

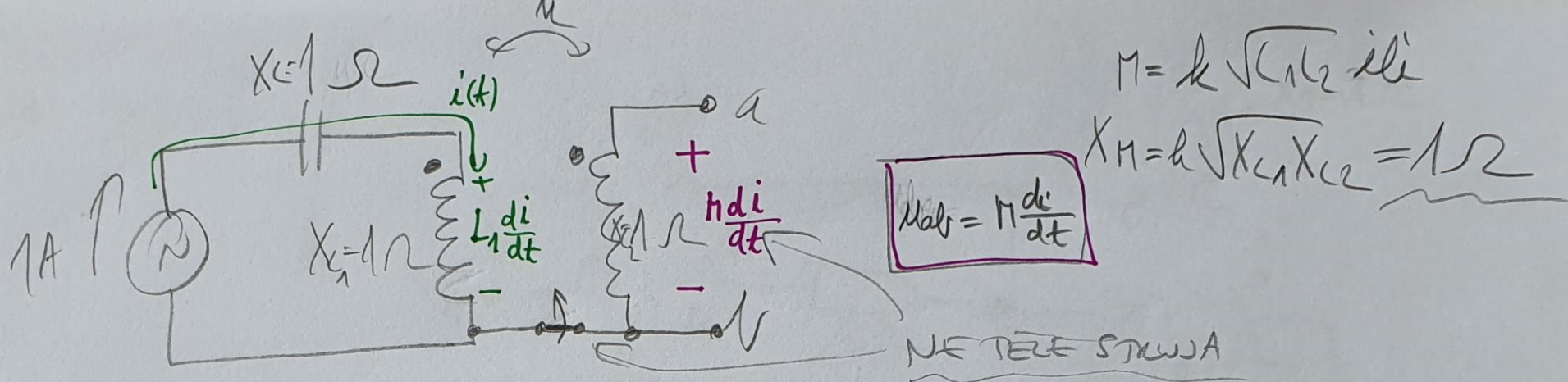
OE - konzultacije

29. svibnja 2020.

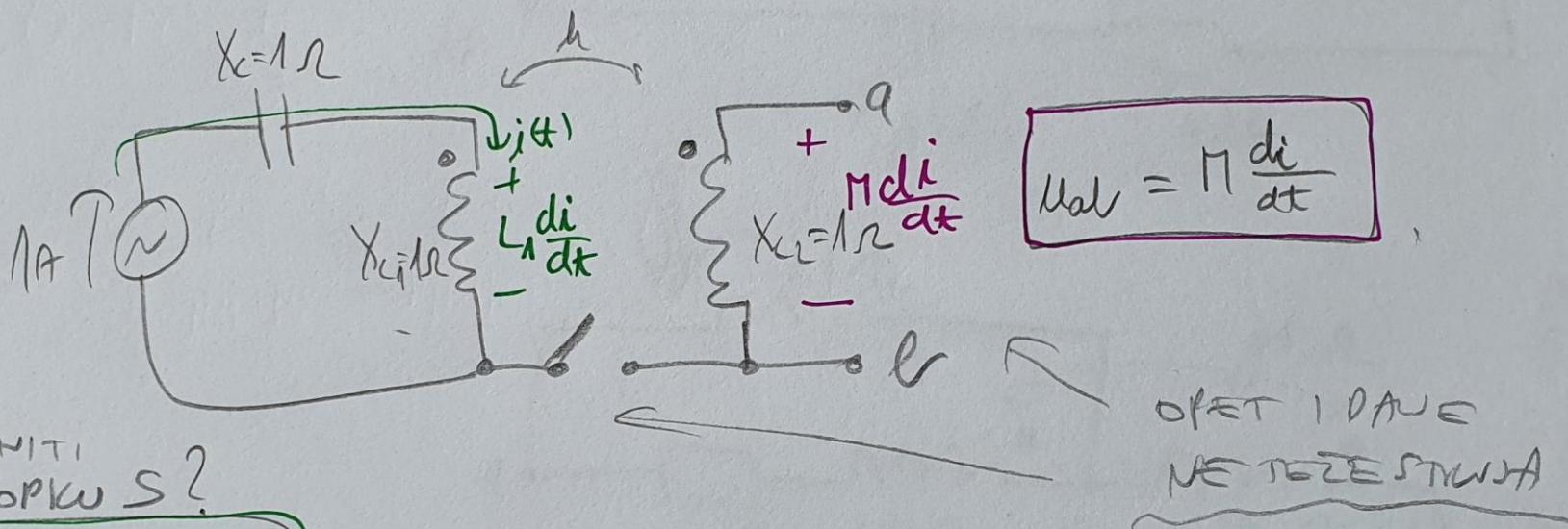
PANIC - PRAVA 2. DIO

IX TEST 17

PRVI



POSLE



HOĆE LI SE I KAKO PROMIJENITI
UAB KADA ONOVIMO SKLOPKU S?

A NE MIJENJA SE

pravilo za polaritet napona međuindukcije:

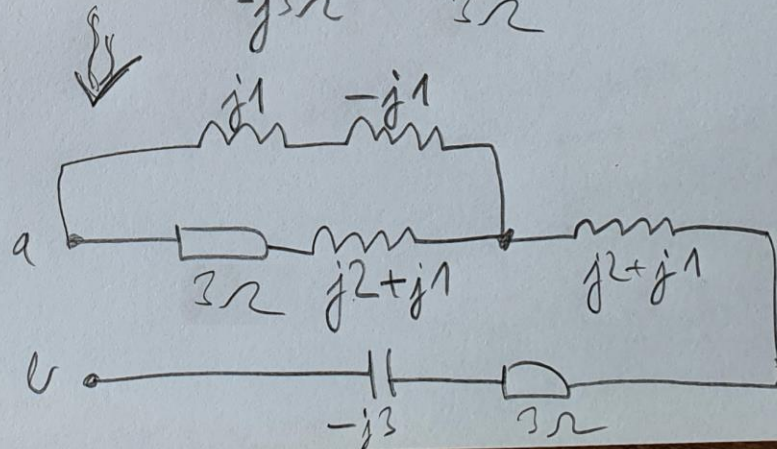
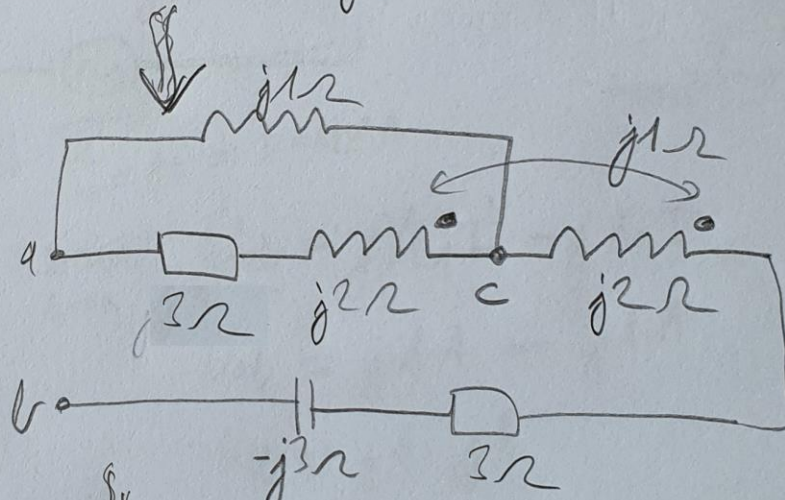
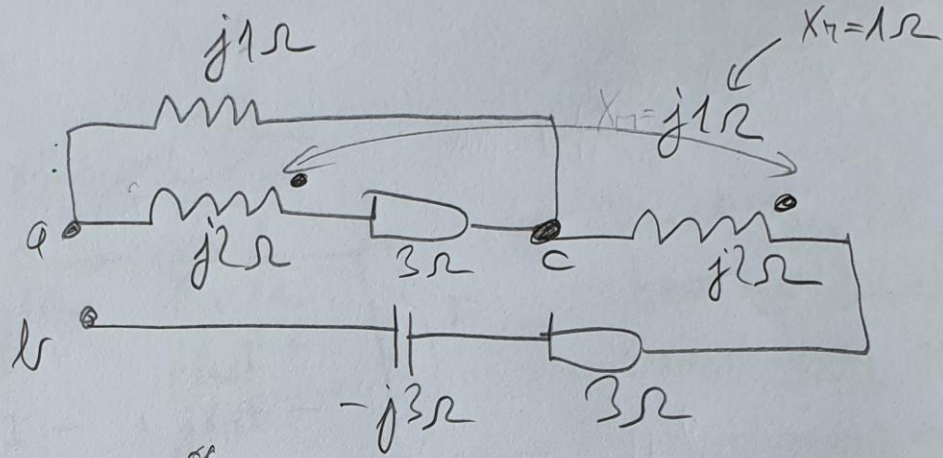
struja ulazi na * jedne zavojnice --> onda je na drugoj zavojnici kod * PLUS polaritet napona međuindukcije

pravilo za polaritet napona samoindukcije ($L di/dt$):

tamo gdje struja ulazi u zavojnicu stavljamo PLUS (kao trošilo)

