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

Principles of Electronics Design 521431A
Exam 06/16/2007

—

1. Assume that the operational amplifier (OPA) shown in figure 1 is ideal and $R_1 = 2\,\mathrm{k\Omega}$, $R_2 = 10\,\mathrm{k\Omega}$, $R_3 = 2\,\mathrm{k\Omega}$, $C_1 = 1\,\mu\mathrm{F}$, $C_2 = 10\,\mathrm{nF}$.
   (a) What is the output impedance of an ideal OPA?
   (b) What is the gain u_o/u_i?
   (c) What is the overall gain in decibels if there is a $-6\,\mathrm{dB}$ attenuator after OPA?
   (d) Does the capacitor C_2 cause a lower or higher corner frequency?
   (e) What is the input impedance of the configuration?
   (f) How is it possible to make a non-inverting configuration from the configuration of figure 1?

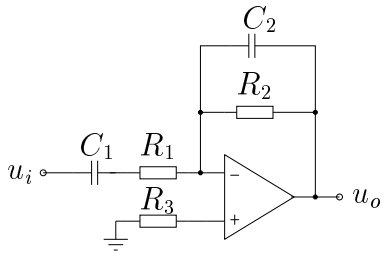

Figure 1: Figure for question 1.

2. What is the input and output impedance of the MOSFET amplifier in figure 2? Select the resistance R_1 and W/L ratio so that the gain $u_L/u_{src} > 10$. Transistor parameters: $\mu_n C_{ox} = 25\,\mathrm{uA/V^2}$, $\lambda = 0$ and $U_t = 2\,\mathrm{V}$. Capacitors C_1, C_2 and C_3 are high capacitance coupling capacitors. (6p)

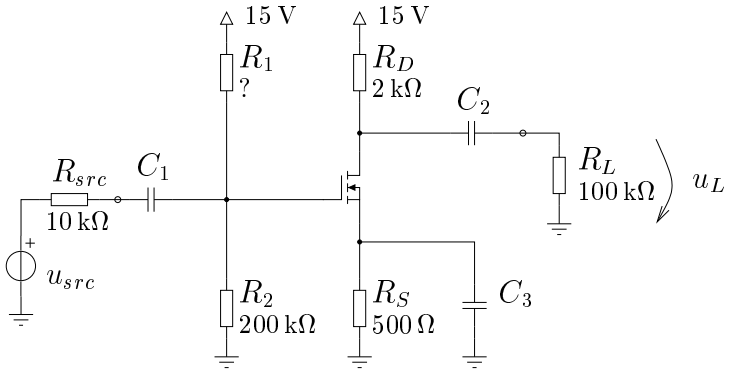

Figure 2: Figure for question 2.

$$i_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(u_{GS} - U_t)^2(1 + \lambda \cdot u_{DS})$$

$$g_m = \frac{\partial i_D}{\partial u_{GS}}|_{u_{GS}=U_{GS}} = \mu_n C_{ox}\frac{W}{L}(U_{GS} - U_t)$$

3. (a) Explain the basic structure of a BJ transistor. (1p)

   (b) What are the operating regions of a BJT and how are they utilized? (1p)

   (c) The basic laws and equations between the terminal currents and voltages of a BJT in the active region. (2p)

   (d) How does a BJT create gain in a circuit? (2p)

4. Draw the signals at nodes (1)-(10) shown in figure 3. The diode may be assumed ideal. (6p)

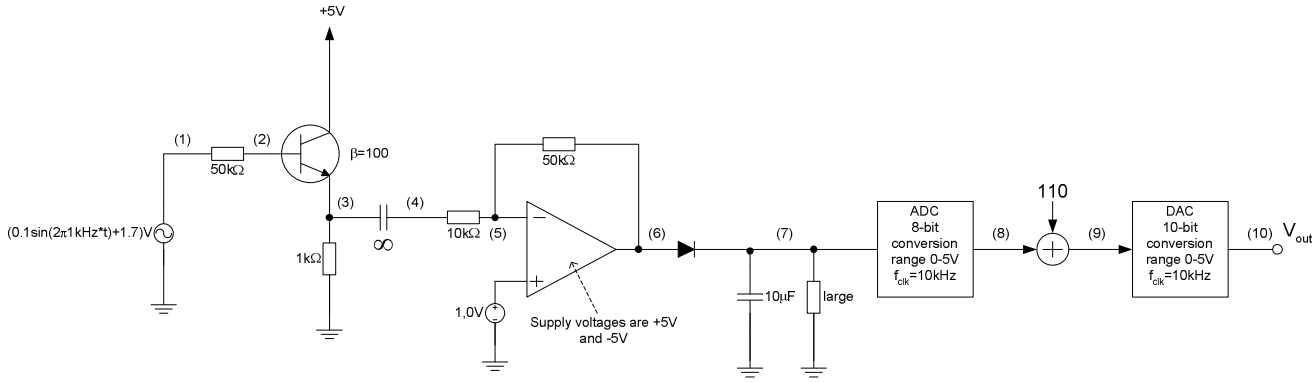

Figure 3: Figure for problem 4.