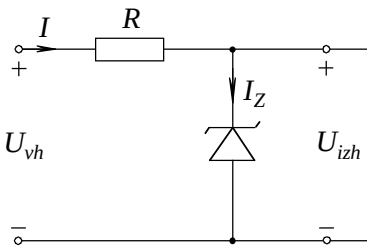
Written exam at the subject

SEMICONDUCTOR DEVICES
(ELEMENTI POLPREVODNIŠKE ELEKTRONIKE)

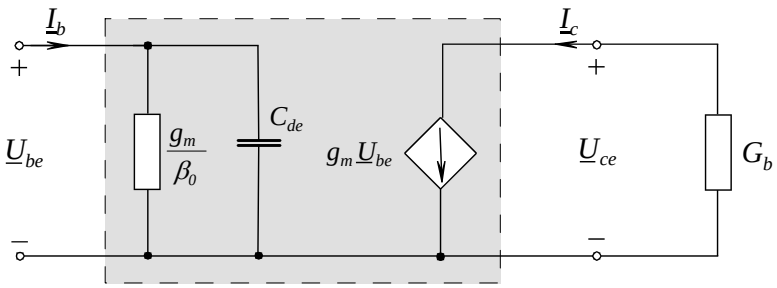
I[st] Bologna grade – 2[nd] year – Electronics – AE

26. 1. 2016

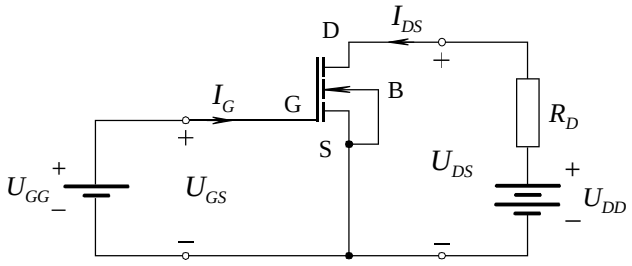
1. Determine semiconductor type for a sample/piece of crystalline Si, which contains homogeneously distributed acceptor impurities of the following concentration $N_A = 5\times10^{17}$ cm^{-3}. Calculate the energy difference (in eV) between the actual and intrinsic Fermi level and sketch energy band diagram. Calculate the specific conductivity of the sample.
   (Data: T = 300 K, μ_n = 1300 cm^2(Vs)$^{-1}$, μ_p = 450 cm^2(Vs)$^{-1}$).
   (Solution: **p-type**, U_T = 25,88 mV; $\boldsymbol{E_F - E_{Fi} = -0{,}459}$ **eV**; $\boldsymbol{\sigma = 36}$ **S/cm**)
2. In a simple voltage stabilizer in the picture below specify the value of the resistor R so that at the input voltage U_{vh} = 24 V the current through the diode equals I_Z = 10 mA. The diode has parameters U_{Z0} = 12 V and r_Z = 15 Ω. Take both parameters into account and determine the value of the output voltage U_{izh} for the given input voltage.



   (Solution: $\boldsymbol{R = 1185\ \Omega}$, $\boldsymbol{U_{izh} = 12{,}15}$ **V**)
3. Using the given model of a bipolar transistor at high frequencies, calculate the (absolute) value of the current gain of the transistor at the frequency f = 10 MHz.
   (Data: g_m = 40 mS, β_0 = 75, C_{de} = 6 pF).



   (Solution: $\boldsymbol{|\beta_f| = 61{,}2}$)
4. In the given circuit with a MOS transistor determine the resistance R_D so that the output voltage U_{DS} equals to half of the supply voltage U_{DD}. Draw the equivalent circuit for small signals, determine the parameter g_{21} and calculate the voltage gain of the circuit, which is defined as the ratio of small amplitude AC component of output to input voltage $A_u = u_{ds}/u_{gs}$.
   (Podatki: U_{DD} = 12 V, U_{GG} = 5 V, U_T = 3 V, $C_o\mu_n$ = 2 mAV^{-2}, W/L = 8)



   (Solution: saturation, I_D = 32 mA, $\boldsymbol{R_D = 188\ \Omega}$, $\boldsymbol{g_{21} = 32}$ **mS**, $\boldsymbol{A_u = -6}$)

You have 60 minutes, you are allowed to use the sheet with basic formulas and constants.
The results are expected to be communicated on tomorrow morning via e-mail.