Written exam at the subject

SEMICONDUCTOR DEVICES
(ELEMENTI POLPREVODNIŠKE ELEKTRONIKE)

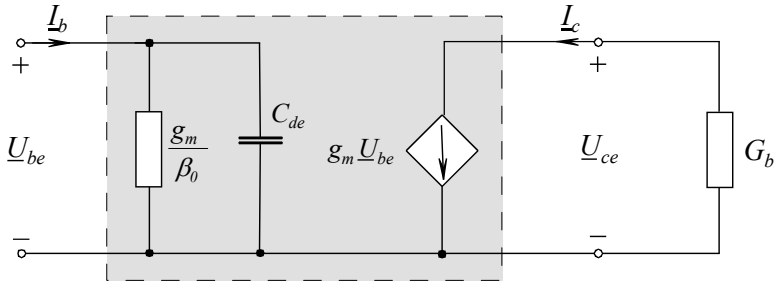
Ist Bologna grade – 2nd year – Electronics – AE

30. 1. 2017

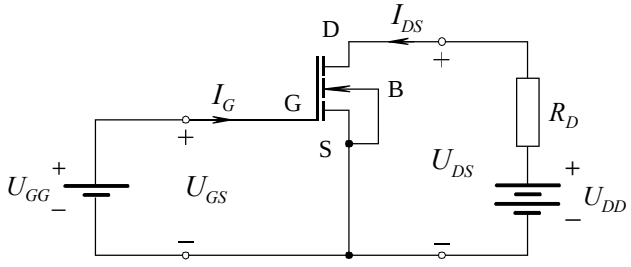
1. Homogeneously doped silicon block of *p*-type with cross-section A = 0,01 cm^2 and length L = 1 cm has resistance R = 40 Ω. Calculate concentration of acceptor impurities and draw energy band diagram. Calculate the energy difference (in eV) between the actual and intrinsic Fermi level.
   (Data: μ_n = 1250 cm^2(Vs)$^{-1}$, μ_p = 440 cm^2(Vs)$^{-1}$)
   (Solution: σ = 2,5 S/cm, $\boldsymbol{N_A = 3{,}55\cdot10^{16}}$ **cm**$^{-3}$, $\boldsymbol{E_{Fi}–E_F = 0{,}387}$ **eV**)

2. Deduce equation for value of differential resistance and calculate it in the operating point I = 1 mA.
   (Data: n = 1,6, U_T = 25,66 mV)
   (Solution: $\boldsymbol{r = n\cdot U_T/I}$, $\boldsymbol{r}$ = **41,1 Ω**)

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 = 20 MHz.
   (Transistor data: g_m = 20 mS, β_0 = 100, C_{de} = 4 pF).
   (Solution: $\boldsymbol{|\beta_f|}$ = **37,0**)



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 $A_u = u_{ds}/u_{gs}$.
   (Data: U_{DD} = 24 V, U_{GG} = 6 V, U_T = 3 V, $C_o\mu_n$ = 2 mAV^{-2}, W/L = 10)
   (Solution: saturation, I_D = 90 mA, $\boldsymbol{R_D}$ = **133 Ω**, $\boldsymbol{g_{21}}$ = **60 mS**, $\boldsymbol{A_u}$ = **–8**)



You have 60 minutes; you are allowed to use the sheet with basic formulas and constants.
The results are expected to be published on tomorrow morning in STUDIS.