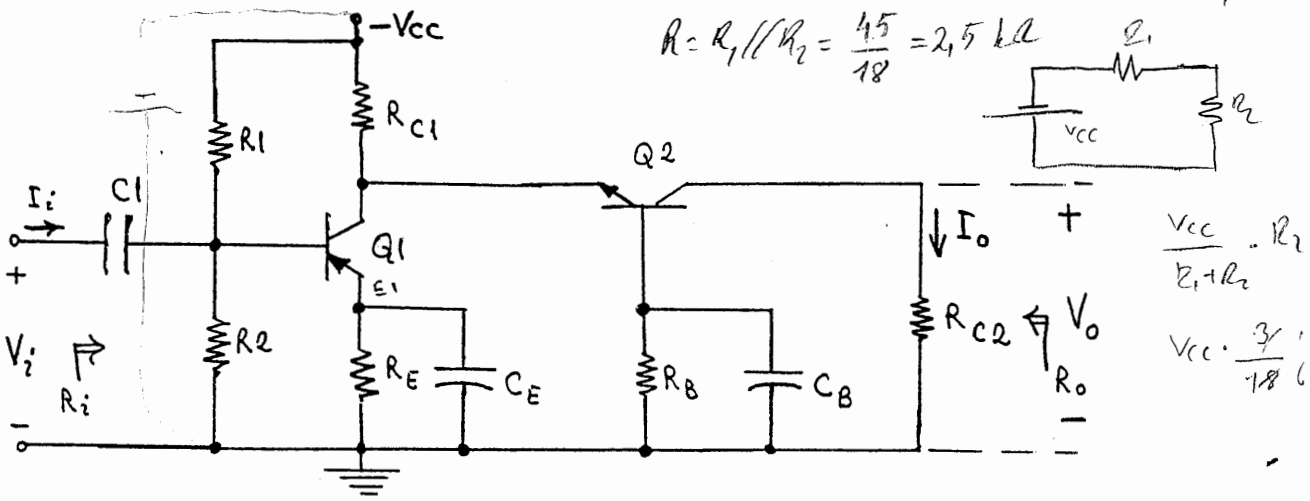
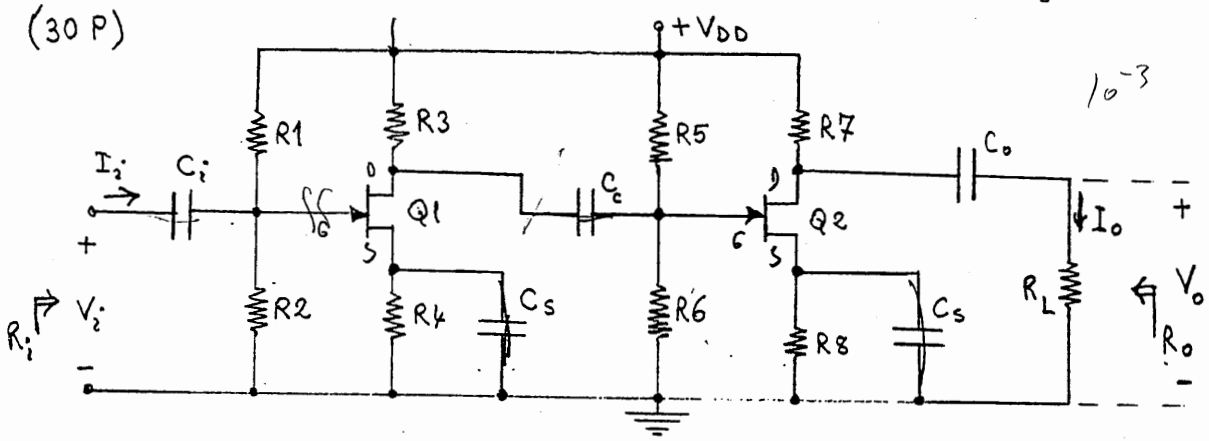
K.T.Ü. Elektrik-Elektronik Müh. Bölümü **05.11.2004**
ELEKTRONİK DEVRELER I Birinci ARASINAVI
Ders sorumlusu : Öğr. Gör. Türen Demircioğlu

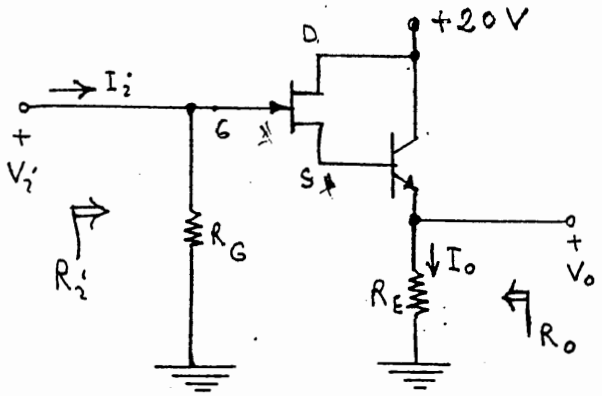
SORU 1. Q1,Q2 : $h_{ie} = 2\,k\Omega$, $h_{fe} = 40$, $h_{re} \approx h_{oe} \approx 0$, R1=15 kohm, R2 = 3 kohm
(30 P) $R_{C1} = 5$ kohm, $R_E = 470$ ohm, $R_B = 100$ kohm, $R_{C2} = 2{,}5$ kohm
Bütün kapasiteler yeterli büyüklükte seçilmiştir.



SORU 2. Fetler özdeştir. $g_m = 1000\,\mu$mho, $r_d \approx \infty$, R1 = R2 =50 kohm,
R3 = 5 kohm R4 = R8 = 1 kohm, R5 = R6 = 20 kohm, R7 = R_L = 10 kohm
(30 P)

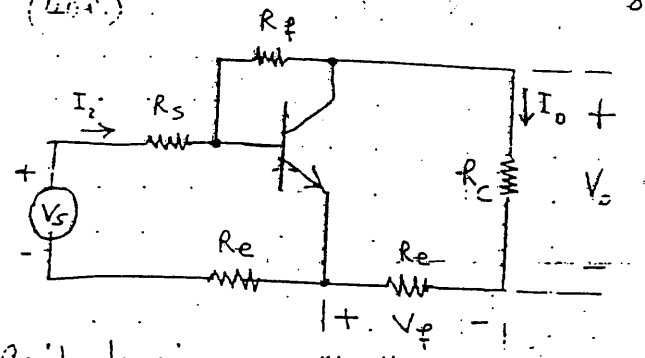


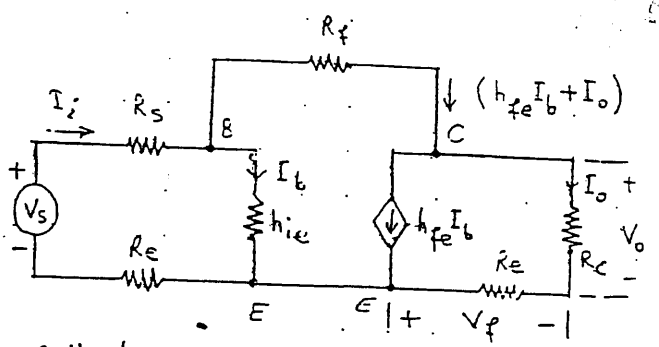
SORU 3. JFET : $g_m = 5\frac{mA}{V}$, $r_d = 50\,k\Omega$, BJT : $h_{ie} = 2\,k\Omega$, $h_{fe} = 60$, $h_{re} \approx h_{oe} \approx 0$
(40 P) $R_G = 10\,M\Omega$, $R_E = 500\Omega$



Yükselteçlerin, alçak frekanslarda küçük genlikli işaretler için **a)** Gerilim kazancını (dB), **b)** Giriş direncini, **c)**Akım kazancını (dB) ve güç kazancını, **d)** Çıkış direncini bulunuz.

SORU 2. Re den dolayı oluşan geribesleme "AKIM-SERİ" dir.





Geribeslemesiz esm gülseltisi

Geribeslemesiz esm gülseltisi eşdeğeri

$$\beta = \frac{V_f}{I_o} = -R_e = -0{,}5\ k\Omega \qquad V_S = (R_s + R_e) I_i + h_{ie} I_b \qquad I_i = (1 + h_{fe}) I_b + I_o$$

$$h_{ie} I_b = R_f (h_{fe} I_b + I_o) + (R_c + R_e) I_o \quad \Rightarrow \quad I_b = \frac{R_f + R_c + R_e}{h_{ie} - h_{fe} R_f} \cdot I_o \cong \frac{100 + 5 + 0{,}5}{2 - 150 \cdot 100} I_o$$

$$\cong -7{,}034 \cdot 10^{-2} I_o$$

$$I_i = (1 + h_{fe}) I_b + I_o = (1 + 150)(-7{,}034 \cdot 10^{-2} I_o) + I_o \cong -0{,}0621\, I_o$$

$$V_S = (1 + 0{,}5)\underbrace{(-0{,}0621\, I_o)}_{I_i} + 2\underbrace{(-7{,}034 \cdot 10^{-3} I_o)}_{I_b} \cong -0{,}1073 I_o$$

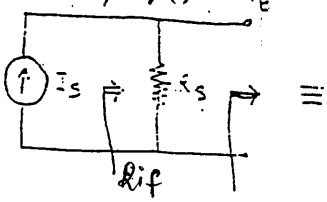
$$A = G_M \equiv \frac{I_o}{V_S} = -\frac{1}{0{,}1073} \cong -9{,}319\ \frac{mA}{V} = G_M = A$$

Yüklüdür, $A_f = G_{Mf} \equiv \frac{I_o}{V_S} = \frac{G_M}{1 + \beta G_M} = \frac{-9{,}319}{1 + (-0{,}5)(-9{,}319)} \cong \frac{-9{,}319}{5{,}6595} \cong -1{,}6465\ \frac{mA}{V} =$

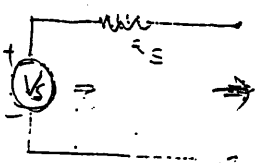
$$A_{Vf} \equiv \frac{V_o}{V_S} = \frac{R_C \cdot I_o}{V_S} = R_C \cdot G_{Mf} = (5)(-1{,}6465) \cong -8{,}232 = A_{Vf}$$

$I_i = -0{,}0621\, I_o \quad \Rightarrow \quad I_o = -16{,}103\, I_i$ $\qquad V_S = (-0{,}1073)(-16{,}103 I_i) \cong 1{,}727\, I_i$

$R_i \equiv \frac{V_S}{I_i} \cong 1{,}727\ k\Omega$ $\qquad R_{if} = R_i(1 + \beta G_M) = 8{,}77$



$\equiv$



$\Rightarrow \quad 8{,}77 - R_S = 8{,}77\ k\Omega$

$R_{if} = (R_S \| 8{,}77) = 1 \| 8{,}77$

$R_{if} \cong 897{,}6\ \Omega$

Çıkış direnci, CE den görülen direnç

$$I = h_{fe} I_b + \frac{V}{R_f + \{(R_S + R_e) \| h_{ie}\}} = \frac{V}{R_f + \{(R_S + R_e) \| h_{ie}\}} \cdot \left[\ldots \right] \ldots$$

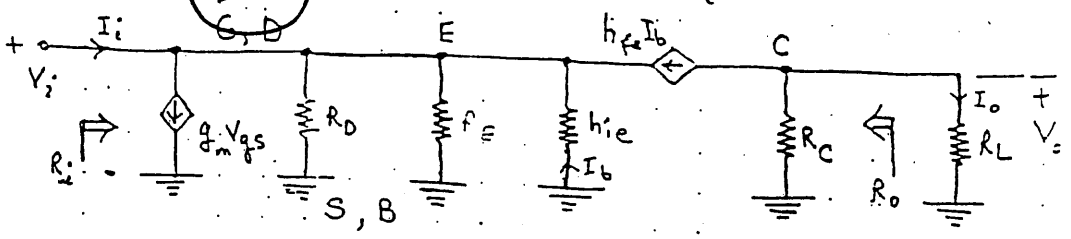
$$= \frac{V}{100{,}857} \left\{ \frac{150}{2} [0{,}858] + 1 \right\} = 0{,}6472 \cdot V$$

$$\frac{V}{I} = \frac{1}{0{,}6472} \cong 1{,}545\ k\Omega$$

(B)

10 - 12 -2004

SORU 1. (30 puan)



$$V_o = -h_{fe}\cdot I_b\cdot(R_C \| R_L) \qquad V_i = -I_b\cdot h_{ie}$$

$$A_V \equiv \frac{V_o}{V_i} = \frac{h_{fe}(R_C\|R_L)}{h_{ie}} = \frac{(120)(4\|4)}{1,5} = 160$$

$$\boxed{A_V = 160}$$

$$I_i = g_m V_{gs} + \frac{V_i}{R_D\|R_E} - (1+h_{fe})I_b \qquad V_i = V_{gs}\ ,\ I_b = -\frac{V_i}{h_{ie}}$$

$$I_i = g_m V_i + \frac{V_i}{R_D\|R_E} + \frac{(1+h_{fe})V_i}{h_{ie}} \Rightarrow \frac{1}{R_i} = \frac{I_i}{V_i} = g_m + \frac{1}{R_D\|R_E} + \frac{1+h_{fe}}{h_{ie}} = 2 + \frac{1}{(2\|3)} + \frac{1+\ldots}{1,5}$$

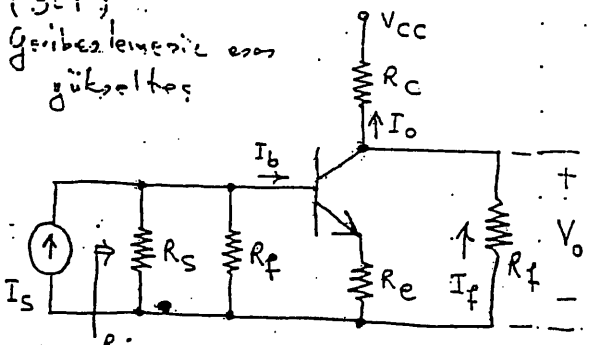
$$\frac{1}{R_i} \cong 83,\overline{33}\ \frac{mA}{V} \Rightarrow R_i \equiv \frac{V_i}{I_i} = \frac{1}{83,33} \cong 0,012\ k\Omega = \boxed{12\ \Omega = R_i}$$

$$A_I \equiv \frac{I_o}{I_i} = \frac{V_o/R_L}{V_i/R_i} = \frac{V_o}{V_i}\cdot\frac{R_i}{R_L} = A_V\cdot\frac{R_i}{R_L} = (160)\cdot\frac{0,012}{4} \cong \boxed{0,48 = A_I}$$

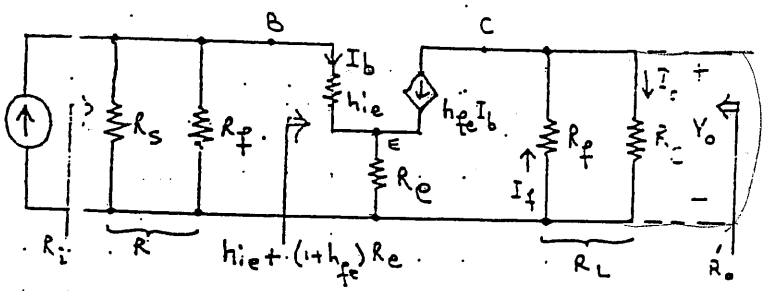
$$R_o \equiv \left.\frac{V}{I}\right|_{V_i=0} = R_C = \boxed{4\ k\Omega = R_o}$$

SORU 2. (30P) R_f den dolayı dizgon geribeslemeye "GERİLİM-PARALEL" dir.

