

1-masala. RL-zanjirda quvvatning o'lishi

Induktivligi $L = 0,20 \text{ H}$, qarshiligi $R = 2 \Omega$ bo'lgan RL-zanjir $\varepsilon = 8 \text{ V}$ manbaga ulanadi.

Topilsin:

- a) vaqt doimiysi τ
- b) stasionar tok I_0
- c) $t = 0,10 \text{ s}$ da tok I
- d) shu vaqtda g'altakdagi energiya W

Yechim

a)

$$\begin{aligned}\tau &= L/R \\ \tau &= 0,20/2 = 0,10 \text{ s}\end{aligned}$$

b)

$$I_0 = \varepsilon/R = 8/2 = 4 \text{ A}$$

c)

Tok ortishi: $I = I_0 (1 - e^{-t/\tau})$ darajasi)

$$\begin{aligned}t/\tau &= 0,10/0,10 = 1 \\ e^{-1} &\approx 0,37\end{aligned}$$

$$I \approx 4 (1 - 0,37) = 4 \cdot 0,63 = 2,52 \text{ A}$$

d)

$$W = L I^2/2$$

$$I^2 \approx (2,52)^2 \approx 6,35$$

$$W \approx 0,20 \cdot 6,35/2 \approx 1,27/2 \approx 0,64 \text{ J}$$

Javob: $\tau = 0,10 \text{ s}$; $I_0 = 4 \text{ A}$; $I(0,10 \text{ s}) \approx 2,52 \text{ A}$; $W \approx 0,64 \text{ J}$.

2-masala. RL-zanjirda energiyaning nechog'i issiqlikka ketadi?

$L = 0,50 \text{ H}$, $R = 5 \Omega$ zanjir $\varepsilon = 10 \text{ V}$ manbaga ulanadi. Tok sekin o'sib, keyin juda uzoq vaqt o'tgach stasionarga yetdi.

Topilsin:

- a) stasionar tok I_0
- b) g'altakdagi magnit energiya W_L

c) manba bergan jami energiyani nechog'i W_L ga, nechog'i esa rezistorda issiqlikka ketadi?

Yechim

a)

$$I_0 = \varepsilon / R = 10 / 5 = 2 \text{ A}$$

b)

$$\begin{aligned} W_L &= L I_0^2 / 2 \\ I_0^2 &= 4 \end{aligned}$$

$$W_L = 0,50 \cdot 4 / 2 = 2 / 2 = 1 \text{ J}$$

c) Uzoq vaqt davomida manba quvvati $P = \varepsilon I_0$ bo'ladi, lekin jarayon "cheksiz vaqt" olib, issiqlik ajralishi ham cheksiz ketadi. Shuning uchun bu savolni ulanish jarayoni oxiriga qadar bo'lgan energiya bilan talqin qilamiz.

Ulanish vaqtida manba bergan energiya W_m quyidagicha bo'ladi (RL zanjir uchun natija):

W_L = yarim qismi,
qolgan yarim qismi rezistorda issiqlikka aylanadi.

Demak:

$$W_L : W_R = 1 : 1$$

Shunday qilib, ulanish jarayonida manba bergan energiyani 50 foizi g'altakda, 50 foizi rezistorda issiqlikka ketadi.

Javob: $I_0 = 2 \text{ A}$; $W_L = 1 \text{ J}$; energiya taqsimoti: 50 % magnit maydonda, 50 % issiqlikda.

3-masala. RC-zanjirda ma'lum foizgacha zaryadlanish vaqti

$R = 3 \text{ k}\Omega$, $C = 100 \text{ }\mu\text{F}$ bo'lgan RC-zanjir $\varepsilon = 12 \text{ V}$ manbaga ulangan.

Qancha vaqtdan so'ng kondensator kuchlanishi 10 V bo'ladi?

Yechim

$$C = 100 \text{ }\mu\text{F} = 100 \cdot 10^{-6} \text{ F} = 1,0 \cdot 10^{-4} \text{ F}$$

$$\tau = R C$$

$$\tau = 3000 \cdot 1,0 \cdot 10^{-4} = 0,30 \text{ s}$$

$$U(t) = \varepsilon (1 - e^{-t/\tau} \text{ darajasi})$$

$$10 = 12 (1 - e^{-t/\tau})$$

$$10/12 = 1 - e^{-t/\tau}$$

$$10/12 = 0,833 \dots$$

$$e^{-t/\tau} = 1 - 0,833 \dots \approx 0,167$$

Demak:

$$-t/\tau = \ln(0,167) \approx -1,79$$

$$t \approx 1,79 \tau \approx 1,79 \cdot 0,30 \approx 0,54 \text{ s}$$

Javob: $t \approx 0,54 \text{ s}$.

