

GMI 2752
GENİ ELEKTRONİĞİ

Doç. Dr. Muhammed Emin BAŞAK
(19.02.2024)

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ODA : T-404

Görüşme Saati : Salı 13.00-13.30

Salı 13.30-14.00

Perş 11.00-11.30

İÇERİK

- 1- Basic Concepts, KCL, KVL, Ohm's Law
 - 2- Semiconductor materials
 - 3- Diodes
 - 4- Diode Applications
 - 5- Bipolar Transistors (BJT)
 - 6- Application of BJTs
 - 7- MOSFETs
 - 8- Application of MOSFETs
 - 9- Op-Amps
 - 10- Application of Op-Amps
 - 11- Ship Electronics.
- Direk. 
→ Bobin 
→ Kondensatör 



Geçme Notu → 40 → DC

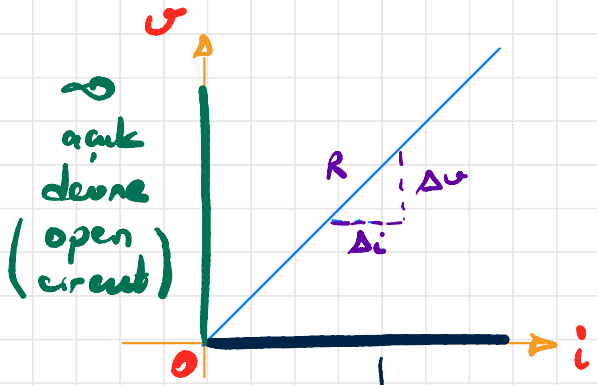
EXAM

- 1- Midterm Exam → %30
- 2- Final Exam → %40
- 3- Quizes $\left. \begin{array}{l} \rightarrow 1. Quiz \\ \rightarrow 2. Quiz \end{array} \right\} + Telafi \right\} \%30$

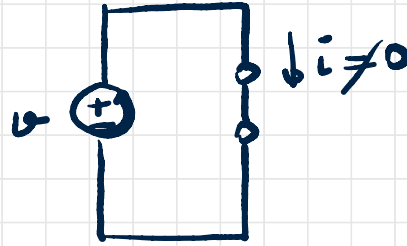
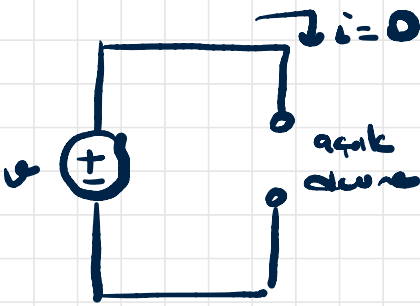
OHM KANUNU



$$U = i \cdot R$$



$R = ? 0$
kısa devre (short circuit)



$$U = i \cdot R$$

→ Ohm kanunu.

$\swarrow$ Volt (V)
 $\downarrow$ Amper (A)
 $\searrow$ (Ohm) Direnç

$$R = \frac{1}{G}$$

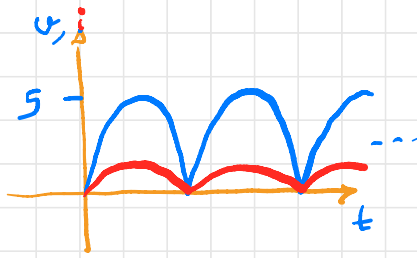
$$I = U \cdot G$$

→ OHM KANUNU

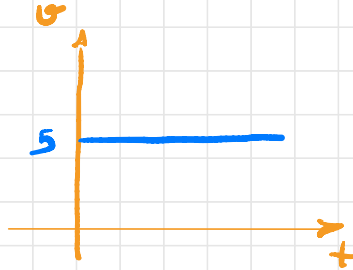
$\swarrow$ Amper
 $\downarrow$ Volt
 $\searrow$ İletkenlik (Siemens) $\text{mHO} \sim$



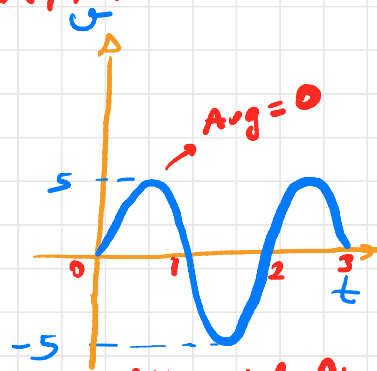
GERİLİM KAYNAĞI - AKIM KAYNAĞI



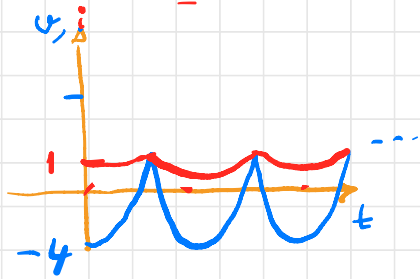
Doğru Akım



DC

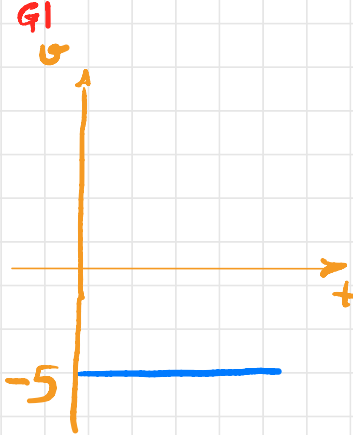


Alternatif Ak.



