Elektronik Elemanlar

Diyot devreleri, BJT, MOSFET girişi (s. 21–40)

Orijinal not: Elektronik-elemanlar-notlarim.pdf

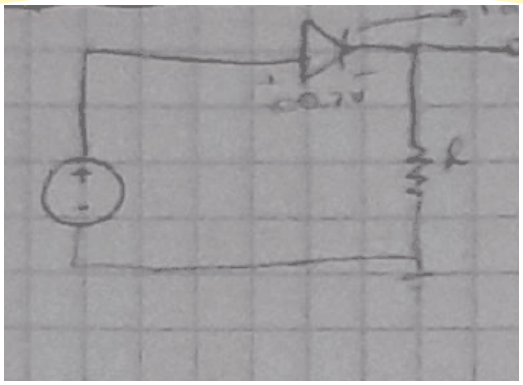
UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

NOTICE *This document was transcribed from handwritten lecture notes with the help of Claude (Anthropic). It is meant as a supplementary resource and may contain errors or omissions. Always check against the original notes and official course material.*

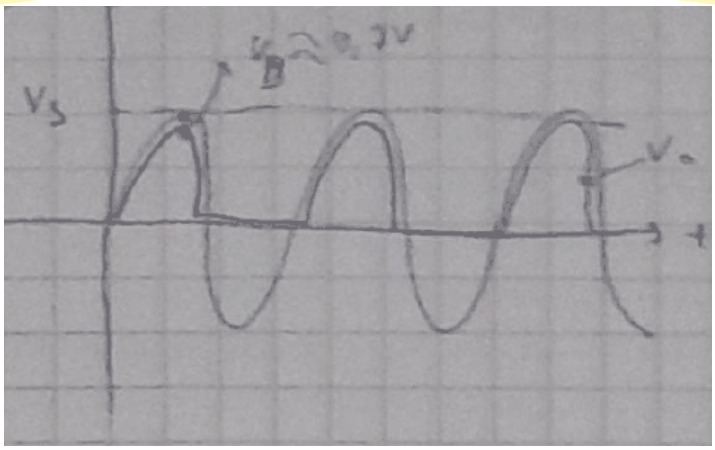
orj. s. 21

Rectifier circuits

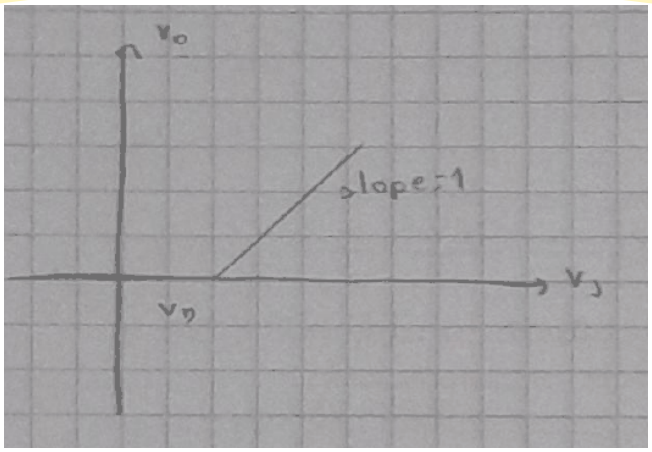
(Doğrultucu ?diyot) ?okunamadı (constant voltage drop model)



orijinal çizim, s. 21



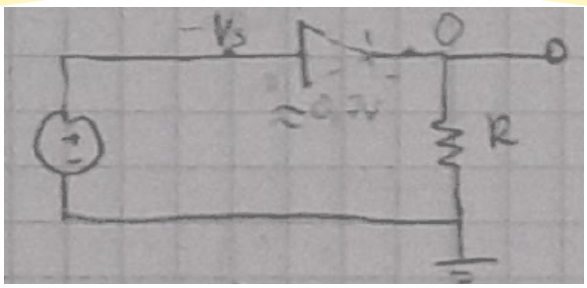
orijinal çizim, s. 21



orijinal çizim, s. 21

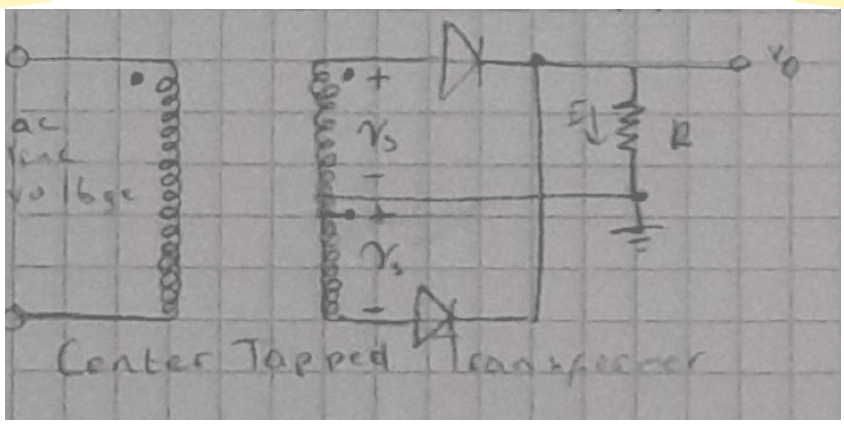
PIV: Peak inverse Diode voltage (Diyot ters gerilimin tepe değeri)

PIV: $V_s \Rightarrow$ nasıl bulunur, diyot kesimdeyken



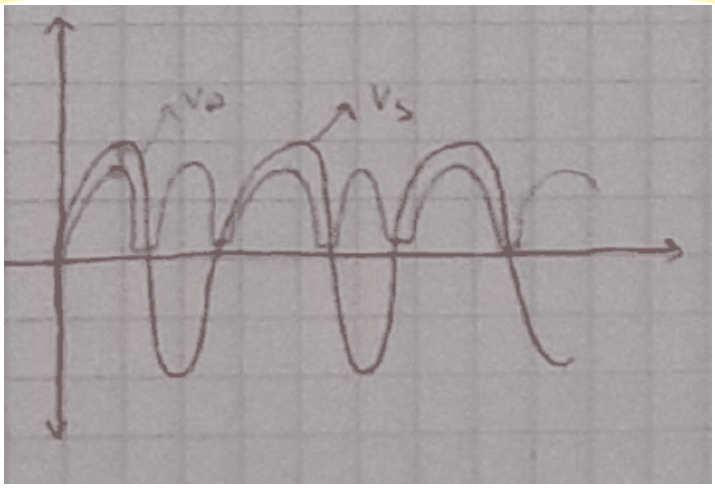
orijinal çizim, s. 21

$$PIV = 0 - (-V_s) = V_s$$



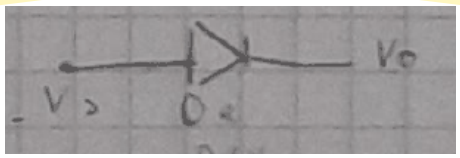
orijinal çizim, s. 21

	D_1	D_2
In positive cycle	on	off
In negative cycle	off	on



orijinal çizim, s. 21

PIV:
In positive cycle D_2 is off



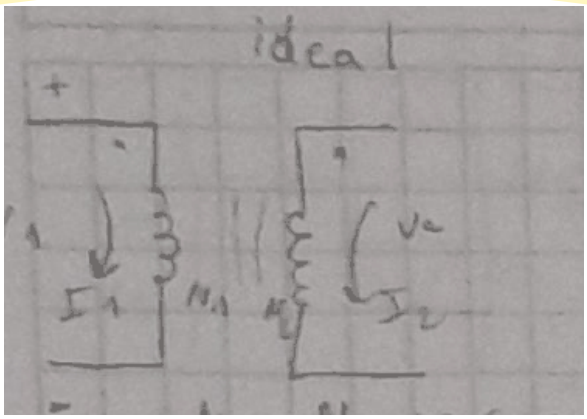
orijinal çizim, s. 21

$$\text{PIV} = v_o - (-v_s) = v_o + v_s$$

$$\max v_o = V_s - V_D$$

$$\text{PIV} = (V_s - V_D) + V_s = 2V_s - V_D$$

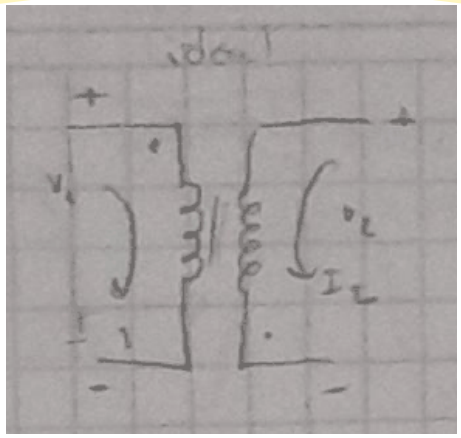
orj. s. 22



orijinal çizim, s. 22

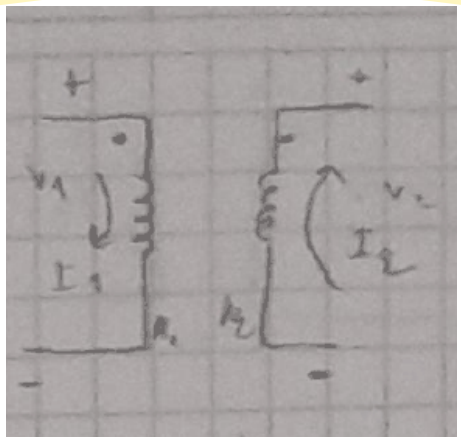
N_1 ve N_2 sarım sayısı

$$\frac{V_1}{N_1} = \frac{V_2}{N_2}, \qquad N_1 I_1 = -N_2 I_2$$



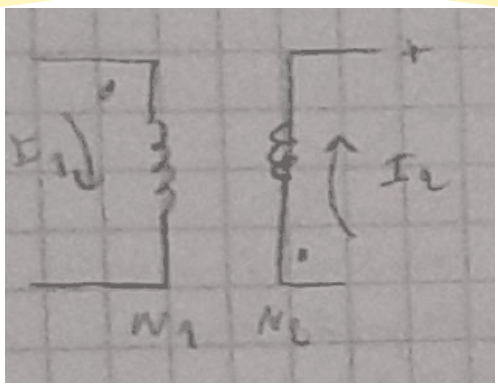
orijinal çizim, s. 22

$$\frac{V_1}{N_1} = -\frac{V_2}{N_2}, \qquad N_1 I_1 = N_2 I_2$$



orijinal çizim, s. 22

$$\frac{V_1}{N_1} = \frac{V_2}{N_2}, \qquad N_1 I_1 = N_2 I_2$$

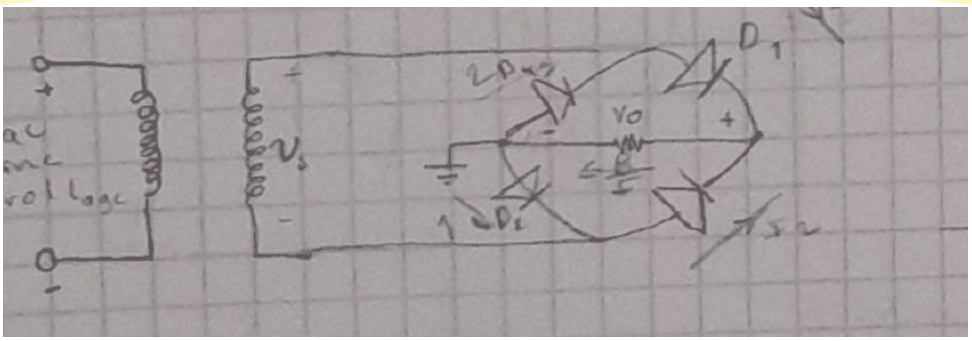


orijinal çizim, s. 22

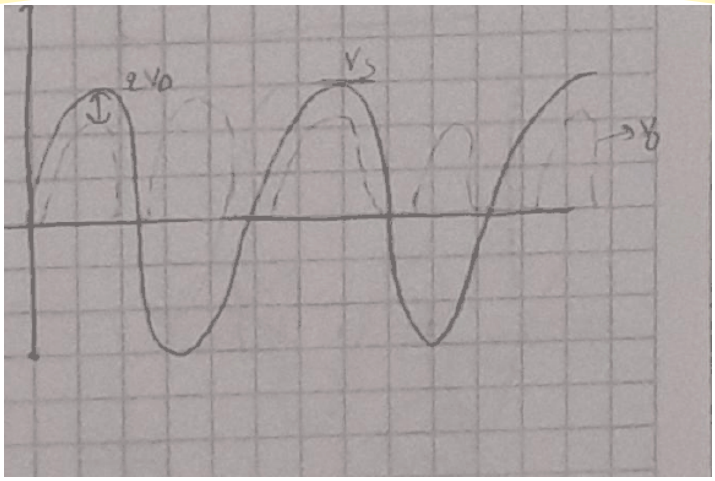
$$\frac{V_1}{N_1} = -\frac{V_2}{N_2}, \qquad N_1 I_1 = -N_2 I_2$$

