RAČUNARSKI HARDVER

MAGISTRALE I PORTOVI. VJEŽBE

ZADATAK 1

Ako je na jednu USB 3.0 sabirnicu priključeno 5 uređaja, kolika je brzina prenosa podataka *DR* (*data rate*) svakog od uređaja?

ZADATAK 1

$$DR_{USB3.0} = 625\ \text{MB/s}$$

$$DR = \frac{DR_{USB3.0}}{5} = \frac{625\ \text{MB/s}}{5} = 125\ \text{MB/s}$$

ZADATAK 2

Koliko se najviše uređaja n_{max} može priključiti na jednu USB 3.0 sabirnicu tako da je brzina prenosa podataka svakog od uređaja veća od DR_{min}=10 MB/s?

ZADATAK 2

$$DR_{min} = \frac{DR_{USB\ 3.0}}{n_{max}} \Rightarrow n_{max} = \frac{DR_{USB\ 3.0}}{DR_{min}} = \frac{625\ \mathrm{MB/s}}{10\ \mathrm{MB/s}}$$

$$= 62.5$$

$$\Rightarrow n_{max} = 62$$

ZADATAK 3

Kolika je dužina L provodnog kabla od bakra ako je njegova vremenska konstanta τ=1 ns, prečnik njegovog kružnog poprečnog presjeka r=1 mm, kapacitivnost kabla po jedinici dužine c=470 pF/m, a specifična provodnost bakra ρ=1.7x10^{-8} Ωm?

ZADATAK 3

$$\tau = RC$$

$$R = \rho \frac{L}{S} = \rho \frac{L}{\left(\frac{r}{2}\right)^2 \pi} = \rho \frac{4L}{r^2 \pi}$$

$$C = cL$$

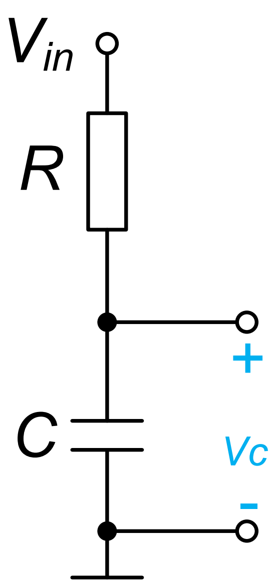
$$\tau = \rho c \frac{4L^2}{r^2 \pi} \Longrightarrow L = \sqrt{\frac{r^2 \pi \tau}{4 \rho c}}$$

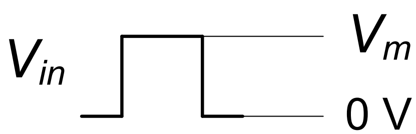
ZADATAK 3

$$L = \sqrt{\frac{r^2 \pi \tau}{4 \rho c}} = \frac{r}{2}\sqrt{\frac{\pi \tau}{\rho c}} =$$

$$= \frac{1 \cdot 10^{-3}\mathrm{m}}{2} \sqrt{\frac{\pi \cdot 1 \cdot 10^{-9} s}{1.7 \cdot 10^{-8} \Omega\mathrm{m} \cdot 470 \cdot 10^{-12} \mathrm{F/m}}} = 9.91\ \mathrm{m}$$

RISE-TIME I FALL-TIME





$$C\frac{dv_c(t)}{dt} = \frac{V_{in} - v_c(t)}{R}$$

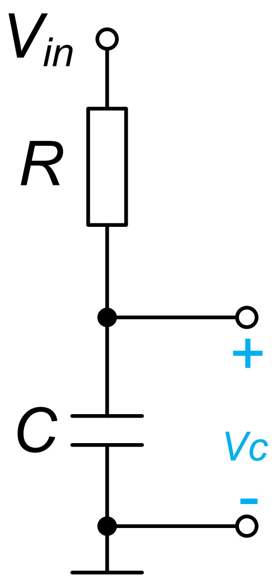
$$\frac{dv_c}{V_{in} - v_c} = \frac{1}{RC}dt$$