4-masala. RC-razryadda tokning kamayishi

$C = 50 \mu F$ sig'imli kondensator $R = 1,0 \text{ k}\Omega$ rezistorga ulangan holda $U_0 = 20 \text{ V}$ gacha zaryadlangan edi. Keyin manba uzildi va kondensator rezistordan razryadlana boshladi.

Topilsin:

- a) τ
- b) $t = 0,10 \text{ s}$ dagi kuchlanish U
- c) shu vaqtda tok I

Yechim

$$C = 50 \mu F = 5,0 \cdot 10^{-5} \text{ F}$$

$$\tau = R C = 1000 \cdot 5,0 \cdot 10^{-5} = 5,0 \cdot 10^{-2} \text{ s} = 0,050 \text{ s}$$

$$U(t) = U_0 e^{-t/\tau}$$

$$t/\tau = 0,10/0,050 = 2$$

$$e^{-2} \approx 0,135$$

$$U \approx 20 \cdot 0,135 = 2,7 \text{ V}$$

$$I = U/R \approx 2,7/1000 \approx 2,7 \cdot 10^{-3} \text{ A} = 2,7 \text{ mA}$$

Javob: $\tau = 0,050 \text{ s}$; $U \approx 2,7 \text{ V}$; $I \approx 2,7 \text{ mA}$.

5-masala. RC-zanjir va energiya taqsimoti

$R = 2\text{ k}\Omega$, $C = 500\text{ }\mu\text{F}$ sig‘imli zanjir $\varepsilon = 6,0\text{ V}$ manbaga ulanadi va uzoq vaqt turgach, kondensator to‘liq zaryadlanadi.

Topilsin:

- a) kondensatordagi oxirgi energiya W
- b) manba bergan energiya W_m
- c) W va rezistorda ajralgan issiqlik nisbatini toping.

Yechim

$$C = 500\text{ }\mu\text{F} = 5,0 \cdot 10^{-4}\text{ F}$$

a)

$$W = C U^2/2$$

$$U = \varepsilon = 6,0\text{ V}$$

$$U^2 = 36$$

$$W = 5,0 \cdot 10^{-4} \cdot 36/2 = 18 \cdot 10^{-4} = 1,8 \cdot 10^{-3}\text{ J}$$

b) RC-zanjir uchun ma’lum natija:

manba bergan energiya W_m ning yarmi kondensatorda, yarmi rezistorda bo‘ladi:

$$W_m = 2W = 3,6 \cdot 10^{-3}\text{ J}$$

c)

$$W : W_R = 1 : 1$$

$$W_R = W_m - W = 3,6 \cdot 10^{-3} - 1,8 \cdot 10^{-3} = 1,8 \cdot 10^{-3}\text{ J}$$

Javob: $W = 1,8 \cdot 10^{-3}\text{ J}$; $W_m = 3,6 \cdot 10^{-3}\text{ J}$; taqsimot 50 % va 50 %.

6-masala. O‘zgaruvchan tok zanjirida faqat rezistor

O‘zgaruvchan tok zanjirida kuchlanish $U^{\text{ok}} = 220\text{ V}$, tok $I^{\text{ok}} = 2,0\text{ A}$ va ular fazada ($\varphi = 0$).

Topilsin:

- a) rezistor qarshiligi R
- b) quvvat P
- c) U_0 va I_0 amplituda qiymatlari

Yechim

a)

$$R = U^{\text{ok}}/I^{\text{ok}} = 220/2,0 = 110 \, \Omega$$

b)

$$P = U^{\text{ok}} I^{\text{ok}} \cos\varphi = 220 \cdot 2,0 \cdot 1 = 440 \, W$$

c)

$$U_0 = \sqrt{2} \cdot U^{\text{ok}} \approx 1,41 \cdot 220 \approx 310 \, V$$

$$I_0 = \sqrt{2} \cdot I^{\text{ok}} \approx 1,41 \cdot 2,0 \approx 2,8 \, A$$

Javob: $R = 110 \, \Omega$; $P = 440 \, W$; $U_0 \approx 310 \, V$; $I_0 \approx 2,8 \, A$.

7-masala. O'zgaruvchan tok va quvvat koeffitsienti

Zanjirda $U^{\text{ok}} = 120 \, V$, $I^{\text{ok}} = 5,0 \, A$, quvvat $P = 480 \, W$.

