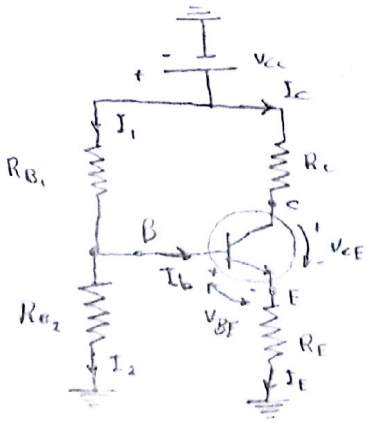
(1)

a) $V_C = 6V$ olacak şekilde $R_E = ?$

$V_{cc} = 16V$, $R_{B_1} = 82k\Omega$, $R_{B_2} = 24k\Omega$, $R_c = 5k\Omega$, $V_{BE} = 0.7\,V$, $\beta = 150$

#Not : Dc analizde Kapasatörlerin direnci $= \frac{1}{2\Pi fC} = \infty$ "yani açık devre"
↳ Dc'de = 0

Devre bu şekle dönüşecek:



npn transistör : akım kollektörden Emetöre

Yaklaşık analizde:

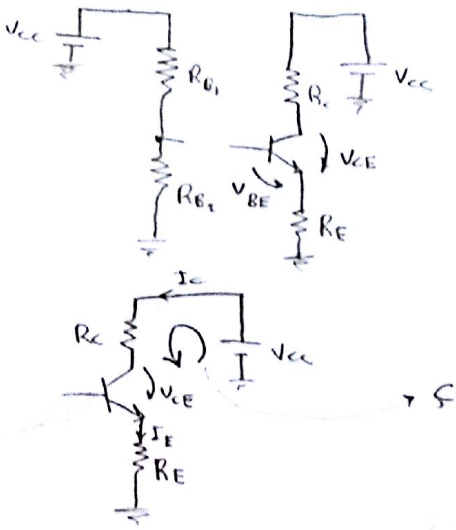
R_E o kadar büyük ki $I_b \approx 0 \Rightarrow I_1 = I_2$

yani R_{B_1} , R_{B_2} seride ,

$$V_B = V_{R_2} = \frac{V_{cc} \cdot R_{B_2}}{R_{B_1} + R_{B_2}} = \frac{16V \cdot 24k\Omega}{(82+24)k\Omega}$$

↳ Gerilim bölücü

$$V_B = 3.63 \text{ Volt}$$



$$\Rightarrow V_{BE} = V_B - V_E$$

$$0.7 = 3.63 - V_E \Rightarrow V_E = 2.93 \text{ Volt}$$

$$V_{CE} = V_c - V_E$$

$$V_{CE} = 6 - 2.93 = 3.07 \text{ Volt}$$

→ çevre denklemlerinden:

$$-V_{cc} + I_c R_c + V_{CE} + \underbrace{I_E R_E}_{V_E} = 0 \quad ; \quad (I_c \approx I_E)$$

$$I_E \approx I_c = \frac{V_{cc} - V_{CE} - V_E}{R_c} = \frac{(16 - 2.93 - 3.07)V}{(5)k\Omega}$$

$$I_E \approx I_c = 2 \text{ mA}$$

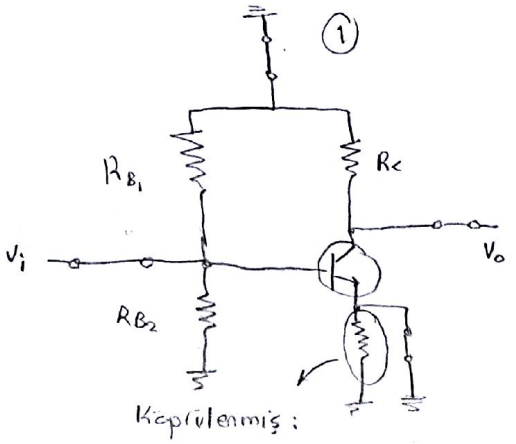
Ve nihayet!! $\Rightarrow R_E = \frac{V_E}{I_E} = \frac{2.93}{2 \times 10^{-3}} = 1.465\,k\Omega$

(b)

(#) Not :→ 1) AC analizde kapasatörlerin dirençleri $= \frac{1}{2\pi f C}$ → f'de çok büyük
yani "Kapasatörler kısa devre"

