5. Gaia – Zirkuituetako oinarrizko legeak eta horien aplikazioak

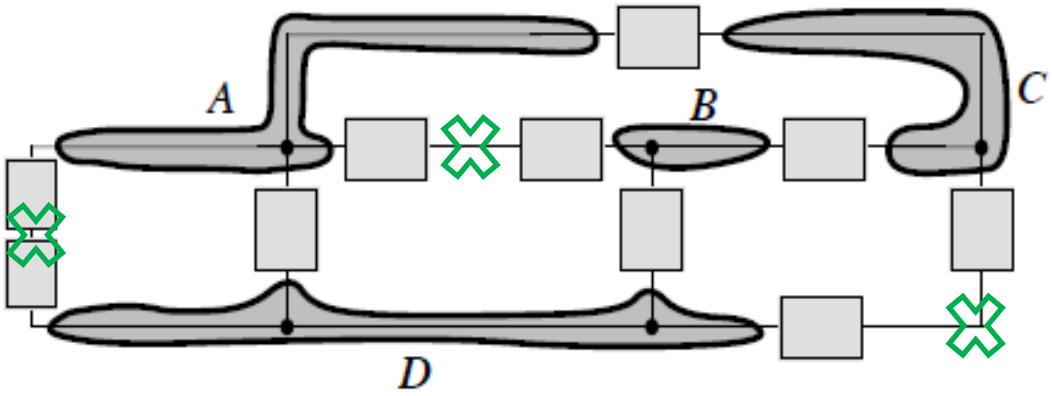
2018-2019 Ikasturtea
Irakaslea: Jose Manuel Gonzalez
Teknologia Elektronikoko Saila
5I28 – Bilboko Ingeniaritza Eskola (II Eraikina)
josemanuel.gonzalezp@ehu.eus

Gaiaren gai-zerrenda

1. Oinarrizko kontzeptuak
2. Kirchhoff-en legeak
3. Zirkuituen ebazpide arrunta
4. Elementuen serie eta paralelo elkarketak
5. Elkarketen aplikazioak
6. Tentsio eta korronte neurketak

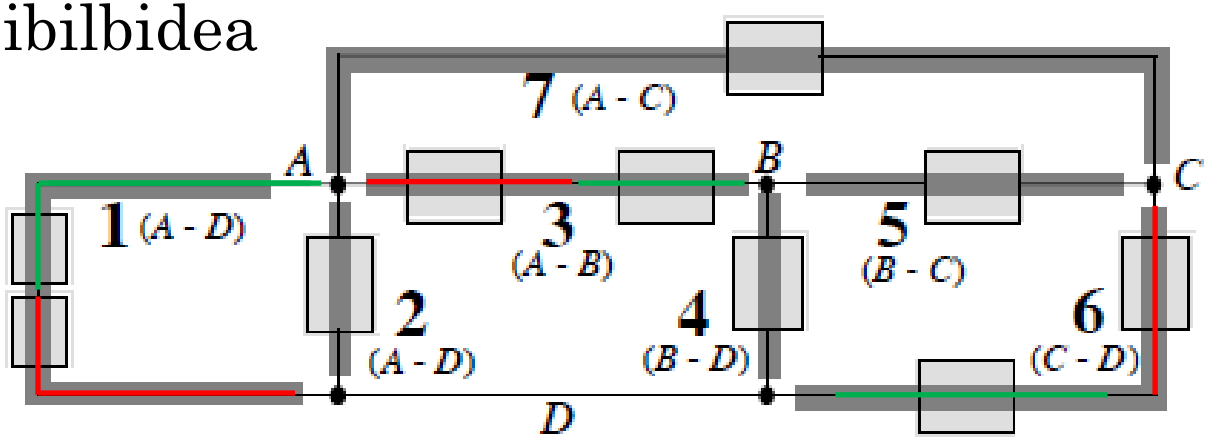
1. Oinarrizko kontzeptuak

- **Nodo edo korapilo:** Bi (hiru) elementu edo gehiago elkartzen direneko puntua