noktalar aynı yerde ise 1. denklem artı,
akımlar aynı noktadan çıkıyorsa 2. –

The bridge rectifier



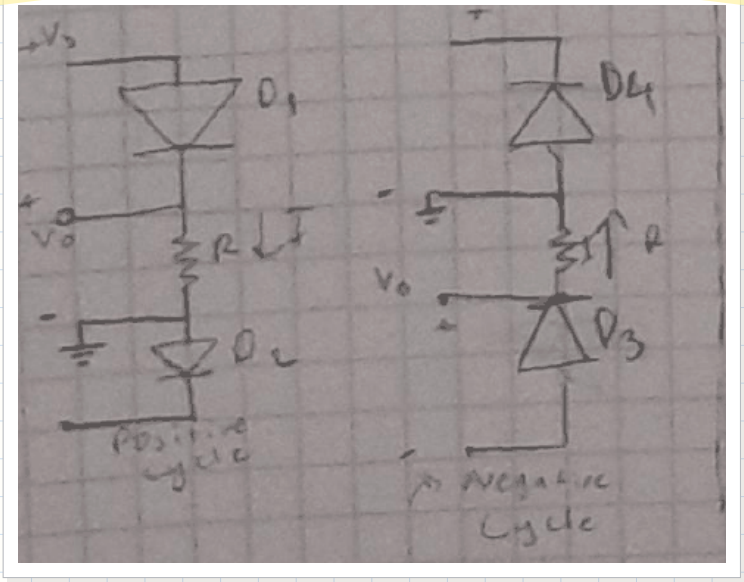
orijinal çizim, s. 22



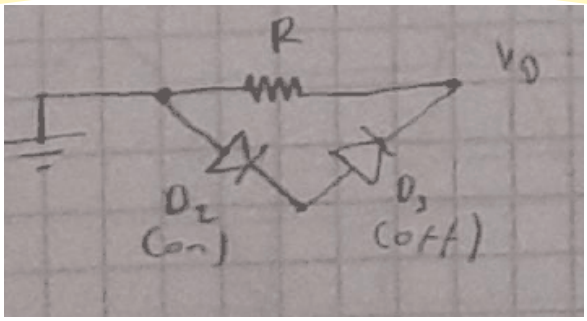
orijinal çizim, s. 22

Full wave

	D_1	D_2	D_3	D_4
Positive Cycle	on	on	off	off
Negative Cycle	off	off	on	on



orijinal çizim, s. 22



orijinal çizim, s. 22

$$V_{D_3} = V_o - (-V_{D_2}) = V_o + V_{D_2} \qquad (V_{D_2} = V_D)$$

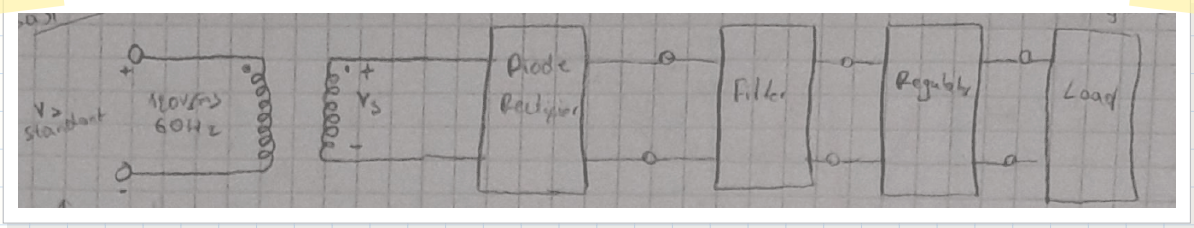
$$V_o \text{ peak} = V_s - 2V_D$$

$$\Rightarrow V_{D_3}(\text{reverse}) = (V_s - 2V_D) + V_D = V_s - V_D$$

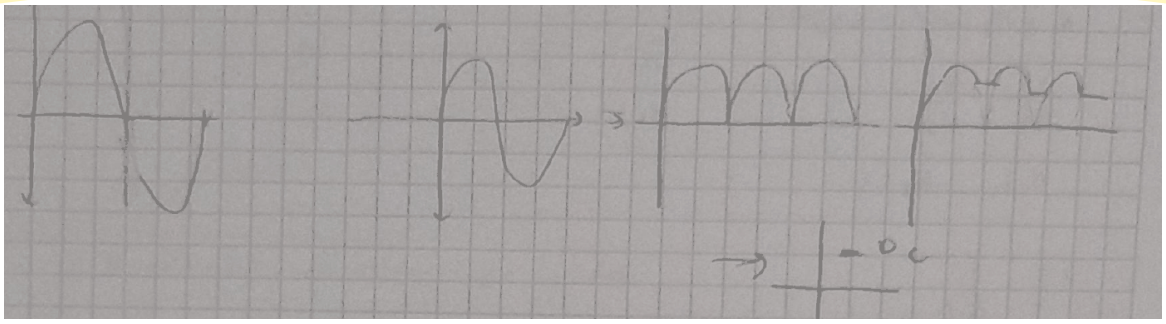
orj. s. 23

Block diagram of a dc power supply

(Başlığın altında okunamayan küçük bir not: ? okunamadı.)

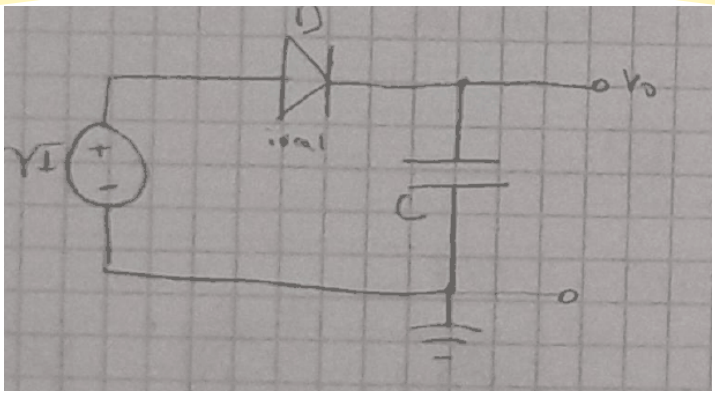


orijinal çizim, s. 23

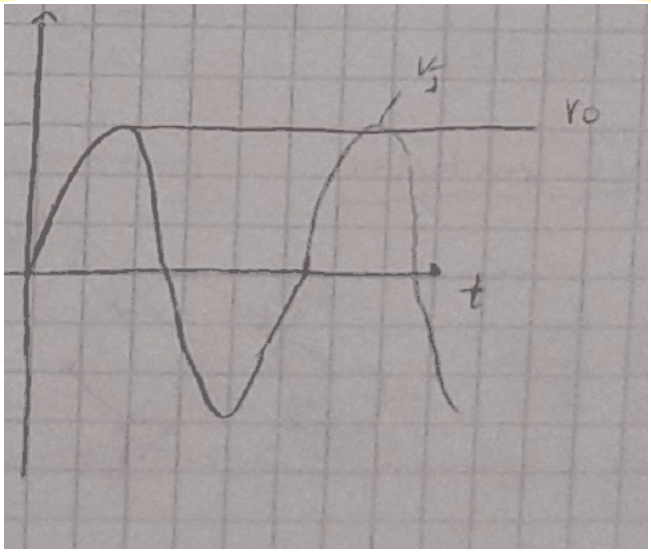


orijinal çizim, s. 23

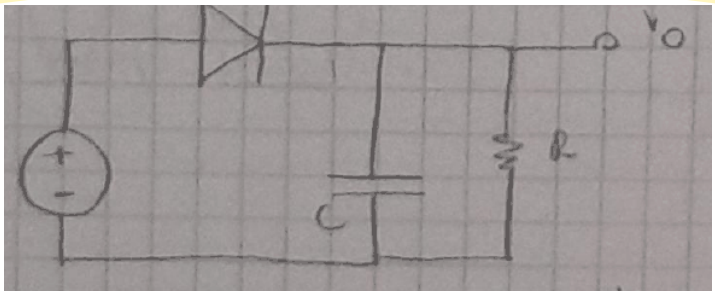
The rectifier with a filter capacitor: The peak rectifier



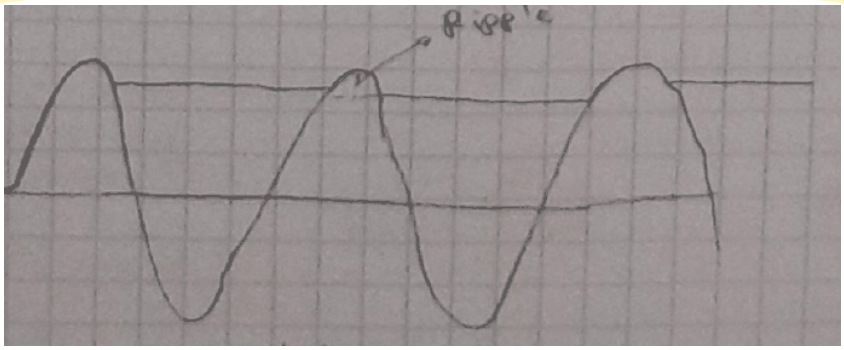
orijinal çizim, s. 23



orijinal çizim, s. 23



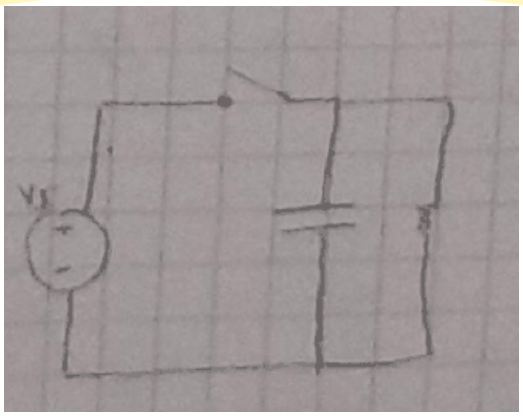
orijinal çizim, s. 23



orijinal çizim, s. 23

$$V_r = \frac{V_p}{fCR}$$

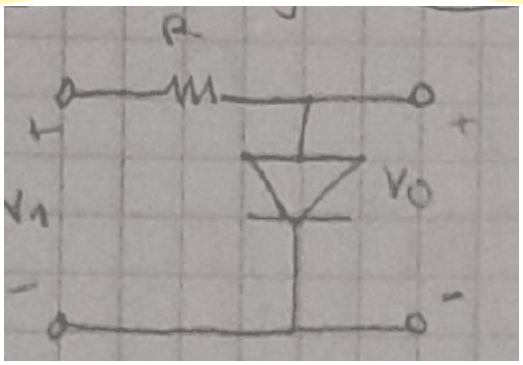
$V_p \rightarrow$? girişin tepe değeri



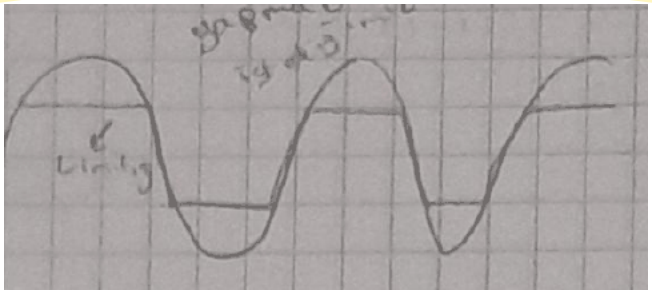
orijinal çizim, s. 23

orj. s. 24

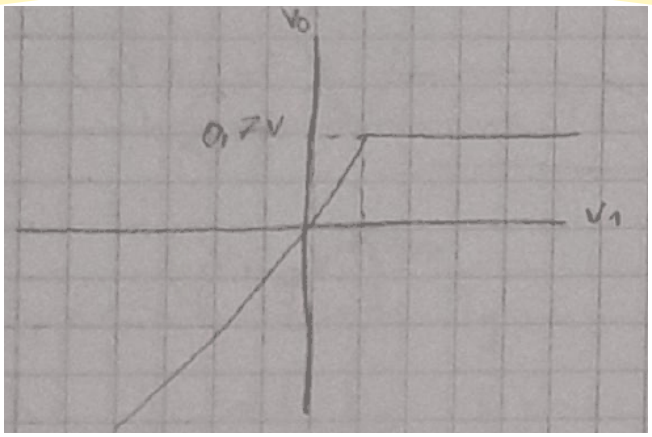
Limiting and Clamping Circuit



orijinal çizim, s. 24

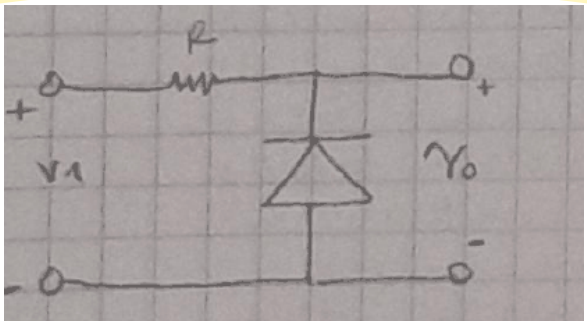


orijinal çizim, s. 24

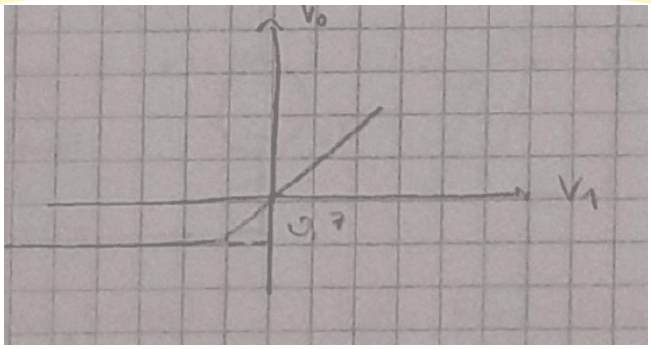


orijinal çizim, s. 24

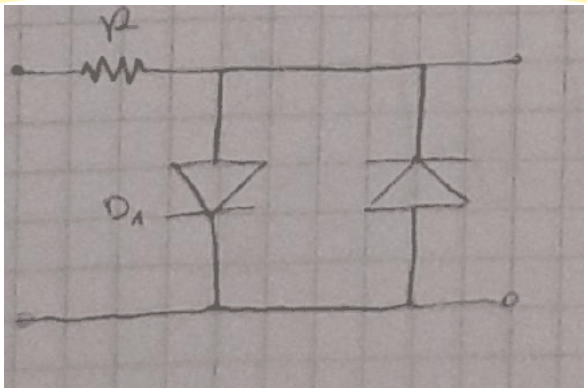
Limiting occurs when the diodes are conducting