Geribeslemesiz esas yükseltec



Geribeslemesiz esas yükseltec eşdeğeri



$R = R_S \| R_f = 1\|100 \cong 0,99\ k\Omega$. $R_L = R_C\|R_f = 5\|100 \cong 4,762\ k\Omega$. $\beta \equiv \frac{I_f}{V_o} = -\frac{1}{R_f} = -\ldots$

R_S kaynak direncini yükseltecin içinde düşünüldüğünden

$$A = R_M \equiv \frac{V_o}{I_S} = \frac{-h_{fe}\,I_b\,(R_f\|R_C)}{I_S} = \frac{-h_{fe}\,R\,(R_f\|R_C)}{R + h_{ie} + (1+h_{fe})R_e} = \frac{-150\cdot(0,99)\cdot(4,762)}{0,99 + 2 + (1+150)(0,5)} \cong \boxed{-9\ k\Omega = R_M =}$$

Tablodan,

$$A_f = R_{Mf} = \frac{R_M}{1+\beta R_M} = \frac{-9}{1+(-0,01)(-9)} = \frac{-9}{1,09} \cong \boxed{-8,256\ k\Omega = R_{Mf} = A_f}$$

$$A_{Vf} \equiv \frac{V_o}{V_S} = \frac{V_o}{I_S R_S} = \frac{R_{Mf}}{R_S} = \boxed{-8,256 = A_{Vf}} \quad R_i = R\|\{h_{ie} + (1+h_{fe})R_e\} = (0,99)\{2 + (1+150)0,5\} \cong \ldots$$

Tablodan, $R_{if} = \frac{R_i}{1+\beta R_M} = \frac{937,5}{1,09} \cong \boxed{836,8\ \Omega = R_{if}}$ & $R_o' = R_C\|R_f = R_L = 4,762\ k\Omega$

Tablodan, $R_{of}' = \frac{R_o'}{D} = \frac{4,762}{1,09} \cong \boxed{4,368\ k\Omega = R_{of}'}$

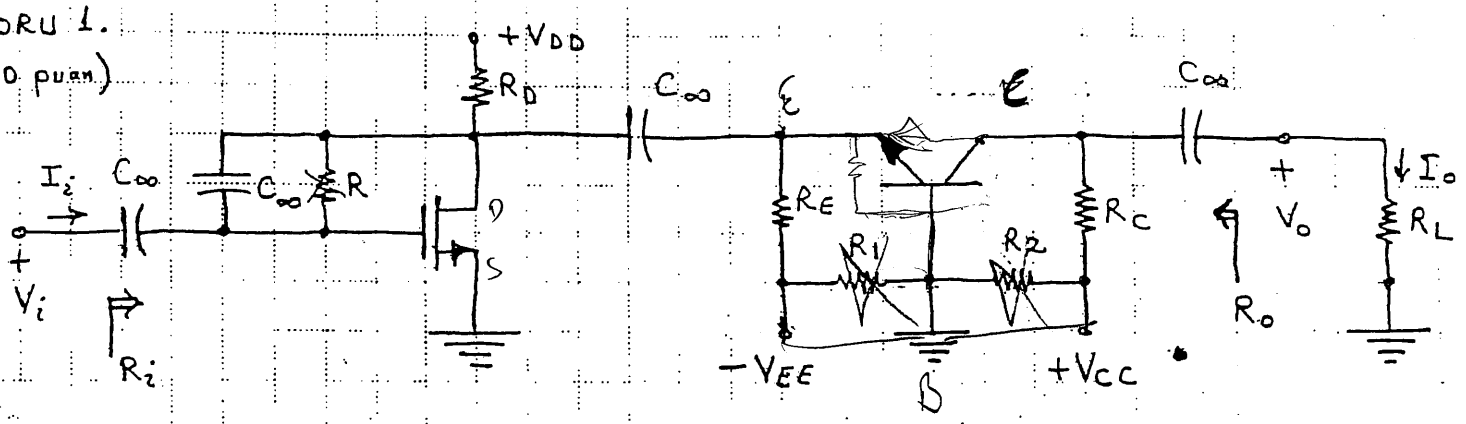
K.T.Ü. Muh. Mim. Fak. Elektrik-Elektronik Müh. Bölümü 10.12.2004

ELEKTRONİK DEVRELER I İkinci ARASINAVI

Öğr. Gör. Türen DEMİRCİOĞLU

(B)

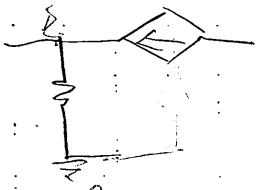
SORU 1. (30 puan)



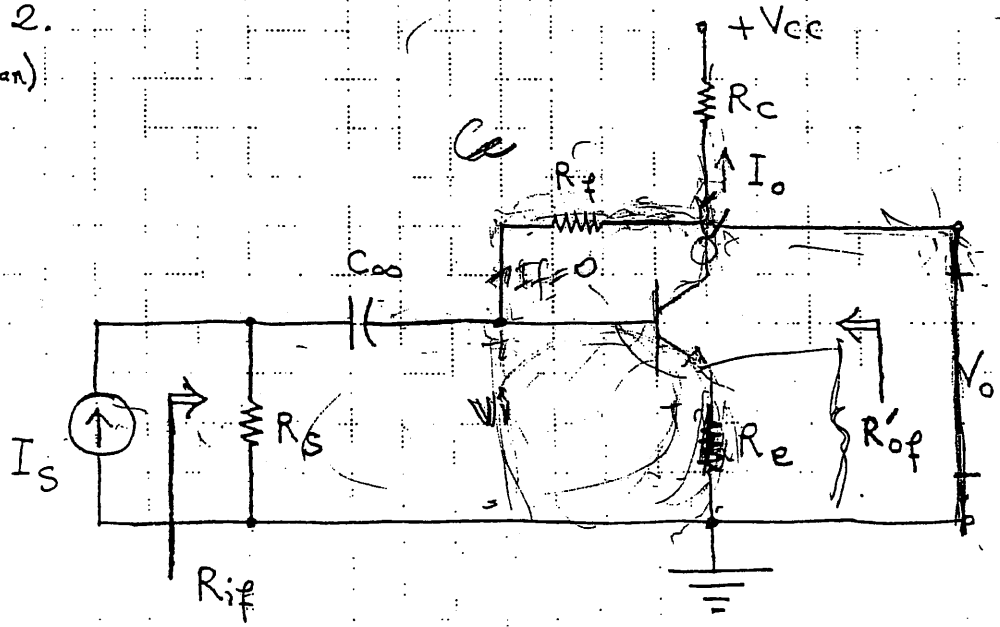
JFET: $g_m = 2$ mA/V, $r_d = \infty$ BJT: $h_{ie} = 1{,}5$ kΩ, $h_{fe} = 120$, $h_{re} \cong h_c$

$R = R_1 = 10$ kΩ, $R_D = R_E = 3$ kΩ $R_2 = 40$ kΩ, $R_C = R_L = 4$ kΩ

Devrenin gerilim kazancını, giriş direncini, akım kazancını ve çıkış direncini bulunuz.



SORU 2. (70 puan)



$h_{ie} = 2$ kΩ

$h_{fe} = 150$

$h_{re} \approx 0$

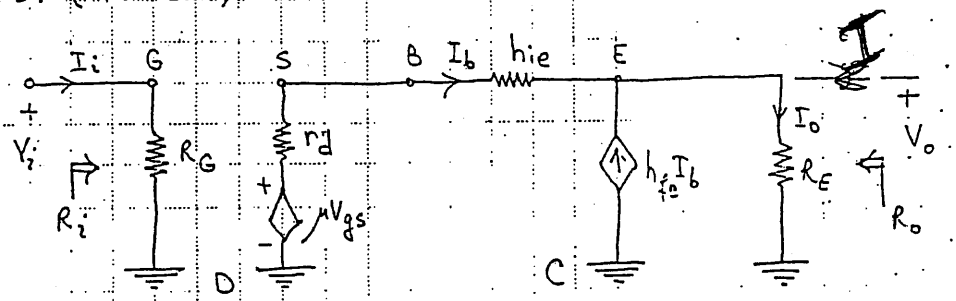
$h_{oe} \approx 0$

$R_S = 1$ kΩ, $R_C = 5$ kΩ, $R_e = 0{,}5$ kΩ, $R_f = 100$ kΩ

Devrede, kaç tür geribesleme mevcuttur. Herbiri için topolojiyi belirleyip A, A_f, A_{vf}, R_{if} ve R'_{of} değerlerini bulunuz.

SORU 3. (40 Puan)

a)



5

$$V_i = V_{gs} + h_{ie} I_b + V_o \qquad I_b = \frac{V_o}{R_E (1+h_{fe})}$$

$$V_{gs} = (r_d + h_{ie}) \cdot I_b + V_o$$

$$= (r_d + h_{ie}) \cdot \frac{V_o}{R_E (1+h_{fe})} + V_o = \frac{R_E (1+h_{fe}) + r_d + h_{ie}}{R_E (1+h_{fe})} \cdot V_o$$

$$V_i = \frac{R_E (1+h_{fe}) + r_d + h_{ie}}{\mu \cdot R_E (1+h_{fe})} V_o + h_{ie} \cdot \frac{V_o}{R_E (1+h_{fe})} + V_o$$

$$A_V \equiv \frac{V_o}{V_i} = \frac{\mu \cdot R_E (1+h_{fe})}{r_d + h_{ie}(1+\mu) + R_E (1+h_{fe})(1+\mu)} \cong 0,929 \quad (\cong -0,639\ dB)$$

10

b) $$R_i \equiv \frac{V_i}{I_i} = R_G = 10\ M\Omega$$

5

c) $$A_I \equiv \frac{I_o}{I_i} = \frac{V_o / R_E}{V_i / R_i} = A_V \cdot \frac{R_i}{R_E} = (0,929) \cdot \frac{10000\ k\Omega}{5,5\ k\Omega} = 18\,580 \quad (\cong 85,38\ dB)$$

Güç kazancı $A_p = A_V \cdot A_I = (0,929)(18\,580) \cong 17\,269,8$

5

d) $V_i = 0$ yapıldığında G, D olur. Çıkışa V uygulandığında akan akım I

$$I = \frac{V}{R_E} - I_b - h_{fe} I_b = \frac{V}{R_E} - I_b (1+h_{fe})$$

$$V_{gs} = -\mu V_{gs} + r_d I_b$$

$$(1+\mu) V_{gs} = r_d \cdot I_b$$

$$V_{gs} + h_{ie} I_b + V = 0 \qquad \frac{r_d \cdot I_b}{1+\mu} + h_{ie} I_b + V = 0$$

$$I_b = -\frac{(1+\mu) \cdot V}{r_d + h_{ie}(1+\mu)}$$

$$I = \frac{V}{R_E} + \frac{(1+\mu)(1+h_{fe}) \cdot V}{r_d + h_{ie}(1+\mu)} = \left\{ \frac{1}{0,5} + \frac{(1+25)(1+60)}{\quad} \right.$$

$$R_o \equiv \frac{V}{I} \cong \frac{1}{29,73\ m\text{mho}} \cong 33,6\ \Omega$$

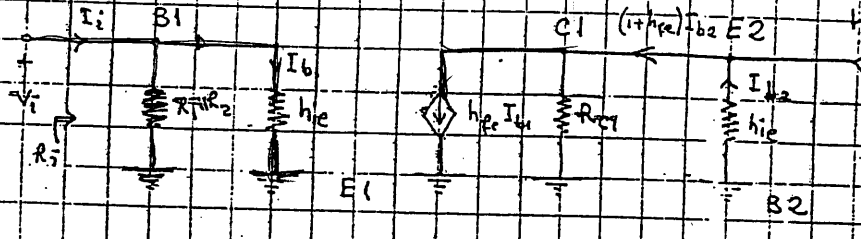
15

ELEKTRONİK DEVRELER Birinci ARASINAV 05.11.2004

(6)

SORU 1 (30 Puan)

a)



$$\{(1+h_{fe})I_{b2} - h_{fe}I_{b1}\}R_{C1} = -I_{b2}\cdot h_{ie} \Rightarrow \{(1+h_{fe})R_{C1} + h_{ie}\}I_{b2} = h_{fe}R_{C1}I_{b1}$$

$$V_o = -h_{fe}I_{b2}\cdot R_{C2} = -h_{fe}R_{C2}\frac{h_{fe}R_{C1}\cdot I_{b1}}{(1+h_{fe})R_{C1}+h_{ie}} \qquad (V_i = h_{ie}\cdot I_{b1})$$

$$A_V = \frac{V_o}{V_i} = \frac{h_{fe}^2\cdot R_{C2}\,R_{C1}}{(1+h_{fe})R_{C1}\,h_{ie} + h_{ie}^2} = \frac{(40)^2(2,5)(5)}{(+40)\cdot(5)\cdot(2)+(2)^2} = -48,3 \quad (\approx 33,6\ dB)$$

10

b) $R_i = \frac{V_i}{I_i} = (R_1 \| R_2) \| h_{ie} = (15 \| 3) \| 2 = 1,1\ k\Omega$ 5

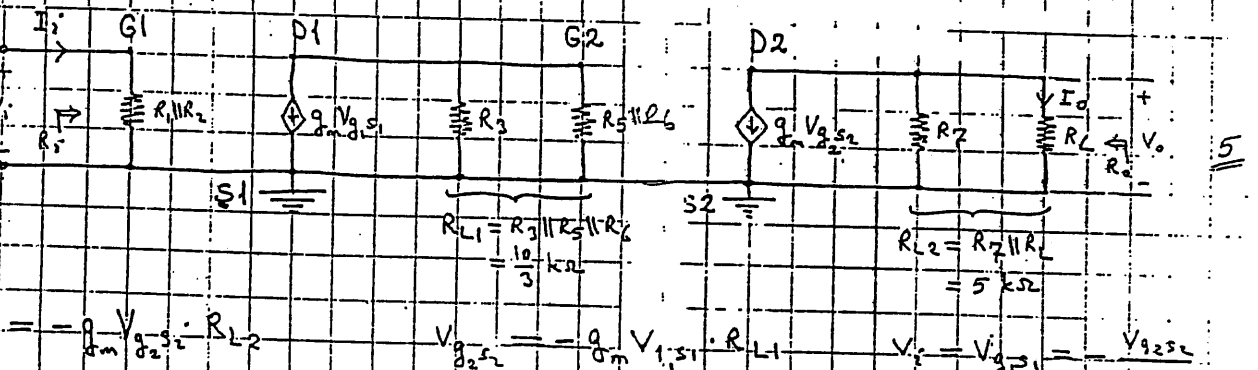
c) $A_I = \frac{I_o}{I_i} = \frac{V_o/R_{C2}}{V_i/R_i} = A_V\frac{R_i}{R_{C2}} = (-48,3)\frac{1,111}{2,5} = -21,46 \quad (\approx 26,6\ dB)$