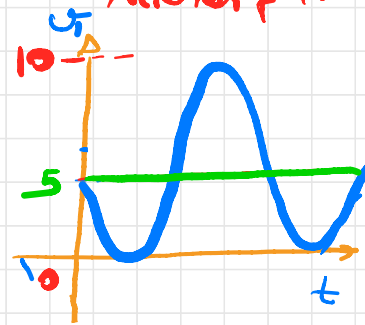
DC

Avg $\neq 0$



DC

Avg $\neq 0$

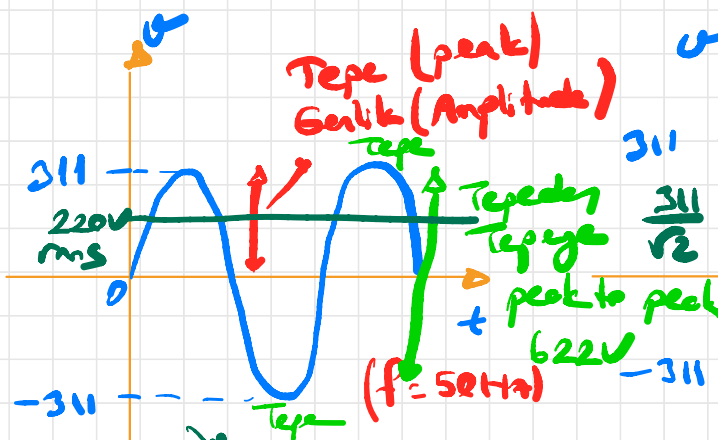


$$V_1 = 5 - 5 \sin \omega t$$

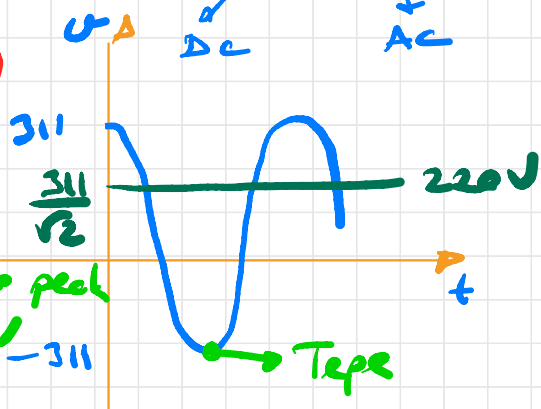
AC + DC

$$5V + 5 \cos \omega t$$

DC AC



$$V = 311 \sin(2\pi \cdot 50t)$$



$$V = 311 \sin(2\pi 50t + 90)$$

RMS Değer / Etkin Değer / Efektif Değer

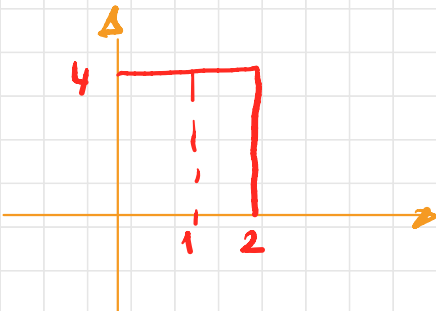
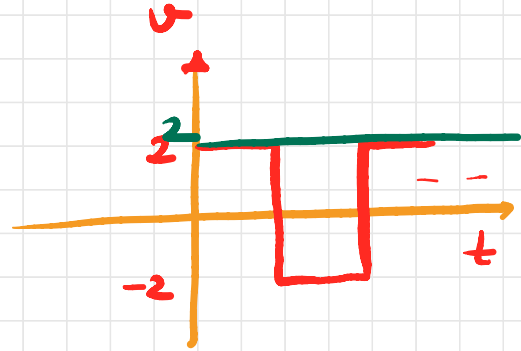
$$\frac{311V}{\sqrt{2}} \approx 220V$$

RMS Değer
Etkin Değer
Efektif Değer

Root-Mean-Square Value

$$\sqrt{\frac{1}{T} \int_0^T v^2(t) dt} = v_{rms}$$

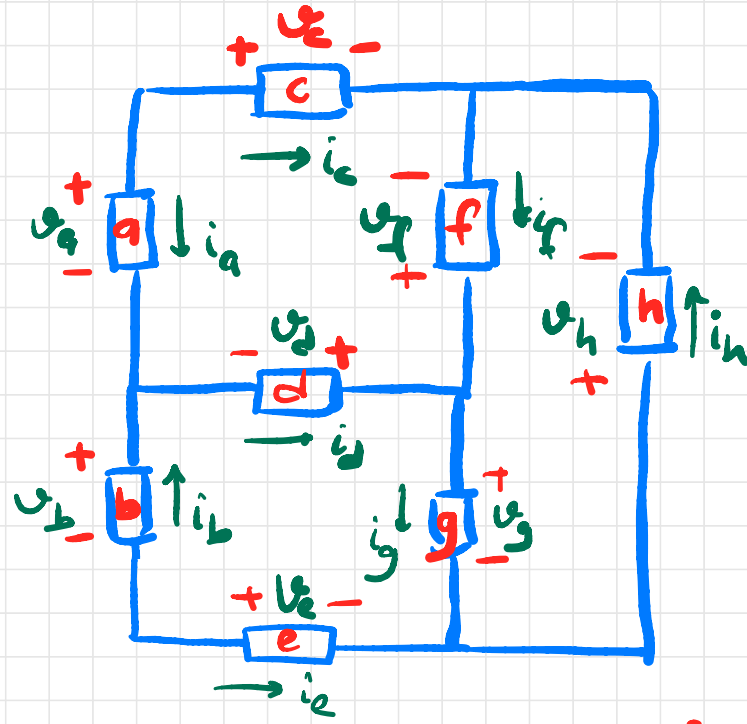
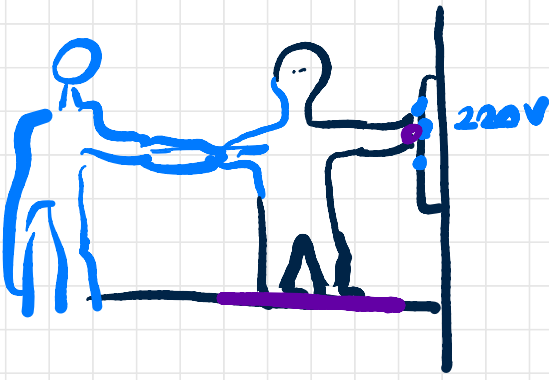
Sinoidal $\rightarrow \frac{v_{max}}{\sqrt{2}}$
Üçgen $\rightarrow \frac{v}{\sqrt{3}}$
Kare $\rightarrow \frac{1}{T} \int_0^T v^2(t) dt$



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27.02.2024

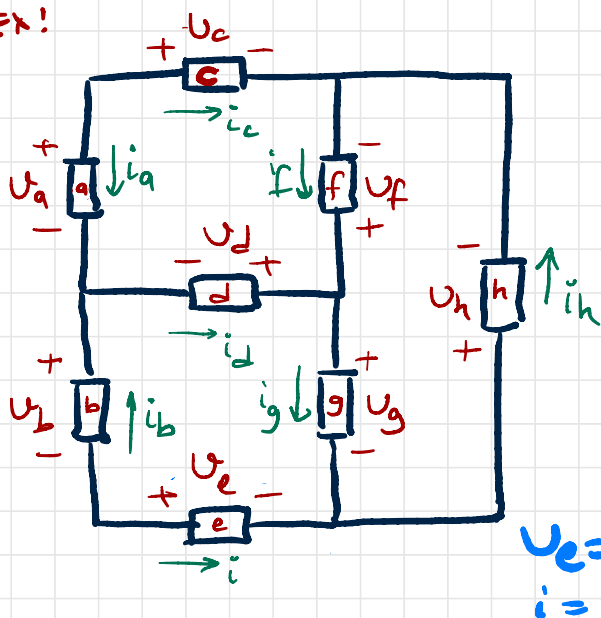
2. HAFTA



Eleman	Gerilim	Akım
a	120V	-10A
b	120V	9A
c	10V	10A
d	10V	-1A
e	-6V	-9A
f	-100V	5A
g	120V	4A
h	-220V	-5A

Soru: Üretilen güç nedir?
Tüketilen güç nedir?
Toplam güç nedir?

Ex!



Component	$V(V)$	$i(A)$
a	120	-10
b	120	9
c	10	10
d	10	-1
e	-10	-9
f	-100	5
g	120	4
h	-220	-5

$$V_e = 10$$

$$i = +9$$

$$\sum P = 0$$

$$P_a = +V_a \cdot i_a = 120 \cdot (-10) = -1200 \text{ W (üreteci)}$$

$$P_b = -V_b \cdot i_b = -(120) 9 = -1080 \text{ W (üreteci)}$$

$$P_c = +V_c \cdot i_c = 10 \cdot 10 = 100 \text{ W (tüketicisi)}$$

$$P_d = -V_d \cdot i_d = -(10)(-1) = 10 \text{ W (tüketicisi)}$$

$$P_e = +V_e \cdot i_e = (-10)(-9) = 90 \text{ W (tüketicisi)}$$

$$P_f = -V_f \cdot i_f = -(-100)(5) = 500 \text{ W (tüketicisi)}$$

$$P_g = +V_g \cdot i_g = (120)(4) = 480 \text{ W (tüketicisi)}$$

$$P_h = V_h \cdot i_h = (-220)(-5) = 1100 \text{ W (tüketicisi)}$$

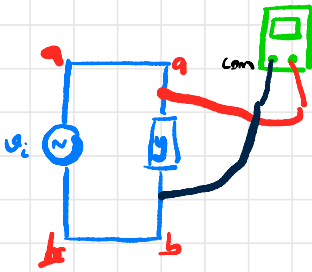
$$P_{\text{supplied}} + P_{\text{consumed}} = 0$$

GEMİ ELEKTRONİĞİ

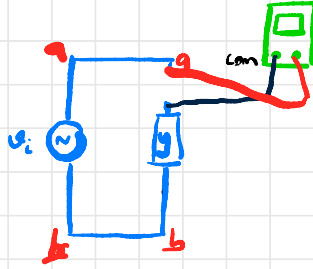
05.03.2024

3. HAFTA

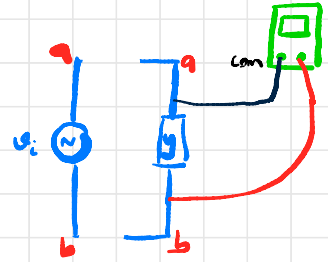
Gerilim Ölçüm



Akım Ölçüm

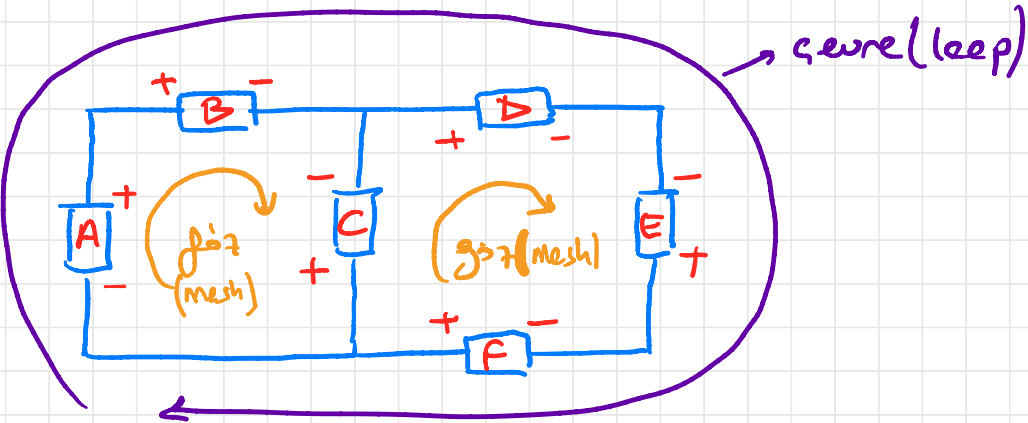


Direnç Ölçüm



Kaynaklar aynıdır.

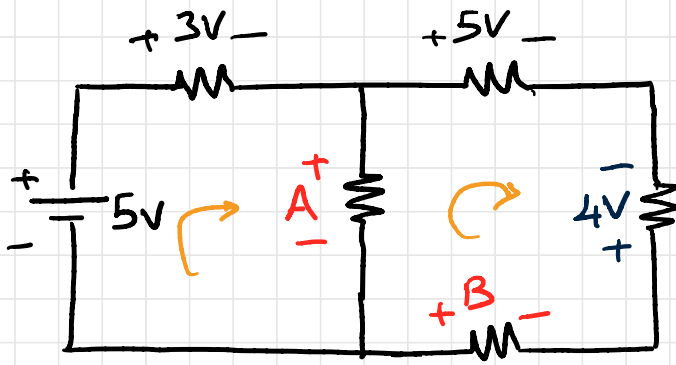
KIRCHOFF'UN GERİLİM YASASI



$$-A + B + D - E - F = 0$$

$$-A + B - C = 0$$

$$+C + D - E - F = 0$$



$$A = ?$$

$$B = ?$$

$$-5 + 3 + A = 0$$

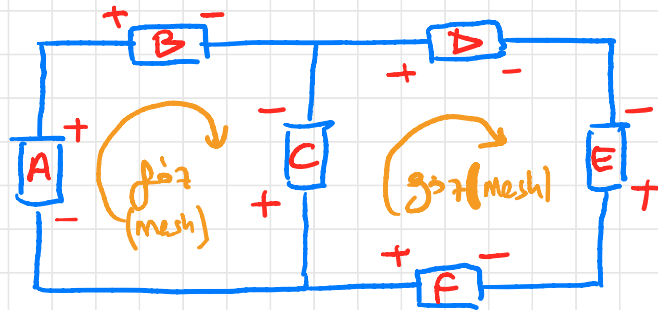
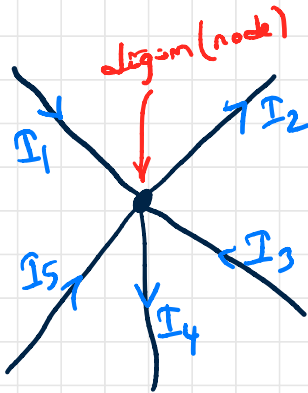
$$A = 2V$$

$$A = 2V \text{ ise}$$

$$-2 + 5 - 4 - B = 0$$

$$B = -1V$$

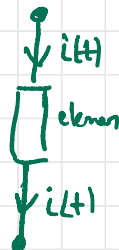
KIRCHHOFF'UN AKIM YASASI



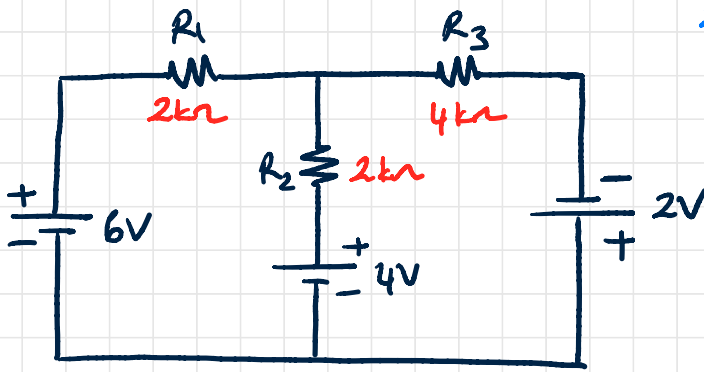
$$+I_1 - I_2 + I_3 - I_4 + I_5 = 0$$

$$I_1 + I_3 + I_5 = I_2 + I_4$$

$$\sum_{i=1}^N I_i(t) = 0$$



Ör:

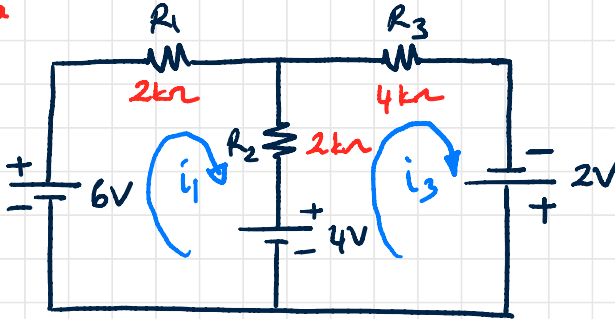


KVL (KGY) bul.

* R_1, R_2 ve R_3 dirençleri için akım ve gerilimleri bulunuz.

* R_2 direnci üzerinde harcanan güç bulunuz.

KG



$$-6 + R_1 \cdot i_1 + R_2 (i_1 - i_3) + 4V = 0$$

$$-4 + R_2 (i_3 - i_1) + R_3 i_3 - 2V = 0$$

$$-6 + 2i_1 + 2i_1 - 2i_3 + 4 = 0$$

$$-4 + 2i_3 - 2i_1 + 4i_3 - 2V = 0$$

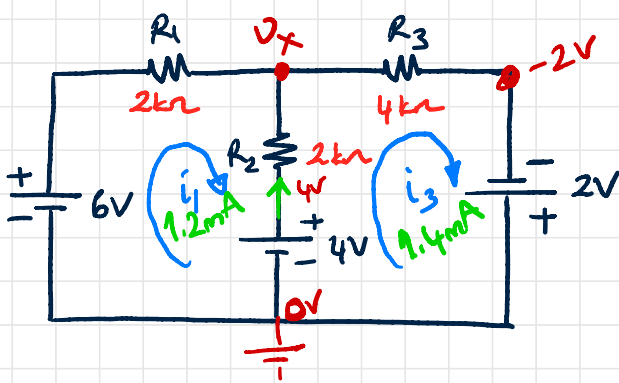
*

$$4i_1 - 2i_3 = 2V$$

$$-2i_1 + 6i_3 = 6V$$

$$\begin{bmatrix} 4 & -2 \\ -2 & 6 \end{bmatrix} \begin{bmatrix} i_1 \\ i_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 6 \end{bmatrix}$$

$$i_1 = \frac{\begin{vmatrix} 2 & -2 \\ 6 & 6 \end{vmatrix}}{24 - (4)} = \frac{12 - (-12)}{20} = 1,2 \text{ mA} \quad i_3 = \frac{\begin{vmatrix} 4 & 2 \\ -2 & 6 \end{vmatrix}}{20} = \frac{24 - (-4)}{20} = 1,4 \text{ mA}$$



$$\begin{aligned} \uparrow I_2 &= 1.4 - 1.2 \\ I_2 &= 0.2 \text{ mA} \uparrow \end{aligned}$$

$$V_{R2} = 0.2 \times 2\text{k}\Omega = 0.4\text{V}$$

$$V_x = 4 - 0.4\text{V} = 3.6\text{V}$$

$$V_{R1} = 6 - V_x = 6 - 3.6 = 2.4\text{V}$$

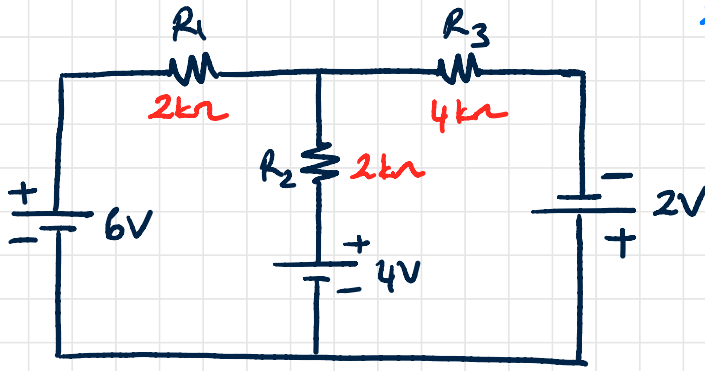
$$V_{R3} = V_x - (-2\text{V}) = 3.6 + 2 = 5.6\text{V}$$

$$P_{R2} = V_{R2} \cdot i_2 = 0.4 \times 0.2 = 0.08 \text{ mW}$$

(V) (mA)

Simulasyonlarla sonuçların doğruluğu
gösterildi...

Ör:



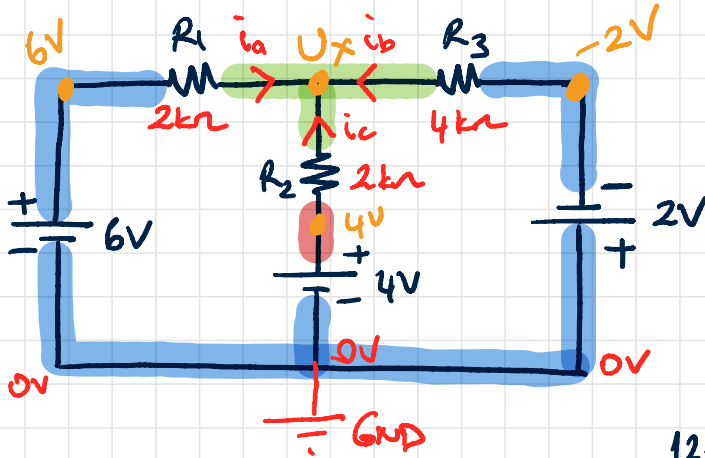
KCL. (KAY) bul

* R_1, R_2 ve R_3 dirençleri için daki akım ve gerilimleri bulur.

* R_2 direnci üzerinde harcanan güç bulunur

Node Analysis

- 1) Tüm düğümleri belirle.
- 2) Bir düğümü referans yap. (GND)
- 3) KCL yap
- 4) Akım ve gerilimleri bul.



$$i_a + i_b + i_c = 0$$

$$\frac{6 - U_x}{2k} + \frac{-2 - U_x}{4k} + \frac{4 - U_x}{2k} = 0$$

$$12 - 2U_x - 2 - U_x + 8 - 2U_x = 0$$

$$18 = 5U_x$$

$$U_x = 3.6V$$

$$i_a = \frac{6 - 3.6}{2} = 1.2mA$$

$$i_c = \frac{4 - 3.6}{2} = 0.2mA$$

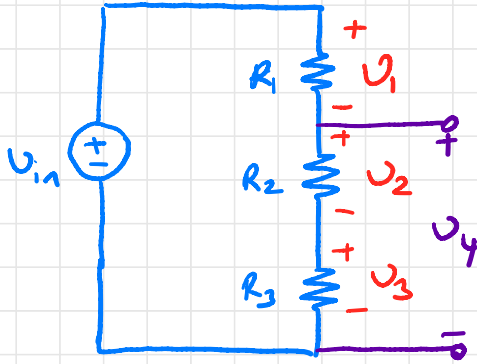
$$i_b = \frac{-2 - 3.6}{4} = -1.4mA$$

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12.03.2024

4. HAFTA

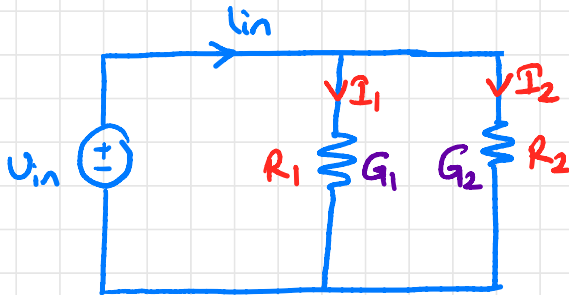
GERİLİM BÖLÜCÜ



$$\frac{U_{in}}{R_1 + R_2 + R_3} = \frac{U_2}{R_2}$$

$$\frac{U_{in}}{R_1 + R_2 + R_3} = \frac{U_4}{R_2 + R_3}$$

AKIM BÖLÜCÜ



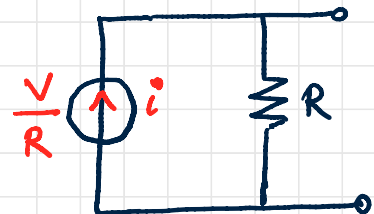
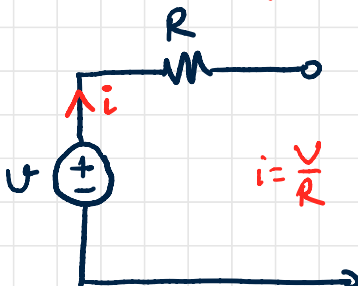
$$G_1 = \frac{1}{R_1} \quad G_2 = \frac{1}{R_2}$$