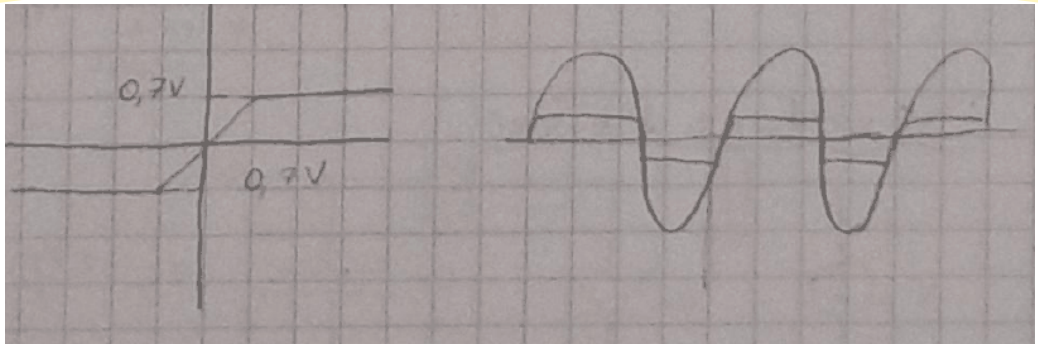
orijinal çizim, s. 24



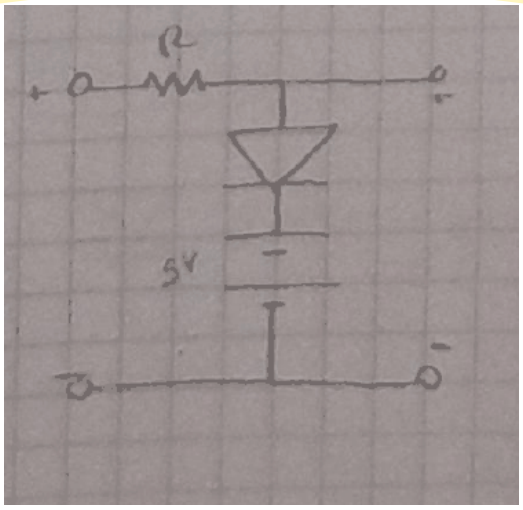
orijinal çizim, s. 24



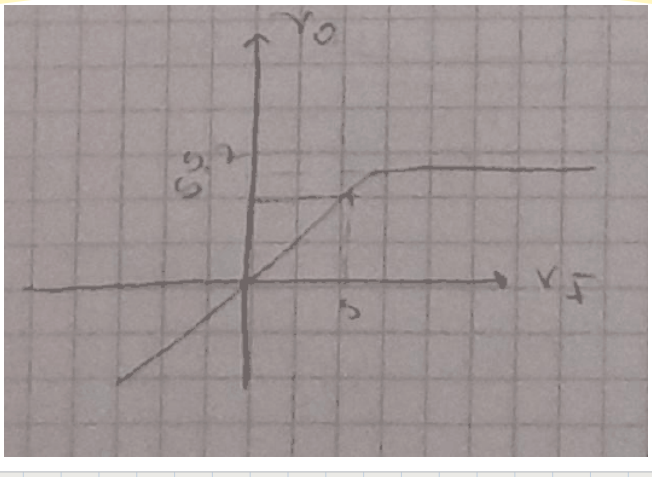
orijinal çizim, s. 24



orijinal çizim, s. 24



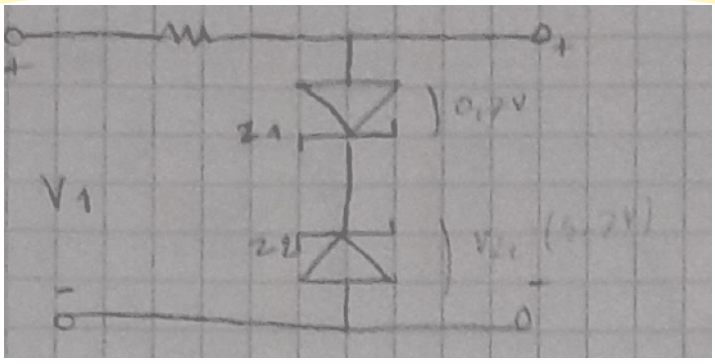
orijinal çizim, s. 24



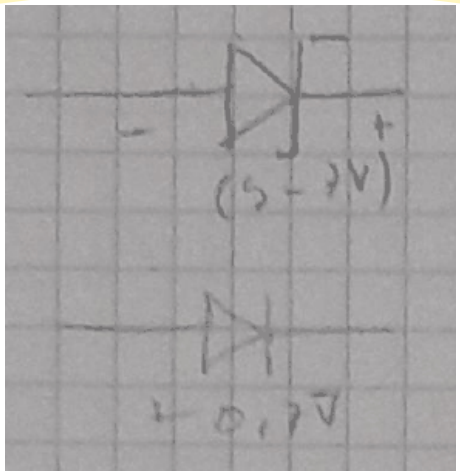
orijinal çizim, s. 24

orj. s. 25

(Sayfanın en üstünde silik küçük bir not: "zener diyot diyotun ?okunamadı".)

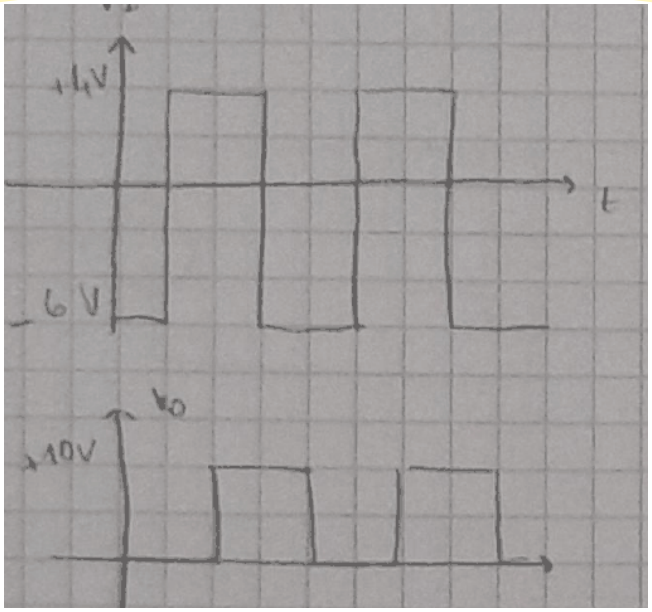


orijinal çizim, s. 25

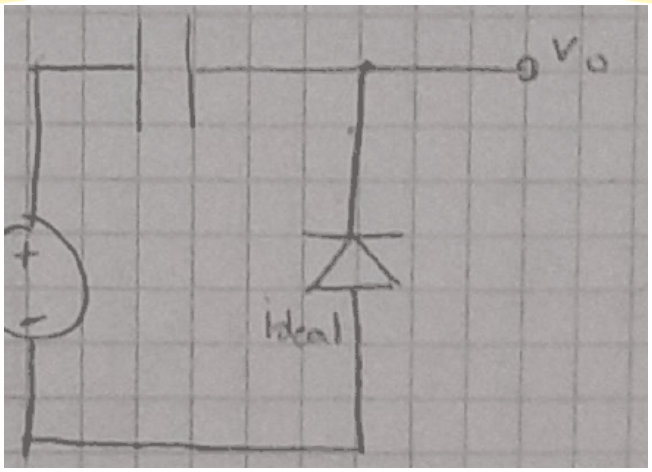


orijinal çizim, s. 25

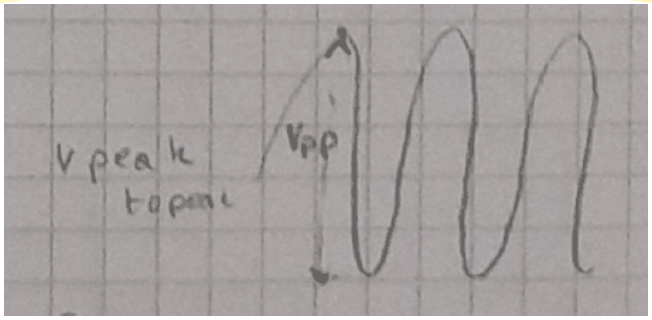
The clamped Capacitor or DC restorer



orijinal çizim, s. 25

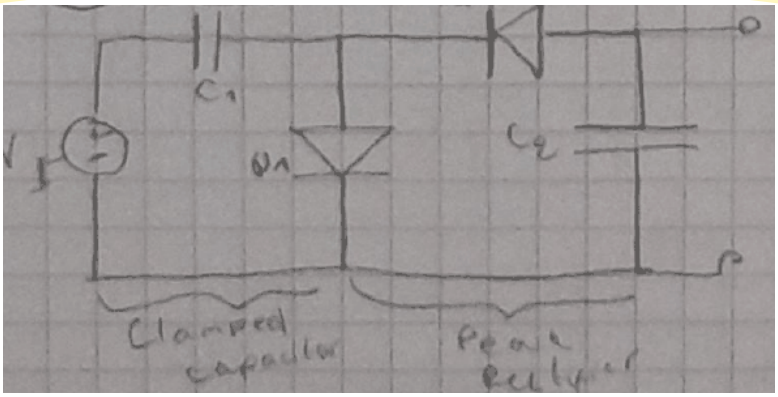


orijinal çizim, s. 25



orijinal çizim, s. 25

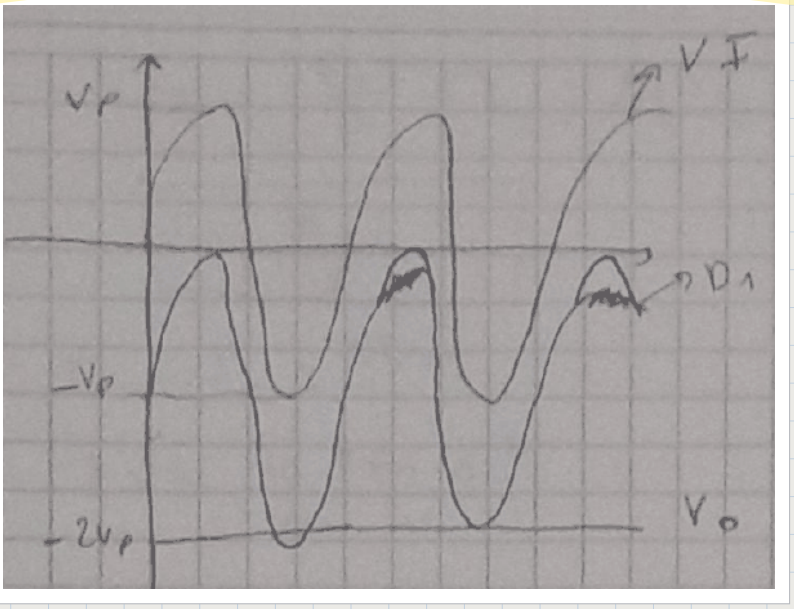
The voltage Doubler



orijinal çizim, s. 25

$$v_o = 2V_p$$

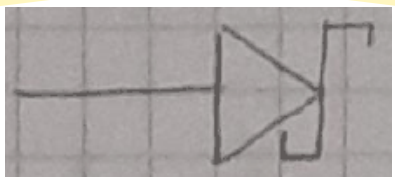
orj. s. 26



orijinal çizim, s. 26

Special Diode Types

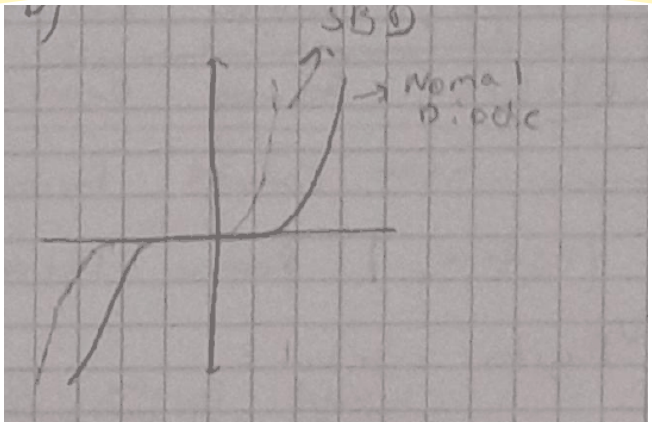
The Schottky Barrier Diode (SBD)



orijinal çizim, s. 26

- metal semiconductor
- voltage drop 0,3V – 0,5V
- faster switching (?zeroby)

