S-87.1010 Electronics I, Exam 18.05.2010 / Marko Kosunen

Write your name and your student number on every paper (also on possible appendices). All calculators allowed. NO literature allowed.

ATTN:. You will gain some points even if your numeric answers were incorrect. The focus of the evaluation is in symbolic calculation demonstrating that you have understood what you are calculating.

1. a) Sketch the output voltage of the circuit in Fig. 1 as a function of time. The input signal is $v_i = 3V \cdot sin(2\pi 1kHz \cdot t)$ for t>0 and $v_i = 0$ for t<=0. You may assume the diode to be ideal (no series resistance, no forward voltage drop. The initial voltage over the capacitor C_1 is zero).
b) Sketch the output voltage of the circuit in Fig. 2 as a function of time in steady state (when the initial transient has passed). The input voltage is the same as in a). The load resistor $R_L = 50k\Omega$, $C_1 = 2\mu F$ and the forward voltage drop of the diode D_1 is 0.7V. You may still assume the dynamic resistance of the diode to be negligible.

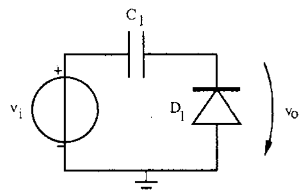

Figure 1:

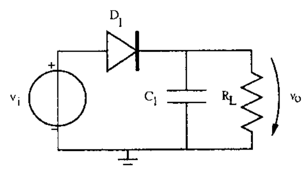

Figure 2:

2. a) Desing the circuit of the figure 3 so that the voltage gain is 10 and the current through the feedback resistor R_2 is at most 1mA when the output voltage is 1V. Assume that the operational amplifier is ideal.
b) The operational amplifier is not ideal, but it has input offset voltage V_O and input bias current I_B. What is their effect on the output voltage?.
c) The unity gain bandwidth (gain-bandwidth product) of the operational amplifier is ω_t. Sketch the Bode plot of the circuit. (Input bias current or input offset voltage have no effect in this part.)

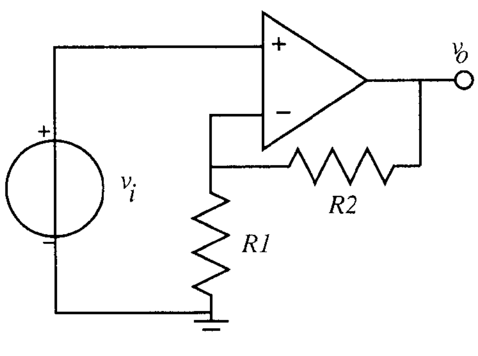

Figure 3:

3. a) Modify the current amplifier circuit of Fig. 4 to a equivalent transresistance amplifier circuit. What is the open circuit transresistance R_{mo} of the amplifier, if the voltage gain $\beta = 100$, $R_{in} = 1k\Omega$, $R_{out} = 100\Omega$, $R_s = 50\Omega$ and $R_L = 100\Omega$.

b) Calculate the available power gain of the circuit. Give the results also in decibels. Is the load R_L matched?

c) If two identical amplifiers of the a-part are connected in cascade, what is the available power gain of the amplifier chain in decibels?

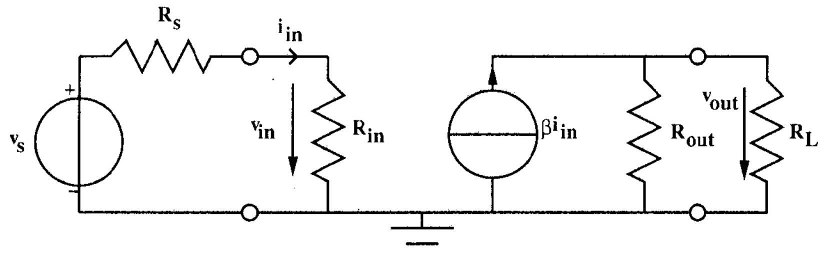

Figure 4:

4. Figure 5 depicts a single stage transistor amplifier. The transistor has following parameters $V_{BE} = 0.7V$ $V_T = 25mV$, $\beta = 100$. In circuit $V_{CC} = 15V$, $R_1 = R_2 = 350k\Omega$, $R_C = R_E = 5k\Omega$. Capacitors are large. Early-efect can be neglected.

a) Which one of the three amplifier types the figure presents? What is the purpose of the resistor R_E in biasing? Calculate the operation point of the transistor.

b) Draw the small signal equivalent circuirt of the amplifier. Calculate the open circuit voltage gain A_{vo} and short circuit current gain A_{is}

c) Calculate the input resistance R_{in} and the output resistance ja R_{out}.

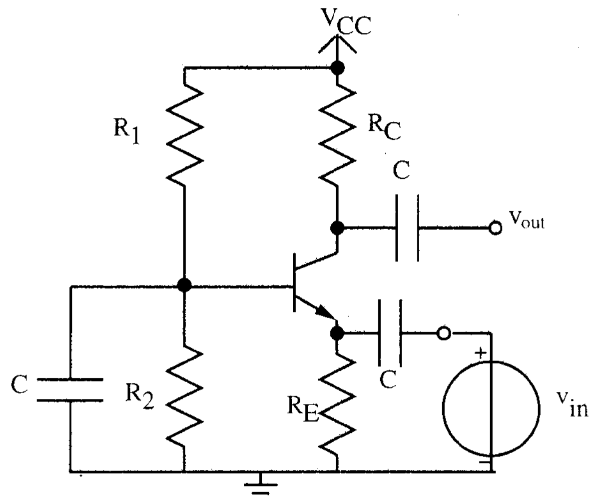

Figure 5: