The final exam of " Introduction to Electronics" on 29.05.2020

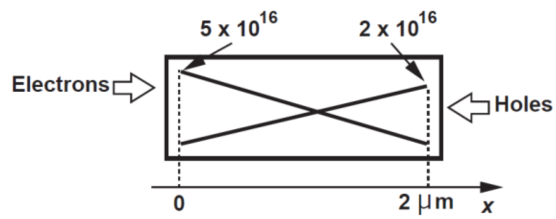
In the final exam we have only 6 questions similar to the following:

Student's name:

Student's ID No:

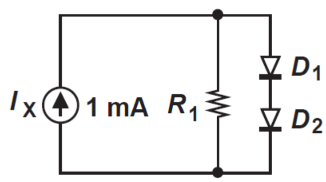
1. Fig. p1 shows a p-type bar of silicon that is subjected to electron injection from the left and hole injection from the right. Determine the total current flowing through the device if the cross-section area is equal to 1 µm × 1 µm.

Fig. p1



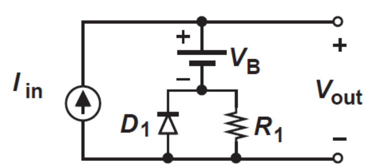
2. In the circuit of Fig. p2, determine the value of R_1 such that this resistor carries 0.5 mA. Assume $I_S = 5 \times 10^{-16}$ A for each diode.

Fig. p2



3. Plot V_{out} as a function of I_{in} for the circuits shown in Fig. p3. Assume a constant voltage diode model.

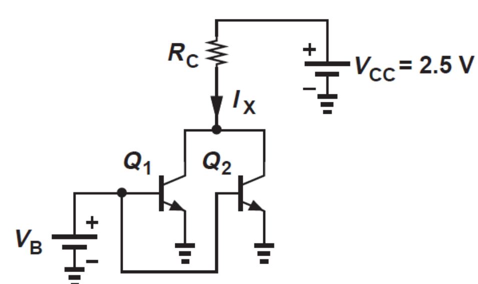
Fig. p3



4. A full-wave rectifier is driven by a sinusoidal input $V_{in} = V_0 \cos \omega t$, where $V_0 = 3$ V and $\omega = 2\pi(60\text{ Hz})$. Assuming $V_{D,on} = 800$ mV, determine the ripple amplitude with a 1000-µF smoothing capacitor and a load resistance of 30 Ω.

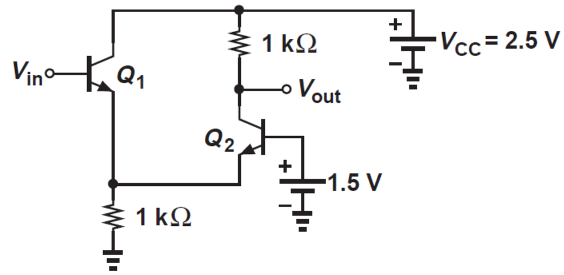
5. Consider the circuit shown in Fig. p5.
   (a) If $I_{S1} = 2I_{S2} = 5 \times 10^{-16}$ A, determine V_B such that $I_X = 1.2$ mA.
   (b) What value of R_C places the transistors at the edge of the active mode?

Fig. p5



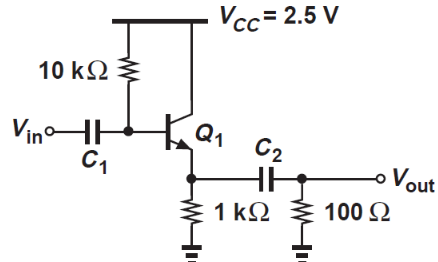
6. Plot the input/output characteristic of the stage shown in Fig. p6 for $0 < V_{in} < 2.5$ V. At what value of V_{in} do Q_1 and Q_2 carry equal collector currents?

