FYSE302 Electronics 1B
Final Exam 11.5.2012

1. Briefly explain/describe:

   (a) Common mode rejection ratio (CMRR) (1p)

   (b) Half-wave and full-wave rectification (1p)

   (c) Zener diode, and how it can be used in voltage regulation (2p)

   (d) Negative and positive feedpack. Draw also the block diagrams (2p)

2. Consider the RCL-circuit shown in figure 1. Determine the resonance frequency ω_0, i.e. the frequency when the total impedance of the circuit is purely real. What is the total impedance at the resonance?

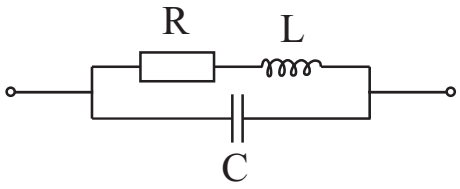


Figure 1:

3. The input resistance R_{in} of a voltage amplifier needs to be as high as possible, so that the amplifier does not induce much load on the other circuitry. A simple inverting amplifier circuit shown in figure 2a) is not an ideal choice in this sense.

   (a) What is the highest possible input impedance $R_{\text{in}} = V_{\text{i}}/I_{\text{i}}$ for the circuit of figure 2a), if the gain $V_{\text{o}}/V_{\text{i}}$ needs to be -100 and resistors higher than 1 MΩ are not allowed to use.

   (b) Better circuit is shown in figure 2b). Choose the components so that the gain $V_{\text{o}}/V_{\text{i}} = -100$ and the input impedance $R_{\text{in}} = V_{\text{i}}/I_{\text{i}} = 1$ MΩ. Largest resistor allowed is 1 MΩ. (Resistors larger than 1 MΩ usually induce problems)

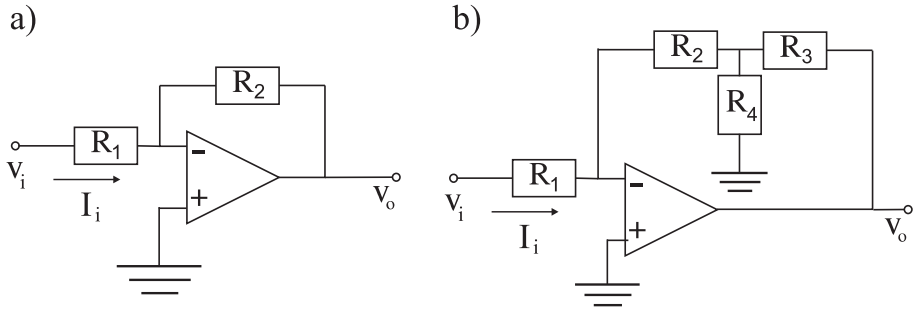
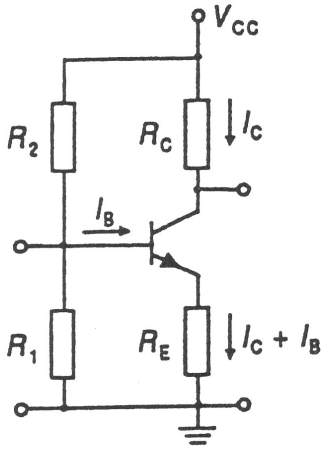


Figure 2:

4. Figure on right represents a self-biased circuit for a bipolar transistor. Choose the values for R_C, R_1 and R_2 in such a way that the operation point becomes $I_C = 1.25$ mA and $V_{CE} = 5$ V. Choose $R_E = 2$ kΩ and $V_{CC} = 15$ V. For the silicon transistor in question $\beta = 100$ and $I_{CBO} \approx 0$ A. Now R_1 and R_2 have to be chosen so that $\beta \gg R_B/R_E \gg 1$, where $R_B = R_1||R_2$. Why? In calculations choose $R_B/R_E = 10$.

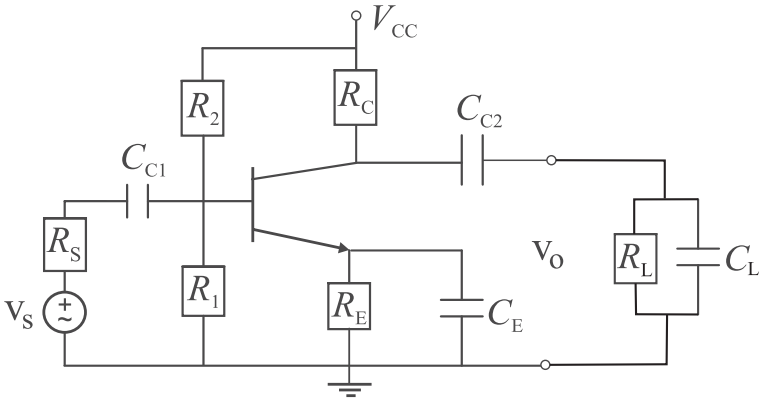


5. In figure 3a) there is shown an amplifier circuit based on a npn-transistor and figure 3b) illustrates its small-signal model.

   (a) Explain what is the small-signal model and what is it used for. What is descriped by the symbols (r_π, C_π, etc.) in figure 3b)? Is there anything missing?

   (b) Determine the gain of the system $A = V_O/V_S$ at low frequencies (C_{C1} ja C_{C2} more significant that the other capacitances) assuming $R_B \gg r_\pi$. Explain qualitatively what happens at very high frequencies and at middle frequencies.

a)



b)

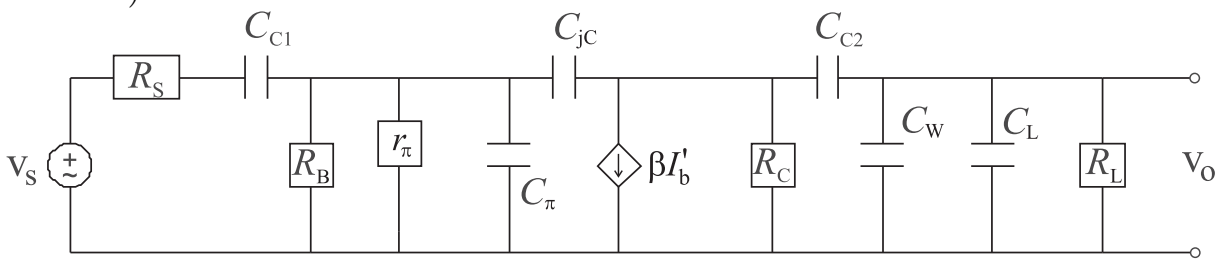


Figure 3: