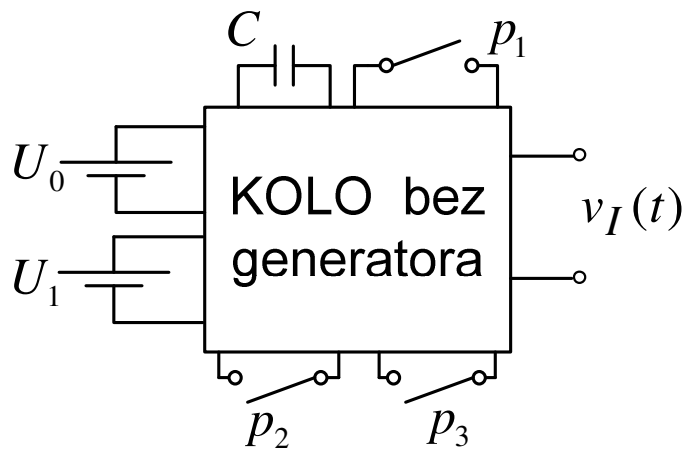


Kola sa komutacijom prekidača

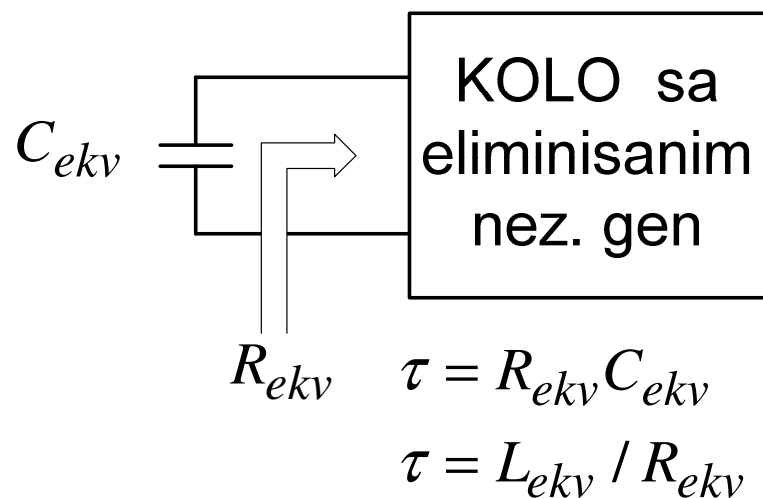
- Prekidači:
 - Tranzistori
 - Diode
- Jedan kondenzator
- U reencima $t_1, t_2, t_3, t_4, \dots$ dolazi do promene stanja prekidača



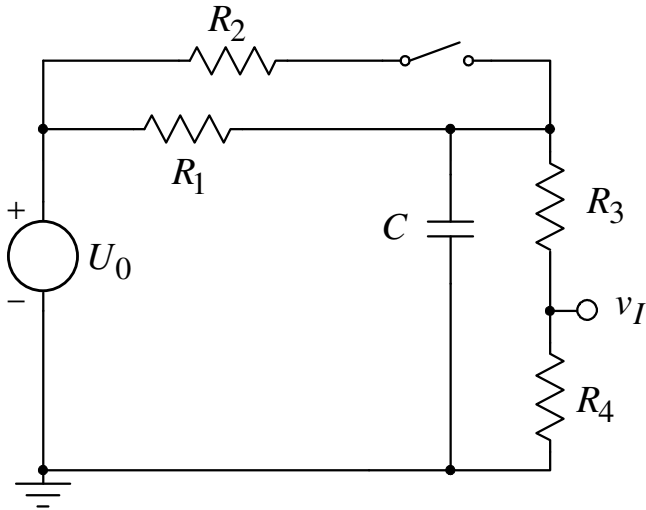
$$v_I(t) = \begin{cases} f_1(t), & t_1 < t < t_2 \\ f_2(t), & t_2 < t < t_3 \\ f_3(t), & t_3 < t < t_4 \\ \dots & \dots \end{cases}$$

Neka se u trenutku $t = 0^*$ zatvori prekidač. Potencijal u proizvoljnoj tački A kola (ili napr.struja proizvoljne grane) , za $t > 0$ se dobija preko formule

$$v_A(t) = v_A(\infty) + (v_A(0+) - v_A(\infty)) e^{-t/\tau}$$

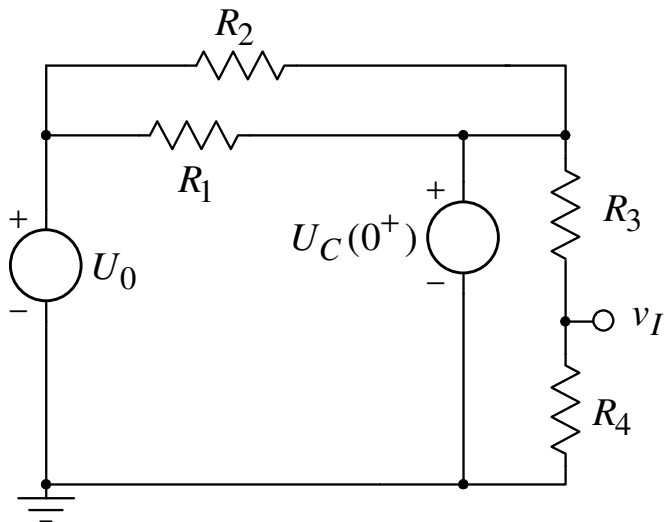


Primer:



$$v_I(t \in -\infty, 0^-) = \frac{R_4}{R_3 + R_4 + R_1} U_0$$

$$U_C(t \in -\infty, 0^-) = \frac{R_3 + R_4}{R_3 + R_4 + R_1} U_0$$



$$v_I(0^+) = v_I(t \in -\infty, 0^-) = \frac{R_4}{R_3 + R_4 + R_1} U_0$$

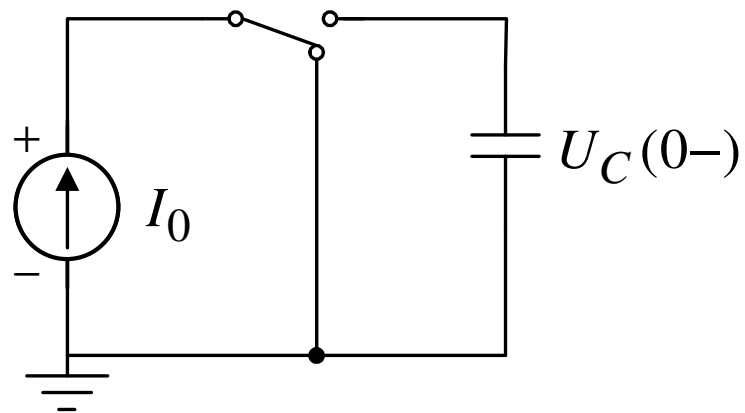
$$\tau = C((R_3 + R_4) \parallel R_1 \parallel R_2)$$

$$v_I(\infty) = \frac{R_4}{R_3 + R_4 + R_2 \parallel R_1} U_0$$

Algoritam za svaku promenu stanja prekidača

- Određivanje akumulisane energije u $t = 0^-$
- Određivanje traženog napona u $t = 0^+$
- nalaženje vremenske konstante
- određivanje asimptotske vrednosti napona u stacionarnom stanju

Ukoliko , jednosmerni strujni izvor puni kondenzator

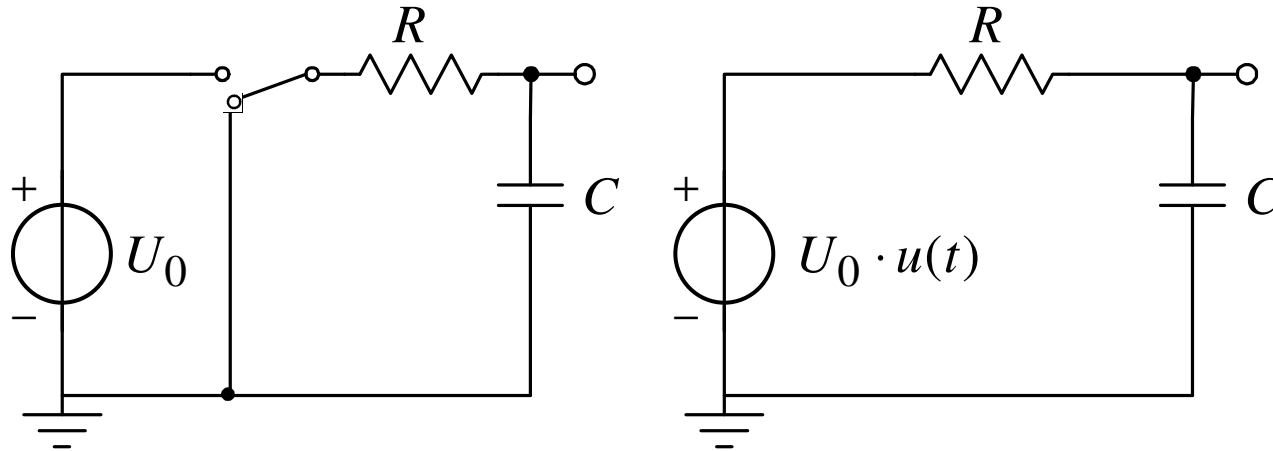


$$u_C(t) = U_C(0-) + \frac{I_0 \cdot t}{C}$$

linearna funkcija!

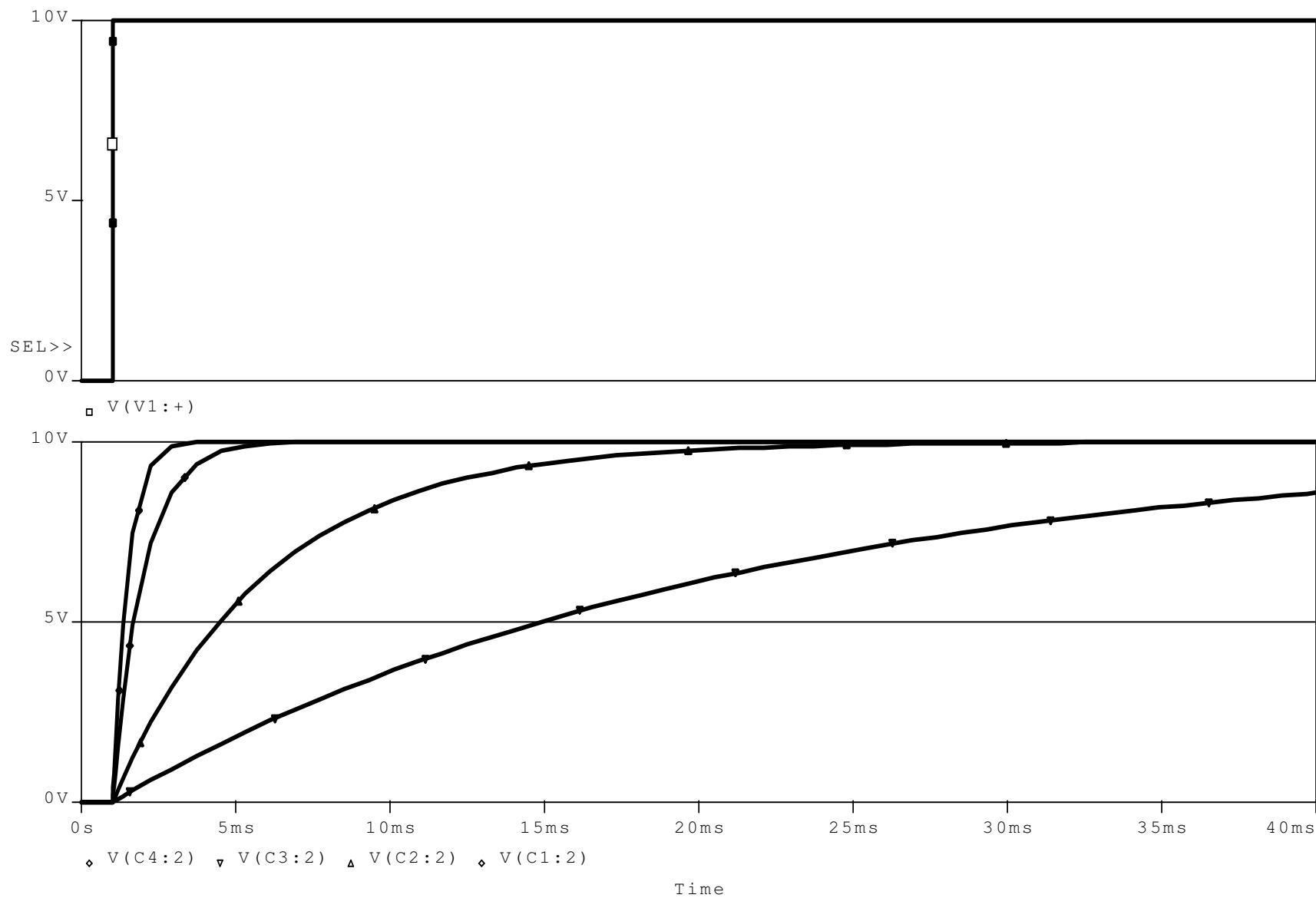
Standardna impulsna kola

RC integrator (RC niskopropusni filter):



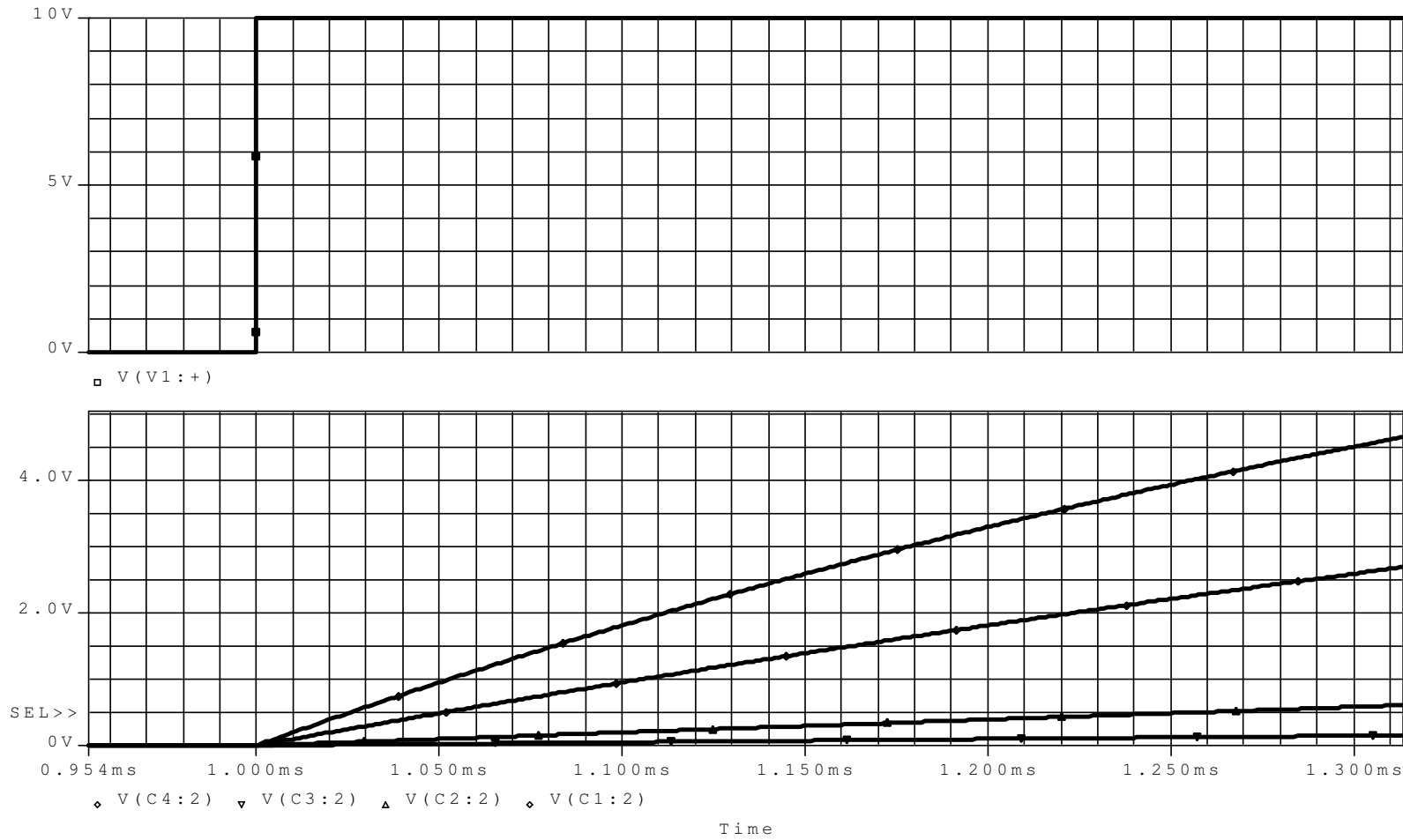
$$v(0+) = 0, v(\infty) = U_0, \tau = RC$$

$$v(t) = U_0(1 - e^{-t/RC})$$



Odziv za različite vremenske konstante $\tau=0.5\text{m}$, 1m , 5m , 20m .