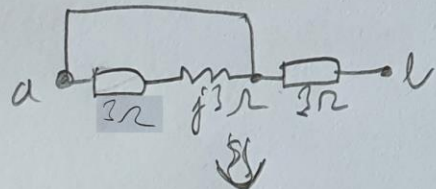
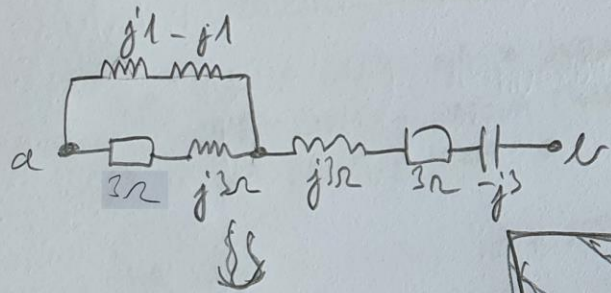
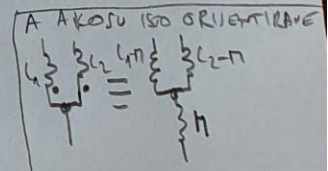
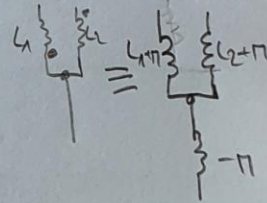
PNIC-FAISA 2. VIO

(X-FAISA-20) KOLIKAJE Z_{ab} ?



ELEMENTE
PREUJESTINO
DASE
BOVE
UOCI

TOČKICE
NIŠU ISTO
ORIJENTIRANE
PRIMA ZAJEDNIČAN
EVOLU



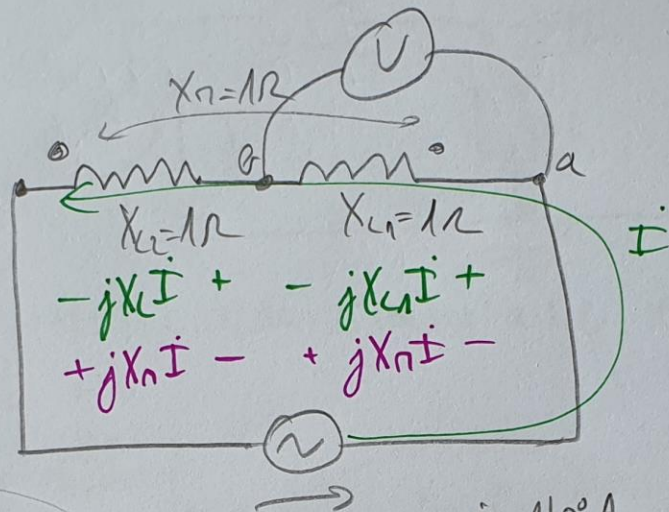
(A)

$$Z_{ab} = 3 \Omega$$

PRAK - FIZJA 2. ROK

(X-TEST 18)

ODNOS
 U_v !



SEMIJA X_{L1} i X_{L2}
STANJA ULAZI KOD X_{L1}
STANJA IZLAZI KOD X_{L2}

NEUGODNA VEZA!
 $L_{EKV} = (L_1 + L_2 - 2M)$

ODREĐIVANJE REFERENTNOG POLARITETA
NAPONA MEĐUINDUKCIJE
PRAVILO ZA SVAKU
RAZNOJNICU POSLEDNO:

