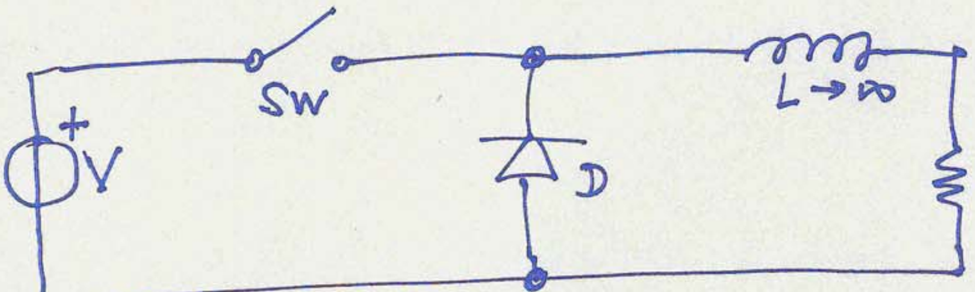
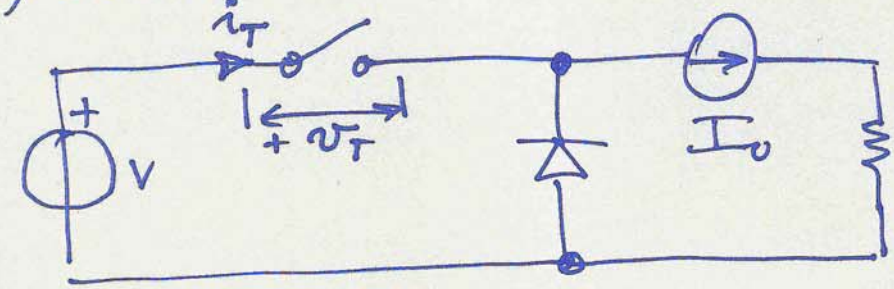
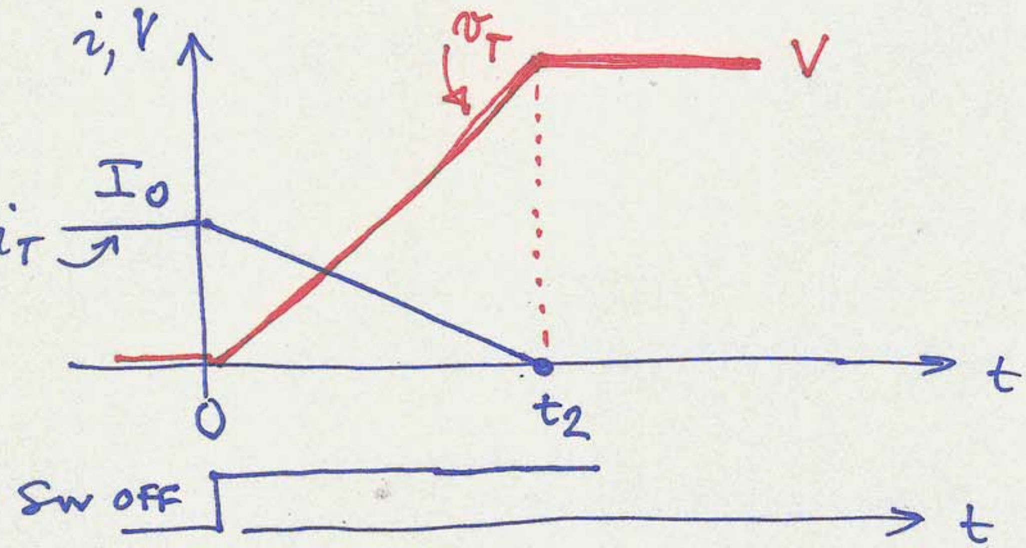
ZADATAK Ø1

ZA DATO KOLO NA SLICI IZRAČUNATI GUBITKE ENERGIJE TOKOM ISKLJUČENJA PREKIDAČKOG ELEMENTA. PRETPOSTAVITI DA TOKOM ISKLJUČENJA STRUJA PREKIDAČKOG ELEMENTA OPADA SA VREDNOSTI I_0 NA VREDNOST Ø, TOKOM VREMENA t_2.
RADI SMANJENJA GUBITAKA ENERGIJE TOKOM ISKLJUČENJA POTREBNO JE PRORAČUNATI VREDNOST KOMUTACIONOG KONDENZATORA C I UPOREDITI ENERGIJU GUBITAKA ZA OBA SLUČAJA.



REŠENJE:
a) SLUČAJ KADA NEMA KONDENZATORA C





JEDNAČINA PROMENE STRUJE i_T: ②

$$\frac{i_T}{I_0} + \frac{t}{t_2} = 1 \Rightarrow i_T = I_0\left(1 - \frac{t}{t_2}\right)$$

JEDNAČINA PROMENE NAPONA v_T:

$$v_T = \frac{V}{t_2} \cdot t$$

TRENUTNA VREDNOST SNAGE DISIPACIJE TOKOM ISKLJUČENJA:

$$P_{dis(t)} = v_{T(t)} i_{T(t)} = V I_0 \left(1 - \frac{t}{t_2}\right) \cdot \frac{t}{t_2}$$

$$\frac{t}{t_2} = x$$

$$P_{dis} = V I_0 (1 - x) \cdot x$$

ZA $x = 0$ $\quad P_{dis} = 0$ $\quad x = 1 \Rightarrow t = t_2$

$x = 1$ $\quad P_{dis} = 0$ $\quad x = 0 \Rightarrow t = 0$

KOLIKA JE MAX VREDNOST SNAGE DISIPACIJE ??

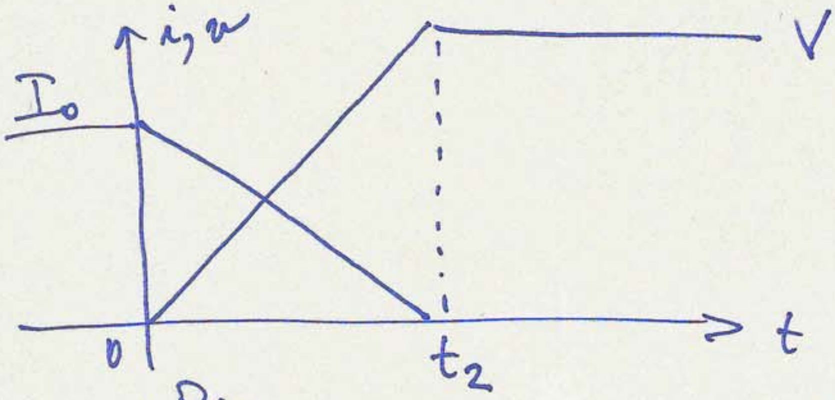
$$P_{dis} \to P_{dis\,MAX} \quad P'_{dis} = \frac{dP_{dis}}{dx} = 0$$

$$P'_{dis} = V I_0 (1 - x) - V I_0 \cdot x = 0$$

$$V I_0 = 2 V I_0 \cdot x \Rightarrow x = \frac{1}{2} \Rightarrow t^* = \frac{1}{2} t_2$$

$$P_{dis\,MAX} = V I_0 \left(1 - \frac{1}{2}\right) \cdot \frac{1}{2} = V I_0 \cdot \frac{1}{4}$$

$$\underline{P_{dis\,MAX} = \frac{1}{4} \cdot V \cdot I_0}$$

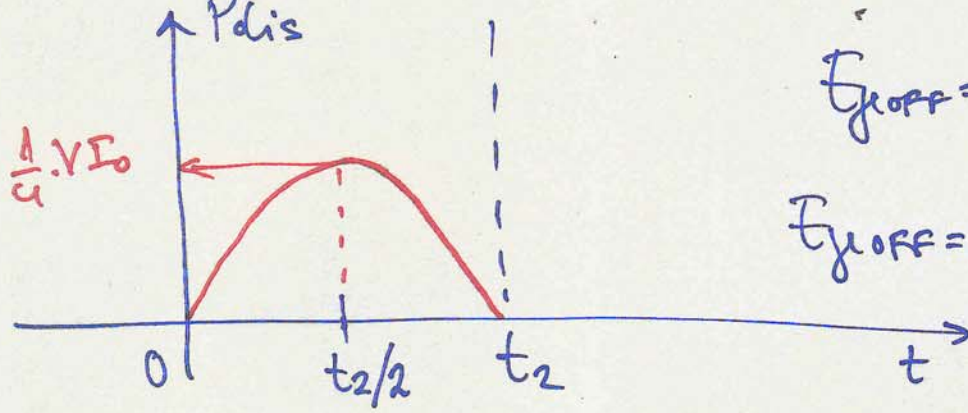


ENERGIJA [illegible]

$$E_{\gamma OFF} = \int_0^{t_2} P_{dis} \cdot dt$$

$$E_{\gamma OFF} = \int_0^{t_2} V I_0 \left(1 - \frac{t}{t_2}\right) \cdot \frac{t}{t_2}$$

$$E_{\gamma OFF} = \int_0^{t_2} V I_0 \left(1 - \frac{t}{t_2}\right) \left(\frac{t}{t_2}\right) dt$$



$$E_{\gamma OFF} = t_2 \int_0^1 V I_0 (1 - x) x \, dx$$

$$x = \frac{t}{t_2}$$

$$dx = \frac{1}{t_2} dt$$

$$dt = t_2 \cdot dx$$

$$E_{\gamma OFF} = V I_0 t_2 \int_0^1 (1 - x) x \, dx$$

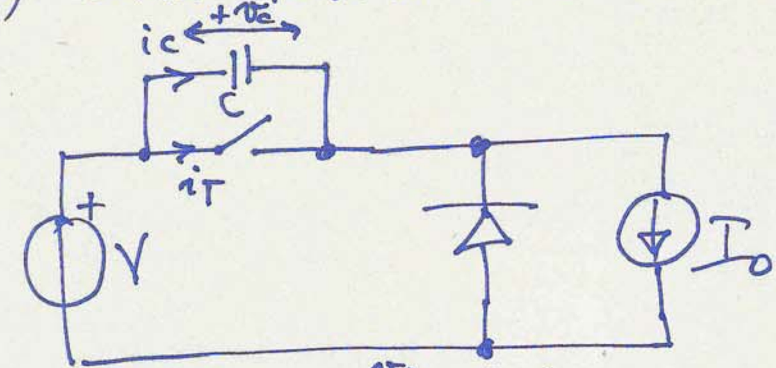
$$= V I_0 t_2 \int_0^1 (x \, dx - x^2 dx)$$

$$= V \cdot I_0 \cdot t_2 \left[\frac{x^2}{2} \Big|_0^1 - \frac{x^3}{3} \Big|_0^1 \right]$$

$$= V I_0 t_2 \left[\frac{1}{2} - \frac{1}{3} \right] = \frac{1}{6} V \cdot I_0 \cdot t_2$$

$$E_{\gamma OFF} = \frac{1}{6} V I_0 t_2 \quad \text{(BEZ KONDENZATORA C)}$$

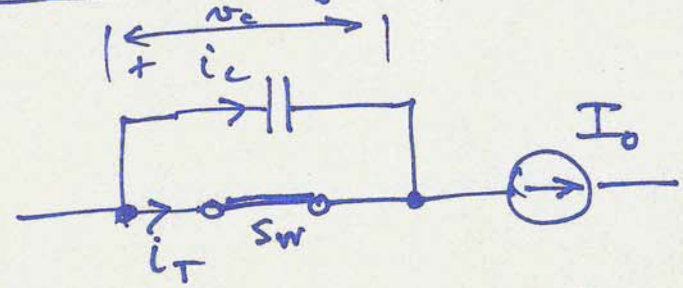
b) Kada postoji kondenz. C



U trenutku isključenja možemo pisati

$$I_0 = i_T + i_C$$

$$i_C = I_0 - i_T$$

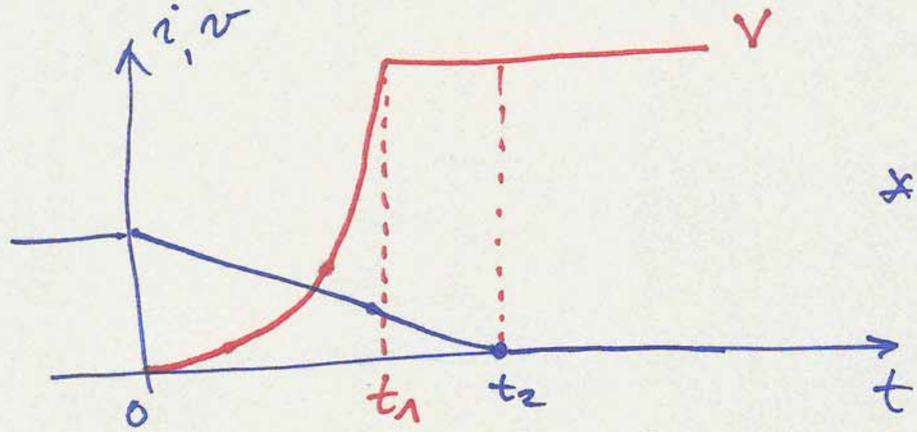


$$i_C = I_0 - I_0\left(1 - \frac{t}{t_2}\right)$$

$$i_C = I_0 - I_0 + I_0 \frac{t}{t_2}$$

$$i_C(t) = I_0 \cdot \frac{t}{t_2}$$

* linearan porast struje



Za $t = t_1$ napon na C postaje jednak V

$$Q = \int_0^{t_1} i_c\,dt = C \cdot V = \int_0^{t_1} \frac{I_0}{t_2} \cdot t\,dt = \frac{I_0}{t_2} \int_0^{t_1} t\,dt$$

$$Q = CV = \frac{I_0}{t_2} \cdot \frac{t_1^2}{2} \rightarrow C = \frac{I_0}{V} \cdot \frac{t_1^2}{2t_2}$$