Nodoen arteko tentsioak

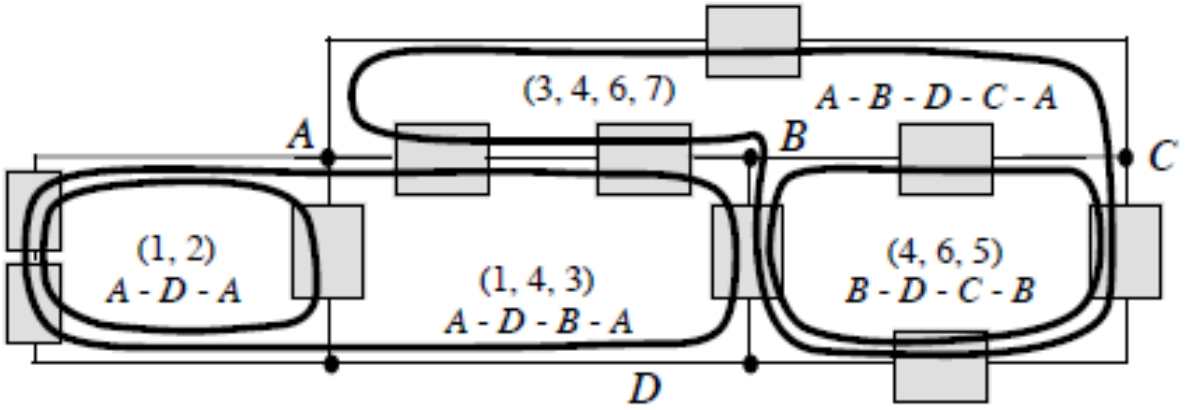
- **Adarra:** Ondoko bi nodo edo korapiloren arteko ibilbidea



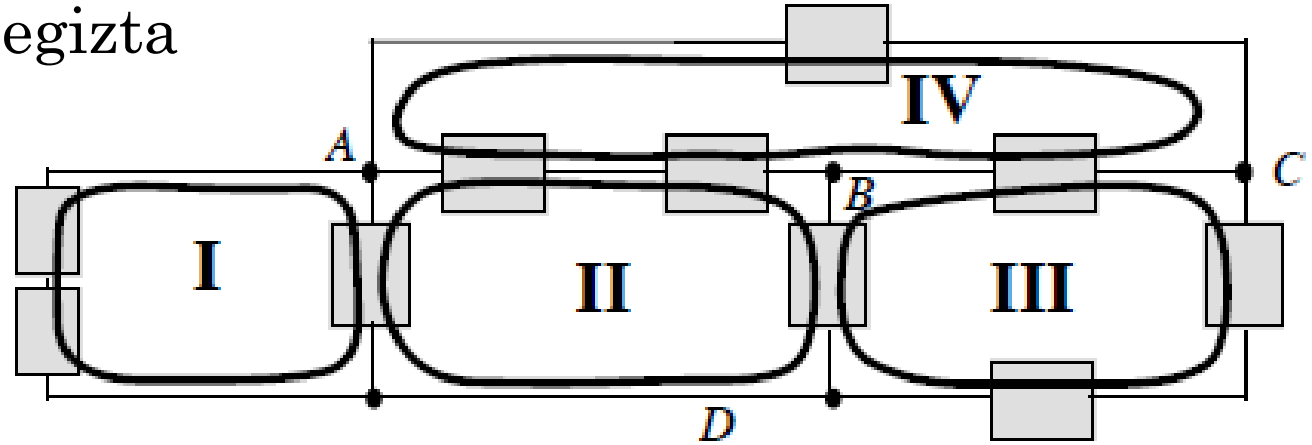
Adarreko korrontea

1. Oinarrizko kontzeptuak

- **Begizta:** Zirkuitu batean, adarreko osaturiko edozein ibilbide itxi

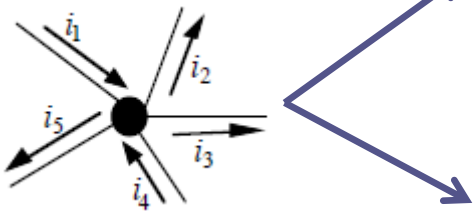


- **Maila:** Barruan adarrik barne hartzen ez duen begizta



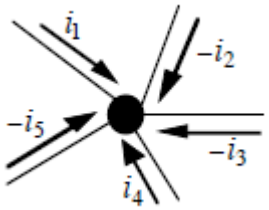
2. KIRCHHOFF-EN LEGEAK

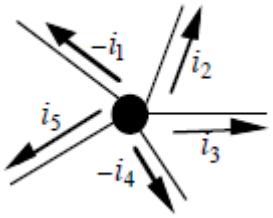
- Kirchhoff-en korronteen legea (KKL edo KCL)
  Nodoen edo korapiloen legea
  - Kargaren kontserbazioaren printzipioan oinarritzen da
  - Definizioa: Korapilo batera iristen diren intentsitate guztien batura aljebraikoa zero da



$$\sum_{guztiak} i_{iritsi} = 0$$

$$\sum_{guztiak} i_{irten} = 0$$

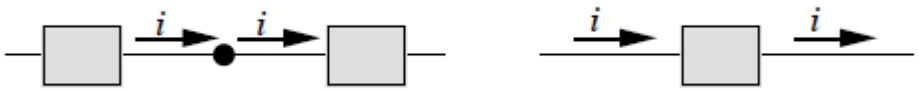


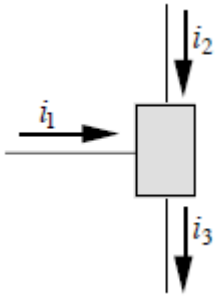


$$\sum i_{iritsi} = \sum i_{irten}$$

2. KIRCHHOFF-EN LEGEAK

- Kirchhoff-en korronteen legea (KKL edo KCL)
  Nodoen edo korapiloen legea
  - Ondorioz:



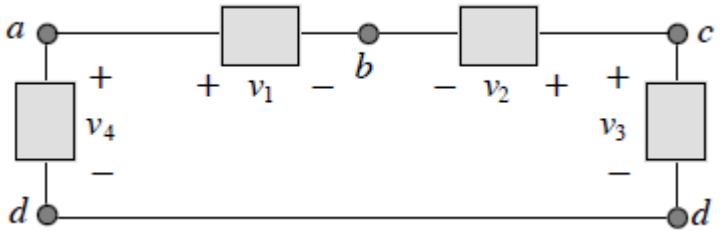


$$i_1 + i_2 = i_3$$

2. KIRCHHOFF-EN LEGEAK

- Kirchhoff-en tentsioen legea (KTL edo KVL) Begizten legea
  - Energiaren kontserbazioaren printzipioan oinarritzen da
  - Definizioa: Begizta batean, tentsio guztien batura algebraikoa zero da (tentsioen zeinuak kontuan hartuz!)

$$\sum_{guztiak} v = 0$$



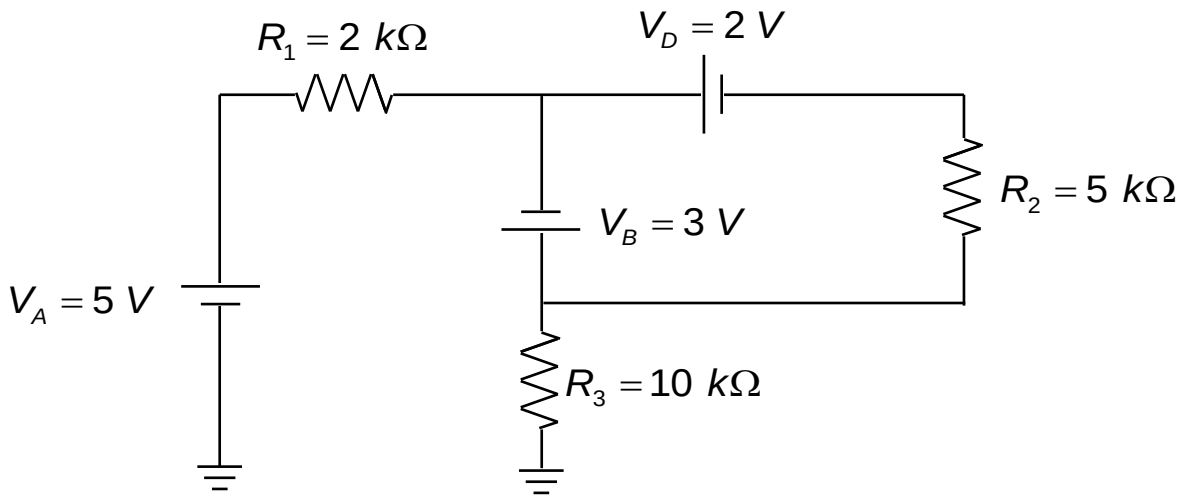
$$v_{ab} + v_{bc} + v_{cd} + v_{da} = v_1 - v_2 + v_3 - v_4 = 0$$

3. Zirkuituen ebazpide arrunta

1. Korapilo kopurua: N
2. Adarretako korronteen noranzkoak arbitrarioki
3. Tentsioen noranzkoak aukeratu
4. Ezezagun kopurua zenbatu → Planteatu ekuazioak (KVL + KCL)
   - Begiztak erabili → Korronte sorgailurik gabeko begiztak
5. Sistema ebatzi
6. Soluzioa eman