$A_p = A_V\cdot A_I = (-48,3)(-21,46) \simeq 1036,5$ 5

d) $R_o = \left.\frac{V}{I}\right|_{V_i=0} = R_{C2} = 2,5\ k\Omega$ 5

SORU 2 (30 Puan)

a)



$$V_o = -g_m V_{gs_2}\cdot R_{L2} \qquad V_{gs_2} = -g_m V_{1,s_1}\cdot R_{L1} \qquad V_i = V_{gs_1} = \frac{V_{gs_2}}{g_m R_{L1}}$$

$$A_V = \frac{V_o}{V_i} = g_m^2 R_{L2}R_{L1} = (10^{-3})^2\cdot(5\ )\left(\frac{10}{3}\cdot 10^3\right) = \frac{50}{3} \simeq 16,66 \quad (\approx 24,43\ dB)$$

10

b) $R_i = \frac{V_i}{I_i} = R_1 \| R_2 = 50 \| 50 = 25\ k\Omega$ 5

c) $A_I = \frac{I_o}{I_i} = \frac{V_o/R_L}{V_i/R_i} = A_V\cdot\frac{R_i}{R_L} = \left(\frac{50}{3}\right)\frac{25}{10} = 41,66 \quad (\approx 32,39\ dB)$

Güç kazancı $= A_p = A_V\cdot A_I = (\ )\left(\frac{125}{3}\right) \simeq 694,4$ 5

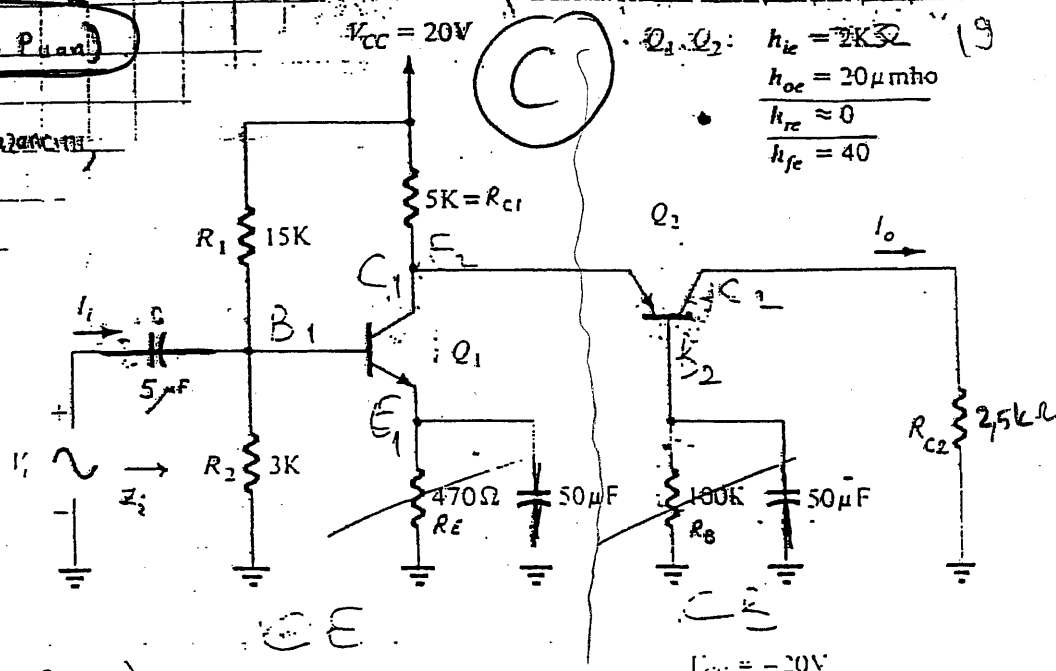
d) $R_o = \left.\frac{V}{I}\right|_{V_i=0} = R_7 \| R_L = R_{L2} = 5\ k\Omega$ 5

ELEKTRONİK DEVRELER I. Bütünleme SINAVI

- Sınav süresi 2 saattir
- Kitap ve ders notları kapalıdır BAŞARILAR Doç. Şeref Tuna Demir

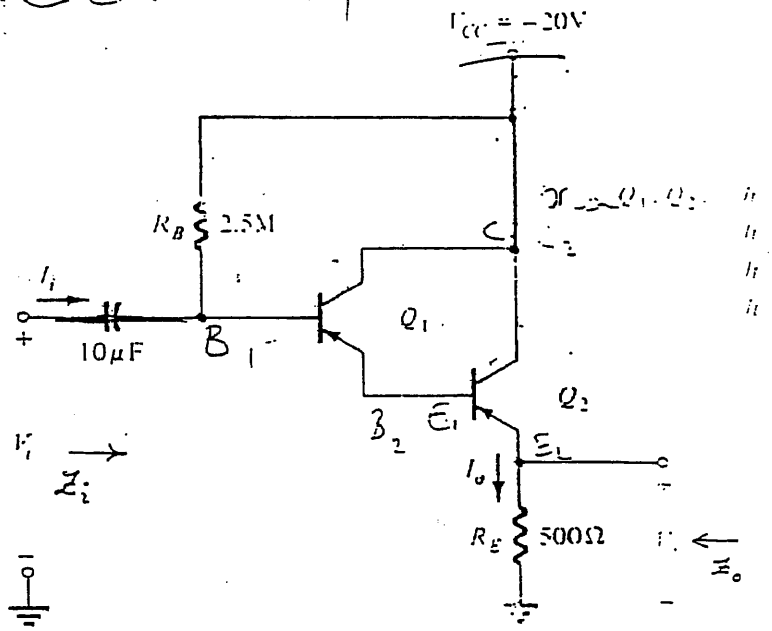
SORU 1. (30 Puan)

Gerilim, akım kazancını, giriş ve çıkış dirençlerini bulunuz.



SORU 2. (30 Puan)

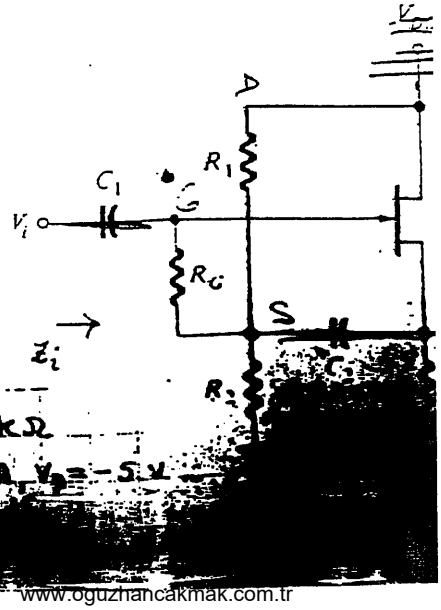
Gerilim, akım kazancını, giriş ve çıkış dirençlerini ... bulunuz.. hre=0 hie=2kΩ nfe=60 1/hoe=100kΩ



SORU 3. (40 Puan)

a) DC çalışma noktasının yaklaşık değerlerini,
b) f=100 Hz de kapasitelerin etkisini ihmal edecek biçimde C_1 ve C_2 değerlerini seçiniz.
c) Gerilim kazancını,
d) Giriş direncini,
e) Çıkış direncini bulunuz.

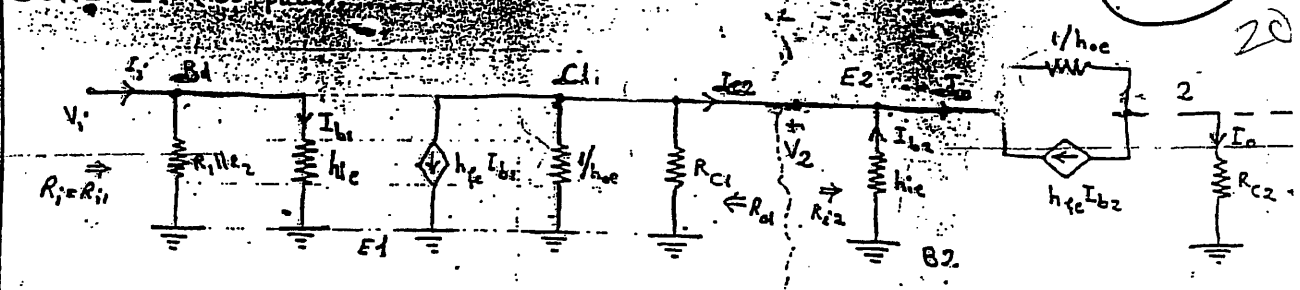
$R_1 = 1,5M\Omega$ $R_2 = 1M\Omega$ $V_{DD} = 8V$ $R_D = 2,7k\Omega$
$g_m = 5mS$ $r_d = 40k\Omega$ $C_1 = 10\mu F$ $V_p = -5V$



2003 1. Ara

C

SORU 1. (30 puan)



$\frac{1}{h_{oe}} = \frac{1}{20\,\mu mho} = 50\ k\Omega$ 1. KAT $\Leftarrow \Rightarrow$ 2. KAT $I_o = V_o / R_{c2}$

$V_2 = -I_{b2} \cdot h_{ie} = (h_{fe} I_{b2} + I_o) \cdot \frac{1}{h_{oe}} + V_o$ çevre denklemlerinden

$A_{V2} \equiv \frac{V_o}{V_2} = \frac{h_{ie} + \frac{h_{fe}}{h_{oe}}}{h_{ie}\left(1 + \frac{1}{h_{oe} R_{c2}}\right)} = \frac{2 + (40)(50)}{2\left(1 + \frac{50}{2,5}\right)} \cong 47,66$ ikinci katın gerilim kazancı

$\frac{V_2}{I_o} = \frac{h_{ie} \cdot R_{c2}\left(1 + \frac{1}{h_{oe} R_{c2}}\right)}{h_{ie} + \frac{h_{fe}}{h_{oe}}} = \frac{2(2,5)\left(1 + \frac{50}{2,5}\right)}{2 + (40)(50)} = \frac{105}{2002} \cong 52,44\ \Omega$ (h_{ie} hariç giriş direnci)

$R_{i2} = h_{ie} \| 52,44 = \frac{(2000)(52,44)}{2000 + 52,44} \cong 51,1\ \Omega$ İkinci katın giriş direnci

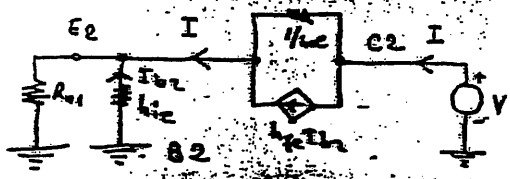
$V_o = I_o \cdot R_{c2}$, $V_2 = I_{e2} \cdot R_{i2}$ $\Rightarrow A_{I2} = A_{V2} \cdot \frac{R_{i2}}{R_{c2}} = (47,66)\frac{51,1}{2500} \cong 0,974$ İkinci katın akım kazancı

$R_i = R_{i1} \equiv \frac{V_i}{I_i} = R_1 \| R_2 \| h_{ie} = 15 \| 2 \| 2 \cong 1,111\ k\Omega$ giriş direnci

$V_2 = -h_{fe} I_{b1} \cdot \left(R_{i2} \| R_{c1} \| \frac{1}{h_{oe}}\right)$, $V_i = I_{b1} \cdot h_{ie}$ $\Rightarrow A_{V1} \equiv \frac{V_2}{V_i} = -\frac{h_{fe}\left(\overbrace{R_{i2} \| R_{c1} \| \frac{1}{h_{oe}}}^{\cong 50\Omega}\right)}{h_{ie}} \cong -1$ Birinci katın gerilim kazancı

$V_2 = I_{e2} \cdot R_{i2}$, $V_i = I_i \cdot R_i$ $\Rightarrow A_{I1} = A_{V1} \cdot \frac{R_i}{R_{i2}} = (-1)\frac{1,111}{51,1} \cong -21,74$ Birinci katın akım kazancı

$R_{o1} \equiv R_{c1} \| 1/h_{oe} = (2,5) \| 50 \cong 2,38\ k\Omega$ Birinci katın çıkış direnci



$\left(\frac{1}{h_{ie}}\right) I = -I_{b2} = \frac{R_{o1} \cdot I}{R_{o1} + h_{ie}}$

$V = (I - h_{fe} I_{b2}) \cdot \frac{1}{h_{oe}} - I_{b2} \cdot h_{ie}$ } denklemlerinden

$\frac{V}{I} = \frac{1}{h_{oe}} + \frac{R_{o1}\left(\frac{1}{h_{oe}} + h_{ie}\right)}{R_{o1} + h_{ie}} = 50 + \frac{2,38(2 + 40 \cdot 50)}{2,38 + 2} \cong 1137,84\ k\Omega$

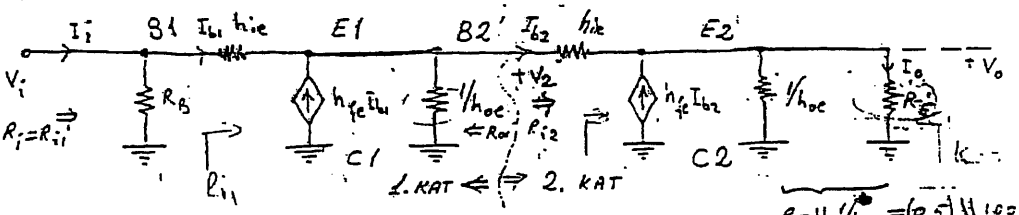
$\Rightarrow R_o \cong 2,49\ k\Omega$ Çıkış

$\frac{I_{e2}}{I_i} = A_{I2} \cdot A_{I1} = (0,974)$

$= -21,$

C

SORU 2. (30 puan)



$R_E \parallel 1/h_{oe} = (0,5) \parallel 100 \cong 0,4975$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot h_{ie} + (1+h_{fe})\, I_{b2}\cdot (R_E \parallel 1/h_{oe}) \\ V_o &= (1+h_{fe})\, I_{b2}\cdot (R_E \parallel 1/h_{oe}) \end{aligned}\right\} \quad A_{V2} \equiv \frac{V_o}{V_2} = \frac{(1+h_{fe})(R_E \parallel 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_E \parallel 1/h_{oe})} \cong$$

$$R_{i2} \equiv \frac{V_2}{I_{b2}} = h_{ie} + (1+h_{fe})\,(R_E \parallel 1/h_{oe}) = 2 + (1+60)\cdot 0,4975 \cong \underline{32,35\ k\Omega}$$ (ikinci katın giriş direnci)

$$\left.\begin{aligned} V_o &= I_o \cdot R_E \\ V_2 &= I_{b2}\cdot R_{i2} \end{aligned}\right\} \Rightarrow \underline{A_{I2}} = \underline{A_{V2}}\cdot \frac{R_{i2}}{R_E} = (0,938)\cdot \frac{32,35}{0,5} \cong \underline{60,68}$$ (ikinci katın akım kazancı)

$$I = \frac{V}{R_E} + h_{oe}\cdot V + \frac{V}{h_{ie}+R_{o1}} - h_{fe}\, I_{b2} \qquad I_{b2} = \frac{V}{h_{ie}+R_{o1}}$$

$$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie}+R_{o1}} + \frac{h_{fe}}{h_{ie}+R_{o1}}$$ ... R_{o1} ni bulduktan sonra hesaplanır.