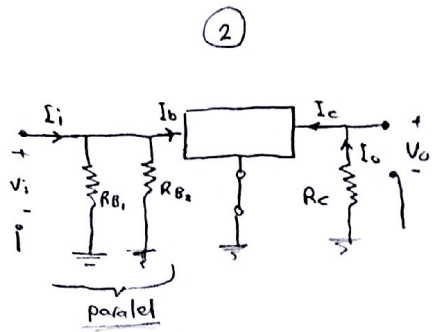
2) DC kaynaklar → kısa devre

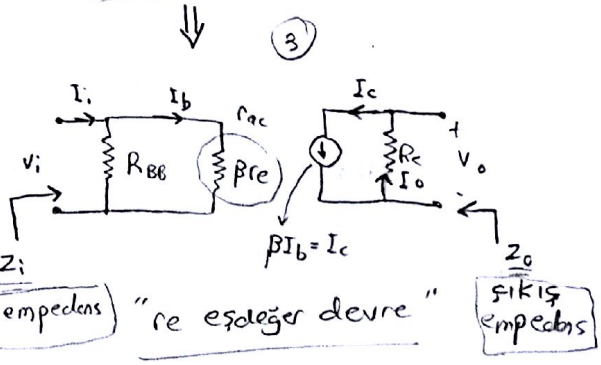
3) köprülenmiş elemanlar devre dışı bırakılır. "az sonra anlatılacak".



Köprülenmiş: akım en kolay yolu seçecek dolayısıyla burdan akım akmayacak.

≙





$$r_e = \frac{26mV}{I_E} = \frac{26mV}{2mA} = 13\,\Omega$$

$$\Rightarrow r_{ac} = \beta r_e = 150 * 13 = 1.95\,K\Omega$$

$$R_{BB} = R_{B_1} // R_{B_2} = 18.6\,K\Omega$$

a) $Z_i = R_{BB} // \beta r_e = 1.76\,K\Omega$

b) Z_o'u bulmak için $V_i = 0$ "kısa devre" $\Rightarrow I_i = 0 \Rightarrow I_b = 0 \Rightarrow I_c = \beta I_b = 0$ "açık devre"

$Z_o = R_C = 5\,K\Omega$

c) A_v "gerilim kazancı" $= \frac{V_o}{V_i}$

Şekil ③'ten $= \frac{-I_o R_C}{V_i} = \frac{-\beta I_b R_C}{V_i} = \frac{-\beta \frac{V_i}{\beta r_e} R_C}{V_i} = \frac{-R_C}{r_e} = \frac{-5\,k\Omega}{13\,\Omega} = -384.6$

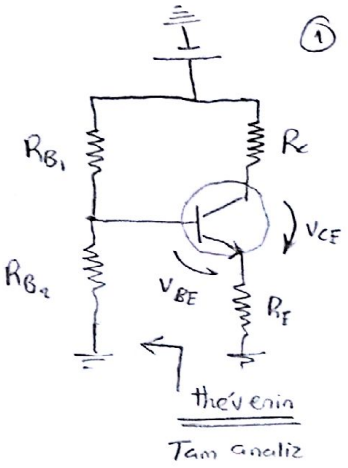
d) A_i "akım kazancı" $= \frac{I_o}{I_i} = \frac{\beta I_b}{I_b} = \beta = 100$ //

(2) $V_{cc} = 25\ V$, $R_{B_1} = 220\ k\Omega$, $R_{B_2} = 33\ k\Omega$, $R_E = 1.8\ k\Omega$, $V_{BE} = 0.7\ V$

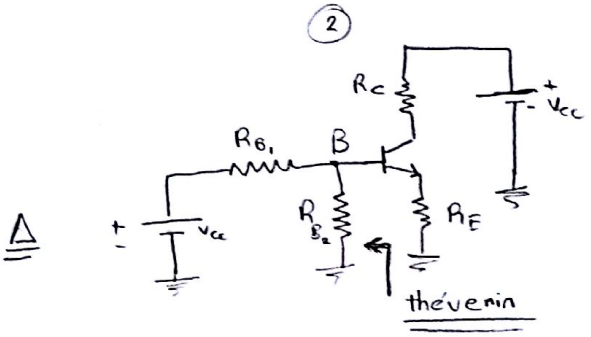
$\beta = 180$

$V_{CE} = 0.5\ V_{cc} = 0.5 * 25 = 12.5\ V$ olacak şekilde $R_c = ?$

★ DC'de kapasatörler açık devre.