Ako STANJA ULAZI NA • JEDNE
ONDA STAVI + NAPONA MEĐUINDUKCIJE
NA DRUGU KOD •

Ako STANJA IZLAZI NA • JEDNE
ONDA STAVI - NAPONA MEĐUINDUKCIJE
NA DRUGU KOD •

SEMIJA
 $b \rightarrow a$

$$\dot{U}_{ab} = jX_{L1} \dot{I} - jX_{L2} \dot{I}$$

$$\dot{U}_{ab} = j \cdot 1 \cdot 1 - j \cdot 1 \cdot 1$$

$$\dot{U}_{ab} = j1 - j1$$

$$\dot{U}_{ab} = 0 \text{ V}$$

0.0 A

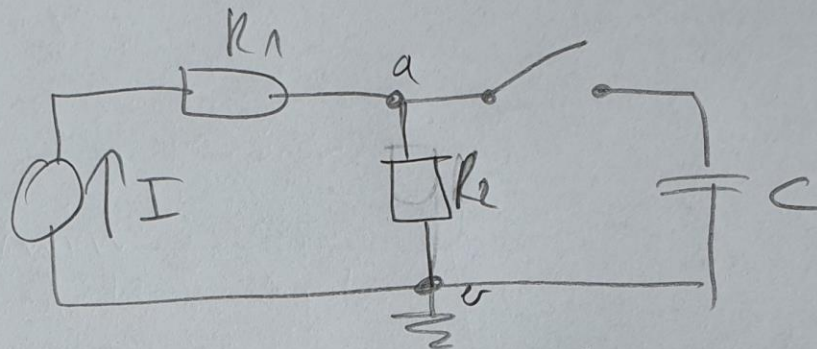
$$U_v = |\dot{U}_{ab}| = 0 \text{ V}$$

(A) NULA

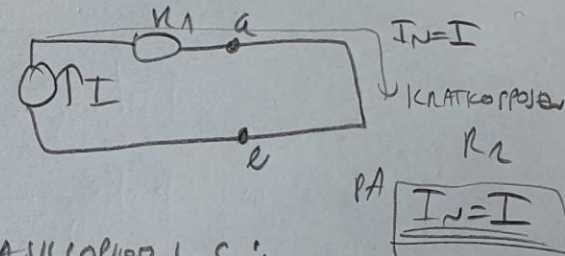
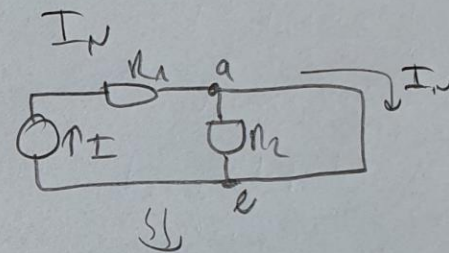
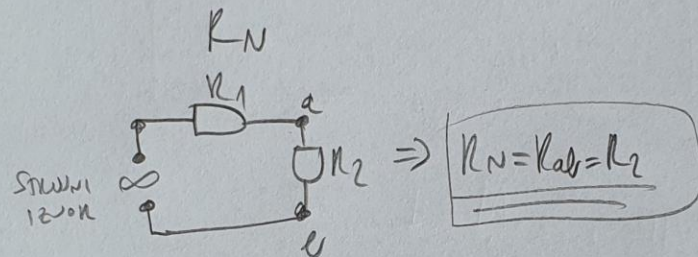
XII-1-TEST

4)

KONAČNI NAPON NA C?



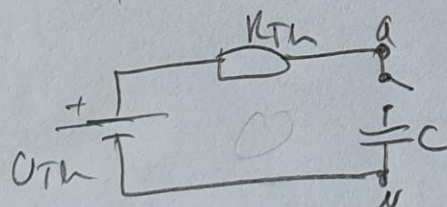
NORTONOV TEOREM STOČKA a i b (GRANA SA SIKLOPILOM I C)



ONDA TRAZIMO TITELVINOVU NAPON $U_{Th} = I_N \cdot R_N$

$$U_{Th} = I \cdot R_2$$

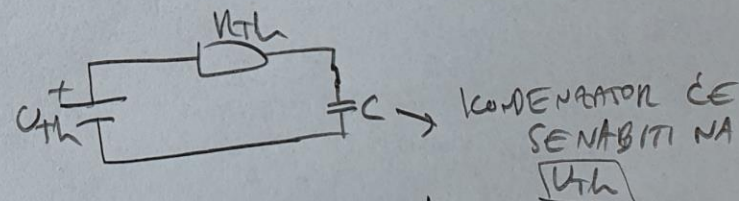
ONDA NA TITELVINOVU 12V ON VRATIMO GRANU SA SIKLOPILOM I C:



ZATVARAMO SIKLOPILO I ZEKAMO KAPACITAN

5s NA ODJE U

STACIONARNO STANJE



$$u_C(t) = U_{Th} (1 - e^{-\frac{t}{\tau}})$$

$$u_C(t \rightarrow \infty) = U_{Th} (1 - e^{-\infty}) = U_{Th} = I \cdot R_2$$

$$I \cdot R_2$$

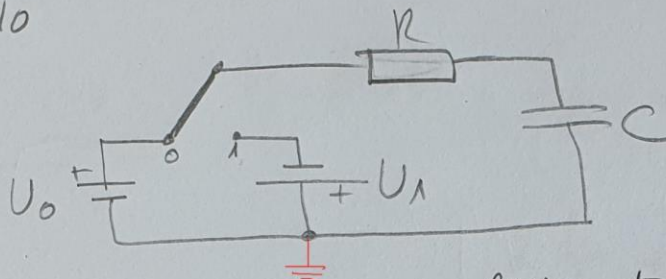
PRVI. POKUŠAJ 2.110

XII-1-5

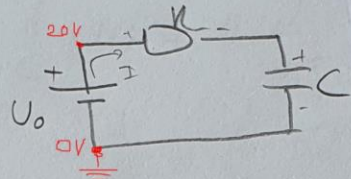
$$U_0 = 20V$$

$$R = 100 \Omega$$

$$U_1 = 40V$$



PRVI $t=0$:



$$u_C(t) = U_0 (1 - e^{-\frac{t}{\tau}}) \Rightarrow u_C(t) = 20 (1 - e^{-\frac{t}{\tau}})$$

DUKO TRAJE...

ZNAZI $u_C \rightarrow U_0$

$$u_C(0^+) = U_0$$

$$\text{onda } u_R(0^+) = 0V$$

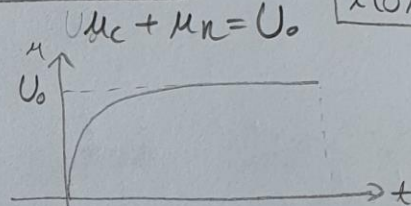
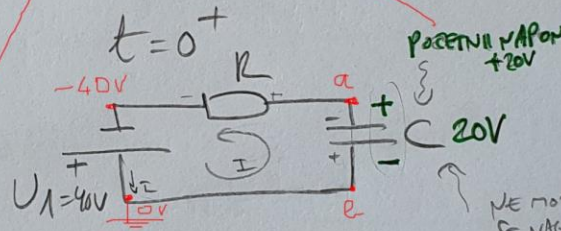
$$i(0^+) = 0A$$

$t=0$
DOK VREMENA
SKLOPIKA NAO
 $t=0^+$
PREKLI SE
SKLOPIKA NA 1

TRAZI SE $u_C(t)$, $u_R(t)$, $i(t)$

ZA $t=0^+$ JE

UPOZNA $t=0$ (14. BAKEN)
5C



NE MOZE
SE NAGLO PROMENITI
NAPON
PRVI

$$t=0^+ \quad U_1 = u_C + u_R$$

$$U_1 = (-u_R) + u_R$$

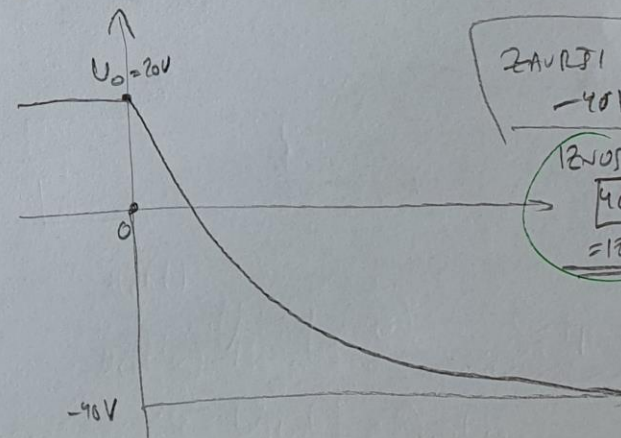
$$u_R = U_1 + u_{poc}$$

$$u_R = 20 + 40 = 60V$$

$$I = \frac{u_R}{R} = \frac{60}{100} = 0.6A$$

$$u_C = 20V$$

PARIMO NA PREZIMALE:



ZAVRŠI MA
-40V

IZNOS
40V
= 120V/kV

komplikiraniji slučaj:

na početku je napon +20 V
i kreće nova prijelazna pojava
na kraju prijelazne pojave
na kondenzatoru

će biti napon novog izvora
-40 V!
prijelaz --> padajuća
eksponencijalna funkcija

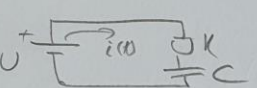
u $t=0^+$

$$U_{oc} = 20V$$

Nakon
5C

$$U_{oc} = -U_1 = -40V$$

Kratki izvod za prethodni zadatak → XII.-2.-5.



$$U = R \cdot i(t) + \frac{Q_c}{C} = R i(t) + \frac{1}{C} \int i(t) dt \quad \left| \frac{d}{dt} \right. \quad Q_c = U_c \cdot C$$

kratki izvod prema 15. predavanju (12. knjižici)
 → razlika početni napon na kondenzatoru nije 0 V nego neki U_{c0}

$$R \frac{di}{dt} + \frac{1}{C} i(t) = 0$$

$$\frac{1}{C} i(t) + R \frac{di}{dt} = 0 \quad | : R$$

$$\left(\frac{di}{dt} + \frac{1}{RC} i(t) \right) = 0$$

kad se ubaci gore zadovoljava gornju diferencijalnu jednačinu!

$$i(t) = C e^{-\frac{t}{\tau}} \quad \tau = R \cdot C$$

OPIRETI C:

$$U = R \cdot i(t) + \frac{Q_c}{C}$$

$$Q_c(t=0) \neq 0 \Rightarrow \text{OPRA} \quad Q_{c0} = C \cdot U_{c0}$$

početni uvjet → na pločama kondenzatora postoji naboj $Q_c \Rightarrow$ iz toga se dobije početni napon na C

$$U = R \cdot i(t) + \frac{C \cdot U_{c0}}{C}$$

$$U = R \cdot i(t) + U_{c0} \Rightarrow i(t) = C e^{-\frac{t}{\tau}} \Rightarrow \text{ZA: } t=0 \Rightarrow i(0) = C \cdot e^{-\frac{0}{\tau}}$$

$$\frac{U - U_{c0}}{R} = C \cdot 1$$

$$C = \frac{U - U_{c0}}{R}$$

a da je početni napon na kondenzatoru 0 onda bi dobili $U/R \cdot e^{-(t/\tau)}$

$$i(t) = \frac{U - U_{c0}}{R} e^{-\frac{t}{\tau}}$$

$$U_R = i(t) \cdot R = (U - U_{c0}) e^{-\frac{t}{\tau}}$$
 a da je početni napon kondenzatora nula dobili bi $U \cdot e^{-(t/\tau)}$

$$U_c = U - U_R(t) = U - (U - U_{c0}) e^{-\frac{t}{\tau}} = U + (U_{c0} - U) e^{-\frac{t}{\tau}}$$
 a da je početni napon kondenzatora nula dobili bi uobičajenu formulu:
 $U - U \cdot e^{-(t/\tau)} = U(1 - e^{-(t/\tau)})$

OVO JE:
 $U_{c0} = 20V$
 $U = -40V$

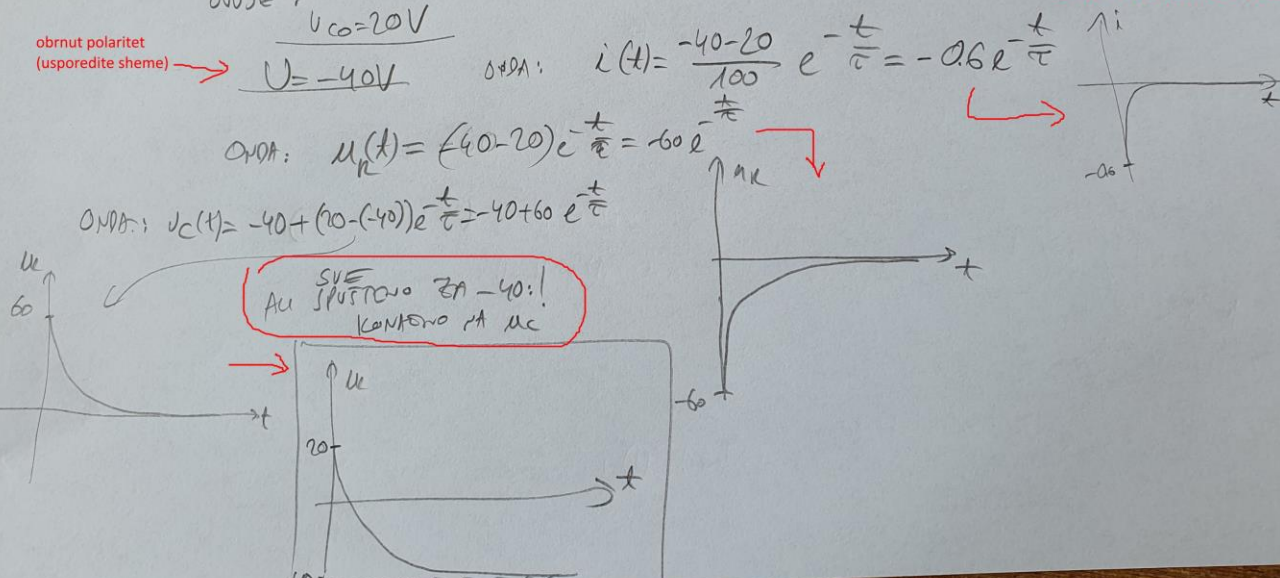
obrnut polaritet (usporedite sheme) →

$$i(t) = \frac{-40 - 20}{100} e^{-\frac{t}{\tau}} = -0.6 e^{-\frac{t}{\tau}}$$

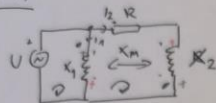
OMDA: $U_R(t) = (-40 - 20) e^{-\frac{t}{\tau}} = -60 e^{-\frac{t}{\tau}}$

OMDA: $U_c(t) = -40 + (20 - (-40)) e^{-\frac{t}{\tau}} = -40 + 60 e^{-\frac{t}{\tau}}$

