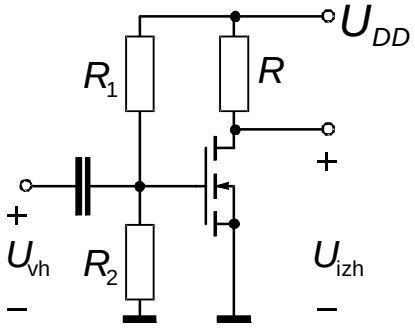
DIGITALNA TEHNIKA

2. kolokvij 13.06 2011

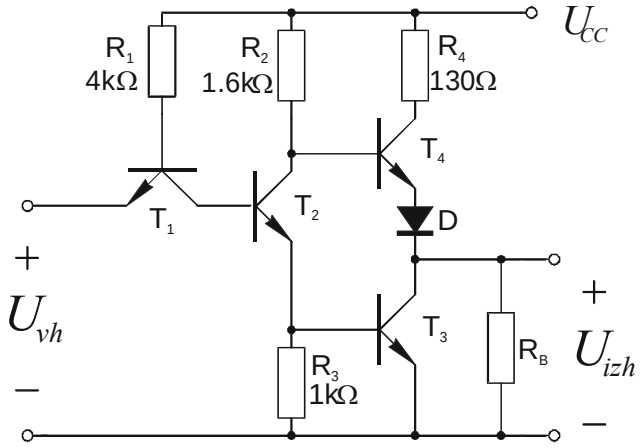
1. Določite bremenski upor R v podanem ojačevalniku z MOS tranzistorjem z induciranim kanalom, da bo napetost U_{DS} polovica napajalne napetosti U_{DD}.
Koliko znaša tedaj napetostno ojačenje A_U za majhne signale?

$U_T = 2$ V,
$K = 1\text{mA/V}^2$
$R_1 = 100$ kΩ
$R_2 = 43$ kΩ
$U_{DD} = 10$ V



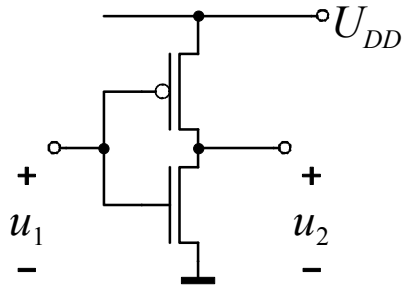
2. Izračunajte izhodno napetost logične enice U_{izh}, če je izhod TTL inverterja obremenjen z uporom $R_B = 100\Omega$. Ostali podatki vezja:

$U_{VH} = 0V$
$U_{CC} = 5V$
$U_{CEsat} = 0.2V$
$U_{BE0} = 0.7V$
$U_{BEsat} = 0.8V$
$U_D = 0.7V$



3. Določite napetost preklopa CMOS inverterja $U_{M.}$

$U_{TP} = -0.74$ V $U_{TN} = 0.74$ V
$k_P' = 27\ \mu\text{A/V}^2$ $k_N' = 80\ \mu\text{A/V}^2$
$(W/L)_P = 5.4/1.2$ $(W/L)_N = 1.8/1.2$
$U_{DD} = 5$V



4. Narišite realizacijo logične funkcije $Y = A + B \cdot \overline{C}$ v CMOS tehnologiji.
Pred realizacijo funkcijo poenostavite z uporabo pravil Booleove algebre.

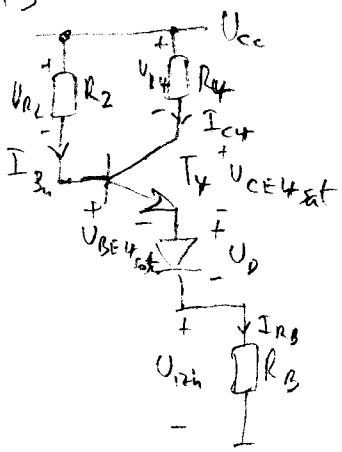
Čas pisanja je 60min. Vsaka naloga je vredna 10 točk. Na list z rešitvami se podpišite in napišite še vpisno številko ter kateri predmet pišete. Rezultati bodo objavljeni na https://estudent.fri.uni-lj.si

① $U_{DS} = \frac{U_{DD}}{2} = 5V$ $\quad U_{GS} = \frac{R_2}{R_1+R_2} U_{DD} = \frac{2}{14{,}3} \cdot 10V \doteq 3V$ $\quad I_D = \frac{k_N}{2}(U_{GS}-U_T)^2 = \frac{1mA/V}{2}(1V)^2 = 0{,}5mA$

$U_T = 2V$ $\quad U_{DS} > U_{GS} - U_T \rightarrow$ nasičenje $\quad U_R = \frac{U_{DD}}{2} \rightarrow R = \frac{U_R}{I_D} = \underline{10k\Omega}$

$A_U = -\frac{g_{21}}{g_{22}+G_B} = \underline{-5}$ $\quad g_{21} = \frac{\partial I_D}{\partial U_{GS}} = k_N(U_{GS}-U_T) = 0{,}5mS$; $g_{22} = 0$; $G_B = 0{,}1mS$

② $T_2, T_3 \rightarrow$ zaprt $\quad T_4 \rightarrow$ odprt (nasičenje)



$U_{R2} + U_{BE4sat} + U_D + U_{R2} = U_{DD}$

$U_{R2} + U_D + U_{CE4sat} + U_{R4} = U_{DD}$

$I_{B4} = \frac{U_{R2}}{R_2}$; $I_{C4} = \frac{U_{R4}}{R_4}$ $\quad I_{E4} = I_{B4} + I_{C4} = I_{RB}$

$\frac{U_{R2}}{R_2} + \frac{U_{R4}}{R_4} = \frac{U_{R2}}{R_B}$

$\frac{U_{CC} - (U_{BE4sat} + U_D + U_{R2})}{R_2} + \frac{U_{CC} - (U_{R2} + U_D + U_{CE4sat})}{R_4} = \frac{U_{R2}}{R_B}$

$\frac{(5 - 0{,}8 - 0{,}7)V}{1{,}6k\Omega} + \frac{5 - 0{,}2 - 0{,}2V}{18\Omega} = \frac{U_{R2}}{100\Omega} + \frac{U_{R2}}{11{,}6k\Omega} + \frac{U_{R2}}{12\Omega} \rightarrow U_{R2} = \underline{1{,}84V}$

③ $U_H = \frac{r(U_{DD} - |U_{TP}|) + U_{TN}}{r+1}$; $r = \sqrt{\frac{k_P}{k_N}} = \sqrt{\frac{k_P' \cdot \frac{W}{L}_P}{k_N' \cdot \frac{W}{L}_N}} = 1{,}01 \rightarrow U_H = \underline{2{,}51V}$

④ $Y = A + B\bar{C}$

$\bar{Y} = A + B\bar{C} \rightarrow \bar{Y} = \bar{A} + B\bar{C} = \bar{A}(\bar{B}\bar{C}) = \bar{A} \cdot (\bar{B} + C)$