Za malo t u odnosu na RC , \rightarrow integrator $v(t) = \frac{U_0 t}{RC}$



- 3τ -vreme potrebno da napon dostigne 95% konačne vrednosti
- 5τ -vreme potrebno da napon dostigne 99.3% konačne vrednosti

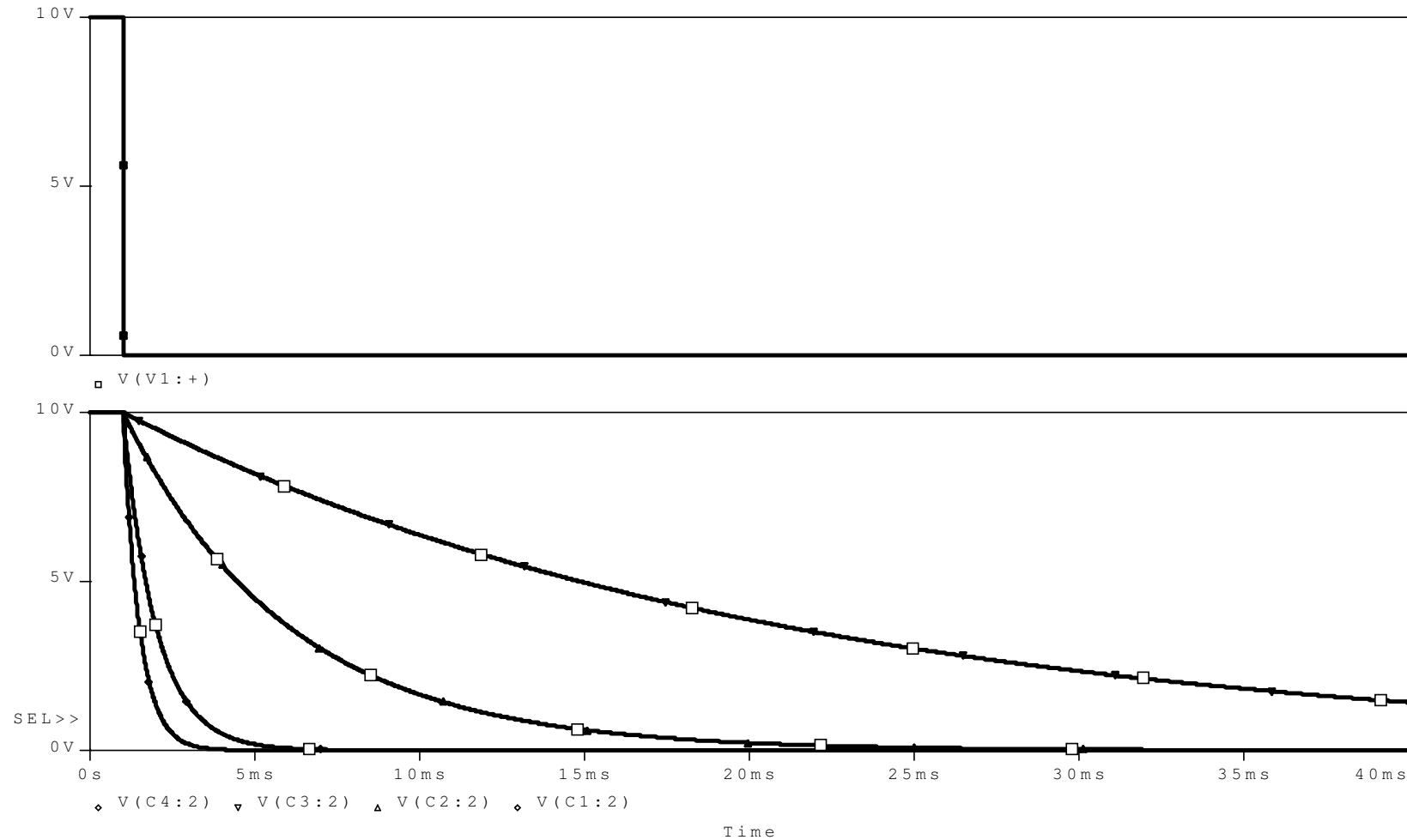
Vreme uspona se definiše kao vreme potrebno da se od 10% dostigne 90%

$$v(0+) = 0.1U_0, \quad v(\infty) = U_0, \quad v(\Delta t) = 0.9U_0$$

$$0.9U_0 = U_0 + (0.1U_0 - U_0)e^{-\Delta t/\tau}$$

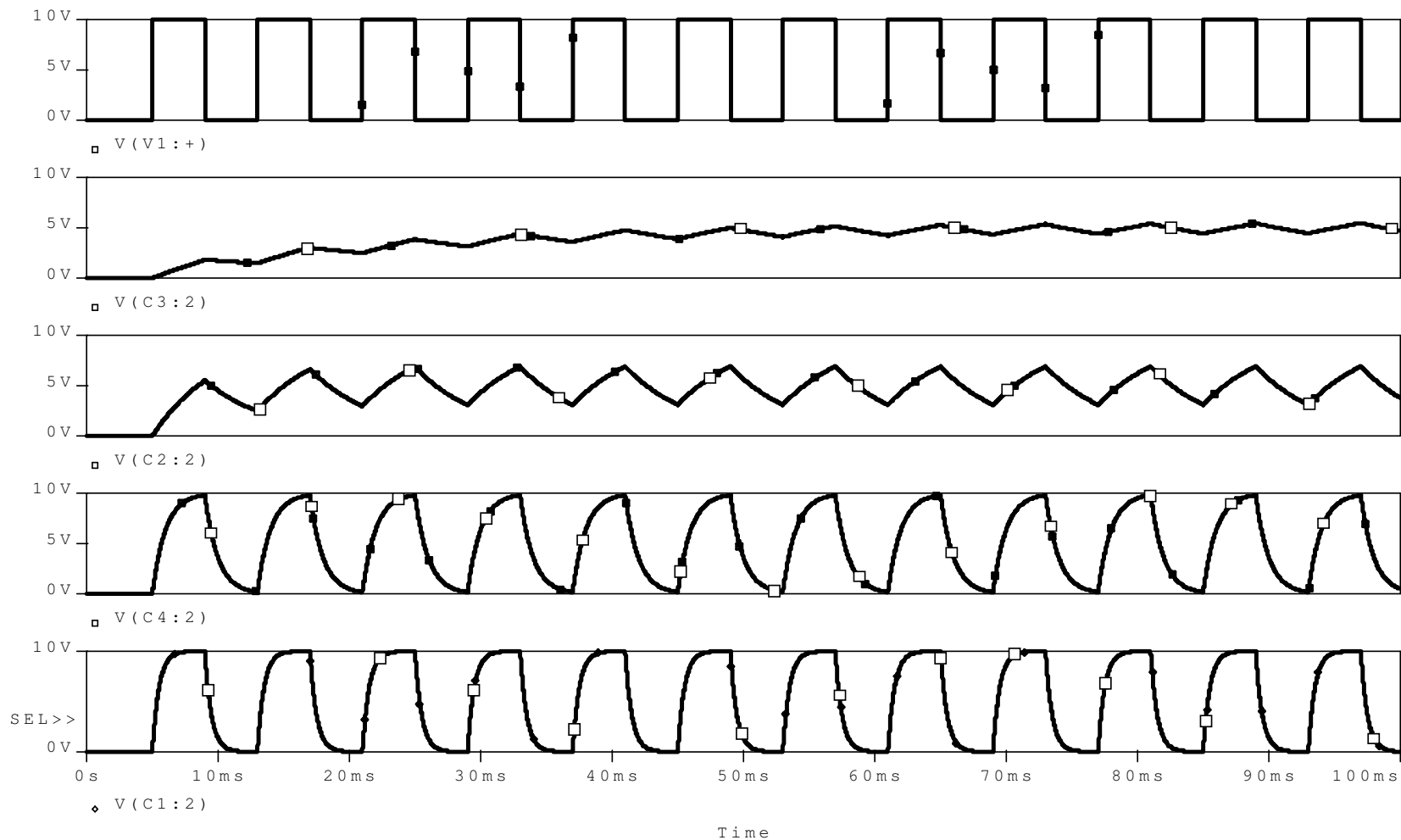
$$\Delta t = -\tau \ln \frac{0.9U_0 - U_0}{0.1U_0 - U_0} = \tau \ln 9 = 2.2\tau$$