$$\frac{V_i}{I_{b1}} = h_{ie} + (1+h_{fe})\,(R_{i2} \parallel 1/h_{oe}) = 2 + (1+60)\cdot 24,44 = 1492,84\ k\Omega \cong \underline{1,493\ M\Omega}$$

($R_{i2} \parallel 1/h_{oe} \cong 24,44\ k\Omega$)

$$R_i = R_{i1} \equiv \frac{V_i}{I_i} = R_B \parallel 1,493 \cong \underline{934,7\ k\Omega}$$ (giriş direnci)

$$\left.\begin{aligned} V_2 &= (1+h_{fe})\, I_{b1}\cdot (R_{i2} \parallel 1/h_{oe}) \\ V_i &= h_{ie}\cdot I_{b1} + (1+h_{fe})\, I_{b1}\cdot (R_{i2} \parallel 1/h_{oe}) \end{aligned}\right\} \Rightarrow A_{V1} \equiv \frac{V_2}{V_i} = \frac{(1+h_{fe})(R_{i2} \parallel 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_{i2} \parallel 1/h_{oe})}$$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot R_{i2} \\ V_i &= I_i \cdot R_i \end{aligned}\right\} \Rightarrow \underline{A_{I1}} \equiv \frac{I_{b2}}{I_i} = \underline{A_{V1}}\,\frac{R_i}{R_{i2}} = (0,998)\cdot \frac{934,7}{32,35} \cong \underline{28,83}$$ (Birinci katın akım kazancı)

R_{o1} yi bulalım.

$$I = h_{oe} V + \frac{V}{h_{ie}} - h_{fe}\, I_{b1} \qquad I_{b1} = -\frac{V}{h_{ie}} \qquad \frac{1}{R_{o1}} \equiv \frac{I}{V} = h_{oe} + \frac{1}{h_{ie}} + \frac{h_{fe}}{h_{ie}} = 10\cdot 10^{-6} + \frac{1}{2000}$$

$R_{o1} \cong 32,776\ \Omega$ Birinci katın çıkış direnci

$$\frac{1}{R_o} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie}+R_{o1}} + \frac{h_{fe}}{h_{ie}+R_{o1}} = \frac{1}{500} + 10\cdot 10^{-6} + \frac{1}{2000+32,776} + \frac{60}{2000+32,776} \cong$$

$R_o \cong \underline{31,23\ \Omega}$ Çıkış direnci $\qquad R_i \cong 934,7\ k\Omega$

$$A_V \equiv \frac{V_o}{V_i} = \frac{V_o}{V_2}\cdot\frac{V_2}{V_i} = A_{V2}\cdot A_{V1} = (0,938)(0,998) \cong 0,936$$ Gerilim kazancı

$$A_I \equiv \frac{I_o}{I_i} = \frac{I_o}{I_{b2}}\cdot\frac{I_{b2}}{I_i} = A_{I2}\cdot A_{I1} = (60,68)(28,83) \cong 1749,4$$ Akım kazancı

(C)

21

SORU 3. (40 puan)

a) DC bakımdan kondansatörler açık-devredir. Gate akımı sıfırdır.

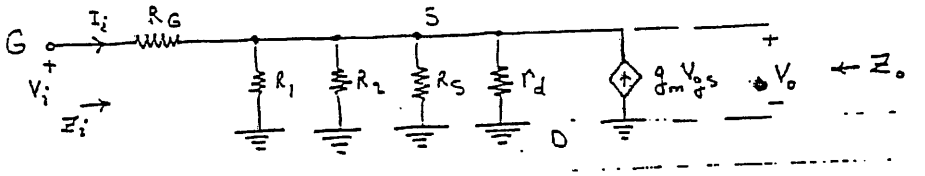
$V_G = \frac{V_{DD}}{R_1+R_2}\cdot R_2 = \frac{18}{1,5+1}\cdot 1 = 7,2\ V$ $\quad V_{GS} = 7,2 - I_D \cdot 2,7$

$I_D = 10\left(1-\frac{V_{GS}}{-5}\right)^2$ denklemlerinden $V_{GS} \cong -2\ V$ ve $I_D \cong 3,5\ mA$ bulunur.

b) $X_{C1} \leq \frac{1}{10} R_G$ $\quad \frac{1}{2\pi\cdot 100\cdot C_1} \leq \frac{1}{10}\cdot 10^6$ $\quad C_1 \geq 0,0159\ \mu F \Rightarrow C_1 \approx 0,02\ \mu F$

$X_{C2} \leq \frac{1}{10}(R_1 \| R_2)$ $\quad \frac{1}{2\pi\cdot 100\cdot C_2} \leq \frac{1}{10}\left(1,5 \| 1\right)\cdot 10^6$ $\quad C_2 \geq 0,0265\ \mu F \Rightarrow C_2 \approx$

c)



$R = R_1 \| R_2 \| r_d \| R_S \cong 2,55\ k\Omega$

$I_i + g_m V_{gs} = \frac{V_o}{R}$ düğüm denklemi $\quad I_i = \frac{V_{gs}}{R_G}$ $\quad V_i = V_{gs} + V_o$ den

$A_V \equiv \frac{V_o}{V_i} = \frac{R(1+g_m R_G)}{R(1+g_m R_G)+R_G} \cong 0,927$ gerilim kazancı

d) Yukarıdaki denklemlerden R_i giriş direnci bulunur.

$R_i \equiv \frac{V_i'}{I_i} = R(1+g_m R_G) + R_G \cong 13,75\ M\Omega$ giriş direnci

Diğer bir yol $R_i = \frac{R_G}{1-A_V} = \frac{1\ M\Omega}{1-0,927} \cong 13,7\ M\Omega$ bulunur.

e) $V_{gs} = -V$ olur.

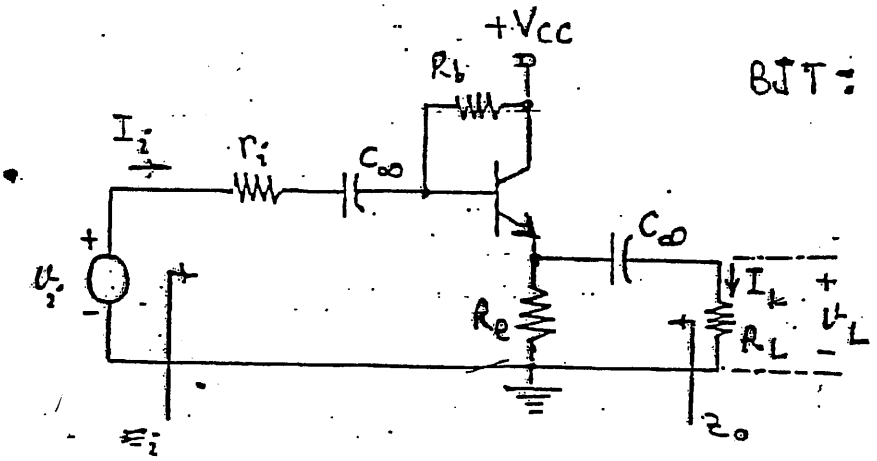
$I = \frac{V}{R} + \frac{V}{R_G} - g_m V_{gs} = \frac{V}{R} + \frac{V}{R_G} + g_m$

$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R} + \frac{1}{R_G} + g_m = \frac{1}{2,55\cdot 10^3} + \frac{1}{1\cdot 10^6} + 5000\cdot 10^{-6} \cong 5,3$

$R_o \equiv \frac{V}{I} \cong \frac{1}{5,393\cdot 10^{-3}} \cong 185,4\ \Omega$ Çıkış direnci

ELEKTRONİK DEVRELER I Birinci ARASINAVI 6.11.2006

1. (40P)



BJT: $I_C = 1{,}3$ mA

$r_\pi = 2$ kΩ

$r_i = 500$ Ω

$R_b = 100$ kΩ

$R_e = R_L = 1$ kΩ

Yükselteçin, alçak frekanslarda, küçük genlikli değişimler için gerilim ve akım kazancını, giriş ve çıkış empedansı bulunuz.

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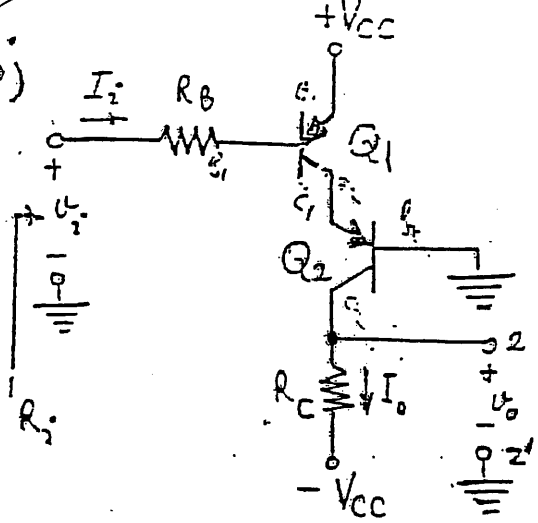
2. (30P)



$h_{fe1} = h_{fe2} = 125$

$h_{ie1} = h_{ie2} = 1{,}5$ kΩ

$h_{oe1} = h_{oe2} \cong 0$

$h_{re1} = h_{re2} \cong 0$

$R_B = 80$ kΩ

$R_C = 300$ kΩ

Alçak frekanslarda, küçük genlikli değişimler

a) Akım kazancını,

b) Gerilim "

c) giriş direncini,

d). Çıkıştaki (2-2') açık-devre gerilimini ve kısa-devre akımını bulunuz.

---

3. (30P) $R_1 = R_2 = 5$ kΩ, $R_C = 3$ kΩ, $R_G = 500$ MΩ

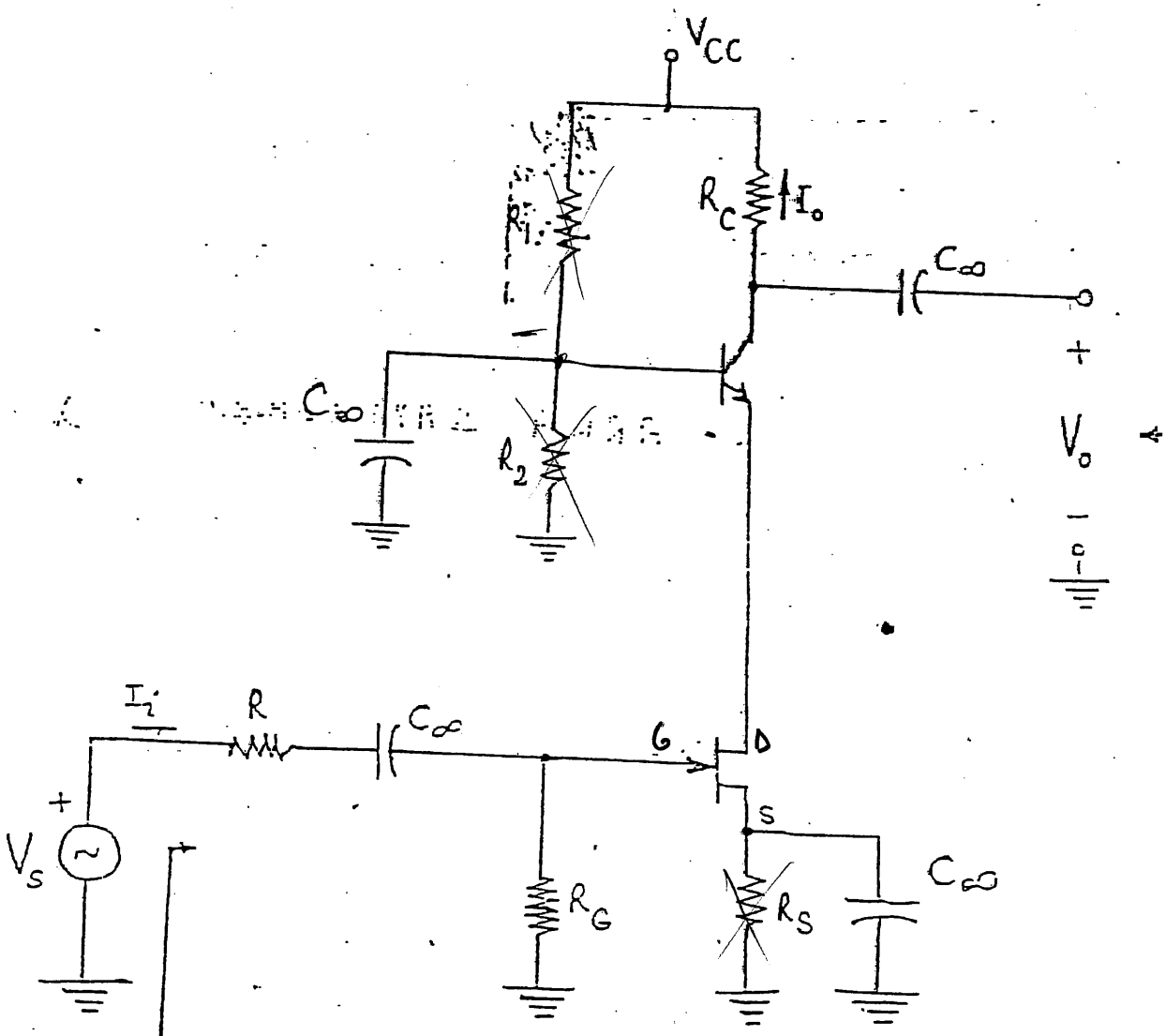
$R_S = 2{,}2$ kΩ, $R = 600$ Ω

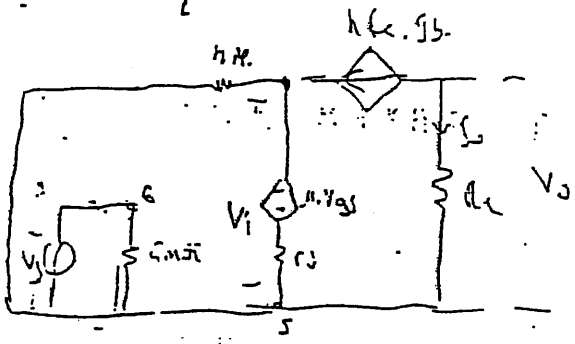
BJT: $h_{ie} = 1$ kΩ, $h_{fe} = 100$, $h_{re} \cong h_{oe} \approx 0$ (ihmal)