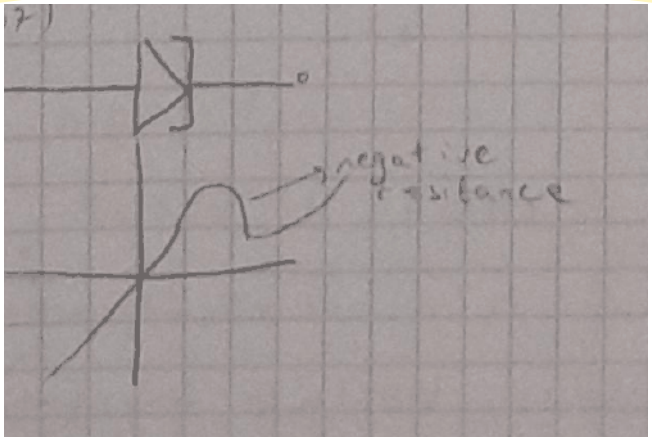
→ power supply (switched mode)
?sample-hold
voltage clamping



orijinal çizim, s. 26

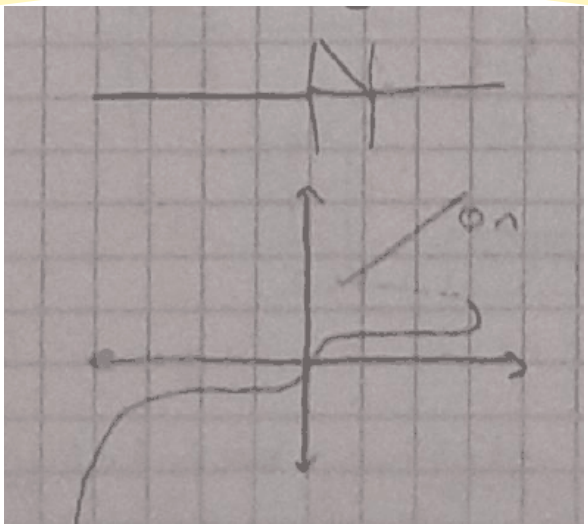
Tunnel Diode (Esaki Diode)

(1957)



orijinal çizim, s. 26

Shockley Diode



orijinal çizim, s. 26

Varactors



orijinal çizim, s. 26

→ Voltage variable capacitors

photo Diode

Light ⟶ Photo Diode ⟶ Electrical signal

LED

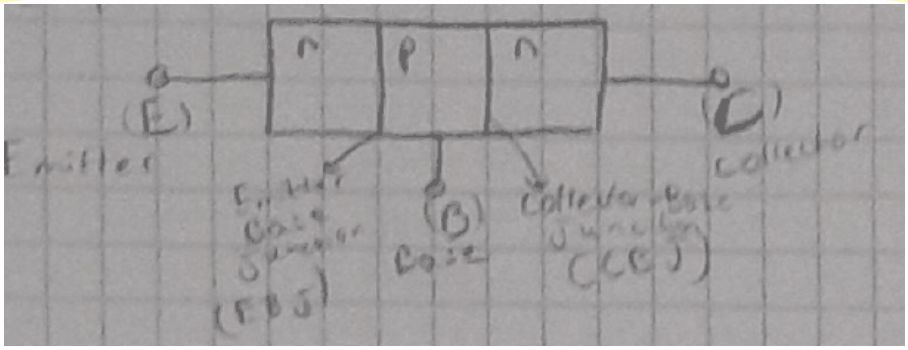
Electrical ⟶ LED ⟶ Light

orj. s. 27

(Sayfanın en üstünde ortada silik küçük bir başlık: ?Optoizolatör.)

Bipolar Junction Transistor (BJT)

(Başlığın altında silik küçük notlar: ? Transfer resistor; ? akım taşıyıcıları ikidir: elektronlar ve boşluklar.)



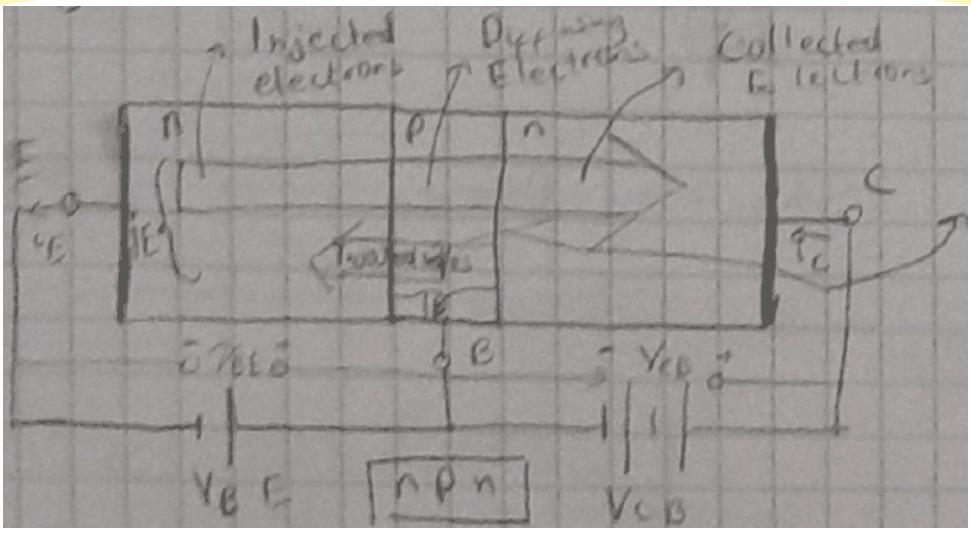
orijinal çizim, s. 27

BJT Modes of Operation

Mode	EBJ	CBJ	
Cut off	Reverse	Reverse	
Active	Forward	Reverse	→ amplifier
Saturation	Forward	Forward	
(Reverse active)	Reverse	Forward	

→ Digital circuits

(Kırmızı bir parantez Cut off ve Saturation satırlarını bu nota bağlıyor.)



orijinal çizim, s. 27

Elektrik alanın etkisiyle $i_E > i_C$ $V_{CB} > V_{BE}$

p bölgesinde recombinasyonu önlemek için çok küçük ? yapılır

akım yönü elektron hareketiyle ters, boşluk hareketiyle aynı yönde

$$I_C = I_S e^{V_{BE}/V_T} \implies \boxed{I_B = \left(\frac{I_S}{\beta}\right) e^{V_{BE}/V_T}}$$

$$\boxed{I_B = \frac{I_C}{\beta} \rightarrow \text{Common Emitter Current Gain}}$$

$$\boxed{I_E = I_C + I_B}$$

$$\boxed{I_C = \beta I_B} \qquad I_C \gg I_B$$

β = ?50, 100, 200 gibi

$$i_E = i_C + i_B$$

$$i_E \rightarrow I_E + i_e, \qquad i_C \rightarrow I_C + i_c, \qquad i_B \rightarrow I_B + i_b$$

- p bölgesinde az katkılama yapılır böylece boşluk sayısı az olur ve ?çok recombinasyonun önüne geçer.

orj. s. 28

$$I_C = \beta I_B, \qquad I_E = I_C + I_B \Rightarrow I_E = \beta I_B + I_B$$

$$I_E = \frac{\beta + 1}{\beta} I_C \rightarrow \frac{I_C}{\beta}$$

$$\boxed{I_E = \frac{\beta + 1}{\beta} I_C}$$

$$I_C = I_S e^{V_{BE}/V_T}$$

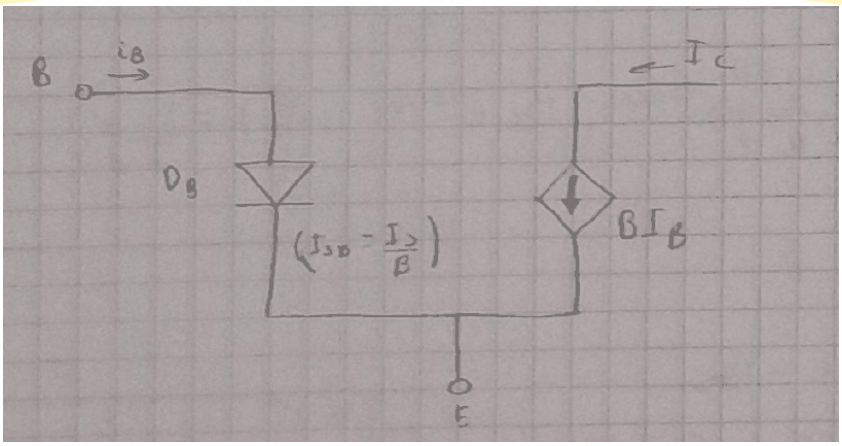
$$I_S = \frac{A_E q D_n n_i^2}{N_A \cdot W}$$

A_E = Base Emitter Junction Cross sectional Area

W = Effective Base Width.

(Sol kenarda mavi, altı çizili: ?Sayfa 313.)

BJT Large Signal Equivalent models in Forward Active



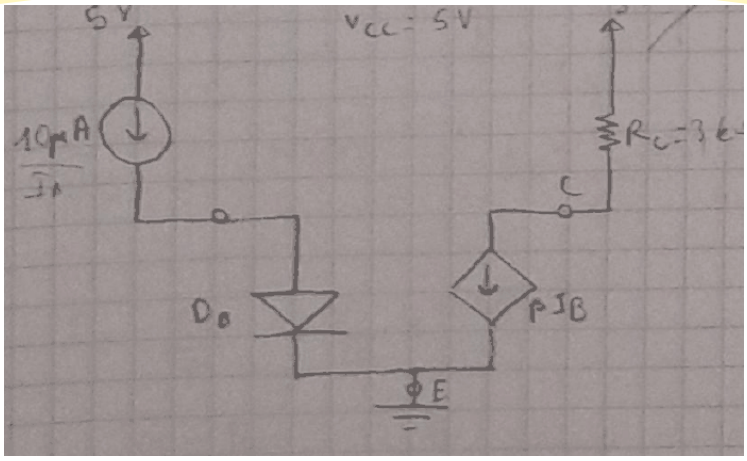
orijinal çizim, s. 28

Örnek 6.1

npn transistor $V_T = 25$ mV

$I_S = 10^{-15}$ A, $\beta = 100$[a]

$V_{CC} = 5$ V



orijinal çizim, s. 28

Active modda → V_{BE} =?, V_{CE} =?, R_B =?

[a] Claude notu: üs el yazısında "–13" gibi de okunabiliyor; aşağıdaki hesaba ($10^{-15}/100 = 10^{-17}$) uygun olarak –15 alındı.