$$v_C(t) = v_T(t)$$

$$v_C(t) = \frac{q}{C} = \frac{1}{C} \int_0^t i_c\,dt = \frac{1}{C} \cdot \frac{2Vt_2C}{I_0 t_1^2} \int_0^t \frac{t}{t_2}\,dt$$

$$v_c(t) = \frac{V}{t_1^2}\cdot t^2 = V\cdot\left(\frac{t}{t_1}\right)^2$$

Gubici usled isključenja

$$E'_{gi\,off} = \int_0^{t_1} v_c(t)\cdot i_T(t)\,dt + \int_{t_1}^{t_2} V\cdot i_T(t)\,dt$$

$$E'_{ge\,off} = \int_0^{t_1} \frac{V}{t_1^2}\cdot t^2\cdot I_0\left(1-\frac{t}{t_2}\right)dt + \int_{t_1}^{t_2} V\cdot I_0\left(1-\frac{t}{t_2}\right)dt$$

$$E'_{ge\,off} = \frac{VI_0}{t_1^2}\int_0^{t_1} t^2\left(1-\frac{t}{t_2}\right)dt + VI_0\int_{t_1}^{t_2}\left(1-\frac{t}{t_2}\right)dt$$

$$E'_{ge\,off} = \frac{VI_0}{t_1^2}\left[\int_0^{t_1} t^2\,dt - \int_0^{t_1}\frac{t^3}{t_2}\,dt\right] + VI_0\left[\int_{t_1}^{t_2} dt - \int_{t_1}^{t_2}\frac{t}{t_2}\,dt\right]$$

$$E'_{g\,off} = \frac{VI_0}{t_1^2}\left[\frac{t_1^3}{3} - \frac{1}{4}\cdot\frac{t_1^4}{t_2}\right] + VI_0\left[t_2 - t_1 - \frac{1}{2t_2}(t_2^2 - t_1^2)\right]$$

$$E'_{ge\,off} = VI_0\left[\frac{t_1}{3} - \frac{t_1^2}{4t_2}\right] + VI_0\left[t_2 - t_1 - \frac{1}{2t_2}(t_2-t_1)(t_2+t_1)\right]$$

$$E'_{ge\,off} = VI_0\left[\frac{t_1}{3} - \frac{t_1^2}{4t_2} + \frac{2t_2(t_2-t_1) - (t_2-t_1)(t_2+t_1)}{2t_2}\right]$$

$$E'_{ge\,off} = VI_0\left[\frac{t_1}{3} - \frac{t_1^2}{4t_2} + \frac{(t_2-t_1)(2t_2 - t_2 - t_1)}{2t_2}\right]$$

$$E'_{ge\,off} = VI_0\left[\frac{t_1}{3} - \frac{t_1^2}{4t_2} + \frac{(t_2-t_1)^2}{2t_2}\right]$$

⑥

$$E'_{je\,off} = VI_0\left[\frac{t_1}{3} - \frac{t_1^2}{4t_2} + \frac{t_2^2}{2t_2} - \frac{2t_1t_2}{2t_2} + \frac{t_1^2}{2t_2}\right]$$

$$E'_{je\,off} = VI_0\left[\frac{t_1}{3} + \frac{1}{4}\cdot\frac{t_1^2}{t_2} + \frac{t_2}{2} - t_1\right]$$

$$E'_{je\,off} = VI_0\left[\frac{t_2}{2} - \frac{2}{3}t_1 + \frac{1}{4}\frac{t_1^2}{t_2}\right]$$

$$E_{je\,off} = \frac{1}{6}VI_0t_2$$

$$E'_{je\,off} = \frac{1}{6}VI_0\left[3t_2 - 4t_1 + \frac{3}{2}\frac{t_1^2}{t_2}\right]$$

$$= \frac{1}{6}VI_0t_2\left[3 - 4\frac{t_1}{t_2} + \frac{3}{2}\left(\frac{t_1}{t_2}\right)^2\right]$$

$$\frac{E'_{je\,off}}{E_{je}} = \frac{3 - 4\frac{t_1}{t_2} + \frac{3}{2}\left(\frac{t_1}{t_2}\right)^2}{1} = 3 - 4\frac{t_1}{t_2} + \frac{3}{2}\left(\frac{t_1}{t_2}\right)^2$$

$$\frac{t_1}{t_2} = 0{,}9 \qquad \frac{E'_{je\,off}}{E_{je}} = 3 - 4\cdot 0{,}9 + \frac{3}{2}(0{,}9)^2$$

$$= 3 - 3{,}6 + 1{,}215$$

$$= 1{,}8$$

$$t_1 \to t_2 \qquad \boxed{\frac{E'_{je\,off}}{E_{je}} = 3 - 4 + 1{,}5 = 0{,}5}$$

t_1 MORA BITI ŠTO „BLIŽE" t_2 DA BI SE POSTIGAO EFEKAT!!!