Fig. p6



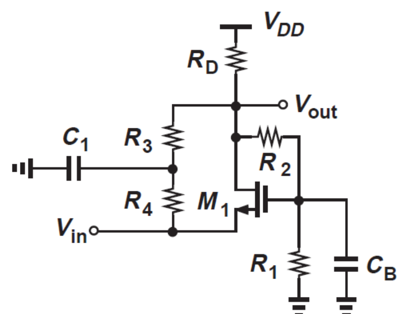
7. Determine the voltage gain of the follower depicted in Fig. p7. Assume $I_S = 7 \times 10^{-16}$ A, $\beta = 100$, and $V_A = 5$ V. (But for bias calculations, assume $V_A = \infty$.) Also, assume the capacitors are very large.

Fig. p7



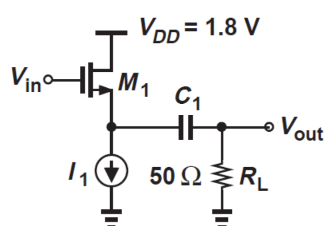
8. Calculate the voltage gain of the stage depicted in Fig. p8. Assume $\lambda = 0$ and the capacitors are very large.

Fig. p8



9. We wish to design the source follower of Fig. p9 for a voltage gain of 0.8 with a power budget of 3 mW. Compute the required value of W/L. Assume C_1 is very large and $\lambda = 0$.

Fig. p9



Wish you full success!

ε_{Si}=εr (Si) × ε_0=11.7× 8.85× 10^{-12} F/m, k= 1.38× 10^{-23} J/K, $D_n = 34\ \mathrm{cm^2/s}$, $D_p = 12\,\mathrm{cm^2/s}$,

$$I_{tot} = I_s(\exp\frac{V_F}{V_T} - 1) \qquad I_s = Aqn_i^{\,2}(\frac{D_n}{N_A L_n} + \frac{D_p}{N_D L_p})$$

$$V_0 = \frac{kT}{q}\ln\frac{N_A N_D}{n_i^2}.$$

$$C_j = \frac{C_{j0}}{\sqrt{1 - \frac{V_R}{V_0}}}, \qquad C_{j0} = \sqrt{\frac{\epsilon_{si} q}{2}\frac{N_A N_D}{N_A + N_D}\frac{1}{V_0}}, \qquad \frac{D}{\mu} = \frac{kT}{q}.$$

$$J_{tot} = q(\mu_n n + \mu_p p)E \qquad J_{tot} = q(D_n dn/dx - D_p dp/dx)$$

$$V_R \approx \frac{V_p - V_{D,on}}{R_L}\cdot\frac{T_{in}}{C_1} \approx \frac{V_p - V_{D,on}}{R_L C_1 f_{in}},$$

$$I_p \approx C_1\omega_{in}V_p\sqrt{\frac{2V_R}{V_p}} + \frac{V_p}{R_L} \approx \frac{V_p}{R_L}(R_L C_1 \omega_{in}\sqrt{\frac{2V_R}{V_p}} + 1)$$

$$I_C = \frac{A_E q D_n n_i^2}{N_E W_B}\left(\exp\frac{V_{BE}}{V_T} - 1\right)$$

$$I_C = I_S \exp\frac{V_{BE}}{V_T}$$

$$I_S = \frac{A_E q D_n n_i^2}{N_E W_B} \qquad r_O = \frac{V_A}{I_C}$$

$$V_{TH} = V_{TH0} + \rho\left(\sqrt{2\phi_F + V_{SB}} - \sqrt{2\phi_F}\right)$$

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left[2(V_{GS} - V_{TH})V_{DS} - V_{DS}^2\right]$$

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2(1 + \lambda V_{DS}), \qquad r_O = \frac{1}{\lambda I_D}$$

$$R_{on} = \frac{1}{\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})}.$$

$$g_m = \mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH}) \qquad g_m = \frac{2I_D}{V_{GS} - V_{TH}} \qquad g_m = \sqrt{2\mu_n C_{ox}\frac{W}{L}I_D}$$