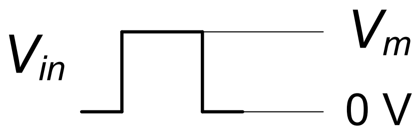
$$\int \frac{dv_c}{V_{in} - v_c} = \frac{1}{RC}\int dt$$

$$m = V_{in} - v_c$$

$$dm = -dv_c$$

RISE-TIME | FALL-TIME





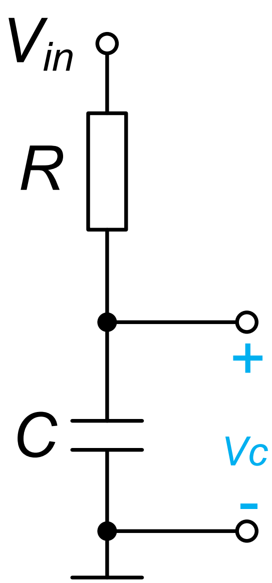
$$-\int \frac{dm}{m} = \frac{1}{RC}\int dt$$

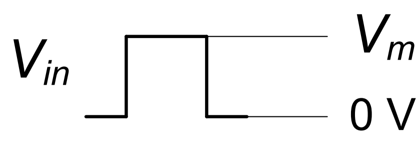
$$-ln(V_{in} - v_c) + A = \frac{1}{RC}t + B$$

$$V_{in} - v_c = e^{\frac{-t}{RC}} e^D$$

$$v_c = V_{in} - e^{\frac{-t}{RC}} e^D$$

RISE-TIME I FALL-TIME





$$v_c = V_{in} - e^{\frac{-t}{RC}} e^{D}$$

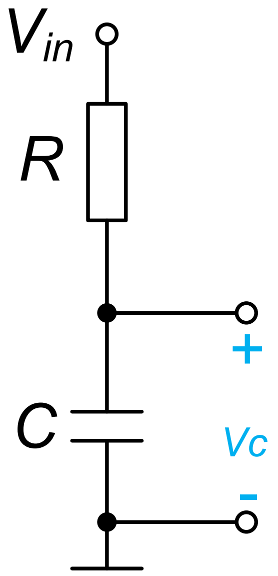
rastuća ivica

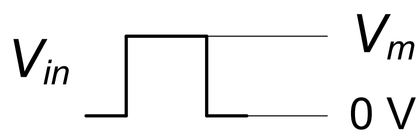
$$\left.\begin{aligned} v_c(0_-) &= 0 \\ v_c(0_+) &= V_m - e^{D} \end{aligned}\right\}$$

$$\Longrightarrow e^{D} = V_m$$

$$v_c = V_m - V_m e^{\frac{-t}{RC}} = V_m\left(1 - e^{\frac{-t}{RC}}\right)$$

RISE-TIME I FALL-TIME





$$v_c = V_m\left(1 - e^{\frac{-t}{RC}}\right)$$

rise-time

$$t_r = t_{90\%} - t_{10\%}$$

$$V_m\left(1 - e^{\frac{-t_{90\%}}{RC}}\right) = 0.9V_m$$

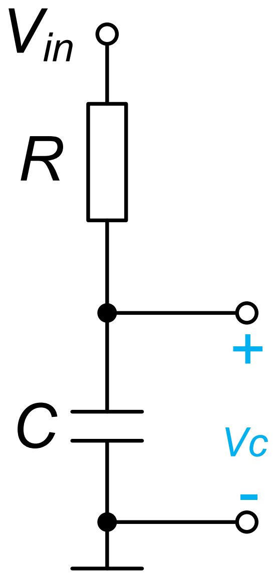
$$t_{90\%} = RCln10$$

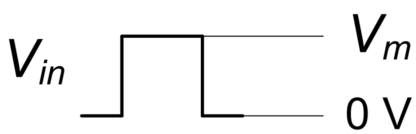
$$V_m\left(1 - e^{\frac{-t_{10\%}}{RC}}\right) = 0.1V_m$$