$$\frac{I_{in}}{G_1 + G_2} = \frac{I_1}{G_1}$$

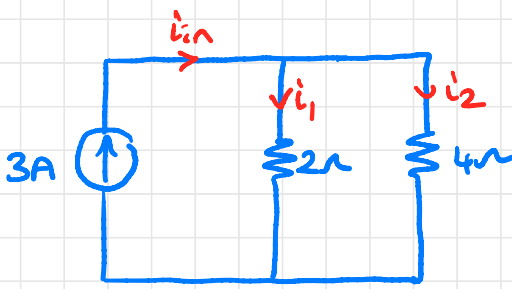
$$\frac{I_{in}}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{I_1}{\frac{1}{R_1}}$$

$$\frac{I_{in} \cdot \cancel{R_1} R_2}{R_1 + R_2} = \cancel{I_{in} \cdot R_1} \quad \frac{I_{in}}{R_1 + R_2} = \frac{I_1}{R_2}$$

KAYNAK DÖNÜŞÜMÜ



Ör:



$$\frac{i_n}{\frac{1}{2} + \frac{1}{4}} = \frac{i_1}{\frac{1}{2}}$$

$$\frac{i_n \cdot 4}{3} = 2i_1$$

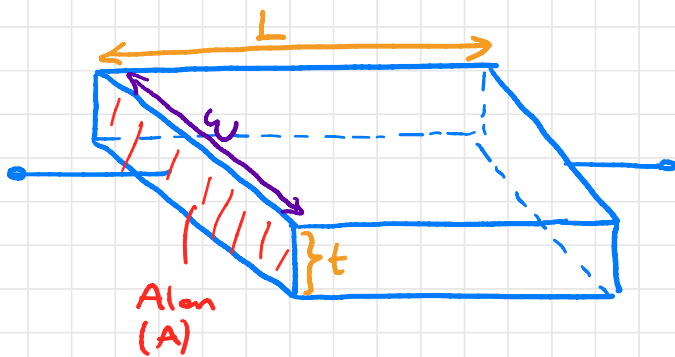
$$4 = 2i_1 \quad i_1 = 2A$$

ELEKTRONİK ELEMANLAR

- * Diyotlar
- * LED (Light Emitting Diodes)
- * Transistörler
- * Mikrocipler (Tandemler - Integrated Circuits)
- * Termistörler
- * Foto transistörler
- * Fotoresistörler
- * Laserler
- * Fotoelektrik hücreler (Photovoltaic cells)

Yarıiletkenlik nedir?

- İletkenler (Conductors)
- Yalıtkenler (Insulators)
- Yarıiletkenler (Semiconductors)

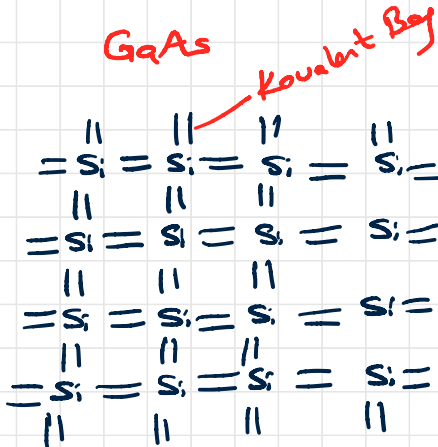
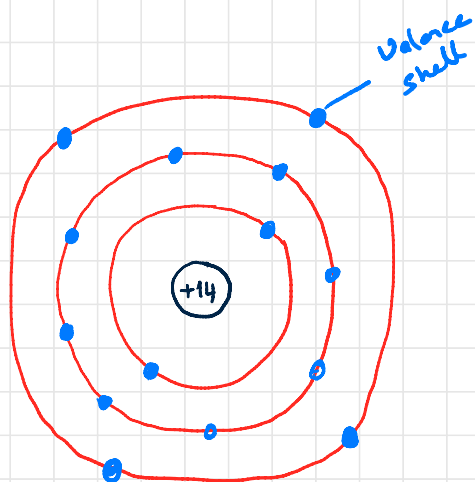


$$R = \rho \cdot \frac{L}{A}$$

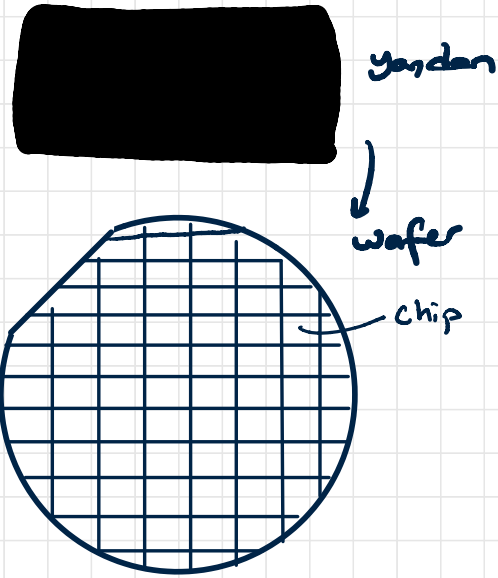
ρ → Resistivity (Ωm)
 L → Boy
 A → Alan
 Direction

$$\sigma = \frac{1}{\rho}$$

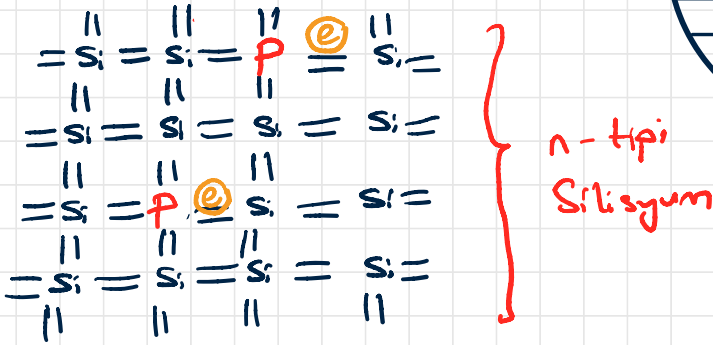
σ → Conductivity (iletkenlik)
 ρ → resistivity