Çözüm:

$$I_B = \frac{I_S}{\beta} e^{V_{BE}/V_T}$$

$$\Rightarrow V_{BE} = V_T \ln \frac{I_B}{I_S/\beta}$$

$$= 25 \ln\left(\frac{10 \times 10^{-6}}{10^{-17}}\right)$$

$$= 690 \text{ mV} = 0{,}69 \text{ V}$$

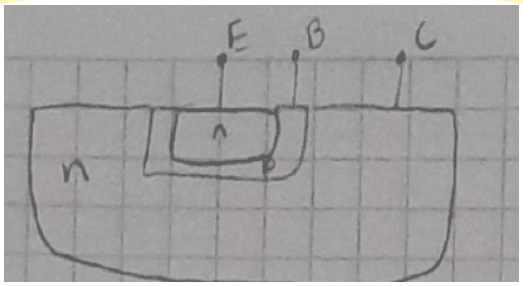
$$I_C = \beta I_B = 100 \times 10 \times 10^{-6}$$
$$= 1\ \text{mA}$$

$$V_C - V_E = V_{CE} = 5 - 3 \times 1 = 2\ \text{V} \qquad V_{CC} - V_C = R_C I_C$$

$$R_B = \frac{5 - 0{,}69}{10\ \mu\text{A}} = 431\ \text{k}\Omega$$

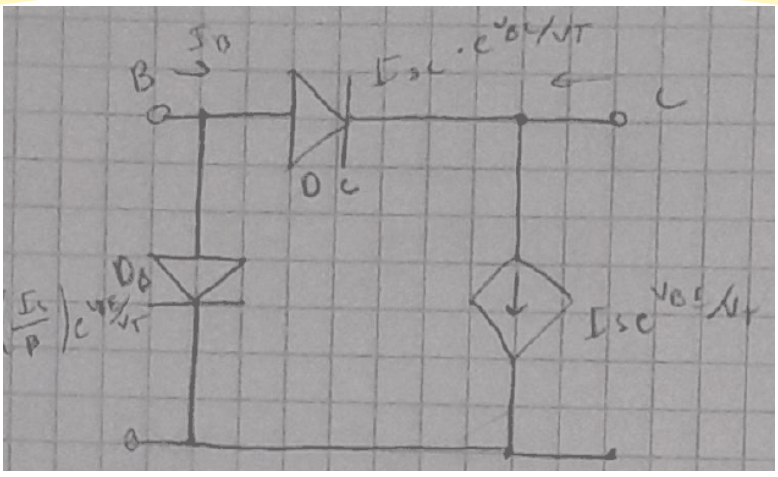
aynı koşulları sağlayan ?direnç kaç olmalıdır akım kaynağı yerine

orj. s. 29



orijinal çizim, s. 29

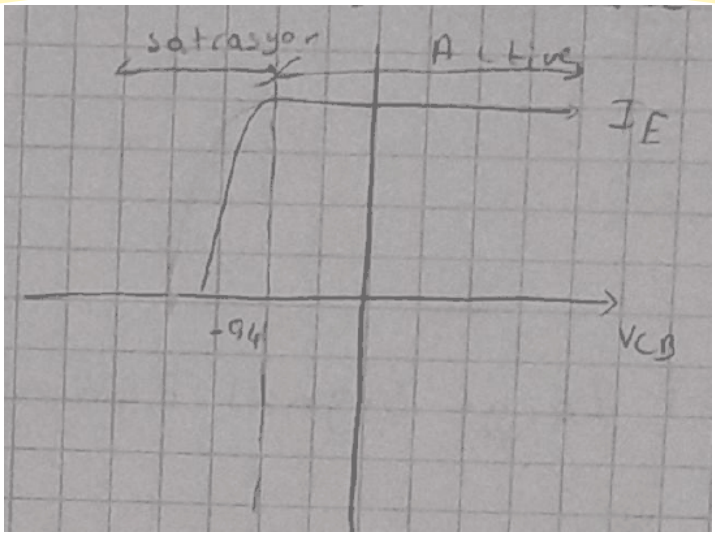
Operation in the saturation mode



orijinal çizim, s. 29

$$I_C = I_S e^{V_{BE}/V_T} - I_{SC} e^{V_{BC}/V_T}$$

$V_{CE\,sat} = 0{,}3\ \text{V} \downarrow$ at the edge of saturation



orijinal çizim, s. 29

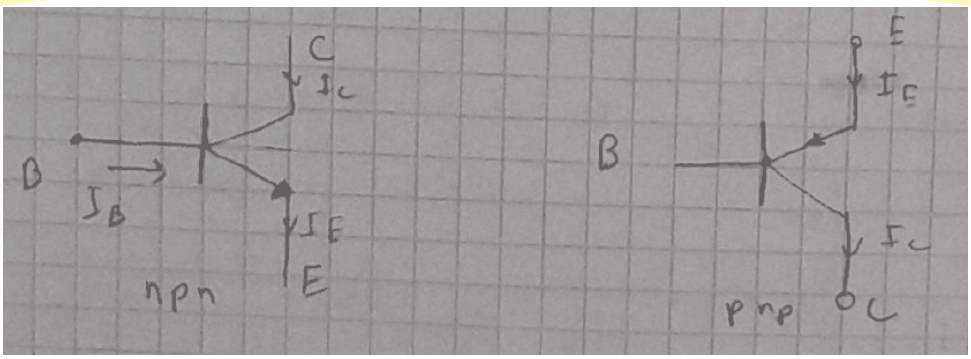
$$I_B = \left(\frac{I_S}{\beta}\right) e^{V_{BE}/V_T} + I_{SC}\, e^{V_{BC}/V_T} \qquad \beta = \frac{I_C}{I_B}$$

Saturasyon

$$\beta_{forced}(sat) = \frac{I_C}{I_B} \leq \beta$$

$$V_{CE\,sat} = V_{BE} - V_{BC}$$

$$V_{CE\,sat} \approx 0{,}1\ V \text{ to } 0{,}3\ V$$



orijinal çizim, s. 29

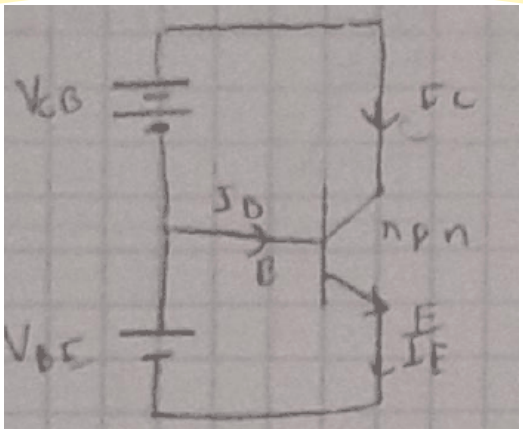
$$I_E = I_B + I_C$$

Active $I_C = \beta I_B$

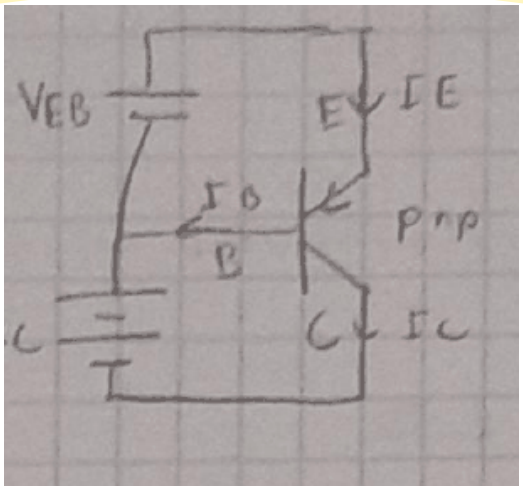
orj. s. 30 (Sayfa üstünde, altı çizili: "ders 7".)

BJT Circuits

(Sol kenarda küçük, altı çizili: "Sayfa 321".)



orijinal çizim, s. 30



orijinal çizim, s. 30

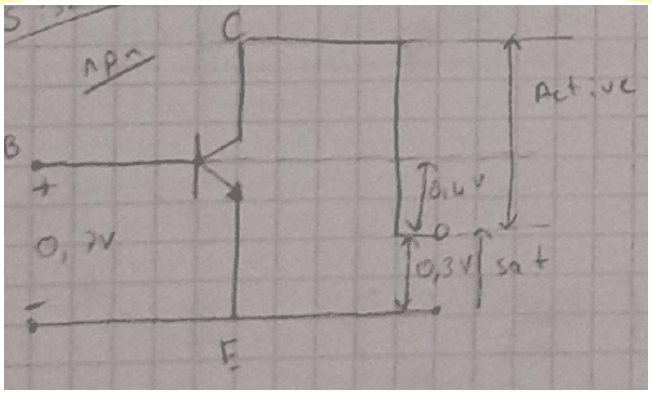
$I_E = I_B + I_C$

$V_{CE\,sat} = 0{,}2\ V$

$I_E = I_B + I_C$

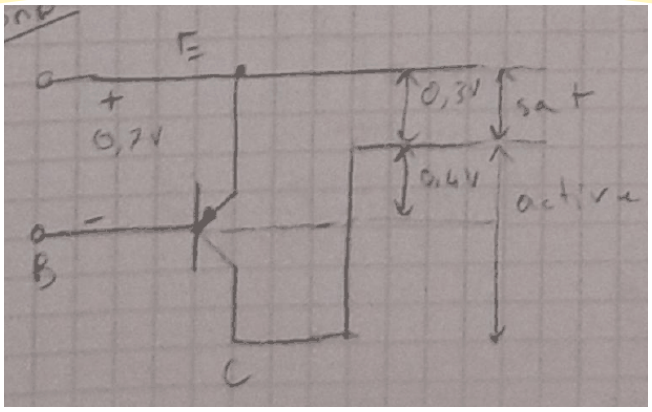
$V_{EC\,sat} = 0{,}2\ V$

(Altı çizili: "S. 322" ve "npn".)



orijinal çizim, s. 30

Base gerilimi referans alırsak 0,4 V aşağına düşmesini Aktif mod için sayabiliriz. Daha fazla düşerse saturasyon olur.



orijinal çizim, s. 30

$$\star \quad I_C = I_S e^{V_{BE}/V_T} \quad \Big| \quad I_B = \frac{I_C}{\beta} = \frac{I_S}{\beta} e^{V_{BE}/V_T}$$

$$I_E = \frac{I_C}{\alpha} = \frac{I_S}{\alpha} e^{V_{BE}/V_T}$$

$$\alpha = \frac{\beta}{\beta + 1}, \qquad V_T = 25 \text{ mV at room temp}$$

orj. s. 31

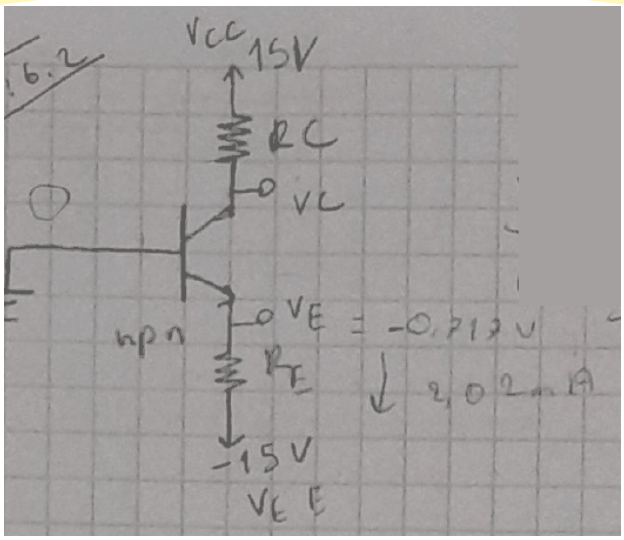
(Sol üstte kırmızı, altı çizili: "?Sf. 323 ex 6.2")

Örnek 6.2

$\beta = 100$

$V_{BE} = 0{,}7$ V @ 1 mA ($\nearrow I_C$)

Design the circuit $\Rightarrow I_E = I_C = 2$ mA, $V_C = 5$ V



orijinal çizim, s. 31

Çözüm:

$$R_C = \frac{15 - 5}{2\ \text{mA}} = 5\ \text{k}\Omega$$

★ $I_{C1} = I_S e^{V_{BE1}/V_T}$ 1mA de 0,7V oluyorsa

$I_{C2} = I_S e^{V_{BE2}/V_T}$ 2mA de kaç volt olur

$$\frac{I_{C2}}{I_{C1}} = e^{\frac{V_{BE2} - V_{BE1}}{V_T}}$$

$$\Rightarrow V_{BE2} - V_{BE1} = V_T \ln\left(\frac{I_{C2}}{I_{C1}}\right)$$

$$V_{BE2} = V_{BE1} + V_T \ln\left(\frac{I_{C2}}{I_{C1}}\right)$$

(İşaretlenenler: V_{BE1} için "0,7V", I_{C2} için "2mA", I_{C1} için "1mA".)

$$\boxed{V_{BE} = 0{,}717\ \text{V}}$$

$$I_E = \frac{I_C}{\alpha} = \frac{2}{0{,}99} = 2{,}02\ \text{mA}$$

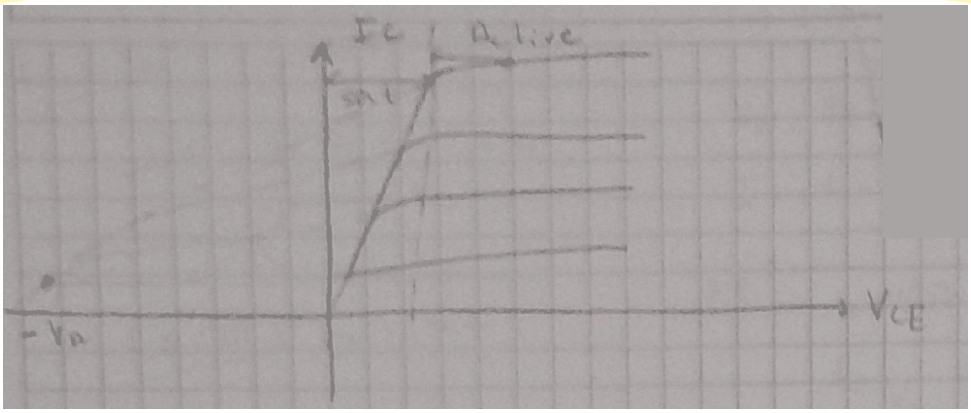
$$R_E = \frac{V_E - (-15)}{I_E} = \frac{-0{,}717 + 15}{2{,}02} = 7{,}07\ \text{k}\Omega$$