JFET: $g_m = 1 \frac{mA}{V}$, $r_d = 40$ kΩ

Alçak frekanslarda, küçük genlikli değişimler için yükselteçin, akım, gerilim kazancını, giriş, çıkış direncini bulunuz.] SORU 3'E AİT ŞEKİL

3. Soru 3'e ait şekil





FİLİZ

D

I. Arasınav Cevapları 6.11.2000

SORU

1. $g_m = \frac{|I_C|\,(mA)}{26} = \frac{1,3}{26} = 0,05\ mho = 50\ \frac{mA}{V}$

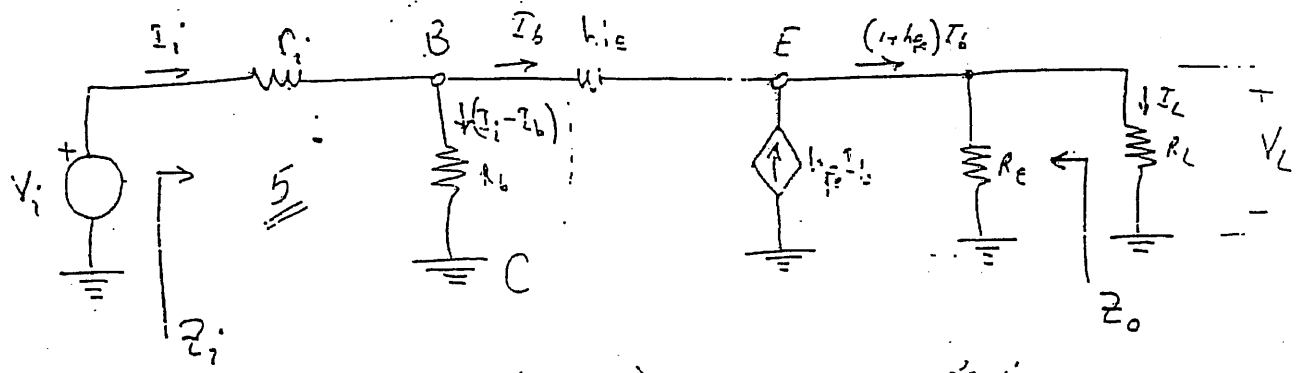
5

$h_{ie} \approx r_\pi = 2\,k\Omega$

$h_{fe} \approx g_m r_\pi = \left(\frac{50\ mA}{V}\right).(2\,k\Omega) = 100$

$h_{re} \approx h_{oe} \approx 0$ (ihmal)

Eşdeğer devre



5

a) Akım kazancı, A_I $\quad R_L' = (R_E \,||\, R_L) = 500\,\Omega = \frac{R_E \cdot R_L}{R_E + R_L}$

$V_L = R_L \cdot I_L = (1+h_{fe})\, I_b\, R_L'$

$\frac{I_L}{I_b} = \frac{(1+h_{fe})\,R_L'}{R_L} = \frac{(1+h_{fe})\,R_E}{R_E + R_L}$

$A_I = \frac{I_L}{I_i'} = \frac{I_L}{I_b} \cdot \frac{I_b}{I_i'}$

10

$-R_b(I_i - I_b) + h_{ie} I_b + (1+h_{fe})\, I_b\, R_L' = 0$

$I_b \{R_b + h_{ie} + (1+h_{fe})\, R_L'\} = R_b I_i$

$\frac{I_b}{I_i} = \frac{R_b}{R_b + h_{ie} + (1+h_{fe})\,R_L'} \cong 0,655?$

Akım kazancı

$A_I = \frac{(1+h_{fe})\,R_E}{R_E + R_L} \cdot \frac{R_b}{R_b + h_{ie} + (1+h_{fe})\,R_L'} \cong 33\ (\approx 30,4\ dB)$

$= \frac{(1+100).1}{1+1} \cdot \frac{100}{100 + 2 + (1+100)\,.5} = \frac{101}{2} \cdot \frac{100}{152,5} = (50,5)(0,65$

1. b) Giriş empedansı Z_i

$$V_i = r_i I_i + R_b (I_i - I_b)$$

5

$$Z_i = \frac{V_i}{I_i} = r_i + R_b - R_b \frac{I_b}{I_i} = 0,5 + 100 - 100 \cdot (0,6$$

$Z_i \cong 34,9\ k\Omega$ giriş empedansı

c) Gerilim kazanç A_V gerilim kaza

$$\frac{V_o}{V_i} = \frac{R_L \cdot I_L}{Z_i \cdot I_i} \qquad A_V = \frac{R_L}{Z_i} \cdot \frac{I_L}{I_i} = \frac{1}{34,9} \cdot 33 \cong 0,9$$

5 $(\approx -$

d) Çıkış empedansı Z_o

$$Z_o = \left. \frac{V}{I} \right|_{\substack{V_i = 0 \\ R_L = \infty}}$$ bu koşullar altında

10

$$I = \frac{V}{R_e} - I_b (1 + h_{fe}) \quad \text{düğüm denklemi}$$

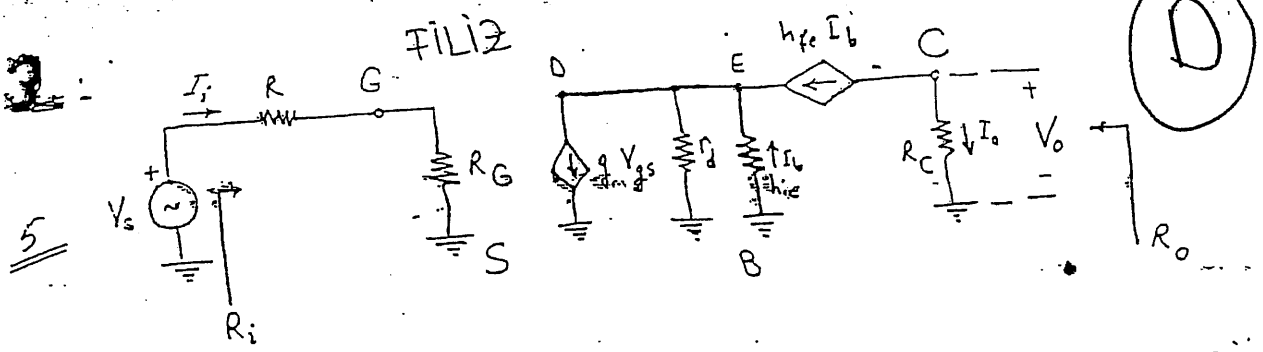
$$I_b = - \frac{V}{h_{ie} + (r_i \| R_b)} \quad \text{yukarıda yerine koyalım}$$

$$I = \frac{V}{R_e} + \frac{V}{h_{ie} + (r_i \| R_b)} \cdot (1 + h_{fe})$$

$$Y_o = \frac{1}{Z_o} = \frac{I}{V} = \frac{1}{R_e} + \frac{1 + h_{fe}}{h_{ie} + (r_i \| R_b)} = \frac{1}{1} + \frac{1+100}{2 + \frac{0,5 \times 100}{0,5+100}} \cong 41$$

$$Z_o = \frac{1}{Y_o} = \frac{1}{41,44} \cong 24\ \Omega$$ Çıkış empedansı

FİLİZ



$R_i = \frac{V_s}{I_i} = R + R_G = 0{,}5 + 500000 = 500000{,}6\ k\Omega \cong \underline{500\ M\Omega}$ giriş direnci

$g_m V_{gs} = (1+h_{fe}) I_b + \frac{h_{ie} I_b}{r_d}$ $\quad V_{gs} = R_G \cdot I_i$, $I_o = -h_{fe} I_b$ } devamında yerine koyalım

$g_m (R_G \cdot I_i) = (1+h_{fe})\left(-\frac{I_o}{h_{fe}}\right) + \frac{h_{ie}}{r_d}\left(-\frac{I_o}{h_{fe}}\right)$

$A_I = \frac{I_o}{I_i} = -\frac{g_m R_G h_{fe} \cdot r_d}{h_{ie} + r_d (1+h_{fe})} = \frac{1 \cdot 500 \cdot 10^3 \cdot 100 \cdot 40}{1 + 40\,(1+100)} \cong -495\,000$ akım kazancı

$(\approx 113{,}89\ dB)$

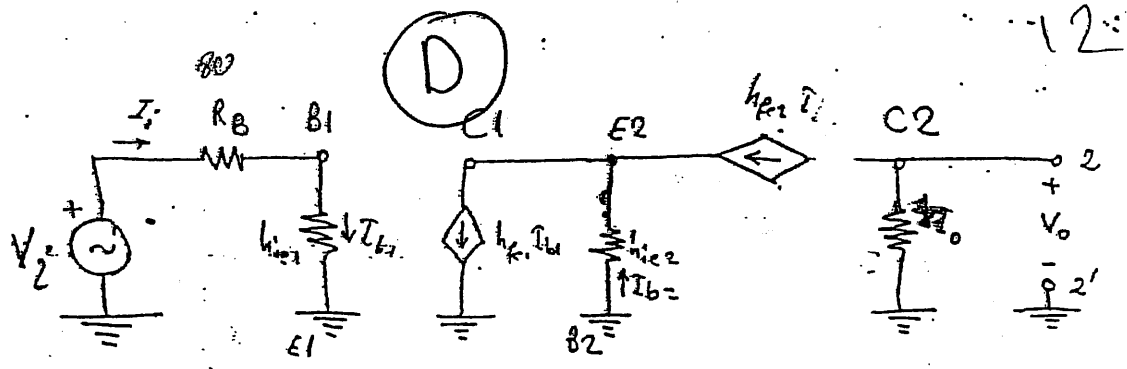
$V_o = R_C I_o$, $V_s = R_i I_i$ } $A_V = \frac{V_o}{V_s} = A_I \frac{R_C}{R_i} = (-495000)\frac{3}{500000{,}6} \cong -2{,}97$ gerilim kazancı

$(\approx 9{,}5\ dB)$

$V_s = 0 \qquad V_{gs} = 0 \qquad g_m V_{gs} = 0$

$R_o = \left.\frac{V}{I}\right|_{V_s = 0} = \underline{R_C = 3\ k\Omega}$ çıkış direnci

SORU 2.



a) Giriş direnci

$$V_i = (R_B + h_{ie1}) I_i$$

$$R_i = \frac{V_i}{I_i} = R_B + h_{ie1} = 80 + 1,5 = 81,5\ k\Omega$$ giriş direnci

b) Akım kazancı

$$h_{fe1} I_{b1} = (1 + h_{fe2}) I_{b2} \qquad I_i = I_{b1}$$

$$I_o = -h_{fe2} I_{b2} = -h_{fe2} \cdot \frac{h_{fe1}}{1 + h_{fe2}}$$

Akım kazanç

$$A_I = \frac{I_o}{I_i} = -\frac{h_{fe2} \cdot h_{fe1}}{1 + h_{fe2}} = -\frac{125 \cdot 125}{126} \cong -124$$

$(\cong 41,86\ dB)$

c) Gerilim kazancı

$$V_o = R_C \cdot I_o$$
$$V_i = R_i \cdot I_i$$

$$A_V = \frac{V_o}{V_i} = \frac{R_C}{R_i} A_I = \frac{300}{81,5} (-124) \cong -456,4$$

gerilim kazanç

$(\cong 53\ dB)$

d) $A_V = \frac{V_o}{V_i}$ Açık-devre gerilimi $V_o = ?$

Açık-devre gerilimi

$$V_o = \frac{R_C}{R_i} A_I \cdot V_i = -\frac{R_C}{R_i} \cdot \frac{h_{fe2} \cdot h_{fe1}}{1 + h_{fe2}} V_i \qquad -\frac{300}{81,5} 124\, V_i \cong \left(\frac{-124}{81,5}\right) 3$$

çık-devre gerilimi $\cong -456,4 V_i$

e) Kısa-devre akımı

$$I_N = -h_{fe2} I_{b2} = -h_{fe2} \cdot \frac{h_{fe1}}{1 + h_{fe2}} I_{b1} \qquad I_i = I_{b1} = \frac{V_i}{R_i} = \frac{V_i}{R_B}$$

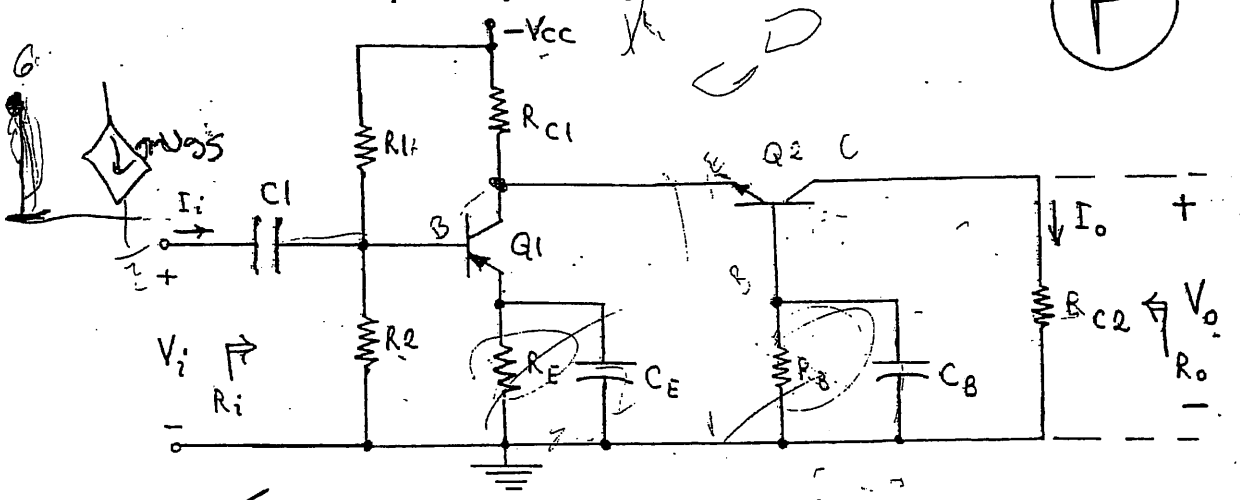
$$I_N = -h_{fe2} \cdot \frac{h_{fe1}}{1 + h_{fe2}} \cdot \frac{V_i}{R_B + h_{ie1}} \qquad R_o = \frac{V_o}{I_N} = \frac{\frac{R_C}{R_i} A_I \cdot V_i}{A_I \frac{V_i}{R_i}} = R_C = 3$$