Analogno tome, ako se dovodi silazna ivica:

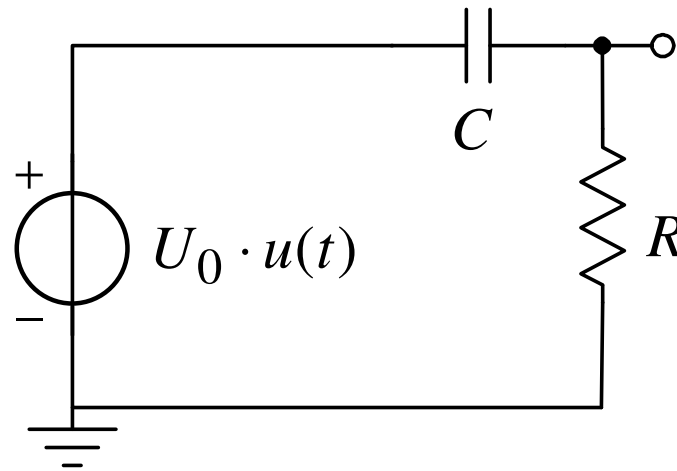


Vreme pada se definiše kao vreme potrebno da od 90% signal padne na 10% i iznosi 2.2τ .

Odziv na povorku impulsa:



RC diferencijator (RC visokopropusni filter):

