University of Oulu
Department of Electrical and Information Engineering, Electronics Laboratory

Principles of Electronics Design 521431A
Exam 03/27/2009

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1. (a) For the circuits in figures 1 b), c) and d) sketch the output for the input shown in figure 1 a). (4p)

   (b) What is the output of the circuit shown in figure 1 e) if the input is $u_i = 10\sin(2\pi ft)\,\mathrm{mV}$? (2p)

   Assume that each diode has a $0.7\,\mathrm{V}$ drop when conducting.

2. The MOSFET in the circuit of figure 2 has $\mu_n C_{ox} = 25\,\mathrm{uA/V^2}$, $\lambda = 0$, $W/L = 100$ and $U_t = 2\,\mathrm{V}$. Capacitors C_1, C_2 and C_3 are large coupling capacitors.

   (a) Find the values of I_D and g_m at the bias point. (2p)

   (b) Draw a small-signal equivalent circuit for the circuit. (1p)

   (c) Find the input and output resistances. (1p)

   (d) Find the gain u_L/u_{src}. (2p)

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\begin{aligned}
i_D &= \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(u_{GS} - U_t)^2(1 + \lambda \cdot u_{DS}) \\
g_m &= \frac{\partial i_D}{\partial u_{GS}}|_{u_{GS}=U_{GS}} = \mu_n C_{ox}\frac{W}{L}(U_{GS} - U_t)
\end{aligned}
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3. (a) Calculate the input impedance and voltage gain for the circuit presented in Fig. 3 a), $\beta = 100$. (3p)

   (b) Calculate the output voltage of the circuit presented in Fig. 3 b), as the $R_2 = R_4 = 10\,\mathrm{k\Omega}$, $R_1 = R_3 = 2{,}5\,\mathrm{k\Omega}$, $u_1 = 1\,\mathrm{V}$ and $u_2 = 2\,\mathrm{V}$ (1p)

   (c) Design an inverting amplifier, which has very large input impedance and gain of -10 using operational amplifiers and resistors. (2p)

4. (a) Draw the schematic diagram of a CMOS inverter and the $V_{IN} - V_{OUT}$ curve of the circuit. (2p)

   (b) What is the advantage of a CMOS switch compared to a switch using one MOS transistor? (1p)

   (c) What is the principle for calculating the dimensions of the transistors in the general structure CMOS logic gate presented in Fig. 4? (1p)

   (d) What is the purpose of the S/H circuit in A/D converters? (2p)

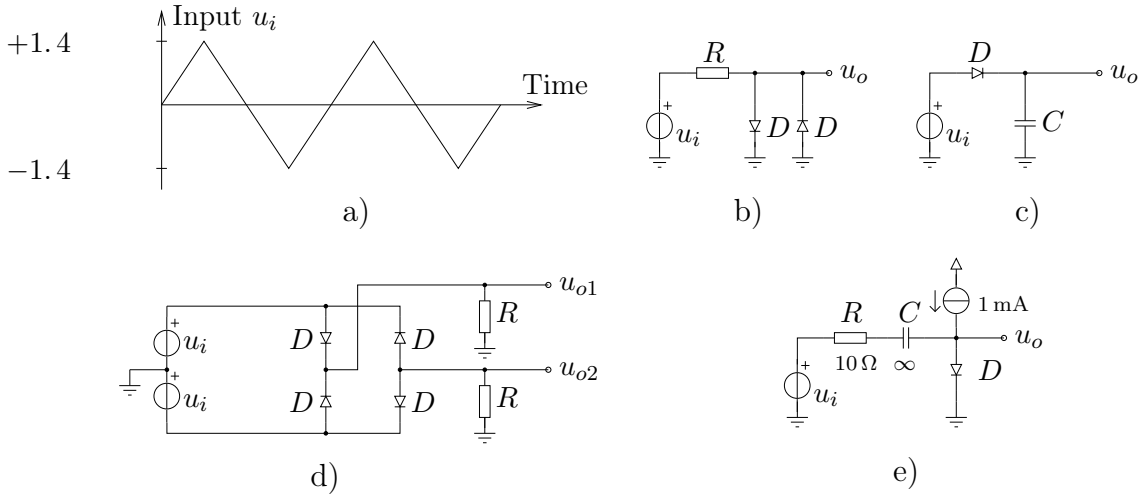

Figure 1: Figure for question 1.

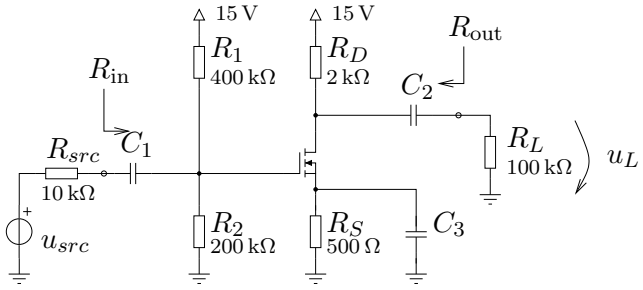

Figure 2: Figure for question 2.

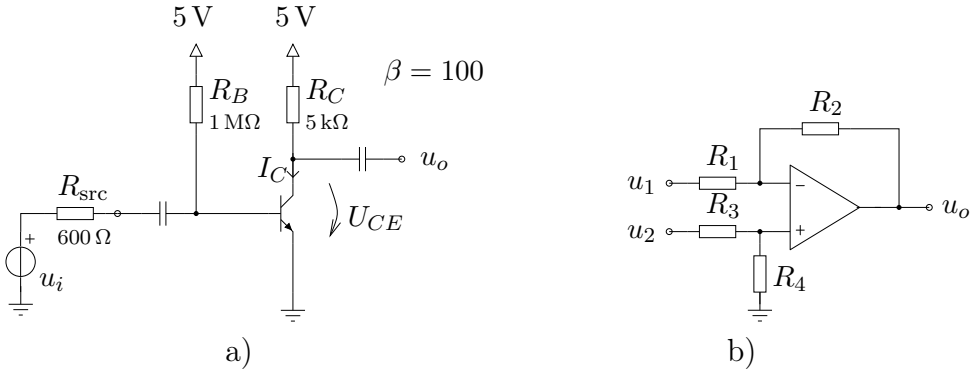

Figure 3: Figures for question 3.

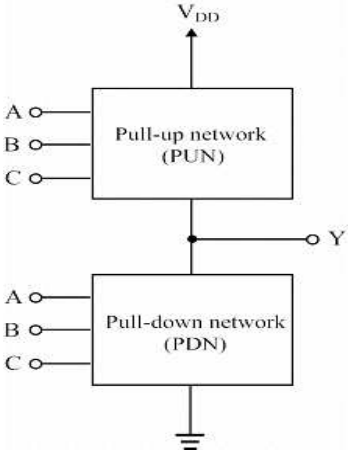

Figure 4: Figure for question 4.