★ $V_{CE} = 5\ \text{V} - (-0{,}717\ \text{V})$ $V_{CE} > 0{,}3$ V o zaman aktif modda

$= 5{,}717$ V

aktif çıkmazsa ?sat'a göre çözmek lazım ve $V_{CE\,sat}$'ı belirlemek lazım $V_{CE} = 0{,}2$ V

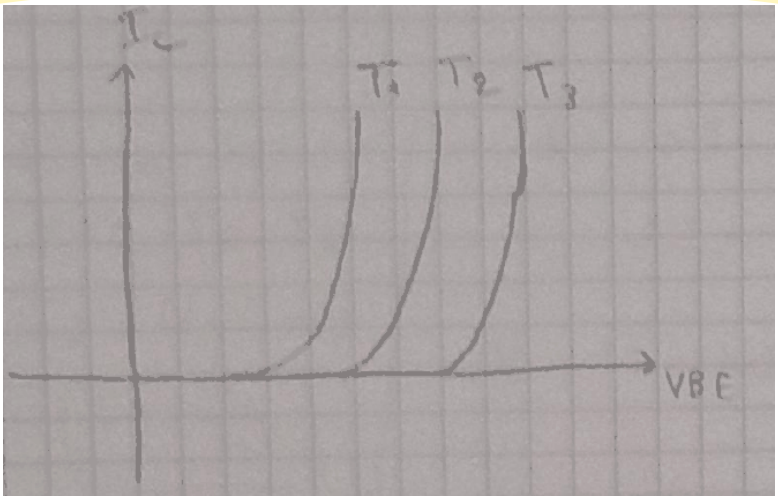
orj. s. 32



orijinal çizim, s. 32

$$I_C = I_S e^{V_{BE}/V_T}\left(1 + \frac{V_{CE}}{V_A}\right)$$

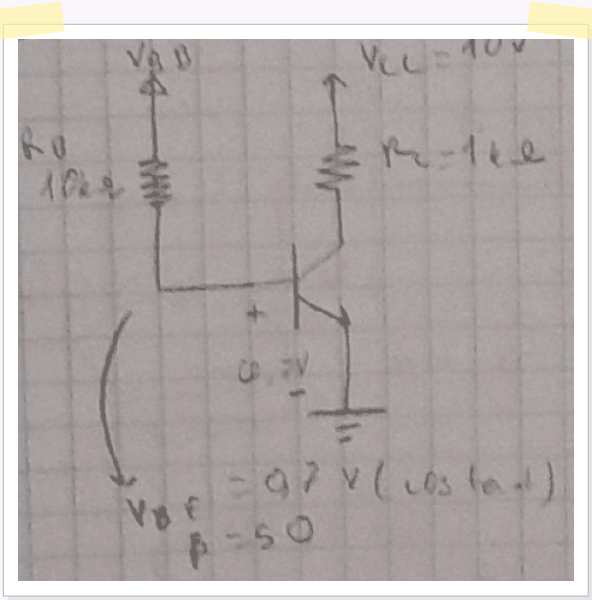
(Süslü parantezin altında silik küçük bir not: ?okunamadı.)



orijinal çizim, s. 32

$$T_1 > T_2 > T_3$$

Örnek 6.3



orijinal çizim, s. 32

V_{BB} =?

a) active mod V_{CE} = 5V
b) at the edge of saturation
c) deep saturation β_{forced} = 10

Çözüm: a)

$$I_C = \frac{10-5}{1k} = 5\ mA$$

$$\rightarrow I_B = \frac{I_C}{\beta} = \frac{5}{50} = 0{,}1\ mA$$

$$V_{BB} = I_B R_B + V_{BE} = (0{,}1)(10) + 0{,}7 = \boxed{1{,}7\ V}$$

⋆ Sınırda V_{CE} = 0,3 V
⋆ Satürasyonda V_{CE} = 0,2 V

b) at the edge of sat
↪ V_{CE} = 0,3 V

$$I_C = \frac{10-0{,}3}{1} = 9{,}7\ mA$$

$$I_B = \frac{9{,}7}{50} = 0{,}194\ mA$$

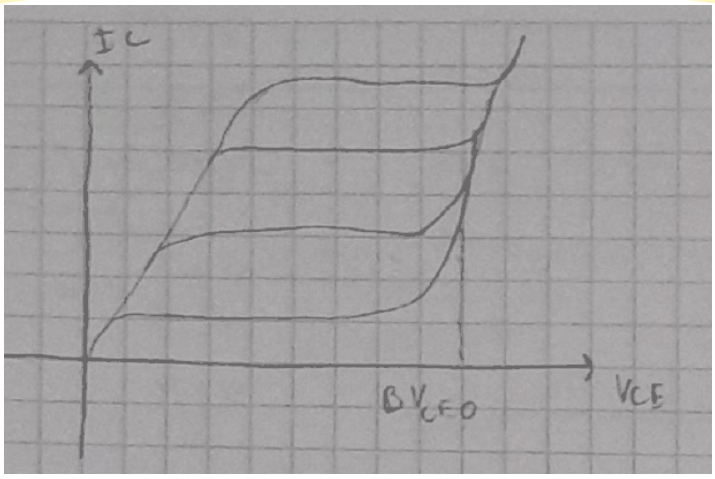
$$V_{BB} = (0{,}194)(10) + 0{,}7 = 2{,}64\ V$$

c) deep saturation → β_{force} = 10
$V_{CE} = V_{CE\,sat} \approx 0{,}2$ V

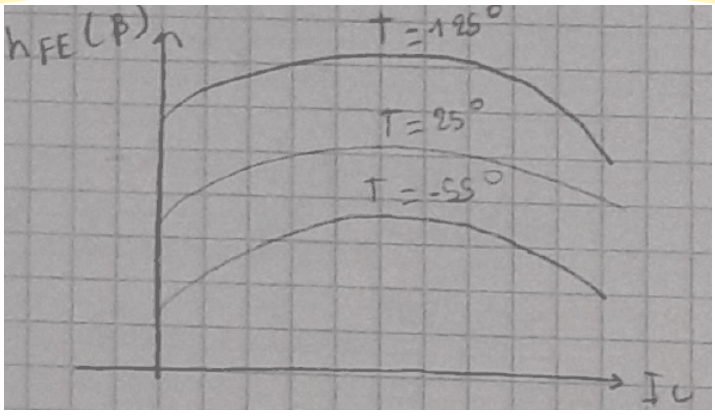
$$I_C = \frac{10-0{,}2}{1} = 9{,}8\ mA \Rightarrow I_B = \frac{I_C}{\beta_{force}} = \frac{9{,}8}{10} = 0{,}98\ mA$$

$$V_{BB} = (0{,}98) \times 10 + 0{,}7 = 10{,}5\ V$$

orj. s. 33 (Sol üstte eğik, altı çizili: "? Sayfa 352".)



orijinal çizim, s. 33

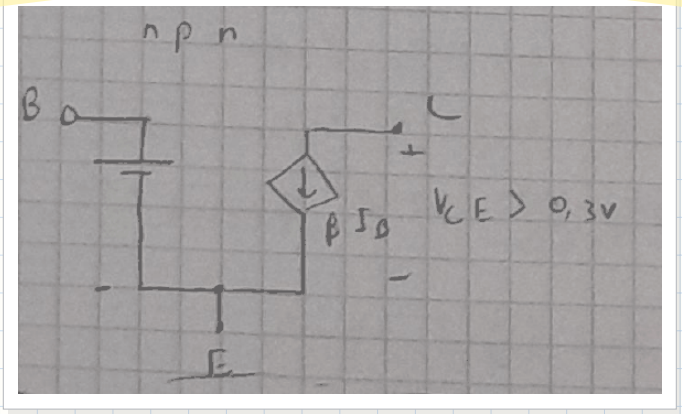


orijinal çizim, s. 33

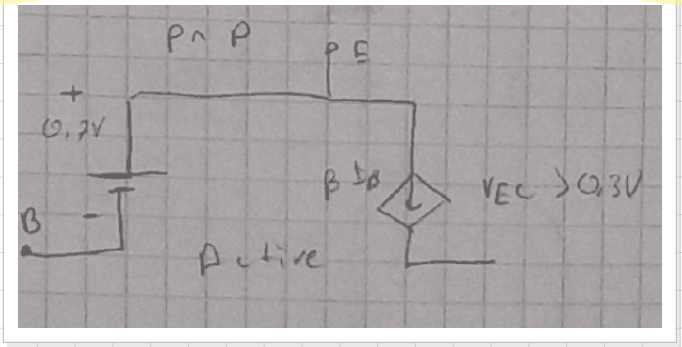
$h_{FE} \leftrightarrow \beta$

(Başlığın solunda küçük, altı çizili bir sayı: ?okunamadı.)

BJT Circuits at DC

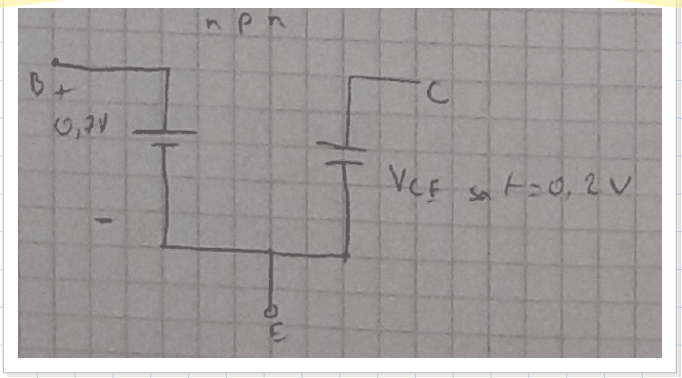


orijinal çizim, s. 33

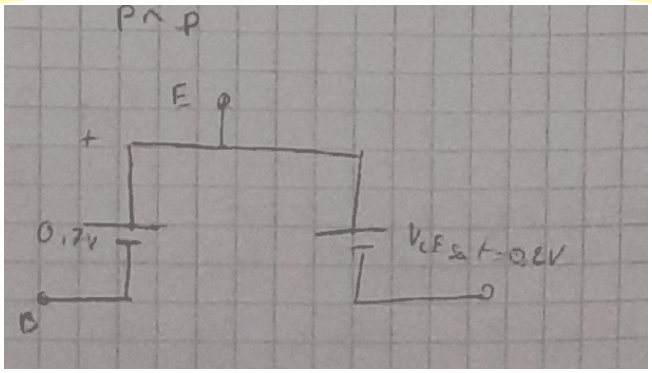


orijinal çizim, s. 33

Saturation



orijinal çizim, s. 33

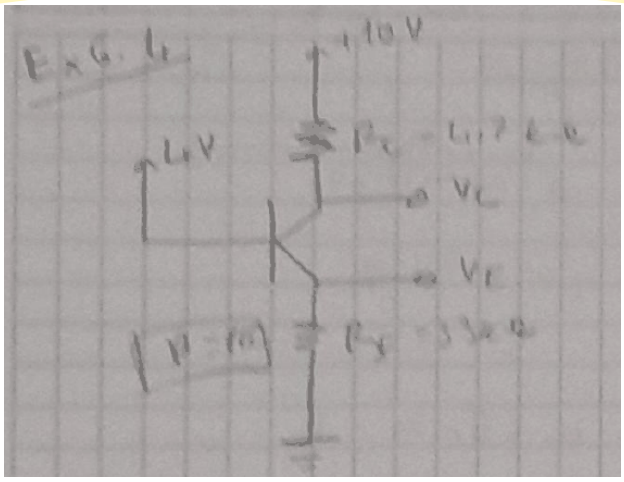


orijinal çizim, s. 33

orj. s. 34

$$I_C \to I_B = \frac{I_C}{\beta} \Rightarrow I_E = I_B + I_C$$

Örnek 6.4



orijinal çizim, s. 34

V_B, V_E, V_C =?
I_B, I_C, I_E =?