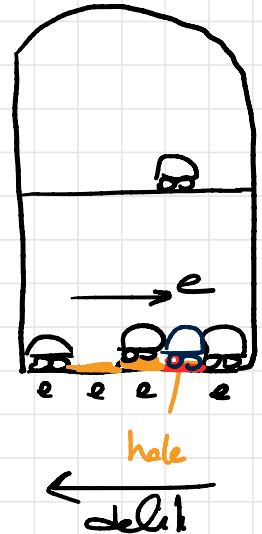
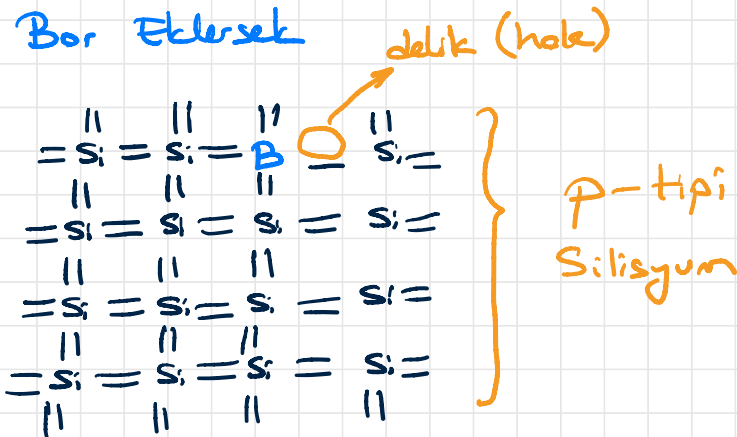
III	IV	V
B	C	N
Al	Si	P
Ga	Ge	As
In	Sn	Sb

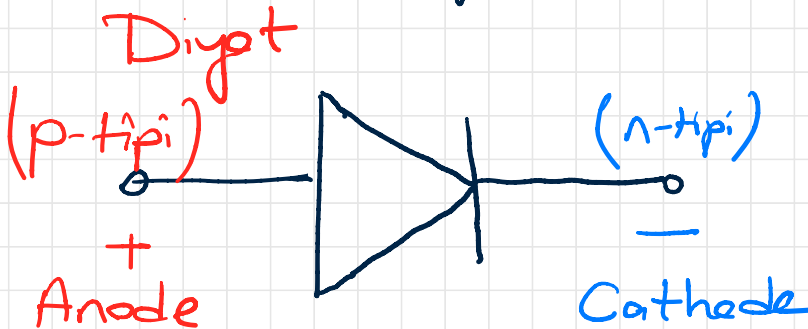
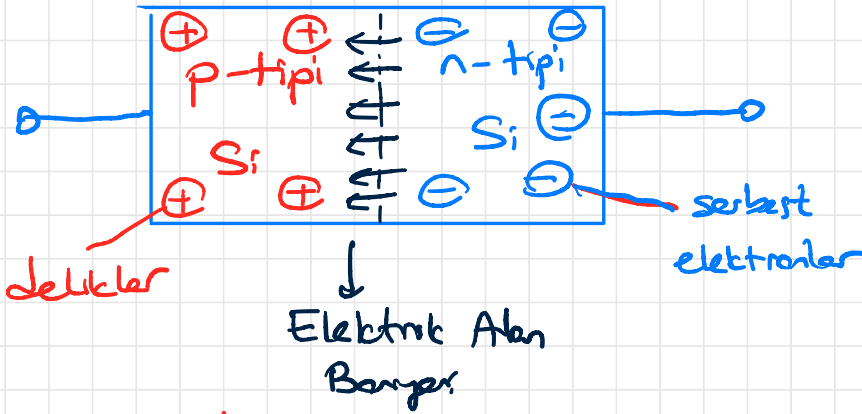
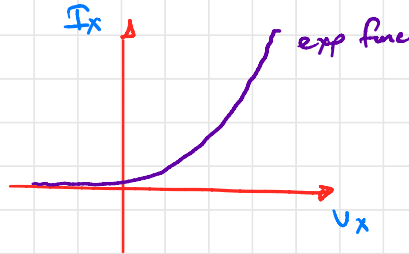
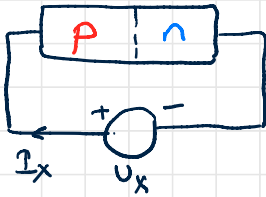
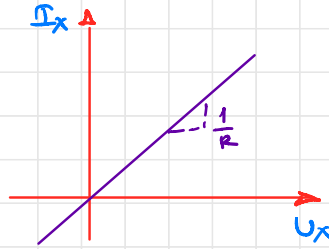
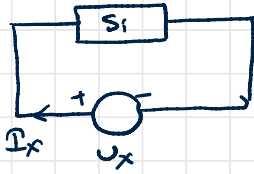
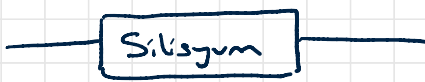