K.T.Ü. Elektrik-Elektronik Müh. Bölümü **05.11.2004**

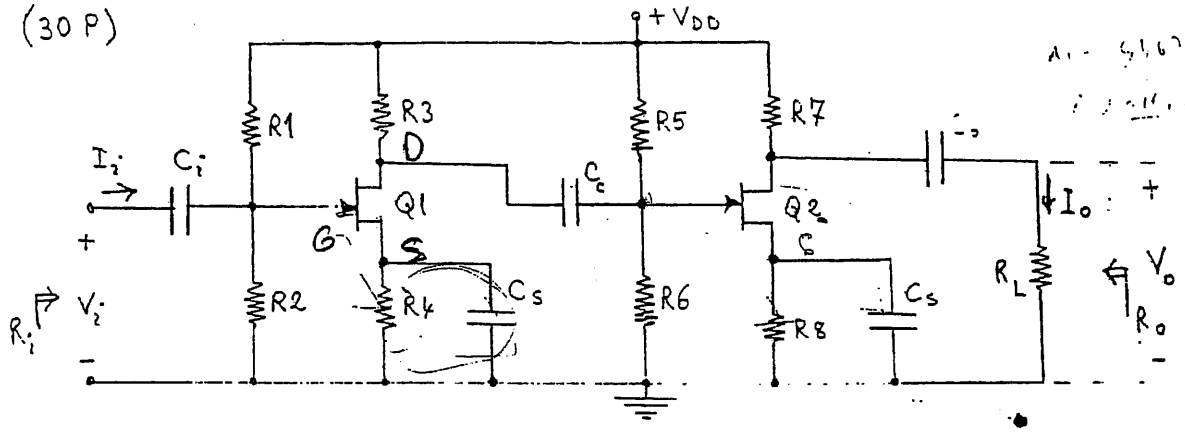
ELEKTRONİK DEVRELER I Birinci ARASINAVI

Ders sorumlusu : Öğr. Gör. Türen Demircioğlu

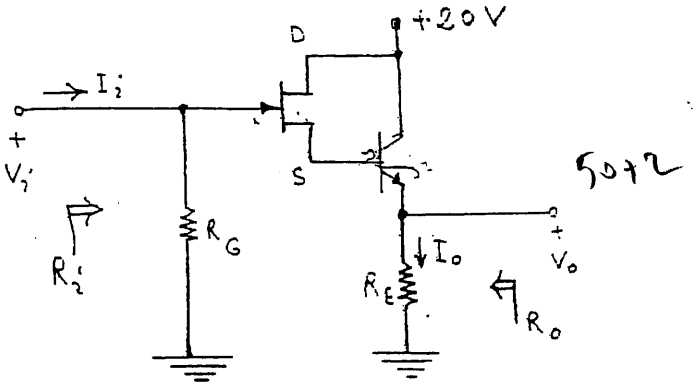
SORU 1. Q1,Q2 : $h_{ie} = 2\,k\Omega$, $h_{fe} = 40$, $h_{re} \approx h_{oe} \approx 0$, R1=15 kohm, R2 = 3 kohm
(30 P) $R_{C1} = 5$ kohm, $R_E = 470$ ohm, $R_B = 100$ kohm, $R_{C2} = 2.5$ kohm
Bütün kapasiteler yeterli büyüklükte seçilmiştir.



SORU 2. Fetler özdeştir. $g_m = 1000\,\mu$ mho, $r_d \approx \infty$, R1 = R2 =50 kohm,
R3 = 5 kohm R4 = R8 = 1 kohm, R5 = R6 = 20 kohm, R7 = R_L = 10 kohm
(30 P)



SORU 3. JFET : $g_m = 5\,\frac{mA}{V}$, $r_d = 50\,k\Omega$, BJT : $h_{ie} = 2\,k\Omega$, $h_{fe} = 60$, $h_{re} \approx h_{oe} \approx 0$
(40 P) $R_G = 10\,M\Omega$, $R_E = 500\Omega$



Yükselteçlerin, alçak frekanslarda küçük genlikli işaretler için a) Gerilim kazancını (c
b) Giriş direncini, c)Akım kazancını (dB) ve güç kazancını, d) Çıkış direncini bulunu

05.11.20

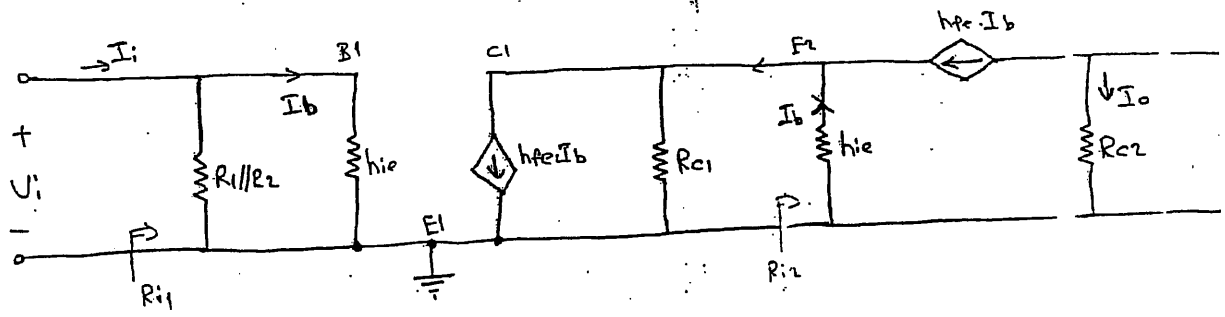
ELEKTRONİK DEVRELER-1

1. A.S.

(F)

- Çözümleri -

1)



$A_V = \frac{V_o}{V_i} = \frac{-h_{fe} \cdot I_b \cdot R_{c2}}{-h_{ie} \cdot I_b} \cdot \frac{-h_{fe} \cdot I_b (R_{c1} // R_{i2})}{h_{ie} \cdot I_b}$, $R_{c1} // R_{i2} = 5k\Omega // 0,0483k\Omega = 0,0483\,k\Omega$

$R_{i2} = \frac{h_{ie}}{1+h_{fe}} = \frac{2}{41} = 0,0488\,k\Omega$

20 log 1 = 1 alacağız.

$A_V = \frac{-40 \cdot (2,5)}{2} \cdot \frac{40(0,0483)}{2} = \boxed{-48,3 = A_V}$

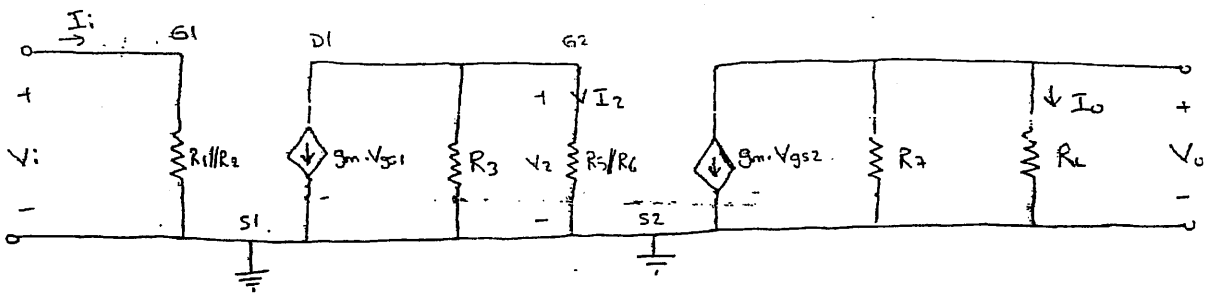
$R_i = R_1 // R_2 // h_{ie} = 15 // 3 // 2 = \boxed{1,11\,k\Omega = R_i}$

$R_o = R_{c2} = \boxed{2,5\,k\Omega}$

$A_I = A_V \cdot \frac{R_i}{R_o} = -48,3 \cdot \frac{1,11}{2,5} = \boxed{-21,46 = A_I}$

$A_p = A_V \cdot A_I = (-48,3) \cdot (-21,46) = \boxed{1036,5 \approx 30,16\,dB = A_p}$

2)



$V_i = V_{gs1}$

$g_m \cdot V_i \cdot (R_3 // R_5 // R_6) = V_2$

$V_o = g_m \cdot V_{gs2} \cdot (R_7 // R_L) = g_m \cdot V_2 \cdot (R_7 // R_L)$

$V_o = g_m \cdot [g_m \cdot V_i (R_3 // R_5 // R_6)] \cdot (R_7 // R_L)$

$A_V = \frac{V_o}{V_i} = g_m^2 \cdot (R_3 // R_5 // R_6) \cdot (R_7 // R_L) = 10^{-6} \cdot (5k // 20k // 20k) \cdot (10k // 10k)$

$\boxed{A_V \cong 16,67 \cong 24,44\ dB}$

$R_i = \frac{V_i}{I_i} = R_1 // R_2 = 50k // 50k = \boxed{25k\ \Omega = R_i}$

$I_o = \frac{V_o}{R_L} = g_m^2 \cdot V_i \cdot (R_3 // R_5 // R_6) \cdot \frac{R_7}{R_7 + R_L}$

$I_i = \frac{V_i}{R_i} = \frac{V_i}{(R_1 // R_2)}$

$A_I = \frac{I_o}{I_i} = \frac{g_m^2 \cdot V_i (R_3 // R_5 // R_6)(R_7 // R_L) \cdot (R_1 // R_2)}{V_i \cdot R_L} = A_V \cdot \frac{R_i}{R_L}$

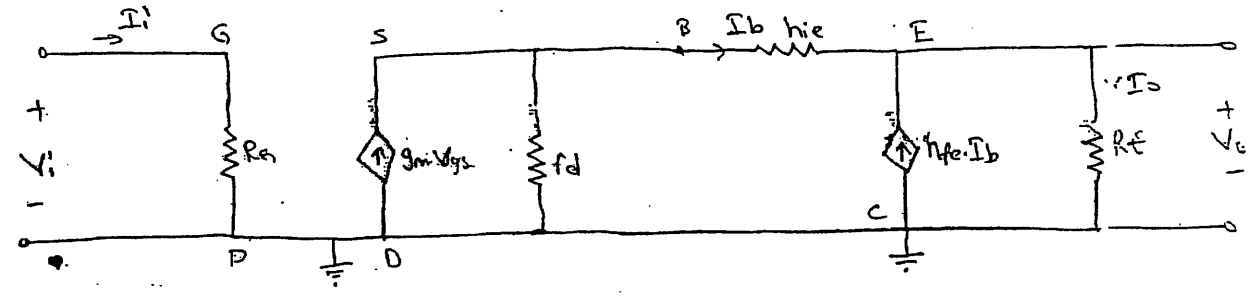
$A_I = 16,67 \cdot \frac{25}{10} \cong \boxed{41,68 \approx 32,4\ dB = A_I}$

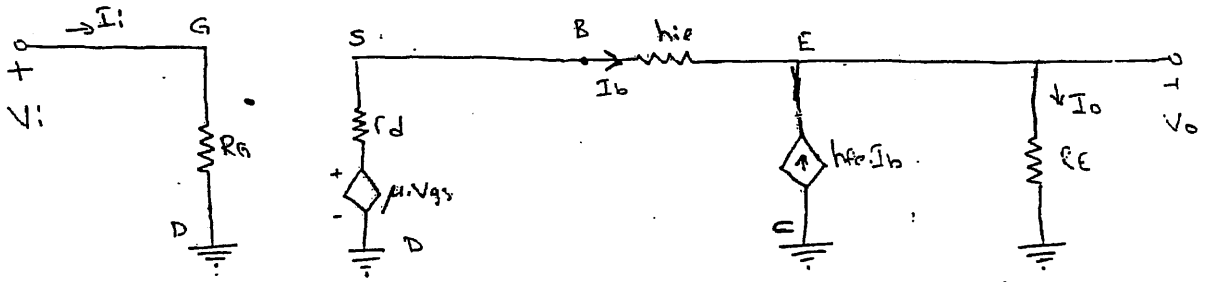
$R_o = R_7 // R_L = 10k // \infty = \boxed{10k\ \Omega}$

$A_P = A_V \cdot A_I = (16,67) \cdot (41,68) = \boxed{694,9 \approx 28,42\ dB = A_P}$

f LS

3)





$$V_i = V_{gs} + h_{ie}\cdot I_b + \underbrace{R_E\cdot I_b\cdot(1+h_{fe})}_{V_o} \quad , \quad I_b = \frac{V_o}{R_E\cdot(1+h_{fe})}$$

$$\mu\cdot V_{gs} = (r_d+h_{ie})\cdot I_b + V_o = \frac{(r_d+h_{ie})\cdot V_o}{R_E\cdot(1+h_{fe})} + V_o = V_o\cdot\frac{(r_d+h_{ie})+R_E(1+h_{fe})}{R_E\cdot(1+h_{fe})}$$

$$V_{gs} = \frac{(r_d+h_{ie})+R_E\cdot(1+h_{fe})}{\mu\cdot R_E\cdot(1+h_{fe})}\cdot V_o \qquad \mu = g_m\cdot r_d = 25$$

$$V_i = \left(\frac{(r_d+h_{ie})+R_E(1+h_{fe})}{\mu\cdot R_E(1+h_{fe})} + \frac{h_{ie}}{R_E(1+h_{fe})} + 1\right)\cdot V_o$$

$$A_V = \frac{V_o}{V_i} = \left(\frac{(50+2)+0,5\cdot(61)}{250\cdot 0,5\cdot(61)} + \frac{2}{0,5\cdot(61)} + 1\right)^{-1} \cong \boxed{0,929 \cong -0,639\ dB = A_V}$$

$$\boxed{R_i = R_G = 10M\Omega}$$

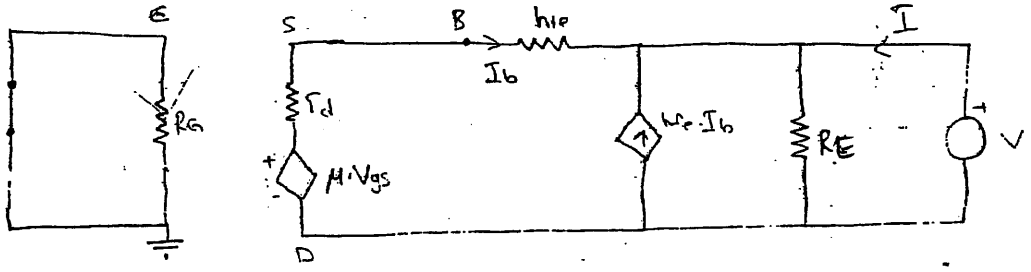
$$A_I = \frac{I_o}{I_i} \quad , \quad I_i = \frac{V_i}{R_i} = \frac{V_i}{R_G}$$

$$I_o = \frac{V_o}{R_E} = \frac{A_V\cdot V_i}{R_E} \Rightarrow A_I = \frac{I_o}{I_i} = \frac{A_V\cdot R_G}{R_E} = 0,929\cdot\frac{10.000}{0,5}$$

$$\boxed{A_I = 18590 \cong 85,38\ dB}$$

$$A_p = A_v \cdot A_I = 0{,}929 \cdot 18580 = \boxed{17\,260{,}8 \approx 42{,}37\ dB}$$

$V_i = 0$ için



$$I = \frac{V}{R_E} - I_b - h_{fe} \cdot I_b = \frac{V}{R_E} - I_b(1+h_{fe})$$

$$V_{gs} + h_{ie} \cdot I_b + V = 0 \quad , \quad \mu \cdot V_{gs} = r_d \cdot I_b - V_{gs}$$

$$V_{gs}(1+\mu) = r_d \cdot I_b \Rightarrow V_{gs} = \frac{r_d \cdot I_b}{(1+\mu)}$$

$$\frac{r_d \cdot I_b}{(1+\mu)} + h_{ie} \cdot I_b + V = 0$$

$$\frac{r_d \cdot I_b + h_{ie}(1+\mu) \cdot I_b}{(1+\mu)} + V = 0$$

$$I_b \cdot \frac{r_d + h_{ie} \cdot (1+\mu)}{(1+\mu)} = -V \Rightarrow I_b = \frac{-V \cdot (1+\mu)}{r_d + h_{ie}(1+\mu)}$$

$$I = \frac{V}{R_E} + \frac{V(1+\mu) \cdot (1+h_{fe})}{r_d + h_{ie}(1+\mu)}$$

$$R_o = \frac{V}{I} = \left(\frac{1}{R_E} + \frac{(1+\mu)(1+h_{fe})}{r_d + h_{ie}(1+\mu)} \right)^{-1} = \frac{1}{\cdots} + \frac{\cdots \cdot (\cdots)}{50 + 2 \cdot (\cdots)}$$

$$\boxed{R_o \cong 33{,}63\ \Omega}$$

Elektrik - Elektronik Müh.