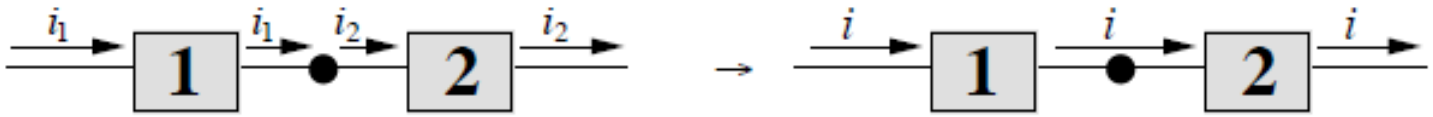
3. Zirkuituen ebazpide arrunta

- Adibidea

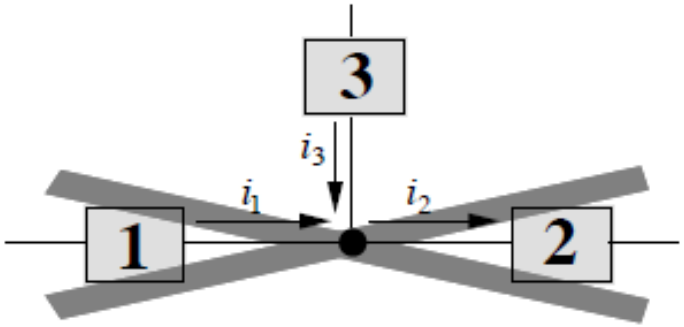


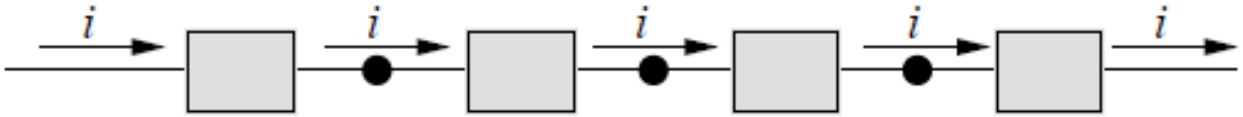
4. Elementuen serie eta paralelo elkarketak

- Serie elkarketa
  - Bi elementu seriean konektaturik daude mutur komun bat baldin badute eta, gainera, mutur komun horretan beste elementu bat konektaturik ez badago.



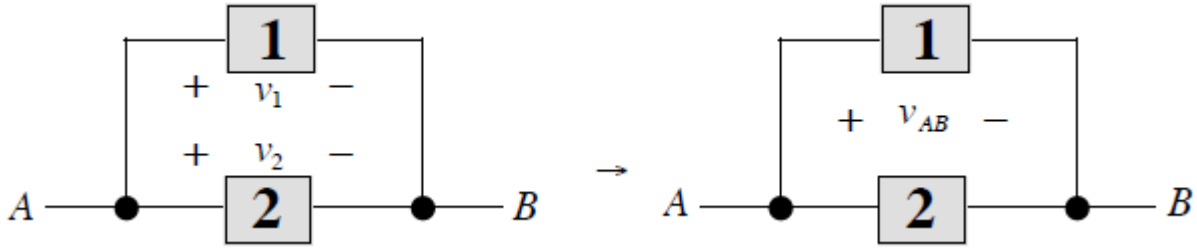
  - Bi elementu seriean konektaturik daude, bietatik korronte bera igarotzen denean.



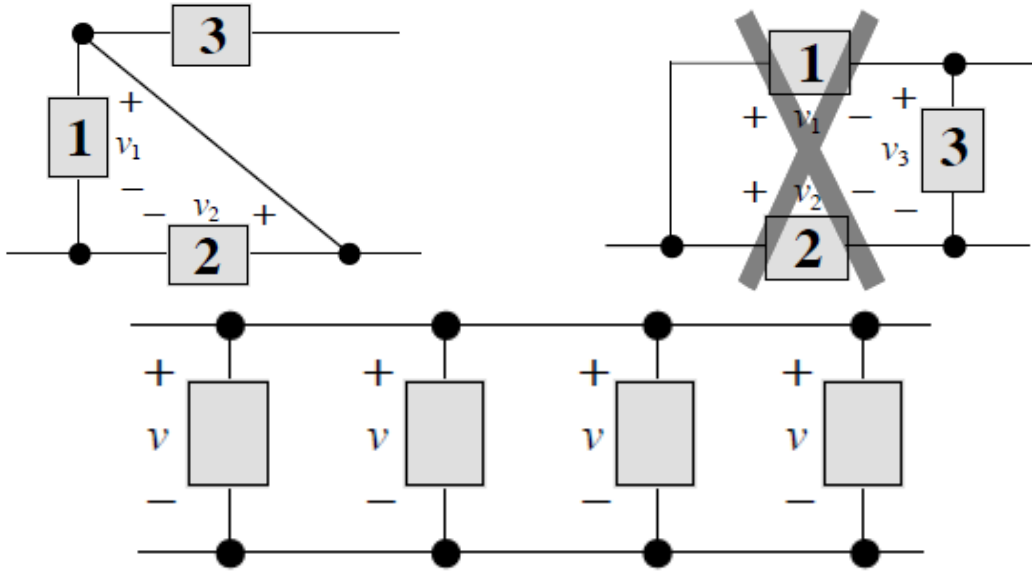


4. Elementuen serie eta paralelo elkarketak

- Paralelo elkarketa
  - Bi elementu paraleloan konektaturik daude, bi muturrak komunak dituztenean.

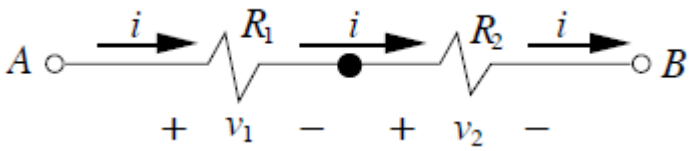


  - Bi elementu paraleloan konektaturik daude, bien muturren arteko tentsioa bera denean.