SVJEŠTANJE ZA -40!
 KONKRETO NA U_c



IX. 2-7.



$$R = 25 \Omega \quad I_R = ?$$

$$X_1 = X_2 = 25 \Omega$$

$$X_M = 20 \Omega$$

$$U = 25V$$

Kirchhoff. ali pazimo na medinduktivitet! (celotno označeno tto se dogaja zbog I_1 , crveno I_2)

1. KONTURA

$$U - I_1 \cdot X_1 + I_2 \cdot X_M = 0$$

2. KONTURA

naponi induc. zbog med. na zavojnici 2, odnosno 1

$$-I_2 \cdot R - I_2 \cdot X_2 + I_1 \cdot X_M + I_1 \cdot X_1 - I_2 \cdot X_M = 0$$

2. jdbe:

$$25 - j \cdot 25 I_1 + j \cdot 20 I_2 = 0 \quad | :5$$

$$-25 I_2 - j I_2 \cdot 25 + j I_1 \cdot 20 + j I_1 \cdot 25 - j I_2 \cdot 20 = 0 \quad | :5$$

$$5 - 5j I_1 + 4j I_2 = 0 \quad \rightarrow I_2 = \frac{5j I_1 - 5}{4j} = 1.25 I_1 + 1.25j$$

$$-5 I_2 - 5j I_2 + 4j I_1 + 5j I_1 - 4j I_2 = 0$$

$$I_2 \cdot (-5 - 5j - 4j) + I_1 (4j + 5j) = 0$$

$$I_2 (-5 - 9j) + I_1 \cdot 9j = 0$$

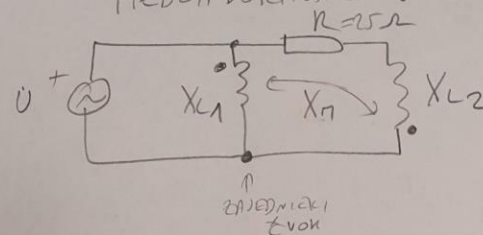
$$(1.25 I_1 + 1.25j) (-5 - 9j) + I_1 \cdot 9j = 0$$

$$-6.25 I_1 - 11.25j I_1 - 6.25j + 11.25 + I_1 \cdot 9j = 0 \quad \rightarrow I_1 = 1.937405759$$

$$\angle -48.85348045^\circ$$

$$\Rightarrow I_2 = 1.693597341 \angle -19.79887635^\circ A \quad P_R = I_R^2 R = 71.71 W$$

ALTERNATIVNI NAČIN
TRANSFORMACIJA
MEDUINDUKTIVNE VEZE

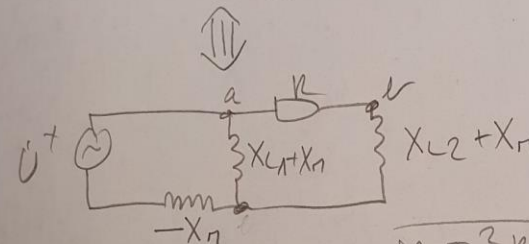


$$X_{L1} = X_{L2} = 25 \Omega$$

$$X_M = 20 \Omega$$

$$U = 25V \quad (\dot{U} = 25 \angle 0^\circ V)$$

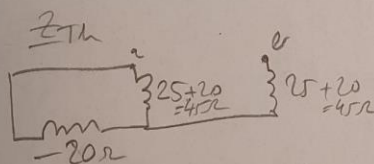
$$P_R = ?$$

DAJTE ODREĐITE I_R IODPA

$$P_R = I_R^2 \cdot R$$

NPR. PRIEDLOG \rightarrow THEVENIN

TOČAKA a i b

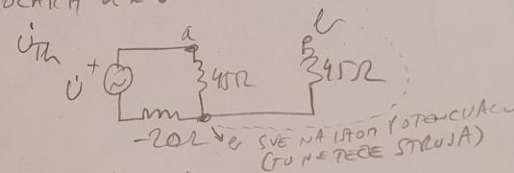


$$Z_{Th} = \frac{j45 \cdot (-j20)}{j45 - j20} + j45$$

$$Z_{Th} = \frac{900}{j25} + j45$$

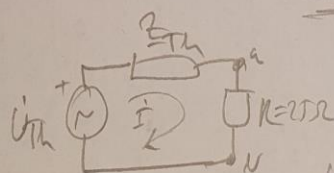
$$Z_{Th} = -j36 + j45$$

$$Z_{Th} = j9 \Omega$$


 $\dot{U}_{Th} = \dot{U}_{ab} \rightarrow$ NAPONSKO PIERLICO:

$$\dot{U}_{Th} = \dot{U}_{ab} = \dot{U} \frac{j45}{j45 - j20} = \dot{U} \frac{j45}{j25}$$

$$\dot{U}_{Th} = \dot{U} \cdot \frac{9}{5} = 45 \angle 0^\circ V$$



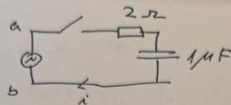
$$I = I_R = \frac{\dot{U}_{Th}}{Z_{Th} + R} = \frac{45}{25 + j9} A$$

$$P_R = |I_R|^2 \cdot R = \left(\frac{45}{\sqrt{25+81}} \right)^2 \cdot 25 = 71.71 W$$

