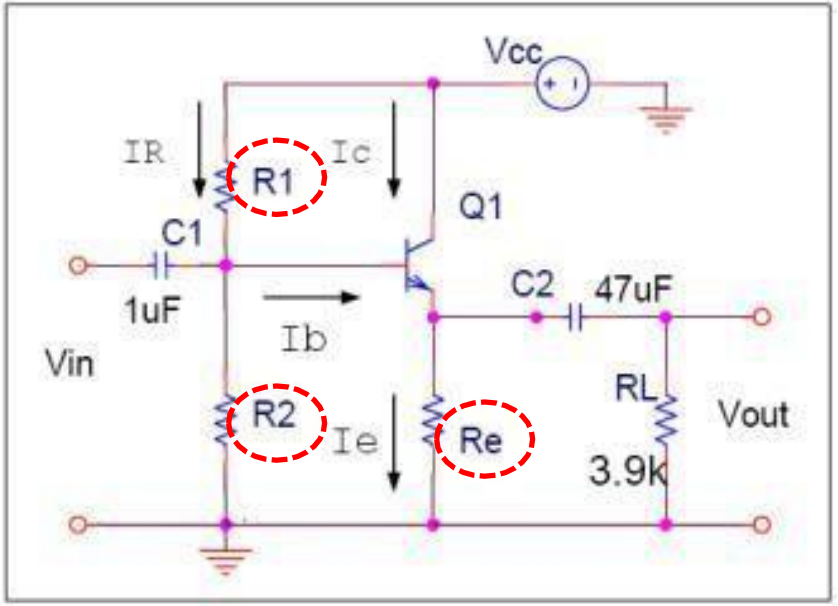
$$V_B = V_E + 0.7$$

$$R_1 = \frac{V_{CC} - V_B}{I_R} = \frac{V_{CC} - V_B}{10I_{BQ}} \qquad R_2 = \frac{V_B}{9I_{BQ}}$$

Common Collector Amplifier

Common Collector Amplifier

- Calculate the values of R_E, R_1 and R_2
  - DC Bias: $V_{CC} = 10$ V, $V_{CE} = 5$ V, $I_C = 5$ mA
- R_1 and R_2 form a potential divider
  - Fix the base voltage of the transistor



Calculations

- Assume $I_R = 10I_{BQ}, V_{CC} = 10\ \text{V}, V_{CE} = 5\ \text{V}, I_{CQ} = 5\ \text{mA}$
- Determine R_E, R_1 and R_2

$$V_{CC} = V_{CE} + I_{EQ}R_E$$

$$I_{CQ} \cong I_{EQ}$$

$$V_B = V_E + 0.7$$

$$R_1 = \frac{V_{CC} - V_B}{I_R} = \frac{V_{CC} - V_B}{10I_{BQ}} \qquad R_2 = \frac{V_B}{9I_{BQ}}$$