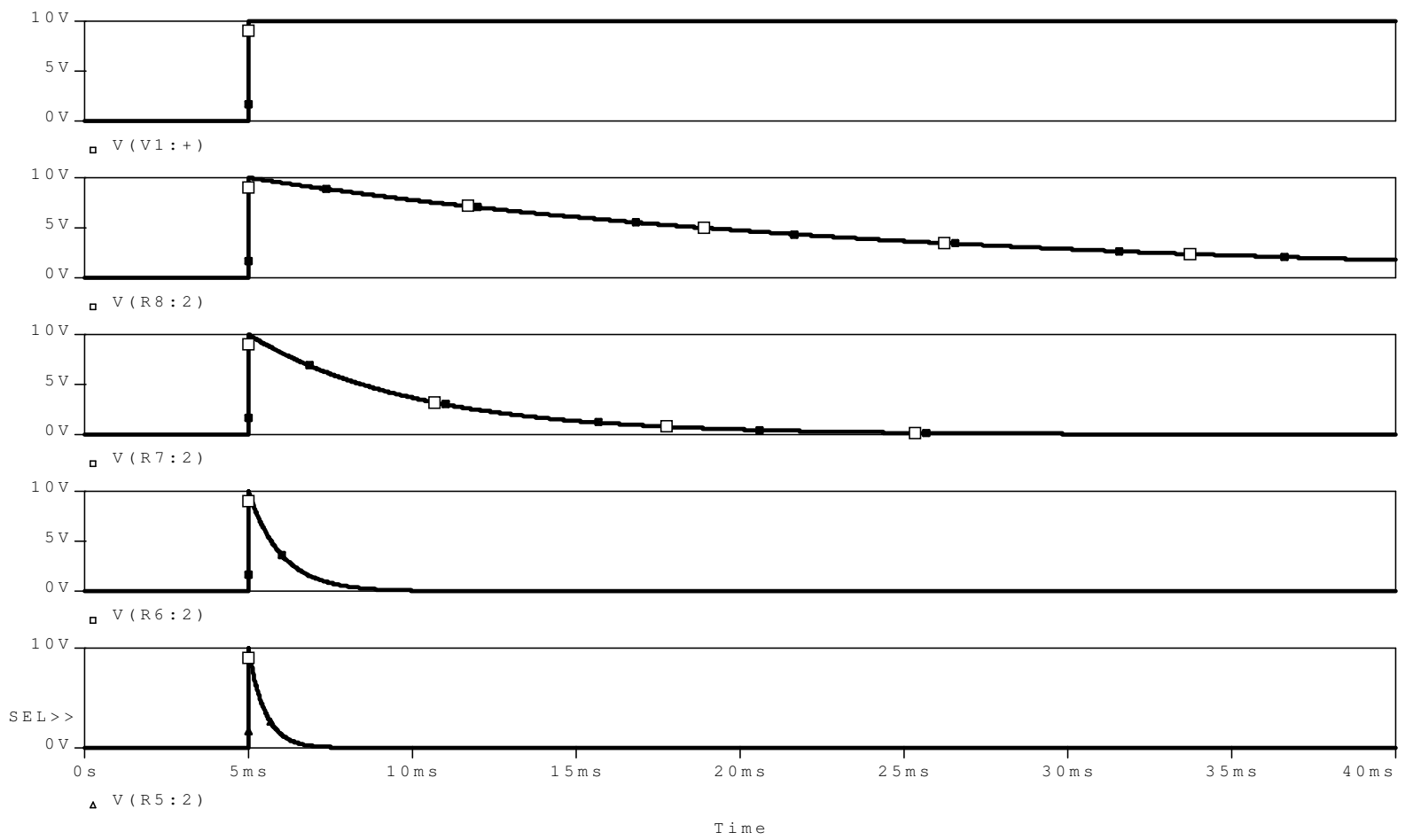


Za $t < 0$ kolo je u stacionarnom stanju,

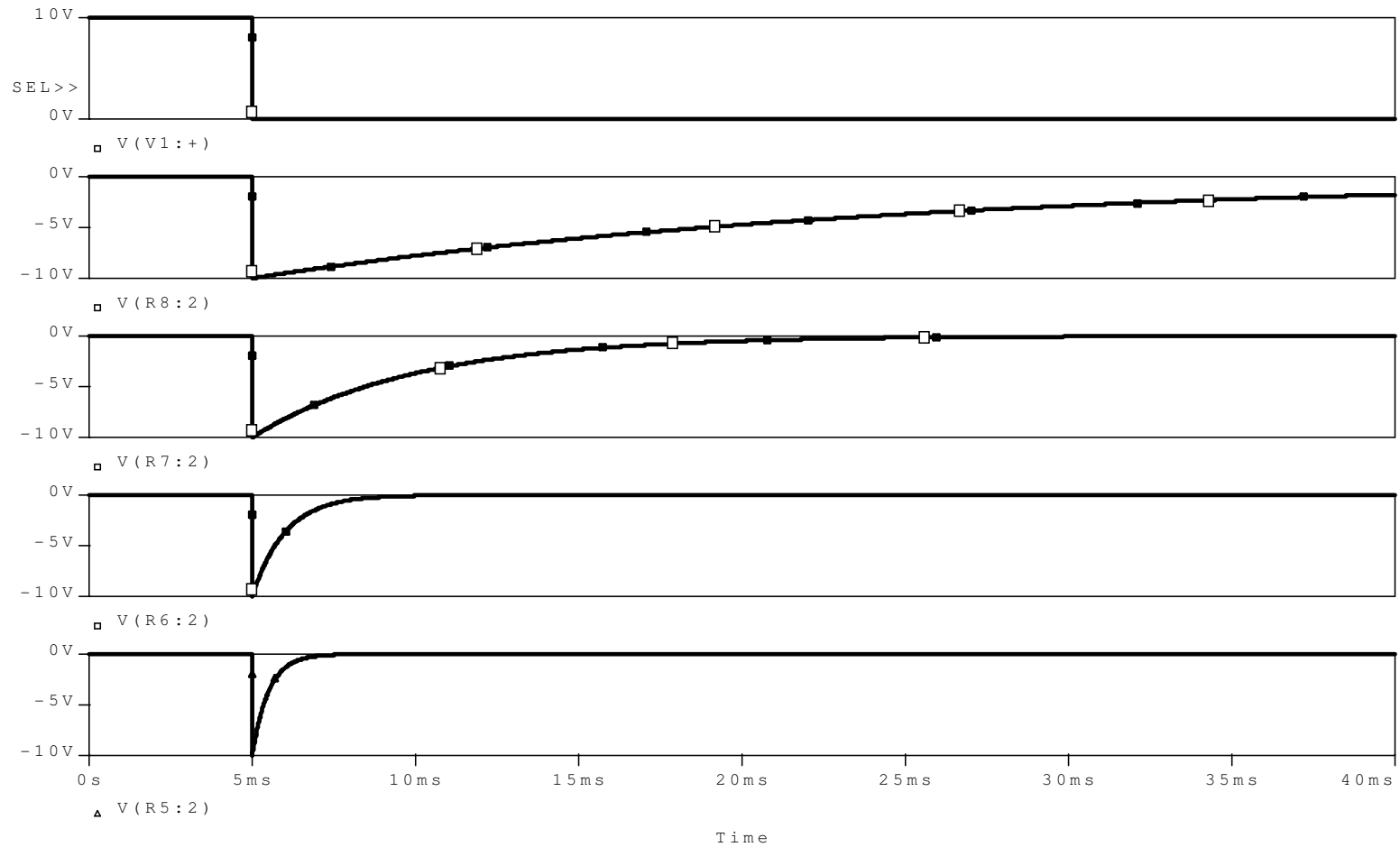
$$v_I(t < 0) = 0, \quad U_C(t < 0) = 0$$

$$v_I(0+) = v_u(0+) + U_C(0+) = U_0 + 0 = U_0$$

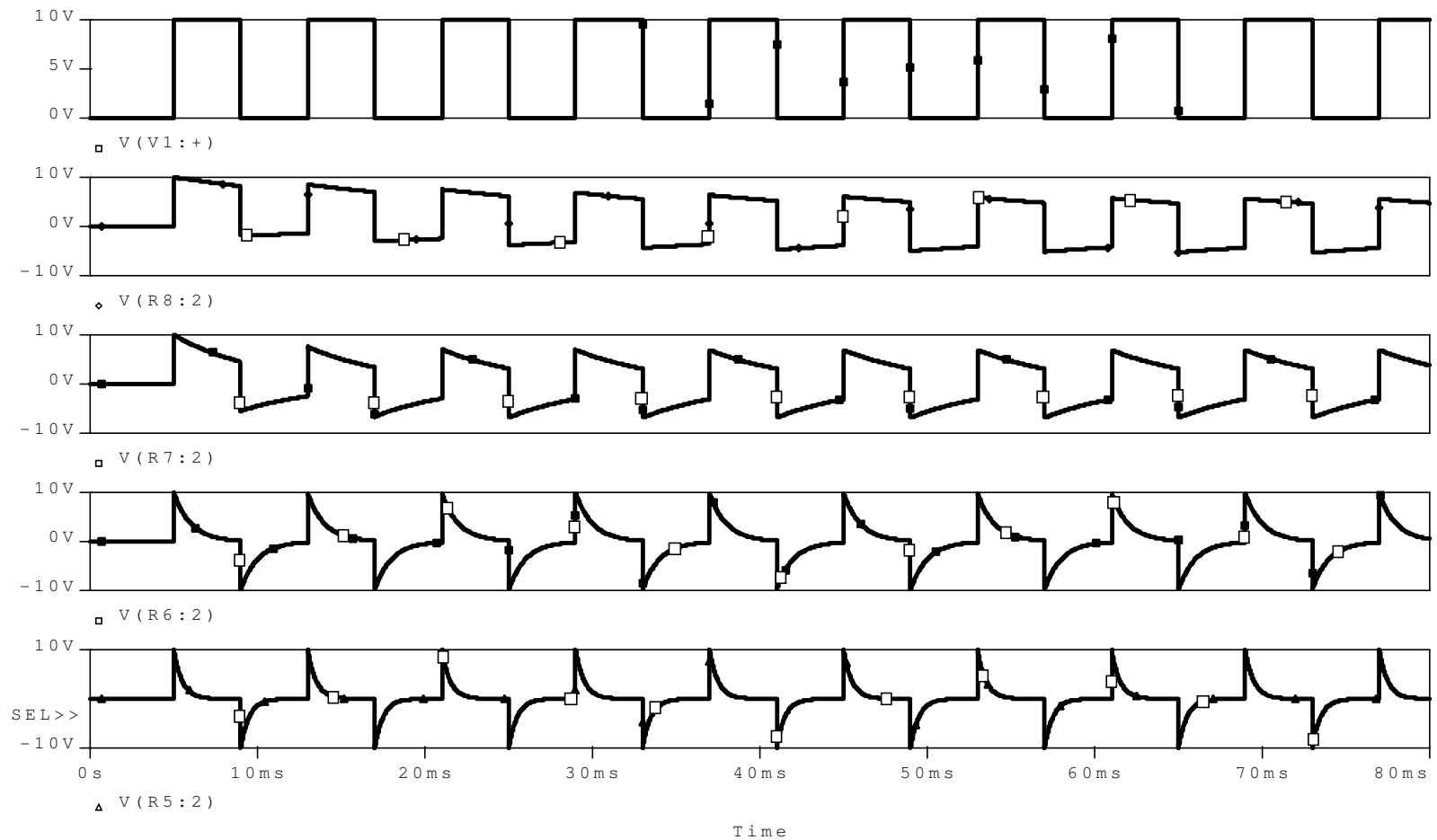
$$v_I(\infty) = 0, \quad \tau = RC \rightarrow v_I(t) = U_0 e^{-t/RC}$$