$$t_{10\%} = RCln\frac{10}{9}$$

$$t_r = RCln10 - RCln\frac{10}{9} = RCln9$$

RISE-TIME I FALL-TIME





$$v_c = V_{in} - e^{\frac{-t}{RC}} e^{D}$$

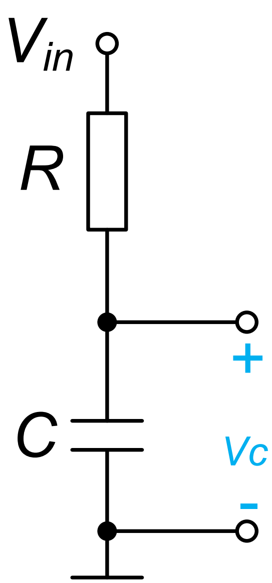
opadajuća ivica

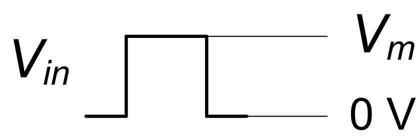
$$\left.\begin{aligned} v_c(0_-) &= V_m \\ v_c(0_+) &= -e^{D} \end{aligned}\right\}$$

$$\Longrightarrow e^{D} = -V_m$$

$$v_c = V_m e^{\frac{-t}{RC}}$$

RISE-TIME I FALL-TIME





$$v_c = V_m e^{\frac{-t}{RC}}$$

fall-time

$$t_f = t_{10\%} - t_{90\%}$$

$$V_m e^{\frac{-t_{90\%}}{RC}} = 0.9V_m$$

$$t_{90\%} = RCln\frac{10}{9}$$

$$V_m e^{\frac{-t_{10\%}}{RC}} = 0.1V_m$$

$$t_{10\%} = RCln10$$

$$t_f = RCln10 - RCln\frac{10}{9} = RCln9$$

ZADATAK 4

Izračunati maksimalnu frekvenciju pravougaonih impulsa kroz provodnik čija je vremenska konstanta $\tau = RC = 100$ ps, podrazumijevajući da su vrijeme porasta i vrijeme pada jednaki ($t_r = t_f$).

ZADATAK 4

$$f_{max} = \frac{1}{T_{min}} \approx \frac{1}{6t_f} = \frac{1}{6\tau ln9}$$

$$= \frac{1}{6 \cdot 100 \cdot 10^{-12}\mathrm{s} \cdot ln9} = 758.53\ \mathrm{MHz}$$

ZADATAK 5

Izračunati maksimalnu dužinu provodnog kabla od bakra tako da je moguće postći frekvenciju prenosa pravougaonih impulsa kroz taj kabal f=1 GHz. Poznato je: prečnik kružnog poprečnog presjeka kabla r=0.2 mm, kapacitivnost kabla po jedinici dužine c=250 pF/m, specifična provodnost bakra ρ=1.7x10^{-8} Ωm, vrijeme porasta i vrijeme pada su jednaki (t_r=t_f).

ZADATAK 5

$$f = \frac{1}{T} \approx \frac{1}{6t_f} = \frac{1}{6\tau ln9} = \frac{1}{6RCln9} = \frac{1}{6ln9\rho \frac{4L}{r^2\pi} cL}$$

$$= \frac{r^2\pi}{24ln9\rho cL^2} \Longrightarrow$$

ZADATAK 5

$$\Longrightarrow L = \sqrt{\frac{r^2\pi}{24ln9\rho cf}} =$$

$$= \sqrt{\frac{(0.2 \cdot 10^{-3}\ \mathrm{m})^2\pi}{24ln9 \cdot 1.7 \cdot 10^{-8}\Omega\mathrm{m} \cdot 250 \cdot 10^{-12}\ \mathrm{F/m} \cdot 10^{9}\mathrm{Hz}}} =$$

$$= 74.88\ \mathrm{cm}$$