University of Oulu
Department of Electrical Engineering

Principles of Electronics Design

Summer exam 29.6.2013

1. Fig. 1 shows the schematic of a NMOS current mirror. Size the resistor R_{in} (3p) and the width-to-length ratio of a NMOS-transistor M_2 (2p) so, that the current through NMOS-transistor M_1 is 50 µA and the output current I_{out} = 300 µA. How large is the output resistance of the current mirror (1p)? All the transistors are in the active region and $\lambda_N = 0$. Table 1 shows the process parameters of MOS-transistors.(6p)

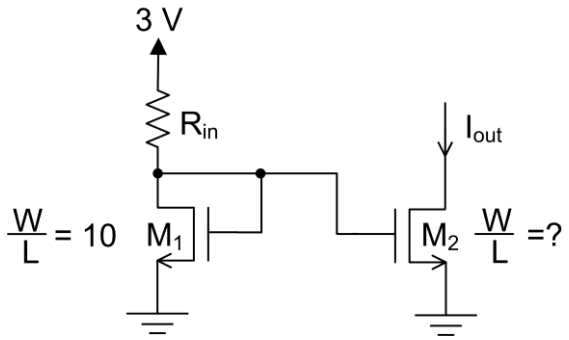

Fig. 1.

2. Calculate the DC operation point of amplifier shown in Fig. 2 (2p) (You can assume that $\beta = \infty$). Calculate the amplification v_{out}/v_s and the input and output impedances R_{in} and R_{out} at the signal band (3p). β=100 and V_{BE} = 0,7 V when a transistor is conducting. Calculate the maximum input amplitude of the v_s, which gives the pure, uncut amplitude of the output signal v_{out} (1p)? Capacitor C is AC coupling capacitance (short circuit at the band). The saturation voltage of the transistor $V_{CE\text{-}sat}$ = 0V.(6p)

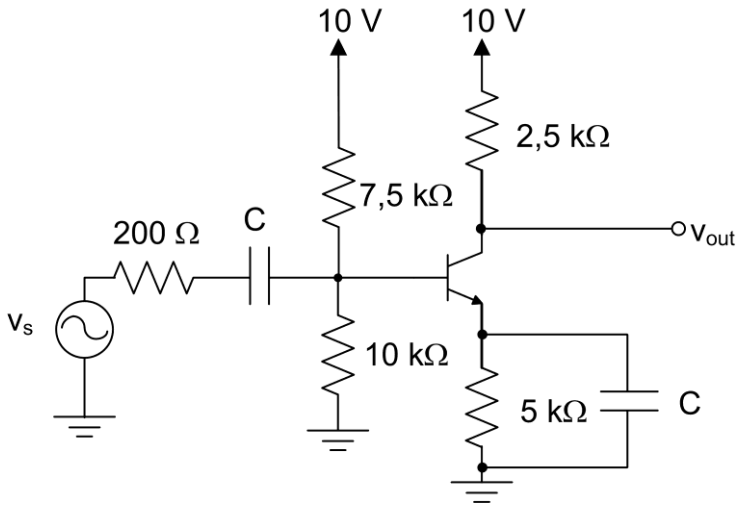

Fig. 2.

3. Write an essay with the following title – *The electrical properties of a diode and the small-signal analysis of a single diode circuit.* (6p)

4. Draw the signals in nodes (1)-(7) marked in Fig. 3. The diode can be assumed ideal. (6p)

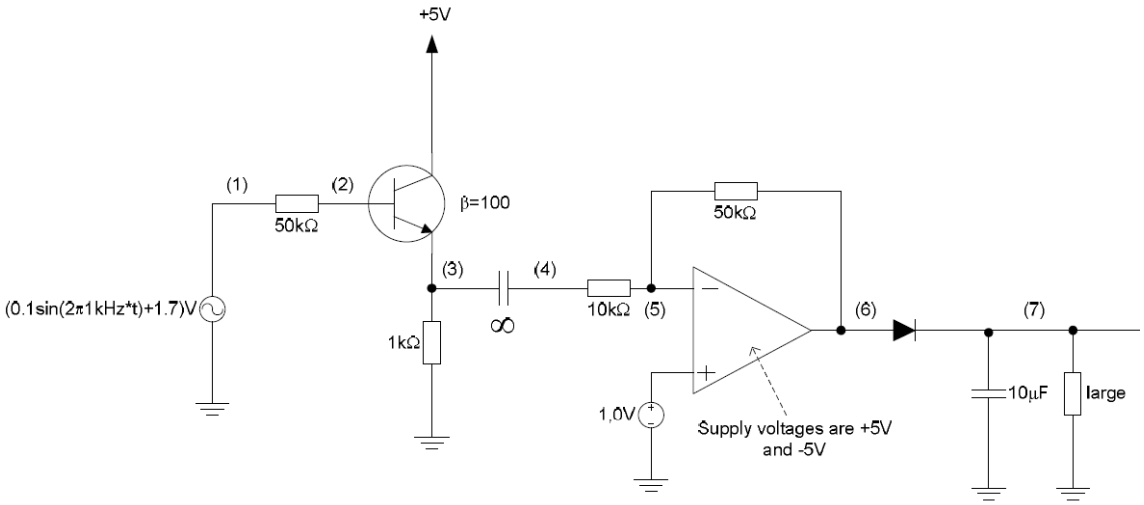

Fig. 3.

Table 1. Process parameters of MOS-transistor.

Type	V_{TH}	μC_{ox}
NMOS	0,5 V	100 µA/V^2
PMOS	-0,5 V	50 µA/V^2

Formulas:

NMOS: $i_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(v_{GS} - V_{TH})^2$

BJT : $i_C = I_S exp\left(\frac{v_{BE}}{V_T}\right), r_E = \frac{V_T}{I_C} \approx \frac{25mV}{I_C}$