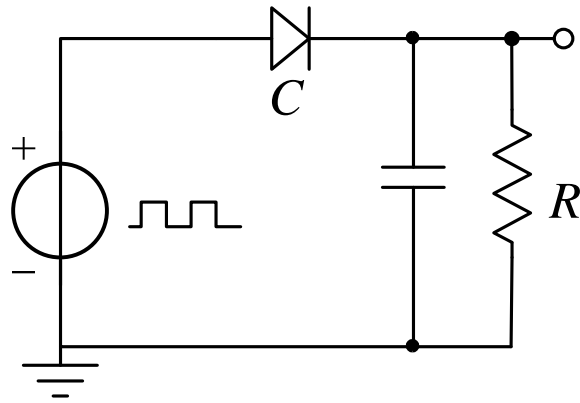
Ukoliko se dovede negativan Hevisajd*



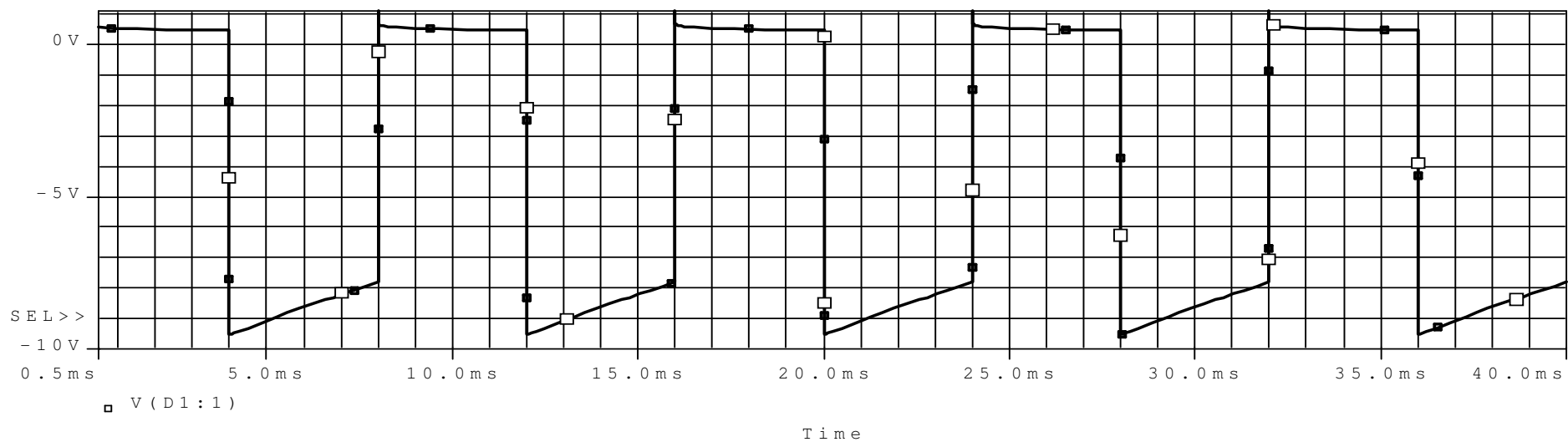
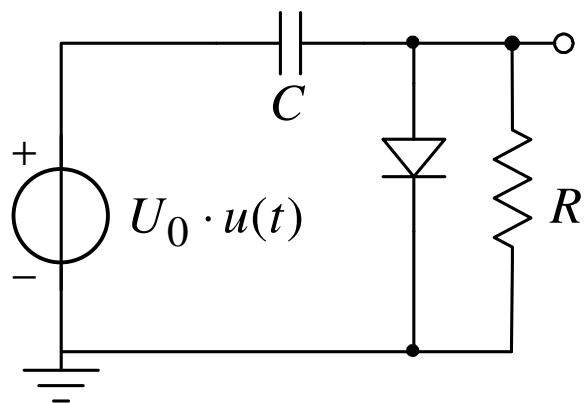
Odziv na povorku impulsa