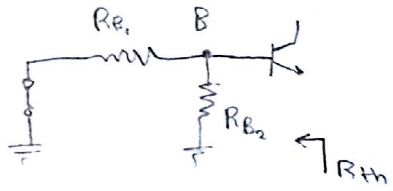


Tam analiz



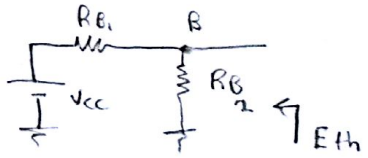
a) Tam Analiz: → $V_{cc} = 0$ "kısa devre" ve R_{th} bulunur.
→ V_{cc} geri konulur ve E_{th} bulunur.

i)



$R_{th} = R_{B_1} // R_{B_2} = 28.7\ k\Omega$

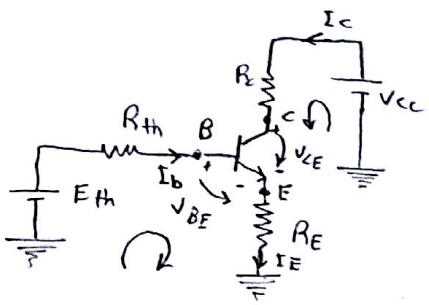
ii)



$E_{th} = V_{R_{B_2}} = \dfrac{V_{cc}\ R_{B_2}}{R_{B_1} + R_{B_2}}$ "Gerilim bölücü seri elemanlarda"

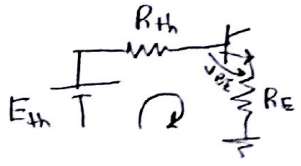
$E_{th} = 3.26\ V_{oH}$

• Sonra "Thevenin" eşdeğer devre konulur [bir kaynak (Eth) ve ona seri bağlanmış direnç (Rth)"]



• giriş çevre denklemi:

$$-E_{th} + I_B R_{th} + V_{BE} + I_E R_E = 0$$



$I_E = I_C + I_B$

$= \beta I_B + I_B$

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

$$-E_{th} + I_B R_{th} + V_{BE} + (\beta+1) I_B R_E = 0$$

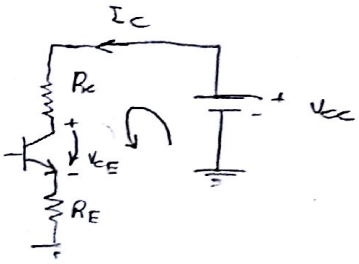
$$\Rightarrow I_B = \frac{E_{th} - V_{BE}}{R_{th} + (\beta+1) R_E} = \frac{(3.26 - 0.7)\,V}{(28.7 + (180+1)\,1.8)\,k\Omega}$$

$$I_B = 7.22\ \mu A$$

$$\Rightarrow I_C = \beta I_B = 180 * 7.22\ \mu A$$

$$I_E \approx I_C = 1.23\ mA$$

• çıkış çevre denklemi:



$$-V_{cc} + I_C R_C + V_{CE} + I_E R_E = 0$$

$$I_C R_C = V_{cc} - V_{CE} - I_E R_E \quad ; I_E \approx I_C$$

$$R_C = \frac{V_{cc} - V_{CE} - I_C R_E}{I_C} = \frac{25 - 12.5 - 2.214}{1.23\ mA} = 8.36\ k\Omega$$

b) yaklaşık analiz: 1. Soruda yapıldığı gibi:

- şekil (1)'den: $V_B = V_{R_{B_2}} = \frac{V_{cc} * R_{B_2}}{R_{B_1} + R_{B_2}}$ Gerilim bölücü.

$V_B = 3.26$ volt "1. şıkkındaki E_{th}"

$V_{BE} = V_B - V_E \Rightarrow V_E = V_B - V_{BE} = 3.26 - 0.7 = 2.56$ Volt

$$I_E \approx I_C = \frac{V_E}{R_E} = \frac{2.56\,V}{1.8\,k\Omega} = 1.42\ mA$$

"az önce bulduğumuz I_C'ye yakın"

* çıkış çevre denkleminden:

$$-V_{cc} + R_C I_C + V_{CE} + I_E R_E = 0 \quad ; I_C \approx I_E$$

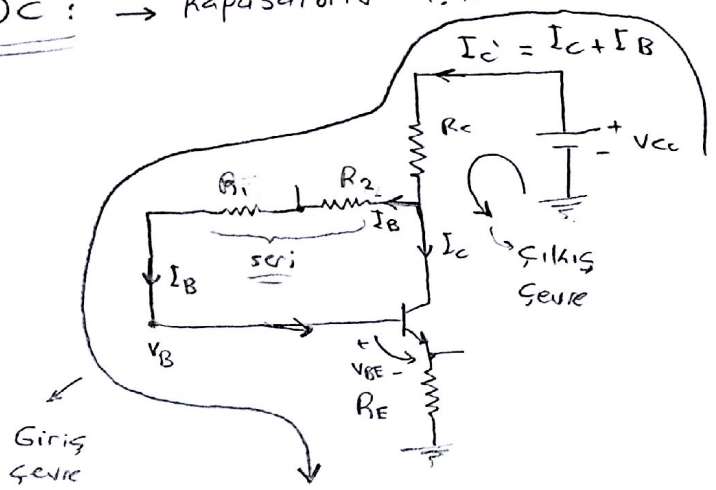
$$\Rightarrow R_C = \frac{V_{cc} - V_{CE} - I_C R_E}{I_C} = \frac{25 - 12.5 - 1.42mA * 1.8k\Omega}{1.42mA} = 7k\Omega$$

yaklaşık metod oyüzden "8.36 kΩ"'den uzak

(3) burada hemen AC analiz istemiş ve "re" eşdeğer devre!!