YII. 1-7.

$$u_{ab} = -5V$$

$$t=0^+$$



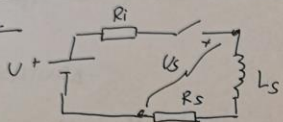
$$I = ?$$

$$I = \frac{U}{R} = \frac{-5}{2} = -2.5 A$$

$$\tau = R \cdot C = 2 \cdot 10^{-6} \rightarrow u_C(0) = 0$$

$$U_R = 5V$$

XII. 1-14.



$$U = 125V \quad R_i = 2\Omega \quad R_s = 2\Omega$$

$$t_1 = 40ms \rightarrow U_s = 85.5V$$

$$L_s = ?$$

PAZI! NAPON NA SVITKU, NE NA L!

$$\tau = \frac{L_s}{R_i + R_s} \rightarrow \tau \text{ nađemo i } L = \tau(R_i + R_s)$$

$$u \quad t_1 = 40ms$$

$$U_L = U \cdot e^{-t/\tau}$$

$$U_{R_s}(t) = U_s(t) - U_L(t) = U_s(t) = U e^{-t/\tau}$$

$$I(t) = \frac{U}{R_i + R_s} (1 - e^{-t/\tau}) \rightarrow \text{ista kroz sve elemente - serija}$$

$$U_{R_s} = U_s - U e^{-t/\tau} = I \cdot R_s$$

$$U_s - U e^{-t/\tau} = \frac{U \cdot R_s}{R_i + R_s} (1 - e^{-t/\tau})$$

$$e^{-t/\tau} \left(\frac{U \cdot R_s}{R_i + R_s} - U \right) = \frac{U \cdot R_s}{R_i + R_s} - U_s$$

uvrstimo za $t = 40ms$

$$e^{-t/\tau} (-62.5) = -23$$

$$e^{-t/\tau} = 0.368$$

$$\tau = 0.0400s$$

$$L = \tau \cdot (R_i + R_s) = 0.16H = 160mH //$$

Trenutni napon sinusoide -5V

Onda je struja $-5/2 = -2,5 A$

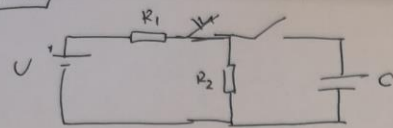
Na kondenzatoru nema skokovite-trenutne promjene napona \rightarrow prije zatvaranja sklopke je bio na 0 V, onda je i u trenutku zatvaranja sklopke isto još uvijek na 0 V

Onda još po KZN (u smjeru kazaljke na satu):

$$U_{ab} = U_R + U_C$$

$$-5 = U_R + 0 \rightarrow U_R = -5V \text{ (odnosno iznos napona na } U_R \text{ je } 5V)$$

X11.1-8.



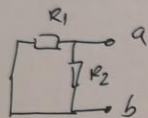
$$\tau = 150 \mu s$$

$$I = ?$$

$$Q = ?$$

$$R_1 = 4 \text{ k}\Omega \quad R_2 = 12 \text{ k}\Omega \quad C = 25 \text{ nF} \quad U = 120 \text{ V}$$

1. THEVENIN - dobije se senja RC

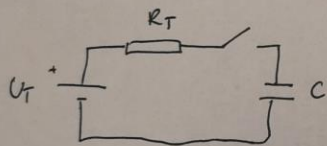


$$R_T = R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2} = 3 \text{ k}\Omega$$

$$U_T = U_{R_2} = \frac{U}{R_1 + R_2} \cdot R_2 = 90 \text{ V}$$

SADA IMAMO SJEDUĆE:

→ standardni RC



$$\tau = R_T \cdot C = 75 \cdot 10^{-6} \text{ s}$$

$$U_C(150 \mu s) = U(1 - e^{-t/\tau}) = 90(1 - e^{-\frac{150 \cdot 10^{-6}}{75 \cdot 10^{-6}}})$$

$$= 77.8198 \text{ V}$$

$$C = \frac{Q}{U} \Rightarrow Q = U \cdot C = 1.945 \cdot 10^{-6} \text{ C}$$

$I = ?$ Pogledajmo shemu.

R_2 i C su paralelni → Napon na C = Napon na R_2

$$I_{R_2} = \frac{U_C}{R_2} = 6.48 \text{ mA}$$