Çözüm:

$$V_E = 4 - V_{BE} \approx 4 - 0{,}7 = 3{,}3\ \text{V}$$
$$I_E = \frac{V_E - 0}{R_E} = \frac{3{,}3}{3{,}3} = 1\ \text{mA}$$

$$I_C + I_B = I_E$$
$$\beta I_B + I_B = I_E$$
$$I_B(\beta + 1) = I_E$$

$$\boxed{I_B = \frac{I_E}{\beta + 1}}$$

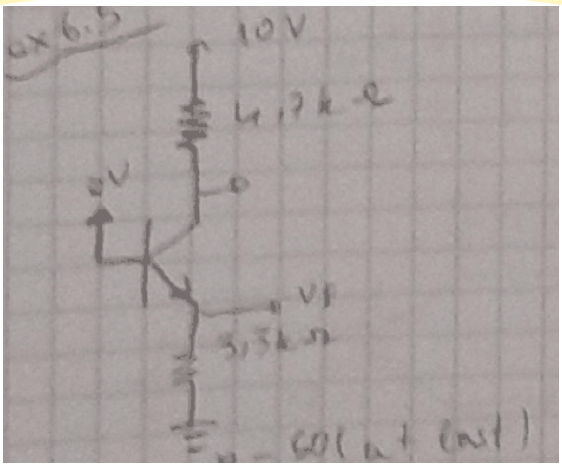
$$I_C = \alpha I_E, \qquad \alpha = \frac{\beta}{\beta + 1} = \frac{100}{101} \simeq 0{,}99$$

$$I_C = 0{,}99 \times 1 = 0{,}99 \text{ mA}$$

$$V_C = 10 - I_C R_C = 10 - 0{,}99 \times 4{,}7 \simeq 5{,}3 \text{ V}$$

$$I_B = \frac{I_E}{\beta + 1} = \frac{1}{101} \simeq 0{,}01 \text{ mA}$$

Örnek 6.5



orijinal çizim, s. 34

$V_B, V_C, V_E, I_B, I_C, I_E = ?$

Çözüm:

$$V_E = 6 - 0{,}7 = 5{,}3 \text{ V}, \qquad I_E = \frac{5{,}3}{3{,}3} = 1{,}6 \text{ mA}, \qquad I_E \simeq I_C$$

$$V_C \simeq 10 - (1{,}6)(4{,}7) = 2{,}48 \text{ V}$$

V_{CE} Aktif ? çıkmazsa o zaman yanlış[a]

Sat

$$V_E = 6 - 0{,}7 = 5{,}3 \text{ V}$$

$$V_C = 5{,}5 \text{ V}$$

$$I_C = \frac{10 - 5{,}5 \text{ V}}{4{,}7} = 0{,}96 \text{ mA}$$

$$I_E = \frac{5{,}3}{3{,}3} = 1{,}6 \text{ mA}$$

$$I_B = I_E - I_C = 0{,}64 \text{ mA}$$

$V_{CE} = 0{,}2$ V alırız

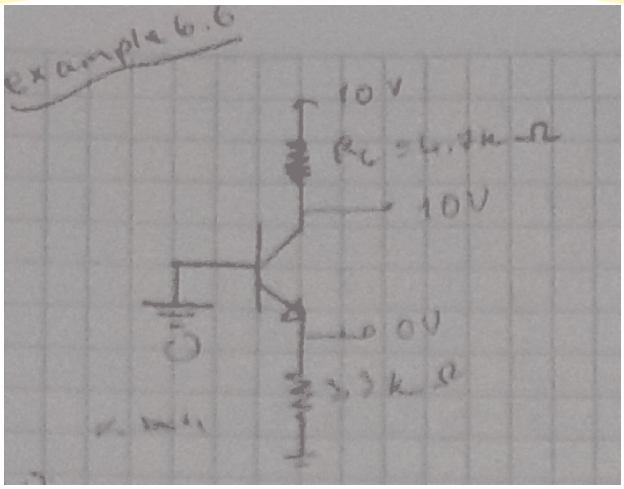
[a] Claude notu: el yazısında bu satırdaki rakamlar tam okunamadı (1,6 ya da 1,61; sonuç yaklaşık 2,4–2,5 V).

orj. s. 35

⋆ npn → V_{CE}

pnp → V_{EC}

Örnek 6.6



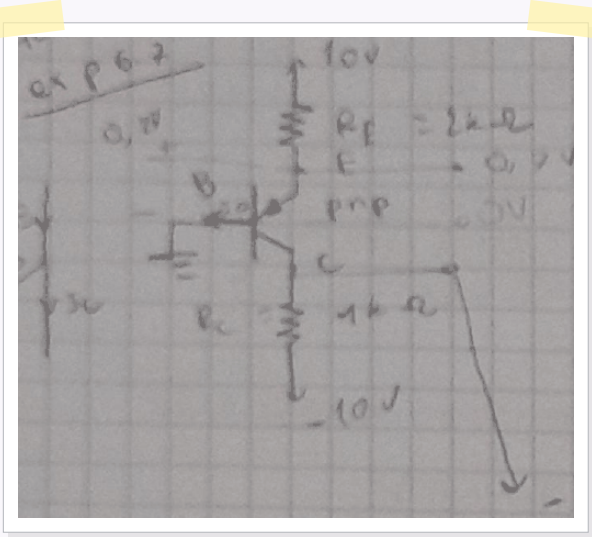
orijinal çizim, s. 35

$I_{B,C,E}$, V_B, V_C, V_E

($I_{B,C,E}$ ifadesinin altında küçük bir "0" yazıyor.)

(Sol üstte küçük: "340".)

Örnek 6.7



orijinal çizim, s. 35

Çözüm:

$$\frac{10 - 0{,}7}{2} = 4{,}65\ \text{mA} = I_E \checkmark$$

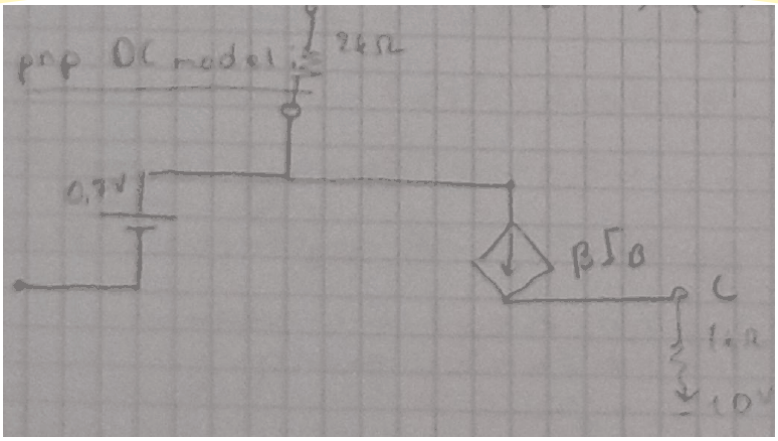
$\beta = 100$ kabul edelim

$$I_B = \frac{4{,}65}{101} \approx 0{,}05\ \text{mA} \checkmark$$

$$I_C = 4{,}6\ \text{mA} \checkmark$$

$$-10 + (4{,}6)(1\text{k}) = -5{,}4$$

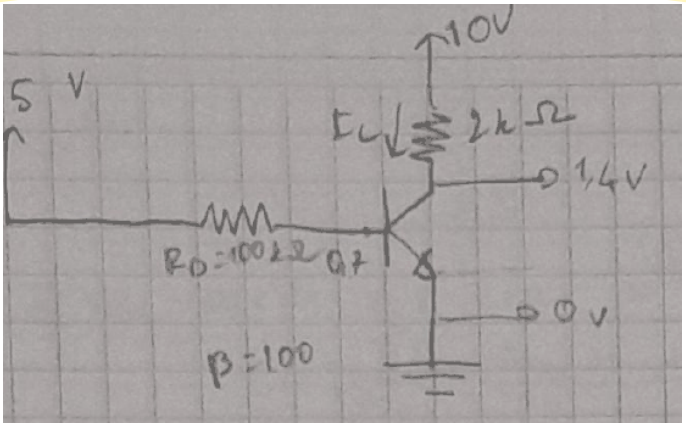
pnp → V_{EC} → $(0{,}7\text{V}) - (-5{,}4) = 6{,}1\ \text{V}$



orijinal çizim, s. 35

orj. s. 36

Örnek 6.8



orijinal çizim, s. 36

Çözüm:

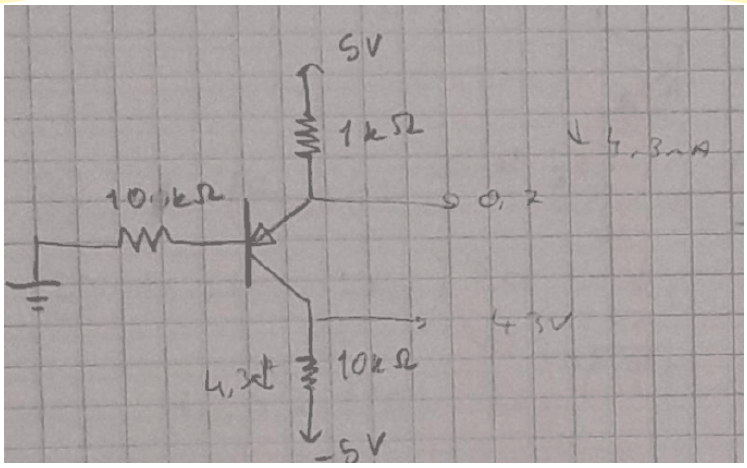
$$I_B = \frac{5 - 0{,}7\ \text{V}}{R_B} = 0{,}043\ \text{mA}$$

$$I_C = \beta I_B = (100)(0{,}043) = 4{,}3\ \text{mA}$$

$$V_C = 10 - (I_C)(R_C) = 10 - (4{,}3)(2) = 1{,}4\ \text{V}$$

$$I_E = (\beta + 1)I_B = 101 \times 0{,}043 \approx 4{,}3\ \text{mA}$$

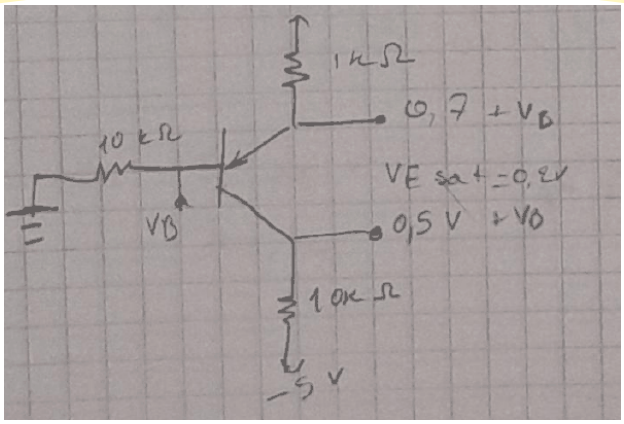
Örnek 6.9



orijinal çizim, s. 36

0,7–?43 aktif mod değil

Çözüm:



orijinal çizim, s. 36

$$I_B = \frac{V_B}{10} = 0{,}1\,V_B$$

$$I_C = \frac{V_B + 0{,}5 - (-5V)}{10}$$

$$= \frac{V_B + 5{,}5}{10} = 0{,}1\,V_B + 0{,}55$$

$$I_E = \frac{5 - (V_B + 0{,}7)}{1k}$$

$$= 4{,}3 - V_B$$

$$4{,}3 - V_B = (0{,}1\,V_B) + (0{,}1\,V_B + 0{,}55)$$

$$V_B = \frac{3{,}75}{1{,}2} \simeq 3{,}13\ \text{V} \quad \rightarrow \quad V_E = 3{,}83\ \text{V}, \quad V_C = 3{,}63\ \text{V}$$

$I_E = 1{,}17$ mA

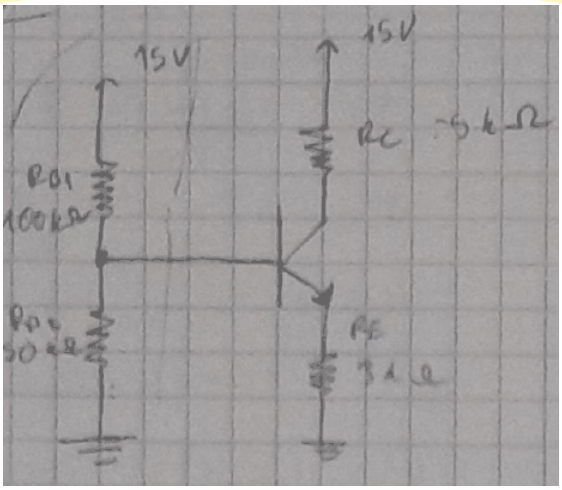
$I_C = 0{,}86$ mA

$I_B = 0{,}31$ mA

$$\beta = \frac{I_C}{I_B} \approx 2{,}8$$

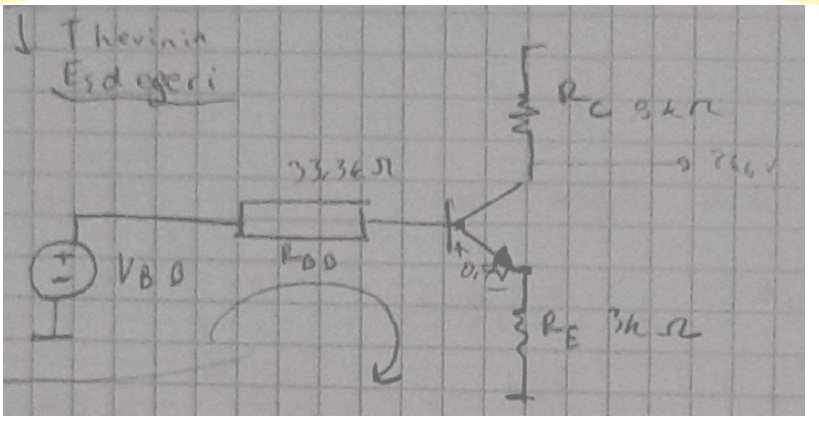
orj. s. 37 (Başlığın altında mavi, altı çizili: "sf: 345".)