ama $r_e = \frac{26\,mV}{I_E}$ → Bunu bulmak için DC analiz yapmalıyız 😑

a) DC : → Kapasatörler açık devre



bu devre 67. sayfada aynısı vardır.

$$-V_{CC} + I_C' R_C + V_{BE} + (R_{F_1} + R_{F_2}) I_B + I_E R_E = 0$$

$$-V_{CC} + (\beta+1) I_B R_C + (R_{F_1} + R_{F_2}) I_B + (\beta+1) R_E + V_{BE} = 0$$

$$\Rightarrow I_B = \frac{V_{CC} - V_{BE}}{R_{F_1} + R_{F_2} + (\beta+1)(R_C + R_E)} = \frac{(12 - 0.7)\ V}{\left[(20 + 30) + (100+1)(3+2)\right] K\Omega}$$

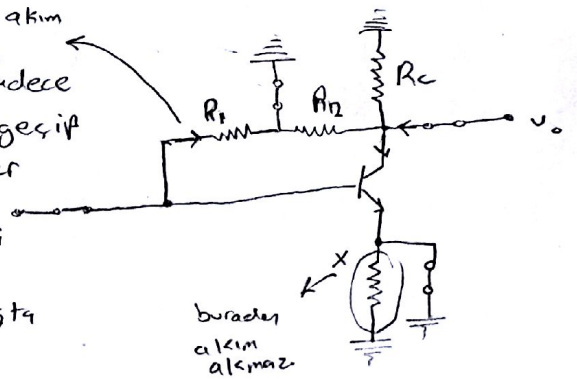
$I_C' = I_C + I_B$
$= \beta I_B + I_B$
$I_C' = (\beta+1) I_B$
$I_E = (\beta+1) I_B$

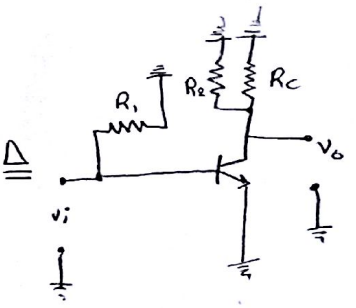
$I_B = 20.3\ \mu A$ ⇒ $I_C = \beta I_B = 2.03\ mA$

⇒ $I_C' \approx I_E = I_C + I_B = 2.05\ mA$

b) AC : → DC kaynaklar kısa devre
→ kapasatörler kısa devre
→ köprülenmiş elemanlar kısa devre.

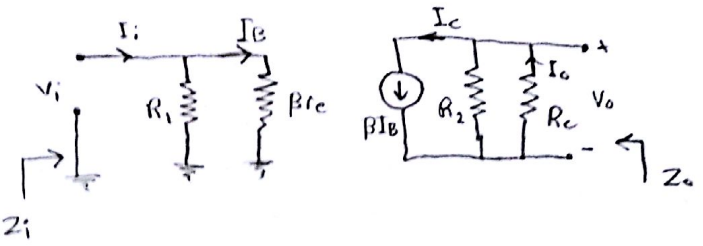
buradan geçen akım (C_3) kısa devre edildiğinden sadece R_{F_1} üzerinden geçip toprağa gider yani "R_{F_2}" eşdeğer devrede çıkışta yansıcak





r_e eş değer devre

kollektör geri beslemeli 99. sayfa



$R_1 \rightarrow R_{F_1} = 2.6\,K\Omega$

$R_2 \rightarrow R_{F_2} = 3\,K\Omega$

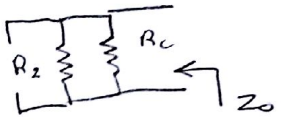
$$r_e = \frac{26mV}{I_E} = \frac{26mV}{2.05mA} = 12.7\,\Omega$$

$$\Rightarrow \boxed{\beta r_e = 1.27\,K\Omega}$$

a) $Z_i = R_1 // \beta r_e$

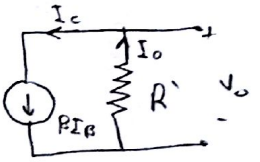
$$\boxed{Z_i = 1.2\,K\Omega}$$

b) Z_o'u bulmakiçin $V_i = 0 \Rightarrow I_b = 0 \Rightarrow I_c = \beta I_B = 0$ "açık devre"



$$\boxed{Z_o = R_2 // R_c = 2.73\,K\Omega}$$

$$R' = R_2 // R_c = 2.73\,K\Omega$$



c) $A_V = \frac{V_o}{V_i} = \frac{-I_o R'}{V_i}$

$$= \frac{-\beta I_B R'}{V_i} = \frac{-\beta \left(\frac{V_i}{\beta r_e}\right) R'}{V_i}$$

$$\boxed{A_V = \frac{-R'}{r_e} = -\frac{2.73\,K\Omega}{12.7\,\Omega} = -214.96}$$