Peak detektor

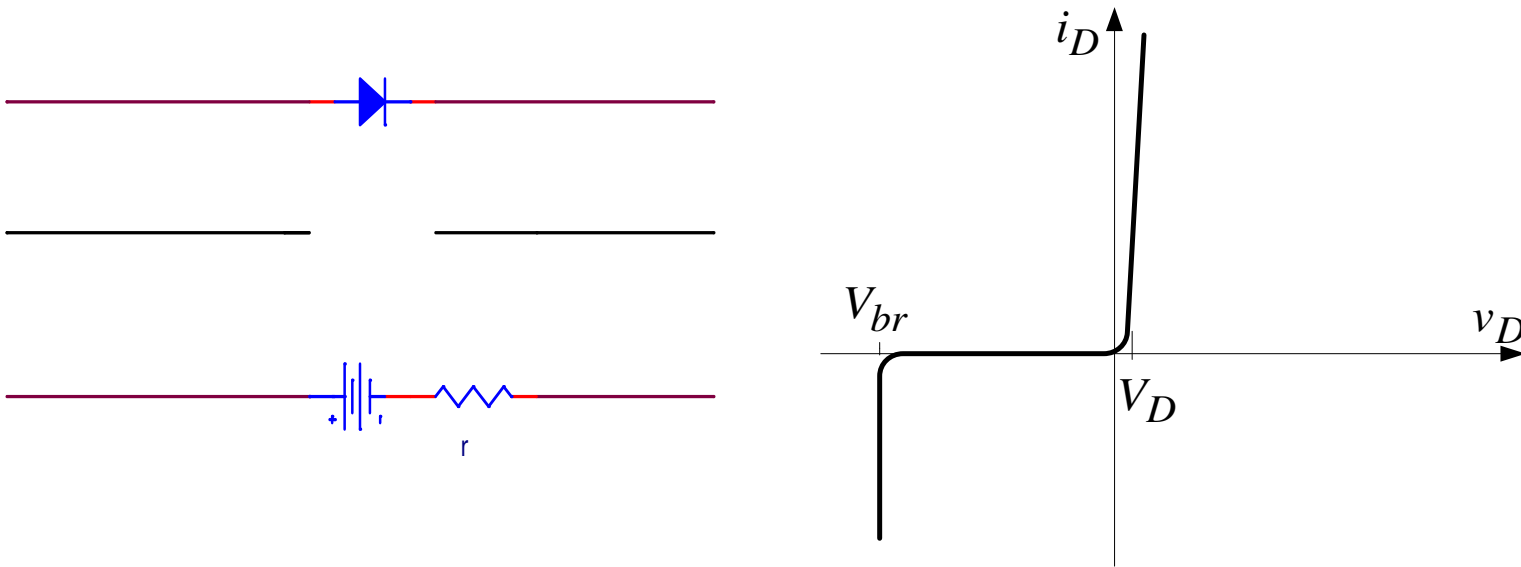


Uspostavljač nivoa



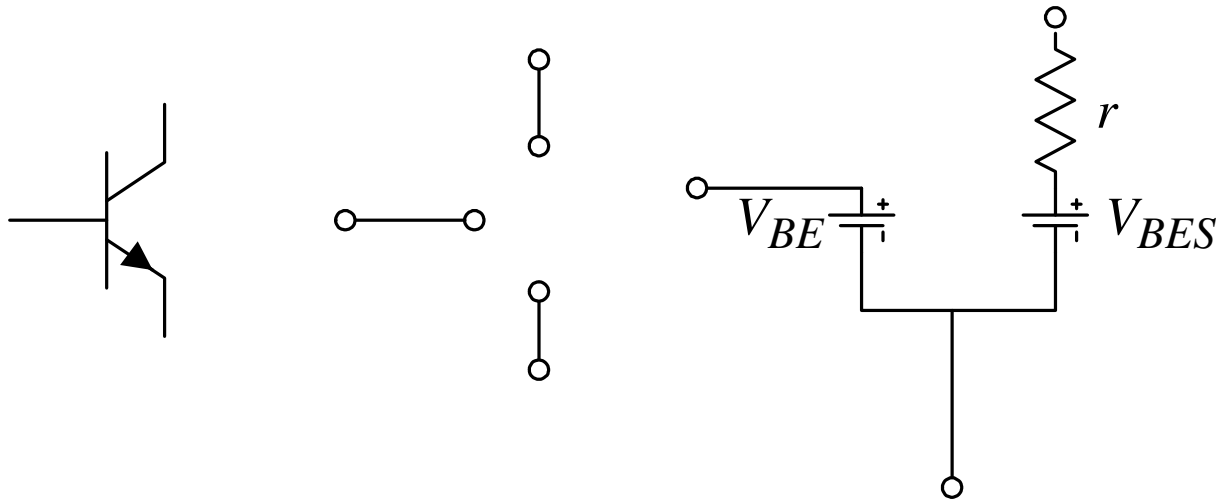
Statičné charakteristiky prekidača

Dioda



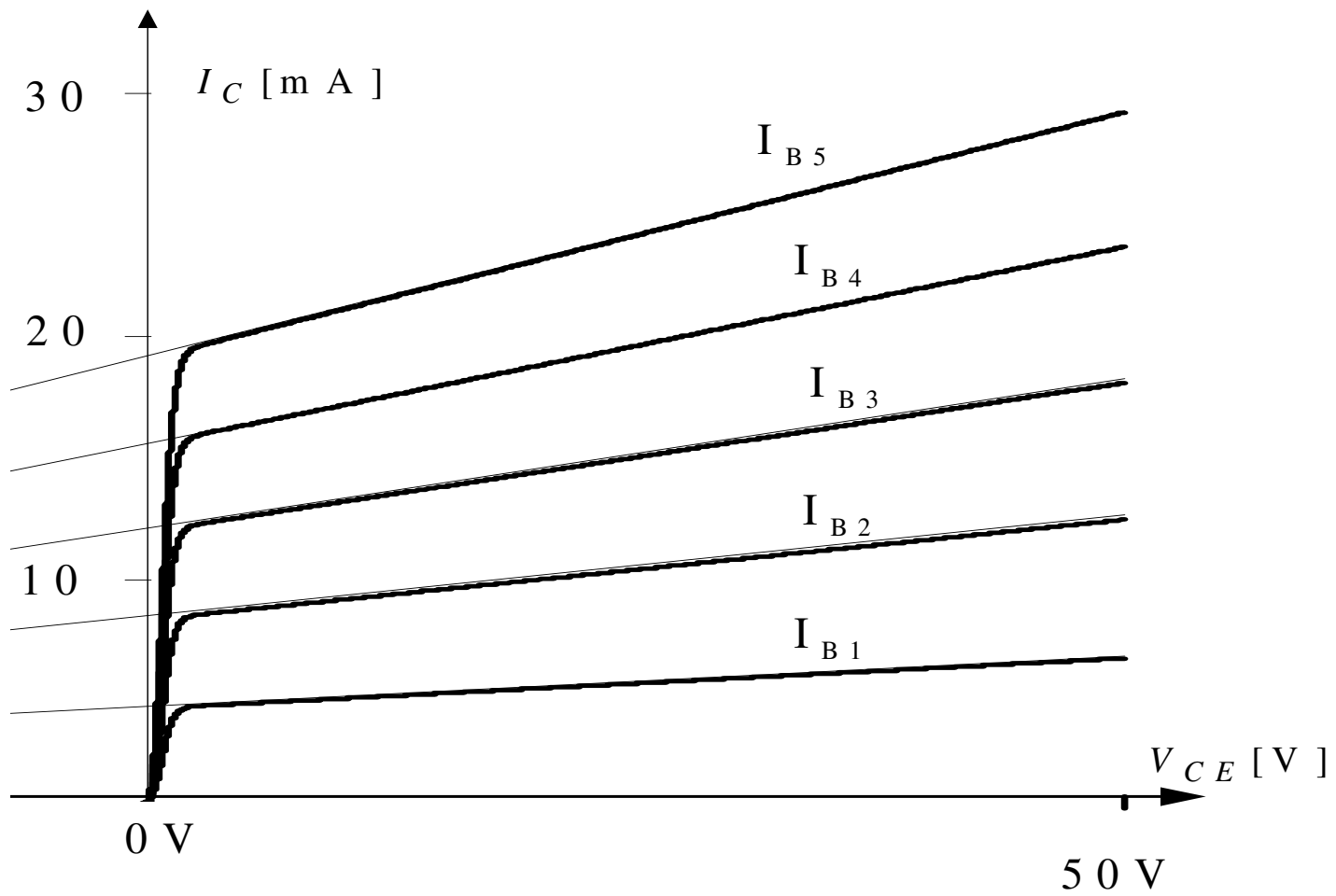
$$P_d < P_{d \max}, \quad v_D > V_{br}, \quad V_D \approx 0.6\text{V} (V_D \approx 0.2\text{V})$$

Bipolarni tranzistor

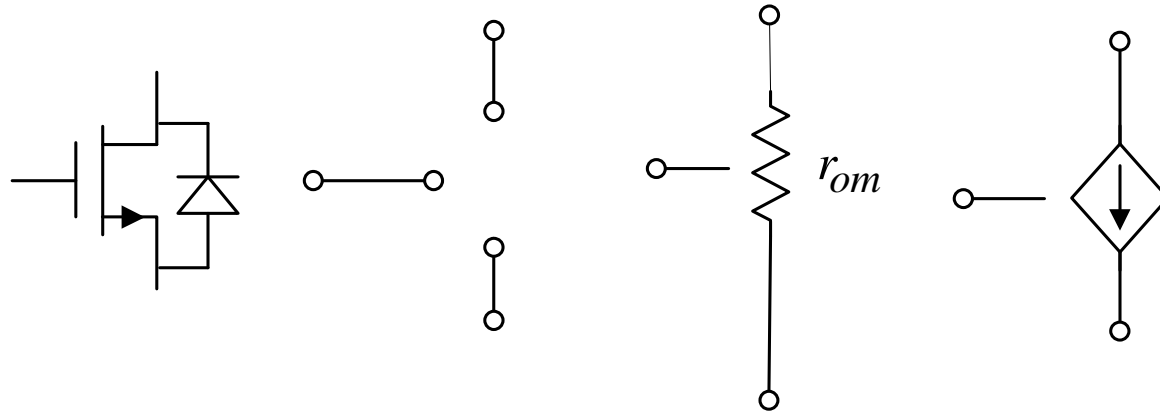


$$V_{BE} \approx 0.6\text{V}, \quad V_{BES} \approx 0.2\text{V} \quad (V_{BESsh} \approx V_{BEsh} - V_{Dsh})$$

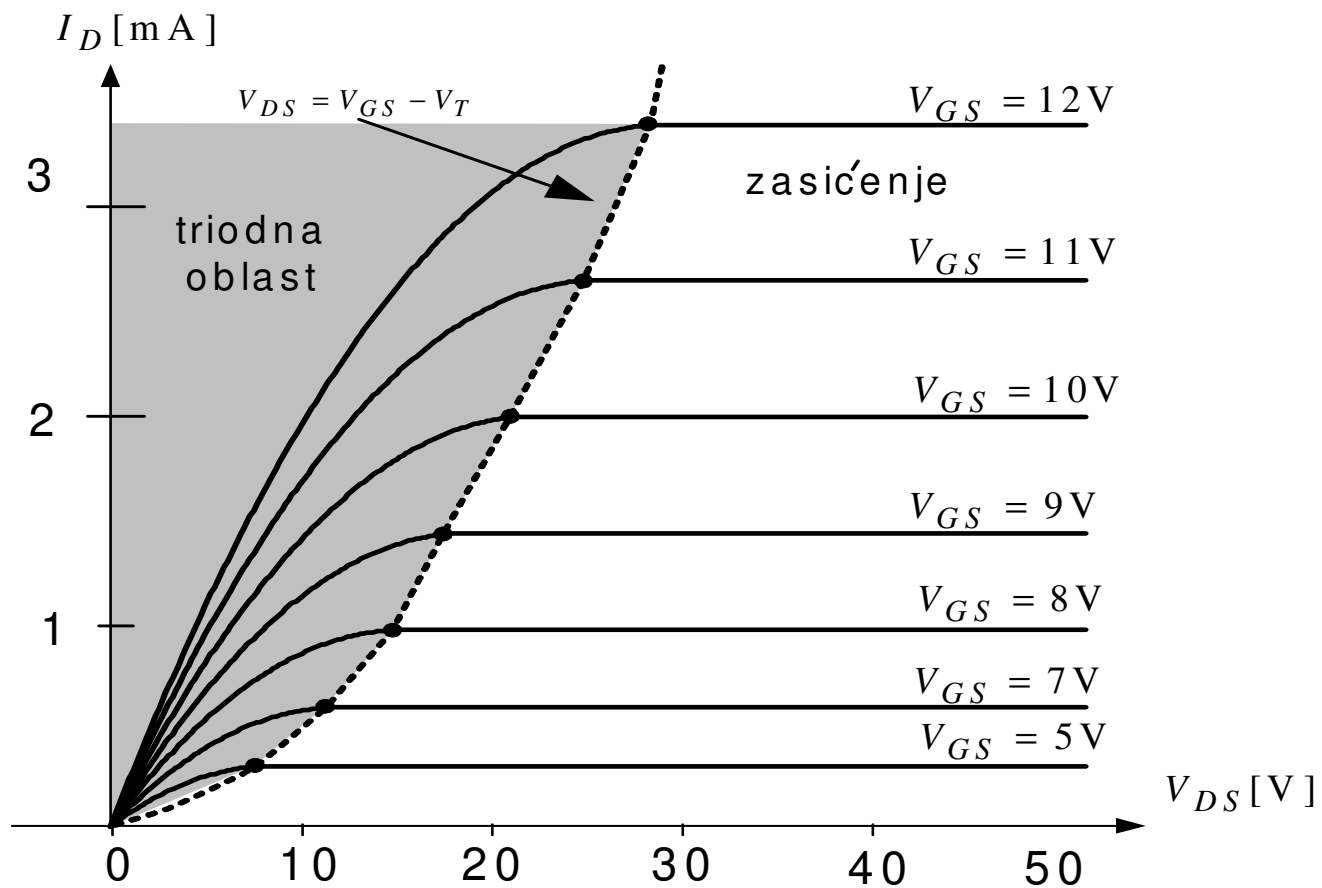
$$V_{CES} < V_{CE} < V_{br} \quad \approx 6\text{V} < V_{BE} \beta_F I_B > I_C$$