Örnek 6.10



orijinal çizim, s. 37

↓ Thevenin Eşdeğeri



orijinal çizim, s. 37

Çözüm:

$$V_{BB} = 15\,\frac{R_{B2}}{R_{B1} + R_{B2}} = 15 \cdot \frac{50}{100 + 50} = 5\ \text{V}$$

$$R_{BB} = R_{B1} \parallel R_{B2} = 100 \parallel 50 = 33{,}3\ \text{k}\Omega$$

$$V_{BB} = I_B R_{BB} + V_{BE} + I_E R_E$$

$$I_B = \frac{I_E}{\beta + 1}$$

$$I_E = \frac{V_{BB} - V_{BE}}{R_E + (R_{BB}/(\beta + 1))}$$

$$I_E = \frac{5 - 0{,}7}{3 + \frac{33{,}3}{\beta + 1}}$$

$$I_E = 1{,}29 \text{ mA}$$

$$I_B = \frac{1{,}29}{101} = 0{,}0127 \text{ mA}$$

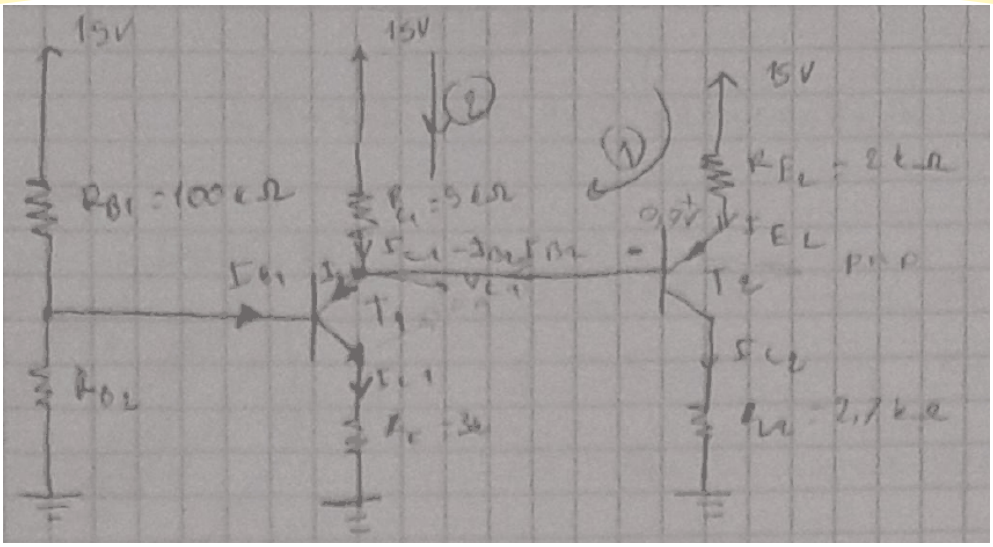
$$V_B = V_{BE} + I_E R_E = 0{,}7 \text{ V} + 1{,}29 \cdot 3 = \boxed{4{,}57 \text{ V}}$$

$$I_C = \alpha I_E = 0{,}99 \cdot 1{,}29 = 1{,}28 \text{ mA}$$

$$V_C = 15 - I_C R_C = 15 - (1{,}28)(5) = 8{,}6 \text{ V}$$

orj. s. 38

Örnek 6.11



orijinal çizim, s. 38

I_{B2} =?
V_{C1} =?

Çözüm:

$$(1) \quad 15 - (R_{E2})(I_{E2}) - 0{,}7 = V_{C1}$$

$$(2) \quad 15 - (I_{C1} - I_{B2}) R_{C1} = V_{C1}$$

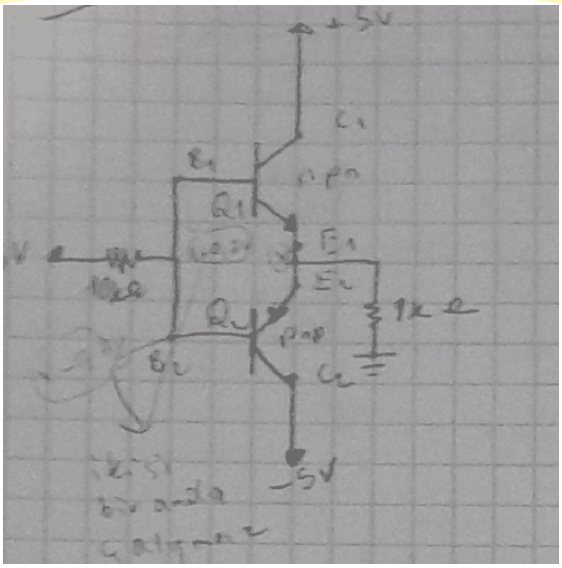
$$14{,}3 - (101)\, I_{B2}\, (2k) = V_{C1} \qquad (1)$$

$$15 - (1{,}28 - I_{B2})\, 5k = V_{C1} \qquad (2)$$

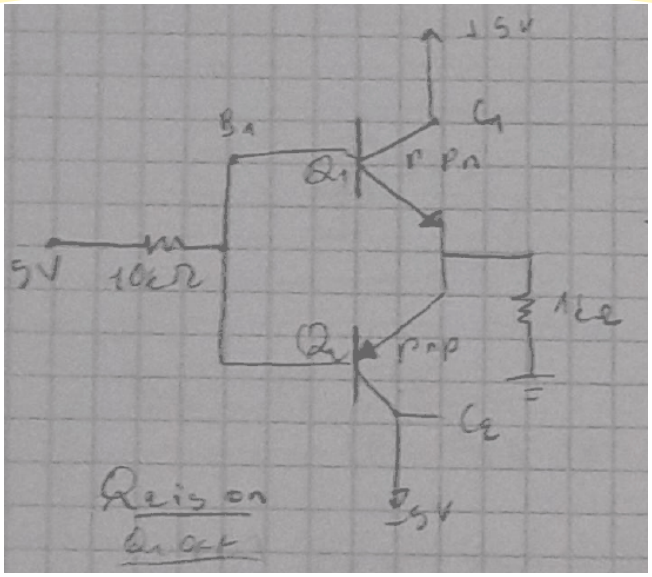
$$V_{C1} = 8{,}738 \text{ V} \approx 8{,}74 \qquad I_{B2} = 27{,}5 \text{ µA}$$

orj. s. 39

Örnek 6.12

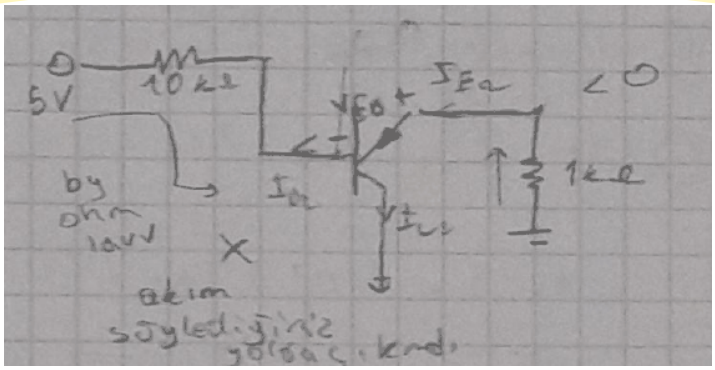


orijinal çizim, s. 39



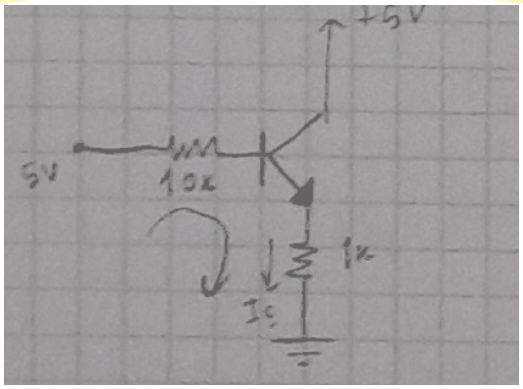
orijinal çizim, s. 39

(Çizimin altında altı çizili iki satırlık not: ? Q_1 on; Q_2 off.)



orijinal çizim, s. 39

akım söylediğiniz yönde çıkmadı



orijinal çizim, s. 39

Çözüm:

$$5\ V = (10k)\,I_{B1} + 0{,}7 + (101)\,I_{B1}\,(1k)$$

$$4{,}3 = 111k\,I_{B1} \Rightarrow I_{B1} \simeq 0{,}039\ mA$$

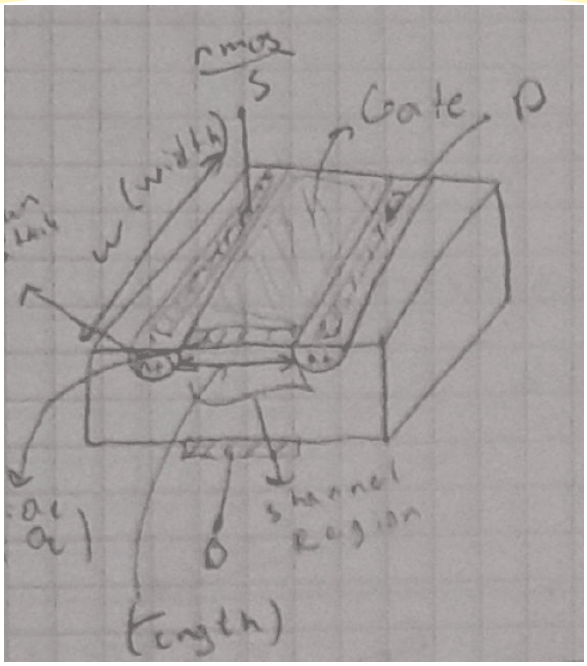
$$\Rightarrow I_{E1} = 101\,I_{B1} \simeq 3{,}9\ mA$$

orj. s. 40

MOSFET

(Metal oxide semiconductor field effect Transistor)

(Sol kenarda oval içinde küçük bir not: ?nFET.)

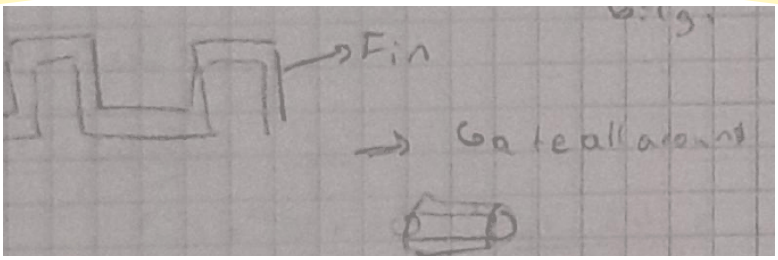


orijinal çizim, s. 40

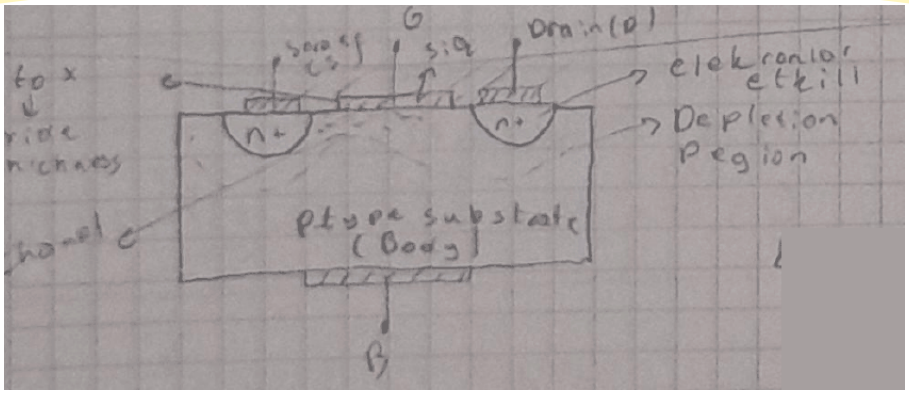
D: Drain → Savak
S: Source → Kaynak
G: Gate → Geçit
B: Body (Bulk) → Gövde

Source ve drain yer değiştirebilir çünkü simetriktir.

Genel bilgi



orijinal çizim, s. 40



orijinal çizim, s. 40

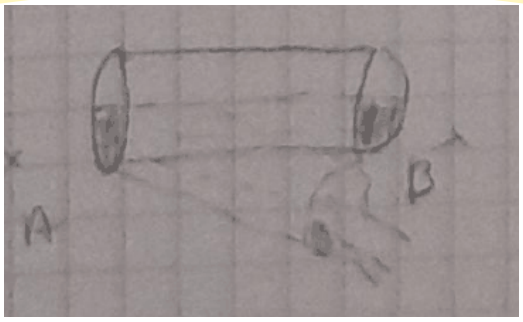
(Sağ tarafta altı çizili bir başlık: ?Modeller.)

Unipolar tek kutupludur

Kullanabilmek için
→ kanal oluşmalı
→ $V_{DS} > 0$

Mosfet türleri: (?üretimde kanal...)
Enhancement → kanal oluşmalı
Depletion → kanal ?azaltılmalı

Threshold Voltage (Eşik seviyesi)
↓ V_{GS}'ye uygulanmalı → V_t, V_{TH}
karışmamalı: $V_T = kT/q$ (farklı)



orijinal çizim, s. 40