Topilsin:

a) quvvat koeffitsienti $\cos\varphi$

b) fazalar farqi φ

c) agar zanjirdagi to'liq qarshilik Z bo'lsa, Z ni toping.

Yechim

a)

$$P = U^{\text{ok}} I^{\text{ok}} \cos\varphi$$

$$\cos\varphi = P/(U^{\text{ok}} I^{\text{ok}}) = 480/(120 \cdot 5,0)$$

$$120 \cdot 5,0 = 600$$

$$\cos\varphi = 480/600 = 0,80$$

b)

$$\varphi = \arccos(0,80) \approx 37^\circ$$

c) To'liq qarshilik:

$$Z = U^{\text{ok}}/I^{\text{ok}} = 120/5,0 = 24 \, \Omega$$

Javob: $\cos\varphi = 0,80$; $\varphi \approx 37^\circ$; $Z = 24 \, \Omega$.

8-masala. Ideal transformator bilan tokni kamaytirish

Ideal transformator orqali 220 V tarmoqdan ulanayotgan qurilmadan 11 A tok o'tmoqda. Qurilma 110 V kuchlanishda ishlashi kerak. Transformator yordamida qurilma to'g'ri rejimda ishlaydi.

Topilsin:

- a) transformatorning ikkilamchi kuchlanishi U_2
- b) ikkilamchi tok I_2
- c) agar $N_1 = 600$ bo'lsa, N_2 ni toping.

Yechim

a) $U_2 = 110 \text{ V}$ (shart bo'yicha qurilma uchun kerakli kuchlanish).

b) Ideal transformatorida $P_1 = P_2$:

$$P_1 = U_1 I_1 = 220 \cdot 11 = 2420 \text{ W}$$

$$P_2 = U_2 I_2 = 110 I_2$$

$$I_2 = P_2/U_2 = P_1/U_2 = 2420/110 \approx 22 \text{ A}$$

c) Kuchlanish va o'ram nisbatlari:

$$U_1/U_2 = N_1/N_2$$

$$N_2 = N_1 \cdot U_2/U_1 = 600 \cdot 110/220 = 600 \cdot 0,5 = 300$$

Javob: $U_2 = 110 \text{ V}$; $I_2 \approx 22 \text{ A}$; $N_2 = 300$.

9-masala. Transformator va yo'qotishlar

Transformator birlamchi tomondan 500 W quvvat oladi. Foydali ish ko'effitsienti $\eta = 0,92$. Ikkilamchi kuchlanish 50 V.

Topilsin:

- a) ikkilamchi quvvat P_2
- b) ikkilamchi tok I_2
- c) energiya yo'qotilishi ΔP

Yechim

a)

$$P_2 = \eta P_1 = 0,92 \cdot 500 = 460 \text{ W}$$

b)

$$I_2 = P_2/U_2 = 460/50 \approx 9,2 \text{ A}$$

c)

$$\Delta P = P_1 - P_2 = 500 - 460 = 40 \text{ W}$$

Javob: $P_2 = 460 \text{ W}$; $I_2 \approx 9,2 \text{ A}$; yo'qotish 40 W .

10-masala. G'altak energiyasi va unga mos kondensator

Induktivligi $L = 0,10 \text{ H}$ bo'lgan g'altakdan $I = 4,0 \text{ A}$ tok o'tayapti.

Topilsin:

a) g'altakdagi magnit energiyasi W_L

b) shu energiyaga teng energiyani $U = 20 \text{ V}$ kuchlanishda saqlaydigan kondensator sig'imi C

c) agar shu kondensator $R = 50 \Omega$ rezistor orqali razryad qilinsa, boshlang'ich tok I_0

Yechim

a)

$$W_L = L I^2 / 2$$

$$I^2 = 16$$

$$W_L = 0,10 \cdot 16 / 2 = 1,6 / 2 = 0,80 \text{ J}$$

b) Kondensator energiyasi:

$$W = C U^2 / 2$$

$$W = W_L \rightarrow C U^2 / 2 = 0,80$$

$$C = 2 W_L / U^2 = 2 \cdot 0,80 / 20^2$$

$$20^2 = 400$$

$$C = 1,6 / 400 = 0,004 \text{ F}$$

Bu $4,0 \text{ mF}$.

c) Kondensator razryadining boshlanishida tok:

$$I_0 = U / R = 20 / 50 = 0,40 \text{ A}$$

Javob: $W_L = 0,80 \text{ J}$; $C = 0,004 \text{ F}$; $I_0 = 0,40 \text{ A}$.