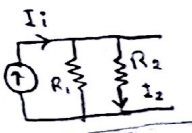
$A_i = \frac{I_o}{I_i}$

$$\rightarrow I_o = \frac{I_c \cdot R_2}{R_2 + R_c} = \frac{\beta I_B R_2}{R_2 + R_c}$$

$$\Rightarrow \frac{I_o}{I_B} = \frac{\beta R_2}{R_2 + R_c}$$

$$I_B = \frac{I_i R_1}{R_1 + \beta r_e} \Rightarrow \frac{I_B}{I_i} = \frac{R_1}{R_1 + \beta r_e}$$

Akım bölücü:



$$I_2 = \frac{I_i \cdot R_1}{R_1 + R_2}$$

$$A_i = \frac{I_o}{I_B} \cdot \frac{I_B}{I_i}$$

d) $$\boxed{A_i = \frac{\beta R_2}{R_2 + R_c} \cdot \frac{R_1}{R_1 + \beta r_e} = 85.48}$$

(4) Bu soru 100%'ü (3)' soruya benzer DC ve AC analizde de sadece değerler farklı ve a) şıkkında ilave olarak I_c bulduktan sonra:

çıkış çevre "önceki soruda gösterilmiş"

$$-V_{cc} + I_c R_c + V_{CE} + I_E R_E = 0$$

($I_E \approx I_c$, $I_B + I_c$)

Verilmiş

ve $\boxed{V_{CE} = V_{cc} - I_c (R_c + R_E)}$ şeklinde bulunur.

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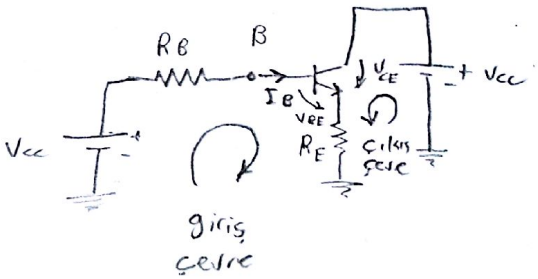
(5) a) Devre bu şekilde çizilebilir:



giriş çevre: $-V_{cc} + I_B R_B + V_{BE} + I_E R_E = 0$

$$-V_{cc} + I_B R_B + V_{BE} + (\beta+1) I_B R_E = 0$$

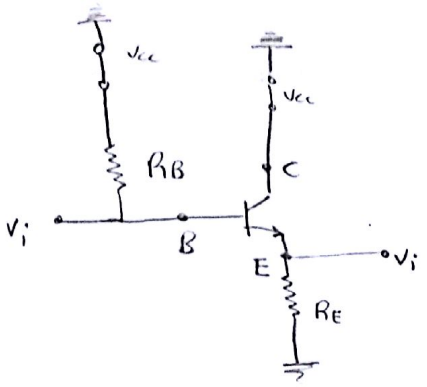
$$\Rightarrow I_B = \frac{V_{cc} - V_{BE}}{R_B + (\beta+1) R_E} = \frac{(12 - 0.7)\ V}{[560 + (100+1)\ 2.2]\ K\Omega}$$

$$\Rightarrow I_B = 14.4\ \mu A$$

$$\Rightarrow \boxed{I_c \approx I_E = \beta I_B = 1.44\ mA}$$

• AC : burada önceki sorulardan tek farkı R_C olmamak ve R_E köprülenmemiş yani eşdeğer devrede dahil edilmedi

Emetör izleyici devre 96. sayfa



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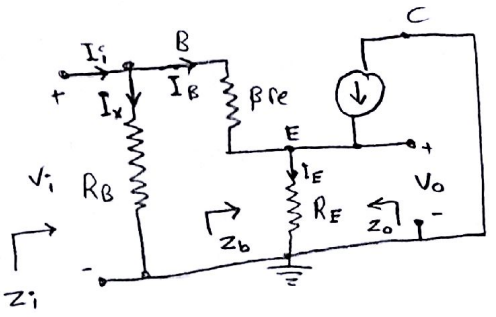
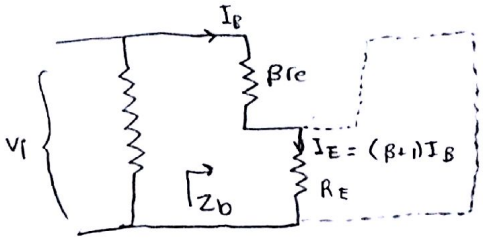