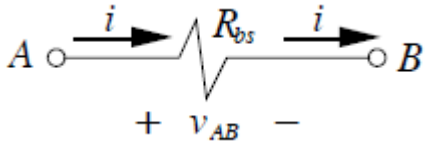


4. Elementuen serie eta paralelo elkarketak

- Erresistentziak seriean



Erresistenzia baliokidea



$$v_1 = R_1 i \qquad v_2 = R_2 i$$

$$v_{AB} = R_{bs} i$$

$$v_{AB} = v_1 + v_2 = R_1 i + R_2 i$$

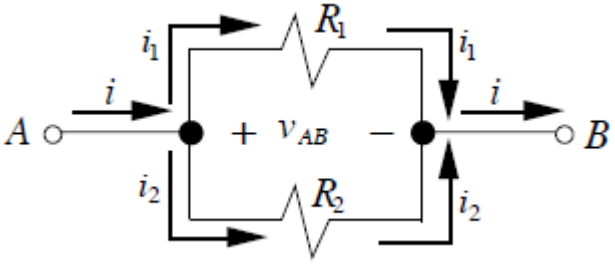
$$v_{AB} = \left(R_1 + R_2\right) i$$

$$R_{bs} = R_1 + R_2$$

$$R_{bs} = \sum_i R_i$$

4. Elementuen serie eta paralelo elkarketak

- Erresistentziak paraleloan

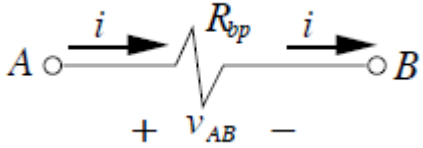


$$v_{AB} = R_1 i_1 \qquad v_{AB} = R_2 i_2$$

$$i = i_1 + i_2 = \left(\frac{v_{AB}}{R_1}\right) + \left(\frac{v_{AB}}{R_2}\right)$$

$$i = \left[\left(\frac{1}{R_1}\right) + \left(\frac{1}{R_2}\right)\right] \cdot v_{AB}$$

Erresistenzia baliokidea



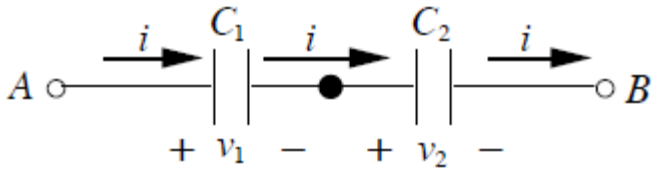
$$i = \frac{v_{AB}}{R_{bp}}$$

$$\frac{1}{R_{bp}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{bp}} = \sum_i \frac{1}{R_i}$$

4. Elementuen serie eta paralelo elkarketak

- Kondentsadoreak seriean



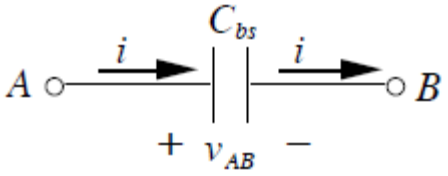
$$i = C_1 \cdot \frac{dv_1}{dt} \qquad i = C_2 \cdot \frac{dv_2}{dt}$$

$$v_{AB} = v_1 + v_2 \rightarrow \frac{dv_{AB}}{dt} = \frac{dv_1}{dt} + \frac{dv_2}{dt}$$

$$\frac{dv_{AB}}{dt} = \frac{i}{C_1} + \frac{i}{C_2} = \left(\frac{1}{C_1} + \frac{1}{C_2}\right) i$$

$$\frac{1}{C_{bs}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Kapazitate baliokidea



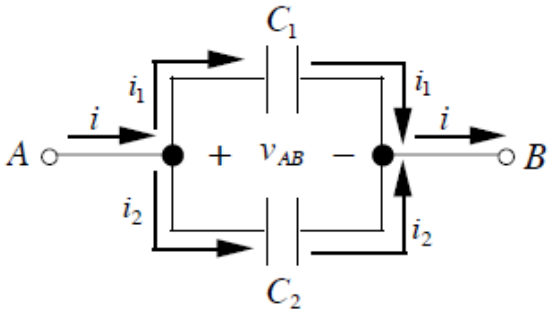
$$i = C_{bs} \cdot \frac{dv_{AB}}{dt}$$

$$\frac{dv_{AB}}{dt} = \left(\frac{1}{C_{BS}}\right) i$$

$$\frac{1}{C_{bs}} = \sum_i \frac{1}{C_i}$$

4. Elementuen serie eta paralelo elkarketak

- Kondentsadoreak paraleloan



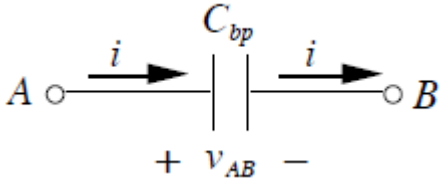
$$i = C_1 \cdot \frac{dv_{AB}}{dt} \qquad i = C_2 \cdot \frac{dv_{AB}}{dt}$$

