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

Principles of Electronics Design 521431A
Exam 12/18/2007

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1. Following questions are related to Fig. 1 and you can assume that $U_{BE} = 0{,}6\,\mathrm{V}$.
   (a) Find the gain of the operational amplifier configuration u_{opa}/u_{in} and the input impedance.
   (b) Find the gain of the emitter follower u_{out}/u_{opa} and the output impedance.
   (c) What is the total gain of the configuration u_{out}/u_{in}?
   (d) The input signal u_{in} is a sine-wave with amplitude of 10 mV, draw signals u_{opa} and u_{out} in the same figure.
   (e) How many decibels the output signal attenuates if 8 Ω load is connected to the output?

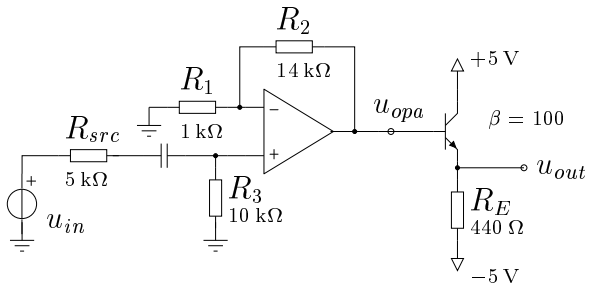

Figure 1: Figure for question 1.

2. Select component values for common source amplifier of Fig. 2 to meet the following specifications: $R_{out} = 1\,\mathrm{k\Omega}$, $R_{in} > 100\,\mathrm{k\Omega}$, $U_D = 4\,\mathrm{V}$, $u_{out}/u_{in} > 10$. Transistor parameters: $K_n = \frac{1}{2}\mu_n C_{ox}\frac{W}{L} = 2\,\mathrm{mA/V^2}$ and $U_t = 1\,\mathrm{V}$. Capacitors C_1, C_2 and C_3 are large coupling capacitors. (6p)

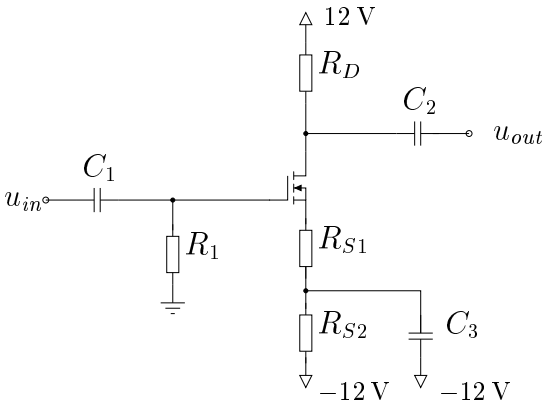

Figure 2: Figure for question 2.

$$i_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(u_{GS} - U_t)^2$$
$$g_m = \frac{\partial i_D}{\partial u_{GS}}|_{u_{GS}=U_{GS}} = \mu_n C_{ox}\frac{W}{L}(U_{GS} - U_t)$$

3. (a) Define the operation of a diode, biased both in forward- and reverse directions (voltage/current, temperature effect) either drawing the curve or using a formula and also using words. (2p)

   (b) Present the ideal model of a diode and define, what means and how you would calculate the value of the dynamic resistance of a diode. (2p)

   (c) How would you make a half-bridge rectifier using a diode? Draw the schematic diagram and explain its operation. (2p)

4. (a) Draw the schematic diagram and the transfer function of a CMOS inverter (using a curve V_{IN}-V_{OUT}) and explain the operation state of the transistors in the different parts of the curve. (2p)

   (b) On which basis and how would you calculate the sizes of the transistors of the CMOS inverter? (2p)

   (c) The schematic diagram of a double integral A/D-converter is presented in Figure 3. Define using words, how it works and draw the voltages in points $-V_S$, V_{ref} and V_x as a function of time. (2p)

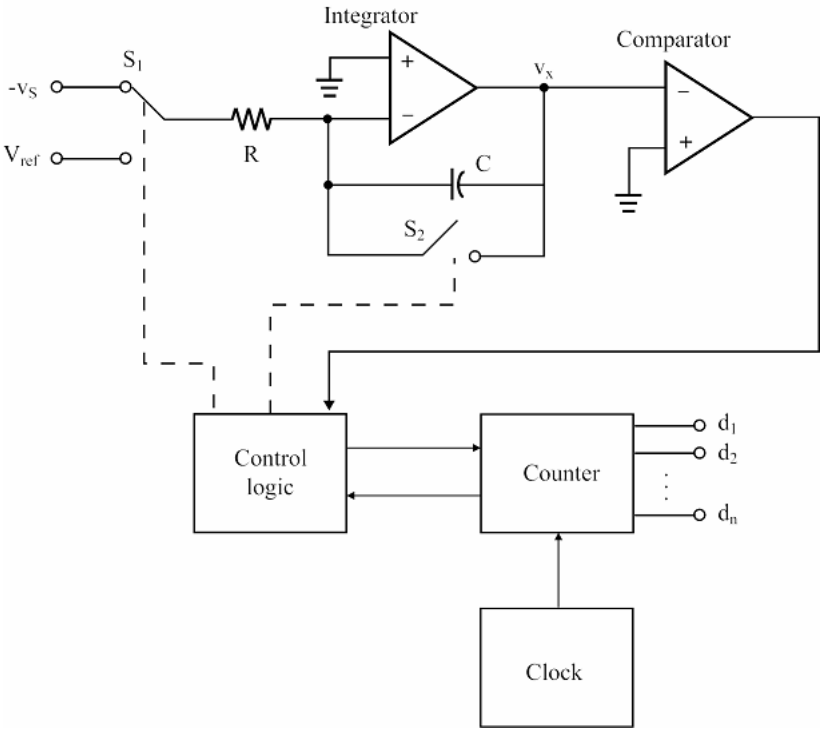

Figure 3: Figure for question 4.