$Z_i = R_B // Z_b$



$V_i = I_B \beta r_e + (\beta+1) I_B R_E$ *

$Z_b = \frac{V_i}{I_B} = \beta r_e + (\beta+1) R_E$

$r_e = \frac{26mV}{I_E} = \frac{26mV}{1.44mA} = 18.1\ \Omega$

$Z_b = 100 \cdot 18.1 + (100+1)\ 2200\Omega$

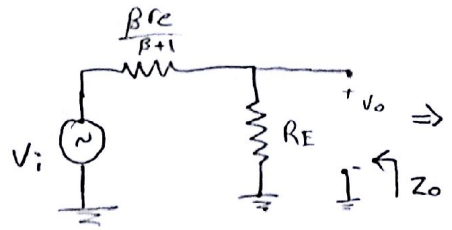
$Z_b = 22.4\ K\Omega$

a) $\Rightarrow Z_i = R_B // Z_b = \frac{560 \cdot 22.4}{560 + 22.4} = 21.5 K\Omega$

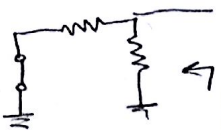
b) Z_o'u bulmak için $V_i = 0$ "kısa devre" fakat burada çıkış emetör üzerinden alındığından (βr_e) Z_o'ye girecek :

$$I_E = (\beta+1) I_B = (\beta+1) \frac{V_i}{Z_b} = \frac{(\beta+1) V_i}{\beta r_e + (\beta+1) R_E} = \frac{V_i}{\frac{\beta r_e}{\beta+1} + R_E}$$

→ bu bir çevre denklemden alındığını düşünürsek o çevrenin devresi bu şekilde olacak:



⇒ Şimdi $V_i = 0$ "kısa devre" Z_o'u bulabiliriz.



$\Rightarrow Z_o = R_E // \frac{\beta r_e}{\beta+1}$

$Z_o = R_E // \frac{\beta re}{\beta+1}$ $\qquad \beta re = 100 * 18.1 = 1.81\ K\Omega$

b) $Z_o = 2.2\ K\Omega // 17.9\ \Omega = \frac{2200 * 17.9}{2217.9} = 17.7\ \Omega$

c) $A_V = \frac{V_o}{V_i}$ → emetör üzerinden alınıyor!!

$= \frac{I_E R_E}{V_i} = \frac{(\beta+1) I_B R_E}{I_B \beta re + (\beta+1) I_B R_E} = \frac{R_E}{\frac{\beta re}{\beta+1} + R_E} = 0.99 \approx 1$ //

d) $A_i = \frac{I_o}{I_i} =$

$I_o = I_E = (\beta+1) I_B \Rightarrow \frac{I_o}{I_b} = (\beta+1)$

$I_B = \frac{I_i R_B}{R_B + Z_b} \Rightarrow \frac{I_B}{I_i} = \frac{R_B}{R_B + Z_b}$

$A_i = \frac{I_o}{I_B} \cdot \frac{I_B}{I_i} = \frac{(\beta+1) R_B}{R_B + Z_b} = \frac{(100+1)\ 560\ K\Omega}{(560 + 22.4)\ K\Omega} = 97.11$

bu devrede Z_i büyük çıkması, Z_o küçük çıkması

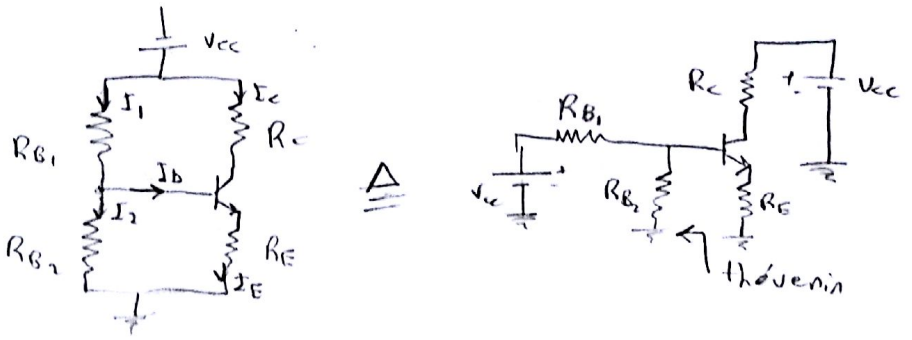
$A_V = 1$, A_i büyük çıkması istenen bir durumdur