$$i = i_1 + i_2$$

$$i = \left(C_1 + C_2\right)\frac{dv_{AB}}{dt}$$

$$C_{bp} = C_1 + C_2 \qquad C_{bp} = \sum_i C_i$$

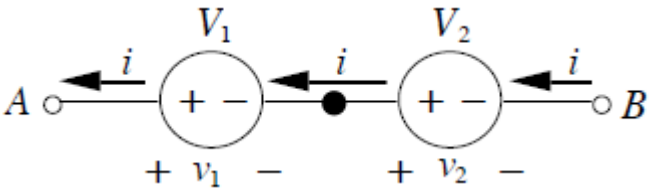
Kapazitate baliokidea



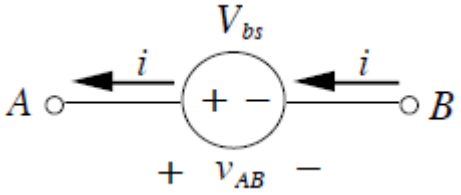
$$i = C_{bp} \cdot \frac{dv_{AB}}{dt}$$

4. Elementuen serie eta paralelo elkarketak

- Tentsio sorgailuak seriean



Tentsio sorgailu baliokidea



$$v_1 = V_1 \qquad v_2 = V_2$$

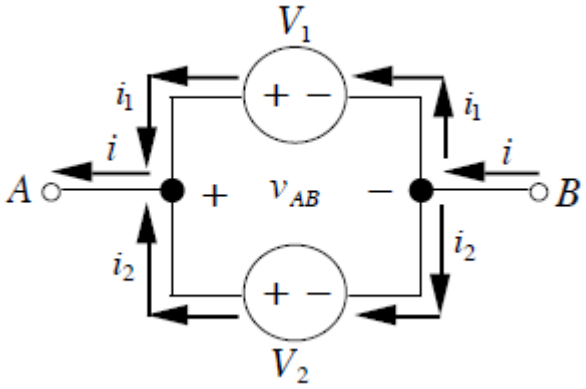
$$v_{AB} = V_{bs}$$

$$v_{AB} = v_1 + v_2 = V_1 + V_2$$

$$V_{bs} = V_1 + V_2 \qquad V_{bs} = \sum_i V_i$$

4. Elementuen serie eta paralelo elkarketak

- Tentsio sorgailuak paraleloan

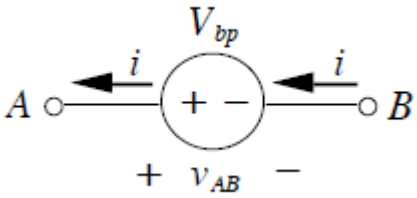


$$v_{AB} = V_1 \qquad v_{AB} = V_2$$

$$V_{bp} = V_1 = V_2$$

Zer gertatzen da ezberdinak badira? Zentzurik badauka paraleloan jartzea tentsio sorgailuak?

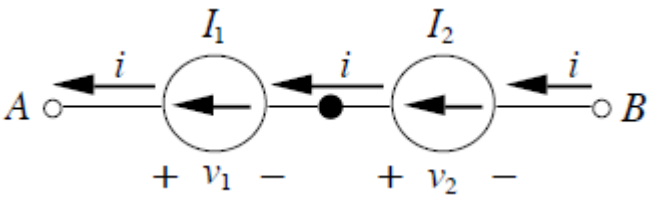
Tentsio sorgailu baliokidea



$$v_{AB} = V_{bp}$$

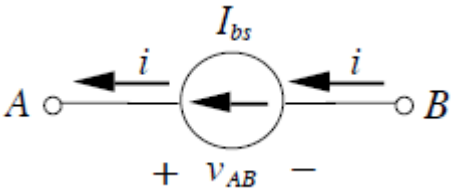
4. Elementuen serie eta paralelo elkarketak