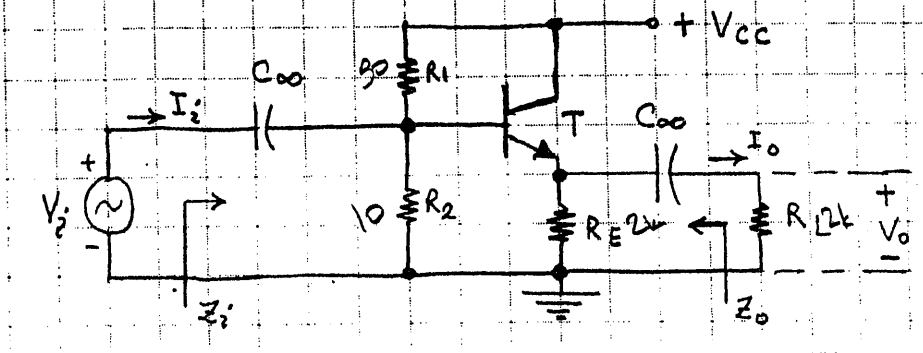
ELEKTRONİK DEVRELER I Birinci ARASINAVI 18.11.2006

SORU 1.

(30 P) Yükseltecin gerilim kazancını, giriş empedansını, akım kazancını ve çıkış empedansını bulunuz. (Küçük genlikli değişimler için)

$R_1 = 90\,k\Omega$, $R_2 = 10\,k\Omega$, $R_E = R_L = 2\,k\Omega$, $V_{CC} = 10\,V$

Transistor : $h_{ie} = 2\,k\Omega$, $h_{fe} = 80$

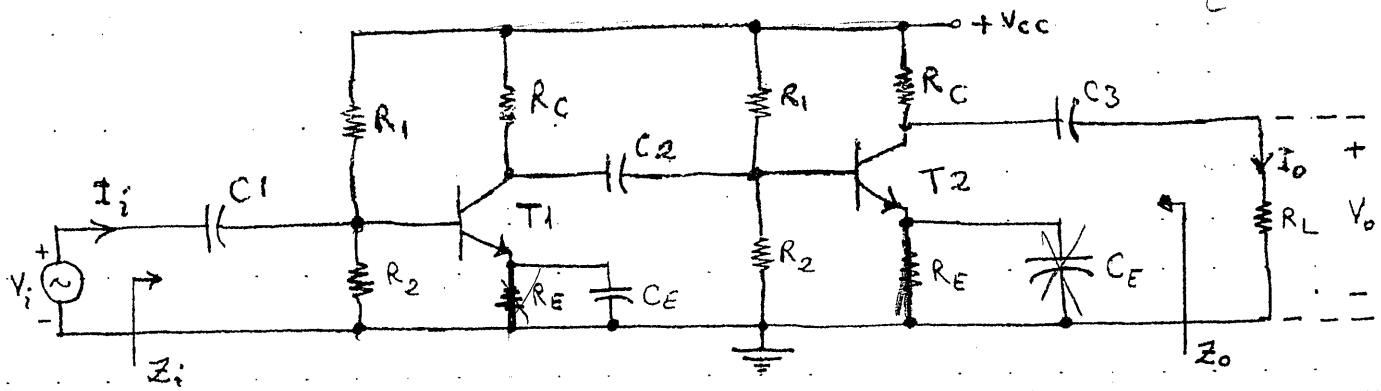


SORU 2.

(35 P) Yükseltecin gerilim kazancını, giriş empedansını, akım kazancını ve çıkış empedansını bulunuz. (Küçük genlikli değişimler için).

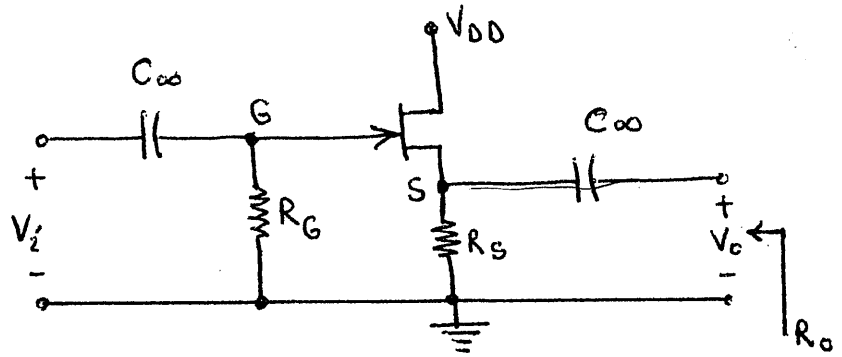
$R_1 = 90k\Omega$, $R_2 = 10\,k\Omega$, $R_E = 1\,k\Omega$ $R_C = R_L = 4\,k\Omega$

Transistorler özdeş $h_{ie} = 2\,k\Omega$, $h_{fe} = 100$



SORU 3.

(35 P)



$g_m = 4\ \frac{mA}{V}$

$r_d = \infty$ (çok büyük)

$R_G = 1\,M\Omega$

$R_S = 1\,k\Omega$

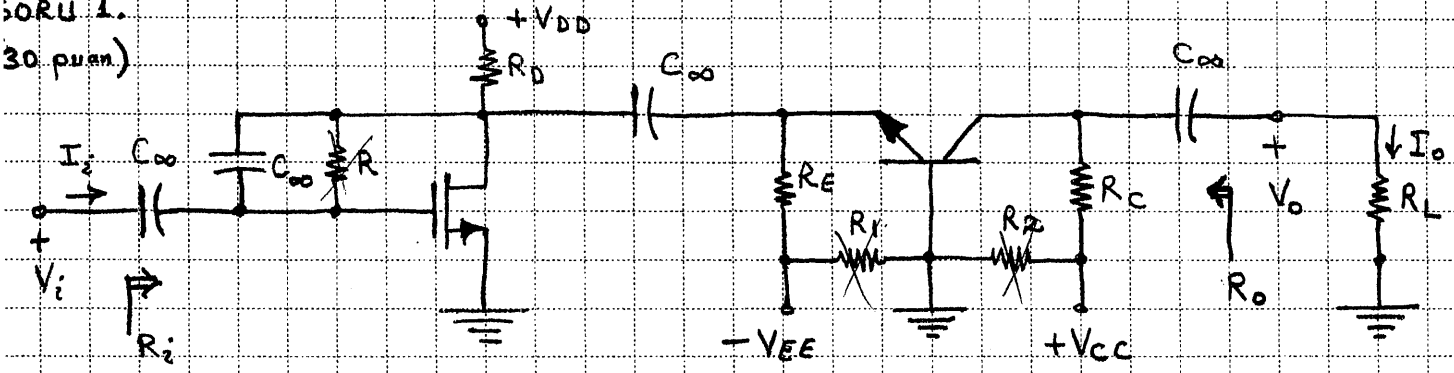
Devrenin gerilim kazancını ve çıkış direncini bulunuz.

İ.T.Ü. Müh. Mim. Fak. Elektrik-Elektronik Müh. Bölümü 12.12.2006

ELEKTRONİK DEVRELER I İkinci ARASINAVI

Öğr. Gör. Türen DEMİRCİOĞLU

SORU 1.
(30 puan)



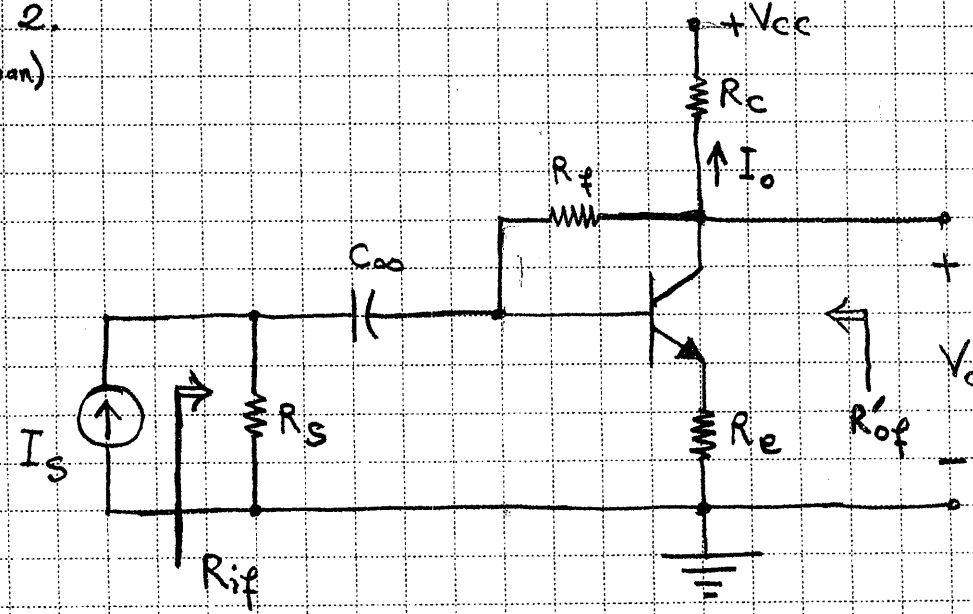
IFET: $g_m = 2$ mA/V, $r_d = \infty$ BIT: $h_{ie} = 1{,}5$ kΩ, $h_{fe} = 120$, $h_{re} \cong h_{oe} \cong 0$

$R = R_1 = 10$ kΩ, $R_D = R_E = 3$ kΩ $R_2 = 40$ kΩ, $R_C = R_L = 4$ kΩ

Devrenin gerilim kazancını, giriş direncini, akım kazancını ve çıkış direncini bulunuz.

160 12 kΩ 8 4 kΩ

SORU 2.
(70 puan)



$h_{ie} = 2$ kΩ

$h_{fe} = 150$

$h_{re} \approx 0$

$h_{oe} \approx 0$

$R_S = 1$ kΩ, $R_C = 5$ kΩ, $R_e = 0{,}5$ kΩ, $R_f = 100$ kΩ

Devrede, kaç tür geribesleme mevcuttur. Herbiri için topolojiyi belirleyip A, A_f, A_{yf}, R_{if} ve R'_{of} değerlerini bulunuz.

−9 −8,256 −8,256 0,896 4,136

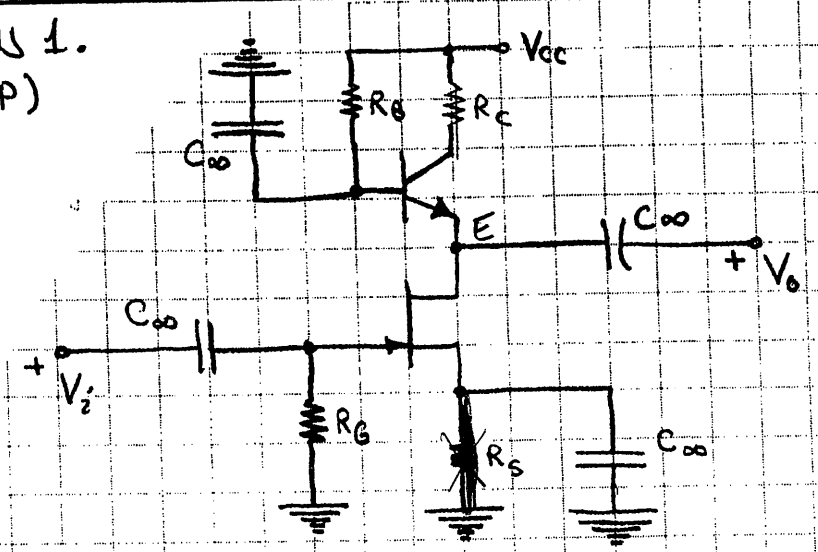
−14,35 −1,75 −8,75 10,77 4,46

Elektronik Devreler I

Dönem Sonu Sınavı

25.01.2007

SORU 1. (30 P)



$R_B = 470\ k\Omega$

$R_C = 3,6\ k\Omega$

$R_S = 2,4\ k\Omega$

$R_G = 1\ M\Omega$

$h_{fe} = 80$, $h_{ie} = 1\ k\Omega$

$\mu = 40$, $r_d = 25\ k\Omega$

Devrenin,

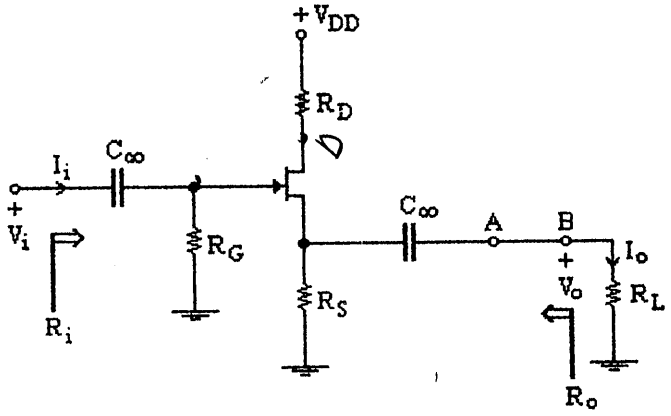
a) Gerilim kazancını b) Çıkış direncini bulunuz.

SORU 2. (35 P)

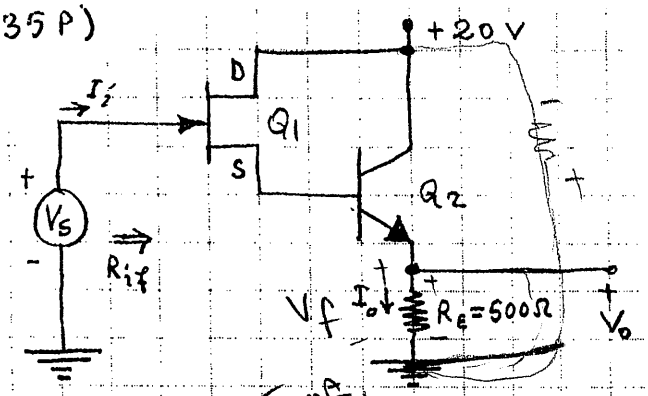
Şekildeki yükselteç devresinin, **a)** Akım kazancını **b)** Gerilim kazancını, **c)** Giriş direncini, **d)** Çıkış direncini bulunuz.