çünkü bu devre akım yükseltmek için sadece

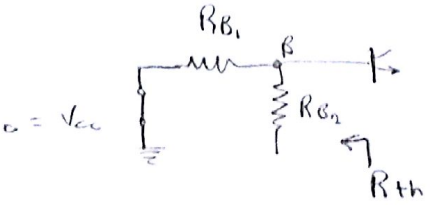
kullanılır

(6)

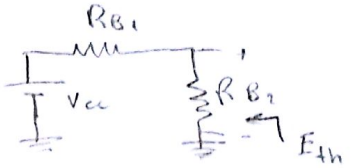
a) Bu devre Tam analiz ile çözülebilir "Thévenin"



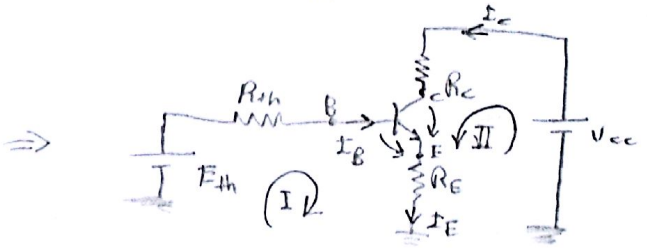
Thévenin eşdeğer devre : → Vcc = 0 "kısa devre" ve R_{th} bulunur.
→ Vcc geri konulur ve E_{th} bulunur



$$R_{th} = R_{B_1} // R_{B_2} = \frac{56 * 5.6}{56 + 5.6} = 5.09\ K\Omega$$



$$E_{th} = V_{R_{B_2}} = \underbrace{\frac{V_{cc} * R_{B_2}}{R_{B_1} + R_{B_2}}}_{\text{Gerilim bölücü}} = 1.81\ Volt$$



(I) : $-E_{th} + I_B R_{th} + V_{BE} + I_E R_E = 0$

$-E_{th} + I_B R_{th} + V_{BE} + (\beta+1) I_B R_E = 0$

$$\Rightarrow I_B = \frac{E_{th} - V_{BE}}{R_{th} + (\beta+1) R_E} = \frac{(1.81 - 0.7)\ V}{(5.09 + (100+1) * 0.56)\ K\Omega}$$

$$\Rightarrow \boxed{I_B = 18\ \mu A} \quad \Rightarrow \boxed{I_c \approx I_E = \beta I_B = 1.8\ mA}$$

(II) : $-V_{cc} + I_C R_C + V_{CE} + I_E R_E = 0$; $I_C \simeq I_E$

$\Rightarrow V_{CE} = V_{cc} - I_C (R_C + R_E)$

$V_{CE} = 20 - 1.8\,mA\,(1 + 0.56)k\Omega$

$\boxed{V_{CE} = 17.2\ V}$

$V_E = I_E R_E = 1.8\,mA * 0.56\,k\Omega$

$\boxed{V_E = 1\ Volt}$

$V_{CE} = V_C - V_E \Rightarrow V_C = V_{CE} + V_E$

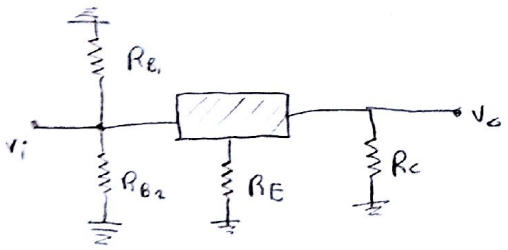
$\boxed{V_C = 17.2 + 1 = 18.2}$

veya $\boxed{V_C = V_{cc} - I_C R_C = 20 - 1.8\,mA * 1\,k\Omega = 18.2\ Volt}$

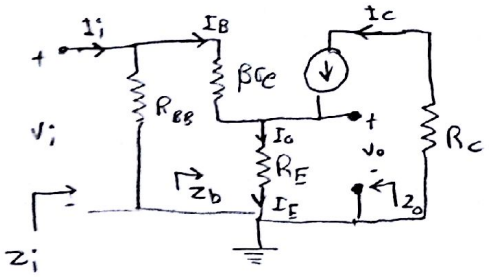
b) Bu devre bir "Emetör izleyici" devresidir [Çıkış emetörden alınmış]

AC → DC Kaynaklar kısa devre.
→ Kapasatörler kısa devre.

(*) burada da (5) soruda gibi R_E köprülenmemiş.