- Korronte sorgailuak seriean



$$i = I_1 \qquad i = I_2$$

Korronte sorgailu baliokidea

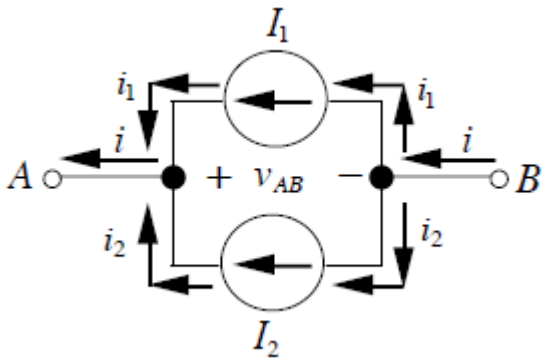


$$i = I_{bs}$$

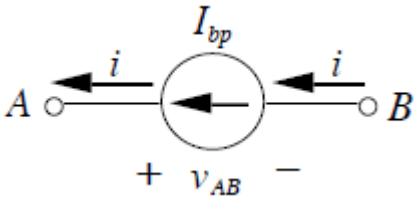
$$I_{bs} = I_1 = I_2$$

4. Elementuen serie eta paralelo elkarketak

- Korronte sorgailuak paraleloan



Korronte sorgailu baliokidea



$$i_1 = I_1 \qquad i_2 = I_2 \qquad i = I_{bp}$$

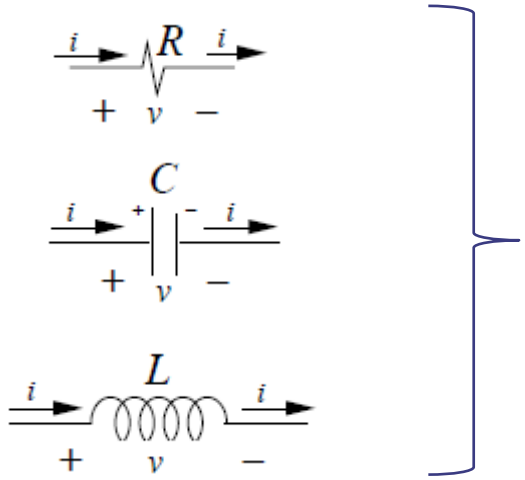
$$i = i_1 + i_2 = I_1 + I_2$$

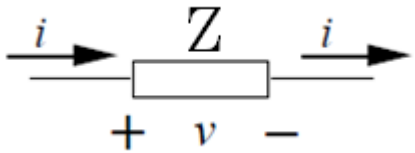
$$I_{bp} = I_1 + I_2$$

$$I_{bp} = \sum_i I_i$$

4. Elementuen serie eta paralelo elkarketak

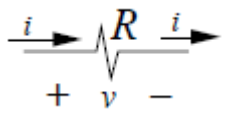
- Inpedantzia kontzeptua



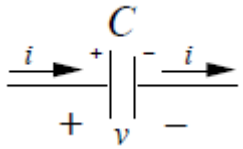


$$Z = R + jX\,[\Omega]$$

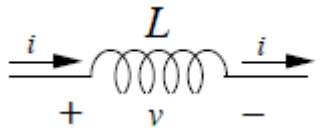
$$G = Y + jB[s]$$



$$Z_R = R$$



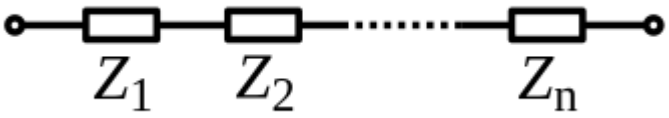
$$Z_c = -jX_c \rightarrow X_c = \frac{1}{\omega C} = \frac{1}{2\pi fC}$$



$$Z_L = jX_L \rightarrow X_L = \omega L = 2\pi fL$$

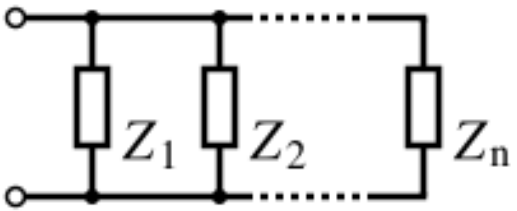
4. Elementuen serie eta paralelo elkarketak

- Inpedantziak seriean



$$Z_{bs} = \sum_i Z_i$$

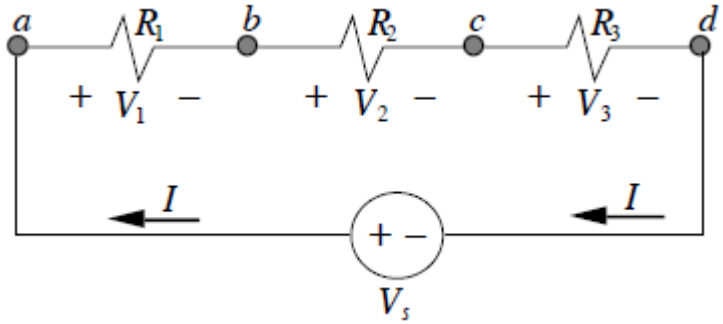
- Inpedantziak paraleloan



$$\frac{1}{Z_{bp}} = \sum_i \frac{1}{Z_i}$$

5. Elkarketen aplikazioak

- Tentsio zatitzailea



$$V_s = V_1 + V_2 + V_3 \qquad V_1 = R_1 I, \quad V_2 = R_2 I, \quad V_3 = R_3 I$$