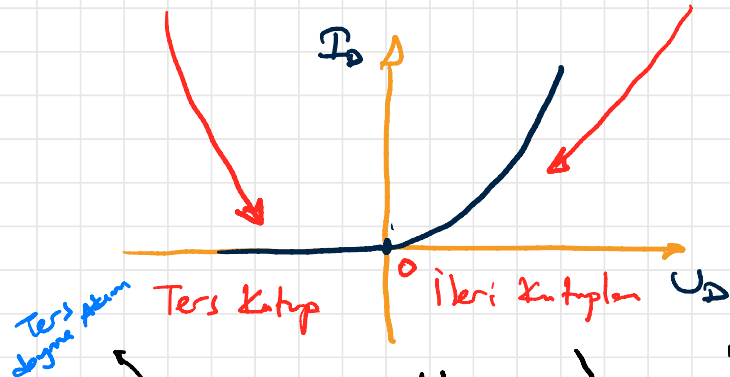
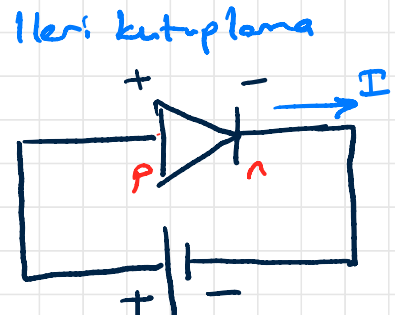
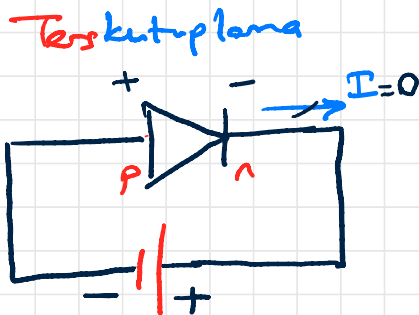
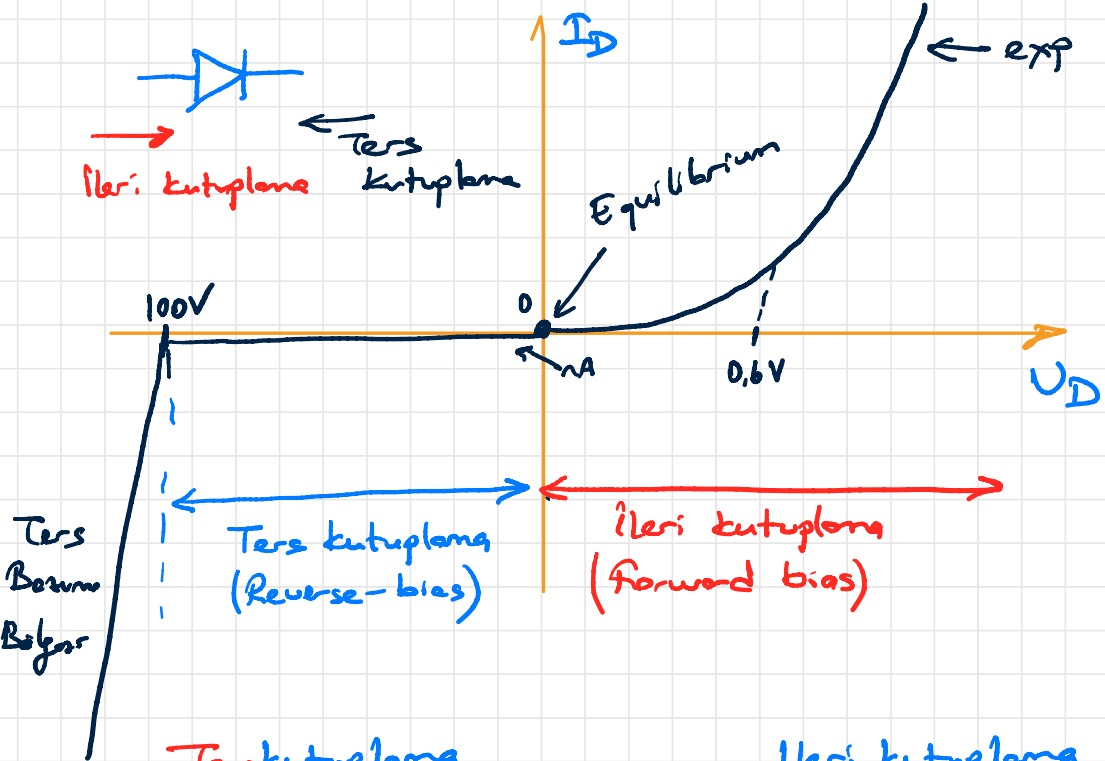
Fosfor Ekle



Bor Eklensek





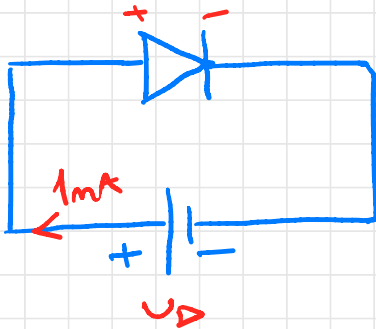


Diğer Akımı $\rightarrow I_D = I_s \left(\exp \frac{U_D}{V_T} - 1 \right)$

V_T : Termal Gerilim
 $V_T \approx 26 \text{ mV}$

$$\Rightarrow I_D = I_S \cdot \exp \frac{V_D}{V_T} = I_S \cdot e^{\frac{V_D}{V_T}}$$

Ör: $I_S = 10^{-16} \text{ A}$ is ve kutuplama akımı 1 mA ise, diyoda uygulanacak gerilim bulunuz. ($V_T = 26 \text{ mV}$)



$$I_D = I_S e^{\frac{V_D}{V_T}}$$

$$V_D = V_T \cdot \ln \frac{I_D}{I_S}$$

$1 \text{ mA} \rightarrow 1 \times 10^{-3} \text{ A}$
 $1 \times 10^{-16} \text{ A}$

$$V_D = 778 \text{ mV}$$

b) Akım 10 kat arttırılırsa, gerilim ne kadar artar?

$$\left. \begin{aligned} V_{D1} &= V_T \ln \frac{I_{D1}}{I_S} \quad \leftarrow 1 \text{ mA} \\ V_{D2} &= V_T \ln \frac{I_{D2}}{I_S} \quad \leftarrow 10 \text{ mA} \end{aligned} \right\}$$

$$V_{D2} - V_{D1} = V_T \ln \frac{I_{D2}}{I_{D1}}$$

$$V_{D2} - V_{D1} = 26 \ln 10 \approx 60 \text{ mV}$$