$R_{BB} = R_{B_1} // R_{B_2}$



$Z_i = R_{BB} // Z_b$

$V_i = I_B \beta r_e + I_E R_E$

$V_i = I_B \beta r_e + (\beta+1) R_E I_B$ (∵ I_B)

$\Rightarrow \frac{V_i}{I_B} = \beta r_e + (\beta+1) R_E = \underline{Z_b}$

$r_e = \frac{26\,mA}{I_E} = \frac{26\,mV}{1.8\,mA} = 14.4\,\Omega$

$\beta r_e = 1.44\,K\Omega$

$Z_b = (\beta\ 14.4 + (\beta+1)\ 560)\,\Omega$

$Z_b = 58\,K\Omega \Rightarrow Z_i = Z_b // R_{BB} = 58 // 5.09$

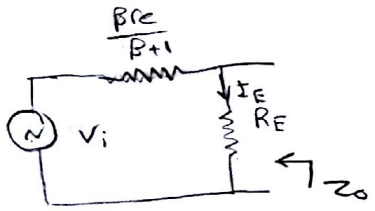
a) $Z_i = 4.68\,K\Omega$

b) yine Z_o'u bulmak için $V_i = 0$ "kısa devre" yapmalıyız ama βr_e katkısı da bulmak için:

$I_o = I_E = (\beta+1) I_B = (\beta+1) \frac{V_i}{Z_b}$

$I_o = I_E = \frac{(\beta+1) V_i}{\beta r_e + (\beta+1) R_E} \Rightarrow I_E = I_o = \frac{V_i}{\frac{\beta r_e}{\beta+1} + R_E}$

bunu bir çevre denklem olduğunu düşünürsek bu çevrenin devre:



şimdi $V_i = 0$ "kısa devre"

$\Rightarrow Z_o = R_E // \frac{\beta r_e}{\beta+1}$

$Z_o = (560 // 14.25)\,\Omega$

$Z_o = 13.9\,\Omega$

c) $A_V = \frac{V_o}{V_i} = \frac{I_E R_E}{I_B Z_b} = \frac{(\beta+1) I_B R_E}{I_B Z_b} = \frac{(\beta+1) R_E}{Z_b} = \frac{(\beta+1) R_E}{\beta r_e + (\beta+1) R_E} = \frac{R_E}{\frac{\beta r_e}{\beta+1} + R_E}$

$A_V = \frac{0.56}{\frac{100 * 14.4}{101} + 0.56} = 0.98 \approx 1$ //

d) $A_i = \frac{I_o}{I_i}$ → $I_o = I_E = I_B(\beta+1) \Rightarrow \frac{I_o}{I_B} = (\beta+1)$

→ $I_B = \frac{R_{BB}\, I_i}{R_{BB}+Z_b}$ "akım bölücü"

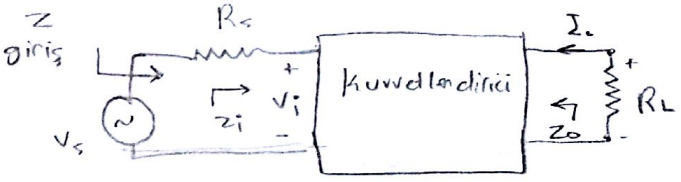
$$\Rightarrow \frac{I_B}{I_i} = \frac{R_{BB}}{R_{BB}+Z_b}$$

$$A_i = \frac{I_o}{I_B}\cdot\frac{I_B}{I_i} = \frac{I_o}{I_i} = \frac{(\beta+1)\,R_{BB}}{R_{BB}+Z_b} = \frac{(101 * 5.09)\,k\Omega}{(5.09+58)\,k\Omega}$$

$A_i = 8.15$

c) * $R_s = 100\ \Omega$ $R_L = 250\ k\Omega$

R_s kaynak direnci ve R_L yük direncinin devrelere etkisi 100. sayfa



$Z_{giriş} = R_s + z_i = 0.1 + 4.68 = 4.78\ k\Omega$

$$v_i = \frac{V_s \cdot z_i}{z_i + R_s}$$ "Gerilim bölücü"

$$\frac{v_i}{V_s} = \frac{z_i}{z_i+R_s}$$

- toplam Gerilim kazancı : $A_{Vs} = \frac{V_o}{V_s} = \frac{V_o}{V_i}\cdot\frac{V_i}{V_s} = A_v \cdot \frac{z_i}{z_i+R_s} = \frac{0.98 * 4.68}{4.68+0.1}$

$A_{Vs} = 0.96$ "Gerilim kazcı azaltılmış"

- → $I_i = \frac{V_i}{z_i}$, → $I_o = \frac{V_o}{R_L}$

$$\Rightarrow A_{is} = \frac{I_o}{I_i} = \frac{\frac{V_o}{R_L}}{\frac{V_i}{z_i}} = \frac{z_i}{R_L} A_v = \frac{4.68}{250} * 0.98 =$$

$A_{is} = 0.018$ $R_{yük}$ çok büyük olunca Akım kazancı azalır. ve burada Akım kazanca hiç yokgibidir.