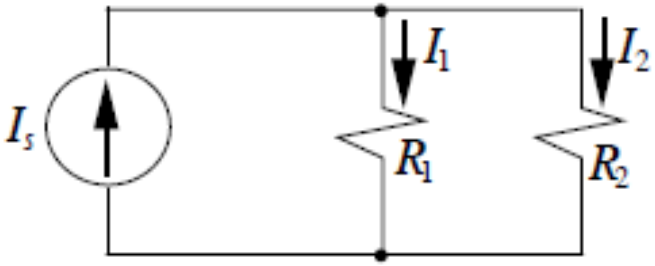
$$I = \frac{V_s}{R_1 + R_2 + R_3} = \frac{V_s}{R_{bs}}$$

$$V_1 = \frac{R_1}{R_{bs}} \mathrm{V}_s, \quad V_2 = \frac{R_2}{R_{bs}} \mathrm{V}_s, \quad V_3 = \frac{R_3}{R_{bs}} \mathrm{V}_s$$

$$V_i = \frac{R_i}{R_{bs}} \mathrm{V}_s$$

5. Elkarketen aplikazioak

- Korronte zatitzailea



$$I_s = I_1 + I_2 \qquad V_1 = R_1 I_1, \quad V_2 = R_2 I_2, \quad V_{bp} = R_{bp} I_s$$

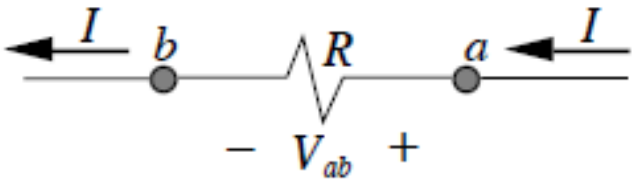
$$V_1 = V_2 = V_{bp}$$

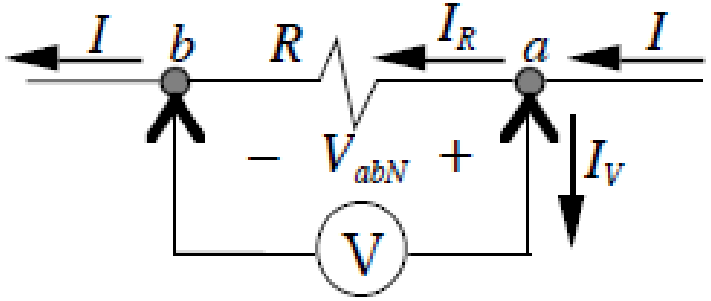
$$I_1 = \frac{V_{bp}}{R_1} = \frac{R_{bp}}{R_1} I_s \qquad I_2 = \frac{V_{bp}}{R_2} = \frac{R_{bp}}{R_2} I_s$$

$$I_i = \frac{V}{R_1} = \frac{R_{bp}}{R_i} I_s$$

6. TENTSIO ETA KORRONTE NEURKETAK

- Voltmetroa





- a eta b puntuen artean neurtzen du tentsioa
- Voltmetroa konektatzean zirkuitua aldatzen dugu → neurtu nahi dugun tentsioa aldatzen dugu
- Voltmetro ideal batean:

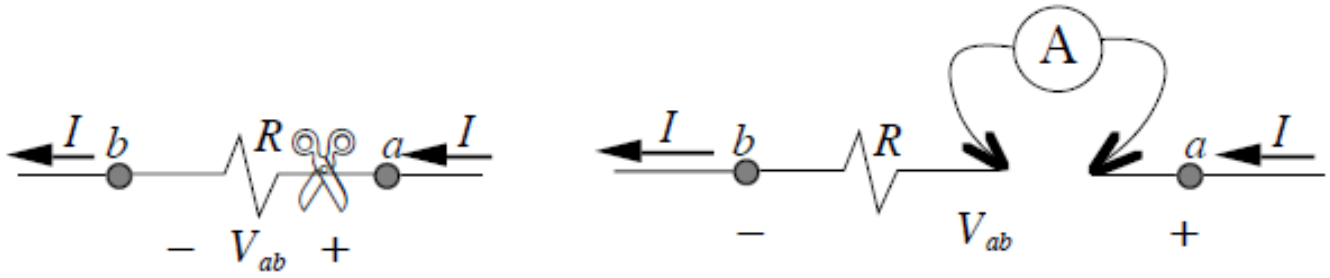
$$R_v = \infty \rightarrow I_v = 0 \rightarrow I_R = I \rightarrow V_{abN} = V_{ab}$$

- Voltmetro erreal batean:

$$R_v \gg R$$

6. TENTSIO ETA KORRONTE NEURKETAK

- Anperemetroa



  - ab adarreko korrontea neurtzen du
  - Anperemetroa konektatzean zirkuitua aldatzen dugu → neurtu nahi dugun korrontea aldatzen dugu
  - Anperemetro ideal batean:

$$R_A = 0 \rightarrow V_A = 0 \rightarrow V'_{ab} = V_{ab} \rightarrow I_N = I$$

  - Anperemetro erreal batean:

$$R_A \ll R$$