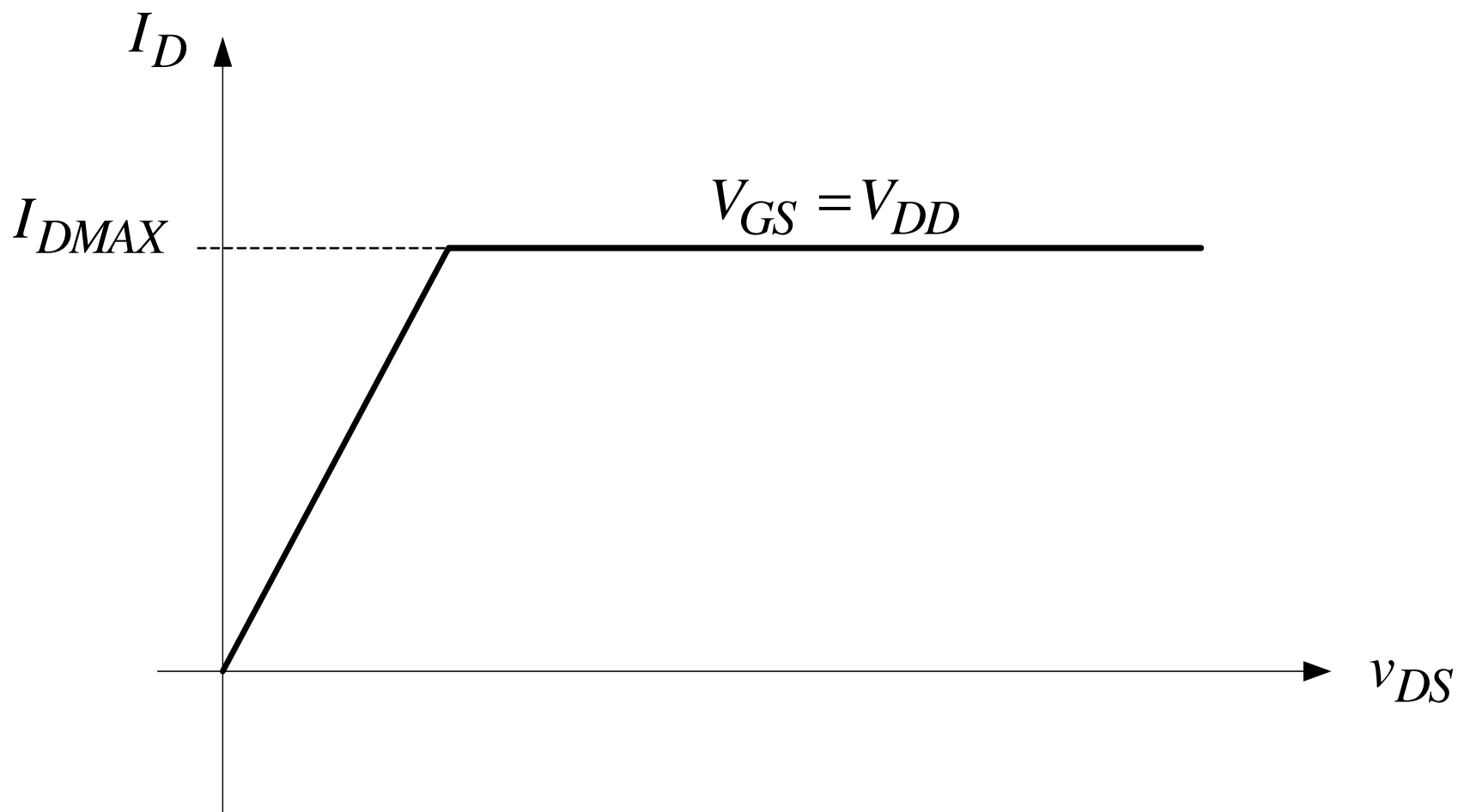


Mos transistor

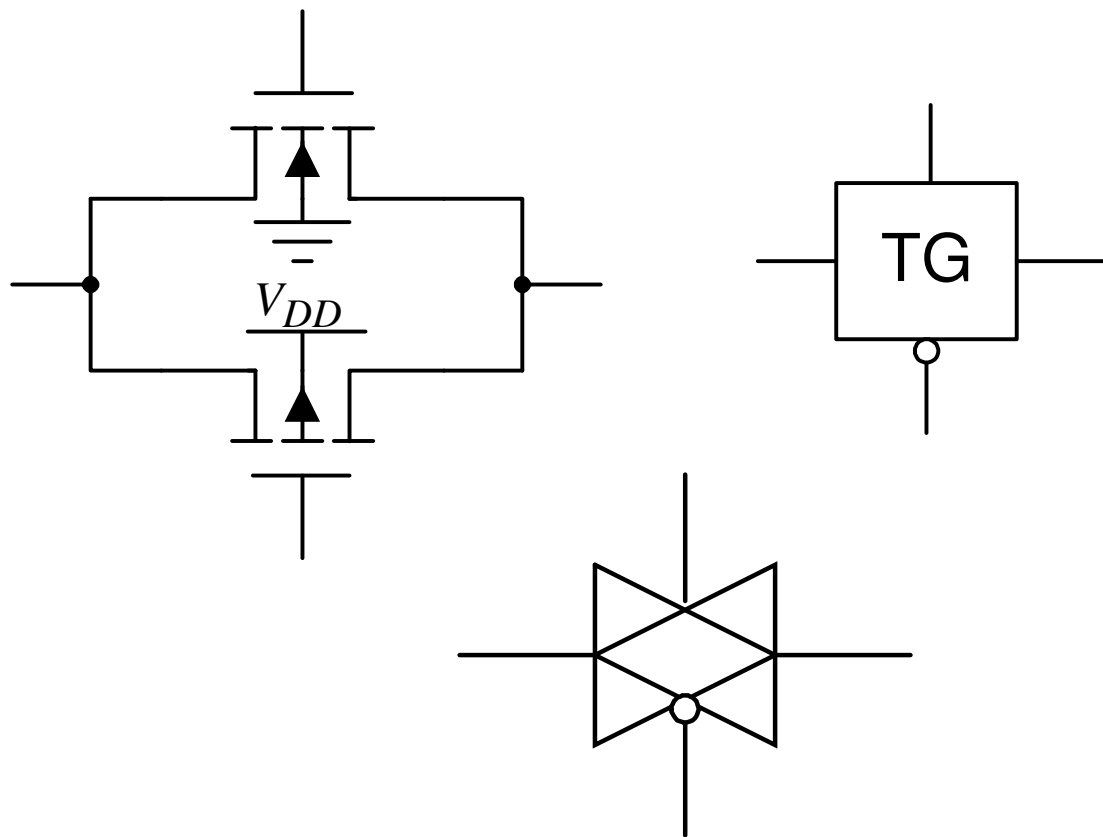


$$I_D = \begin{cases} \approx 0, & V_{GS} < V_T \\ \frac{B}{2}(V_{GS} - V_T)^2 (1 + \lambda V_{DS}) \approx \frac{B}{2}(V_{GS} - V_T)^2, & V_{GS} > V_T, V_{DS} \geq V_{GS} - V_T \\ \frac{B}{2} [2(V_{GS} - V_T)V_{DS} - V_{DS}^2], & V_{GS} > V_T, V_{DS} < V_{GS} - V_T \end{cases}$$





Bilateralni prekidač (transmisioni gejt)



$$I_D = \begin{cases} \approx 0, & V_{GS} < V_T \\ \frac{B}{2}(V_{GS} - V_T)^2 (1 + \lambda V_{DS}) \approx \frac{B}{2}(V_{GS} - V_T)^2, & V_{GS} > V_T, V_{DS} \geq V_{GS} - V_T \\ \frac{B}{2} [2(V_{GS} - V_T)V_{DS} - V_{DS}^2], & V_{GS} > V_T, V_{DS} < V_{GS} - V_T \end{cases}$$