$R_D = 4\ k\Omega$, $R_G = 1\ M\Omega$, $R_S = 1\ k\Omega$, FET : $g_m = 3,236\ mA/V$, $r_d = 10\ k\Omega$

$R_L = 4\ k\Omega$



SORU 3. (35 P)



a) Geribeslemenin ne tür olduğu (Topoloji)

b) Geribeslemesiz yükselteç devresini oluşturunuz.

c) A 'yı bulunuz.

d) Af 'yi hesaplayınız.

e) Geribeslemeli devrenin gerilim ve akım kazancını bulunuz.

f) R_{if} ve R'_{of} 'yü hesaplayınız.

Q_1: $g_m = 5000\ \mu mho$ ($5\ \frac{mA}{V}$), $r_d = 50\ k\Omega$

Q_2: $h_{ie} = 2\ k\Omega$, $h_{fe} = 60$, $h_{re} = h_{oe} \cong 0$ (ihmal)

C

21

SORU 3. (40 puan)

a) DC bakımdan kondansatörler açık-devredir. Gate akımı sıfırdır.

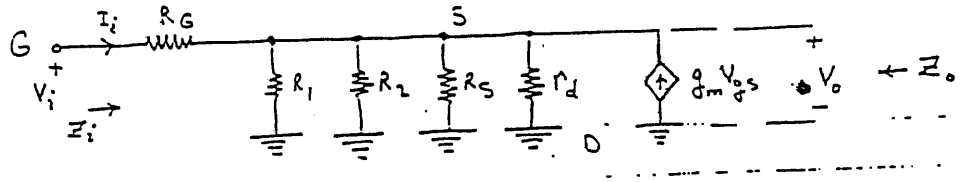
$$V_G = \frac{V_{DD}}{R_1+R_2}\cdot R_2 = \frac{18}{1,5+1}\cdot 1 = 7,2\ V \qquad V_{GS} = 7,2 - I_D\cdot 2,7$$

$I_D = 10\left(1-\frac{V_{GS}}{-5}\right)^2$ denklemlerinden $V_{GS} \cong -2\ V$ ve $I_D \cong 3,5\ mA$ bulunur.

b) $X_{C1} \leq \frac{1}{10} R_G$ $\quad \frac{1}{2\pi\cdot 100\cdot C_1} \leq \frac{1}{10}\cdot 10^6$ $\quad C_1 \geq 0,0159\ \mu F \Rightarrow C_1 \approx 0,02\ \mu F$

$X_{C2} \leq \frac{1}{10}(R_1 \| R_2)$ $\quad \frac{1}{2\pi\cdot 100\cdot C_2} \leq \frac{1}{10}(1,5\|1)\cdot 10^6$ $\quad C_2 \geq 0,0265\ \mu F \Rightarrow C_2 \approx$

c)



$R = R_1 \| R_2 \| r_d \| R_S \cong 2,55\ k\Omega$

$I_i + g_m V_{gs} = \frac{V_o}{R}$ düğüm denklemi $\quad I_i = \frac{V_{gs}}{R_G}$ $\quad V_i = V_{gs} + V_o$ den

$$A_V \equiv \frac{V_o}{V_i} = \frac{R(1+g_m R_G)}{R(1+g_m R_G)+R_G} \cong 0,927$$ gerilim kazancı

d) Yukarıdaki denklemlerden R_i giriş direnci bulunur.

$$R_i \equiv \frac{V_i'}{I_i} = R(1+g_m R_G) + R_G \cong 13,75\ M\Omega$$ giriş direnci

Diğer bir yol $R_i = \frac{R_G}{1-A_V} = \frac{1\ M\Omega}{1-0,927} \cong 13,7\ M\Omega$ bulunur.

e) $V_{gs} = -V$ olur.

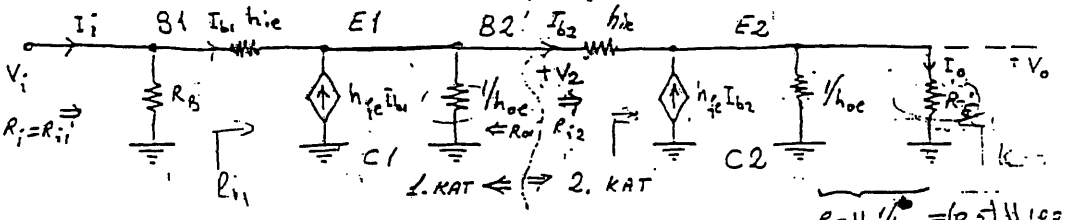
$$I = \frac{V}{R} + \frac{V}{R_G} - g_m V_{gs} = \frac{V}{R} + \frac{V}{R_G} + g_m$$

$$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R} + \frac{1}{R_G} + g_m = \frac{1}{2,55\cdot 10^3} + \frac{1}{1\cdot 10^6} + 5000\cdot 10^{-6} \cong 5,3$$

$$R_o \equiv \frac{V}{I} \cong \frac{1}{5,393\cdot 10^{-3}} \cong 185,4\ \Omega$$ Çıkış direnci

C

SORU 2. (30 puan)



$R_E \parallel 1/h_{oe} = (0,5) \parallel 100 \cong 0,495$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot h_{ie} + (1+h_{fe})\, I_{b2}\cdot (R_E \parallel 1/h_{oe}) \\ V_o &= (1+h_{fe})\, I_{b2}\cdot (R_E \parallel 1/h_{oe}) \end{aligned}\right\} \quad A_{V2} \equiv \frac{V_o}{V_2} = \frac{(1+h_{fe})(R_E \parallel 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_E \parallel 1/h_{oe})} \cong$$

$$R_{i2} \equiv \frac{V_2}{I_{b2}} = h_{ie} + (1+h_{fe})(R_E \parallel 1/h_{oe}) = 2 + (1+60)\cdot 0,4975 \cong \underline{32,35\ k\Omega}$$

$$\left.\begin{aligned} V_o &= I_o \cdot R_E \\ V_2 &= I_{b2}\cdot R_{i2} \end{aligned}\right\} \Rightarrow \underline{A_{I2} = A_{V2}\cdot \frac{R_{i2}}{R_E} = (0,938)\cdot \frac{32,35}{0,5} \cong 60,68}$$

$$I = \frac{V}{R_E} + h_{oe} V + \frac{V}{h_{ie} + R_{o1}} - h_{fe} I_{b2} \qquad I_{b2} = -\frac{V}{h_{ie} + R_{o1}}$$

$$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie} + R_{o1}} + \frac{h_{fe}}{h_{ie} + R_{o1}}$$ ... R_{o1} ni bulduktan sonra hesaplanır.

$$\frac{V_i}{I_{b1}} = h_{ie} + (1+h_{fe})\,(R_{i2} \parallel 1/h_{oe}) = 2 + (1+60)\cdot 24,44 = 1492,84\ k\Omega \cong \underline{1,493\ M\Omega}$$

($R_{i2} \parallel 1/h_{oe} \approx 24,44\ k\Omega$)

$$R_i' = R_{i1} \equiv \frac{V_i}{I_i} = R_B \parallel 1,493 \cong \underline{934,7\ k\Omega}$$ gir

$$\left.\begin{aligned} V_2 &= (1+h_{fe})\, I_{b1}\cdot (R_{i2} \parallel 1/h_{oe}) \\ V_i &= h_{ie}\cdot I_{b1} + (1+h_{fe})\, I_{b1}\cdot (R_{i2} \parallel 1/h_{oe}) \end{aligned}\right\} \Rightarrow A_{V1} \equiv \frac{V_2}{V_i} = \frac{(1+h_{fe})(R_{i2} \parallel 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_{i2} \parallel 1/h_{oe})}$$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot R_{i2} \\ V_i &= I_i \cdot R_i' \end{aligned}\right\} \Rightarrow \underline{A_{I1} \equiv \frac{I_{b2}}{I_i} = A_{V1}\frac{R_i'}{R_{i2}} = (0,998)\cdot \frac{934,7}{32,35} \cong 28,83}$$ Ç

R_{o1} ni bulalım.

$$I = h_{oe} V + \frac{V}{h_{ie}} - h_{fe} I_{b1} \qquad I_{b1} = -\frac{V}{h_{ie}} \qquad \frac{1}{R_{o1}} \equiv \frac{I}{V} = h_{oe} + \frac{1}{h_{ie}} + \frac{h_{fe}}{h_{ie}} = 10\cdot 10^{-6} + \frac{1}{2000}$$

$$\underline{R_{o1} \cong 32,776\ \Omega}$$ Birinci katın çıkış direnci

$$\frac{1}{R_o} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie} + R_{o1}} + \frac{h_{fe}}{h_{ie} + R_{s1}} = \frac{1}{500} + 10\cdot 10^{-6} + \frac{1}{2000 + 32,776} + \frac{60}{2000 + 32,776} \cong$$

$$\underline{R_o \cong 31,23\ \Omega}$$ Çıkış direnci $\qquad R_i \cong 934,7\ k\Omega$

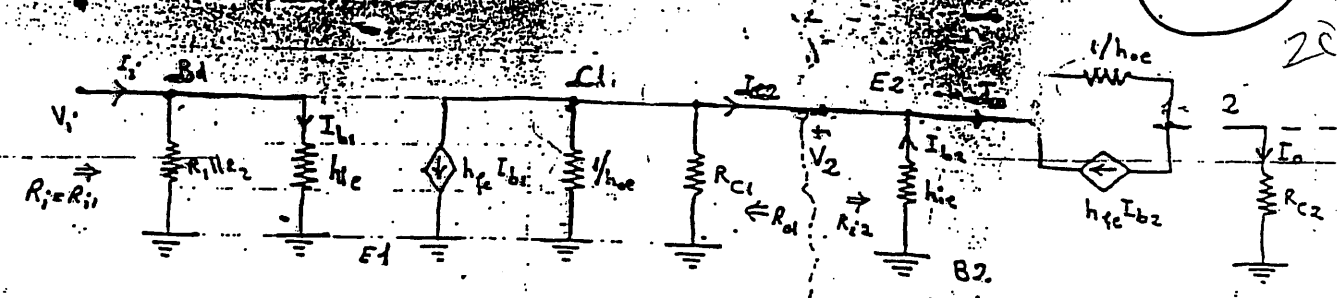
$$A_V \equiv \frac{V_o}{V_i} = \frac{V_o}{V_2}\cdot\frac{V_2}{V_i} = A_{V2}\cdot A_{V1} = (0,938)(0,998) \cong 0,936$$ Gerilim kazancı

$$A_I \equiv \frac{I_o}{I_i} = \frac{I_o}{I_{b2}}\cdot\frac{I_{b2}}{I_i} = A_{I2}\cdot A_{I1} = (60,68)(28,83) \cong 1749,4$$ Akım kazancı

2003 1. Ara

C

SORU 1 : (30 puan)



$\frac{1}{h_{oe}} = \frac{1}{20\,\mu mho} = 50\,k\Omega$ 1. KAT ⇐ ⇒ 2. KAT $I_o = V_o / R_{c2}$

$V_2 = -I_{b2} \cdot h_{ie} = \left(h_{fe} I_{b2} + I_o\right) \cdot \frac{1}{h_{oe}} + V_o$ çevre denklemlerinden

$A_{V2} \equiv \frac{V_o}{V_2} = \frac{h_{ie} + \frac{h_{fe}}{h_{oe}}}{h_{ie}\left(1 + \frac{1}{h_{oe} R_{c2}}\right)} = \frac{2 + (40)(50)}{2\left(1 + \frac{50}{2,5}\right)} \cong 47,66$ ikinci katın gerilim kazancı

$\frac{V_2}{I_o} = \frac{h_{ie} \cdot R_{c2}\left(1 + \frac{1}{h_{oe} R_{c2}}\right)}{h_{ie} + \frac{h_{fe}}{h_{oe}}} = \frac{2(2,5)\left(1 + \frac{50}{2,5}\right)}{2 + (40)(50)} = \frac{105}{2002} \cong 52,44\,\Omega$ (ikinci katın giriş direnci)

$R_{i2} = h_{ie} \| 52,44 = \frac{(2000)(52,44)}{2000 + 52,44} \cong 51,1\,\Omega$ İkinci katın giriş direnci

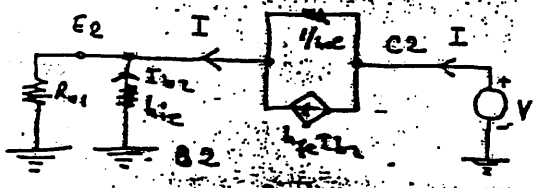
$V_o = I_o \cdot R_{c2}$, $V_2 = I_{e2} \cdot R_{i2}$ $\Rightarrow A_{I2} = A_{V2} \cdot \frac{R_{i2}}{R_{c2}} = (47,66)\frac{51,1}{2500} \cong 0,974$ İkinci katın akım kazancı

$R_i = R_{i1} \equiv \frac{V_i}{I_i} = R_1 \| R_2 \| h_{ie} = 15 \| 3 \| 2 \cong 1,111\,k\Omega$ giriş direnci

$V_2 = -h_{fe} I_{b1} \cdot \left(R_{i2} \| R_{c1} \| \frac{1}{h_{oe}}\right)$, $V_i = I_{b1} \cdot h_{ie}$ $\Rightarrow A_{V1} \equiv \frac{V_2}{V_i} = -\frac{h_{fe}\left(\overbrace{R_{i2} \| R_{c1} \| \frac{1}{h_{oe}}}^{\cong 50\,\Omega}\right)}{h_{ie}} \cong -1$ Birinci katın gerilim kazanı

$V_2 = I_{e2} \cdot R_{i2}$, $V_i = I_i \cdot R_i$ $\Rightarrow A_{I1} = A_{V1} \cdot \frac{R_i}{R_{i2}} = (-1)\frac{1111}{51} \cong -21,74$ Birinci katın akım kazancı

$R_{o1} \equiv R_{c1} \| 1/h_{oe} = (2,5) \| 50 \cong 2,3\,k\Omega$ Birinci katın çıkış direnci



$\left(\frac{R_{o1}}{R_{o1} + h_{ie}}\right) \cdot I = -I_{b2} = \frac{R_{o1} \cdot I}{R_{o1} + h_{ie}}$

$V = (I - h_{fe} I_{b2}) \cdot \frac{1}{h_{oe}} - I_{b2} \cdot h_{ie}$ } denklemlerinden

$\frac{V}{I} = \frac{1}{h_{oe}} + \frac{R_{o1}\left(\frac{h_{ie}}{h_{oe}} + h_{ie}\right)}{R_{o1} + h_{ie}} = 50 + \frac{2,38(2 + 40 \cdot 50)}{2,38 + 2} \cong 1137,84\,k\Omega$

$R_o \cong 2,49\,k\Omega$ Cıkış

$\frac{I_{e2}}{I_i} = A_{I2} \cdot A_{I1} = (0,974)$

$= -21,$

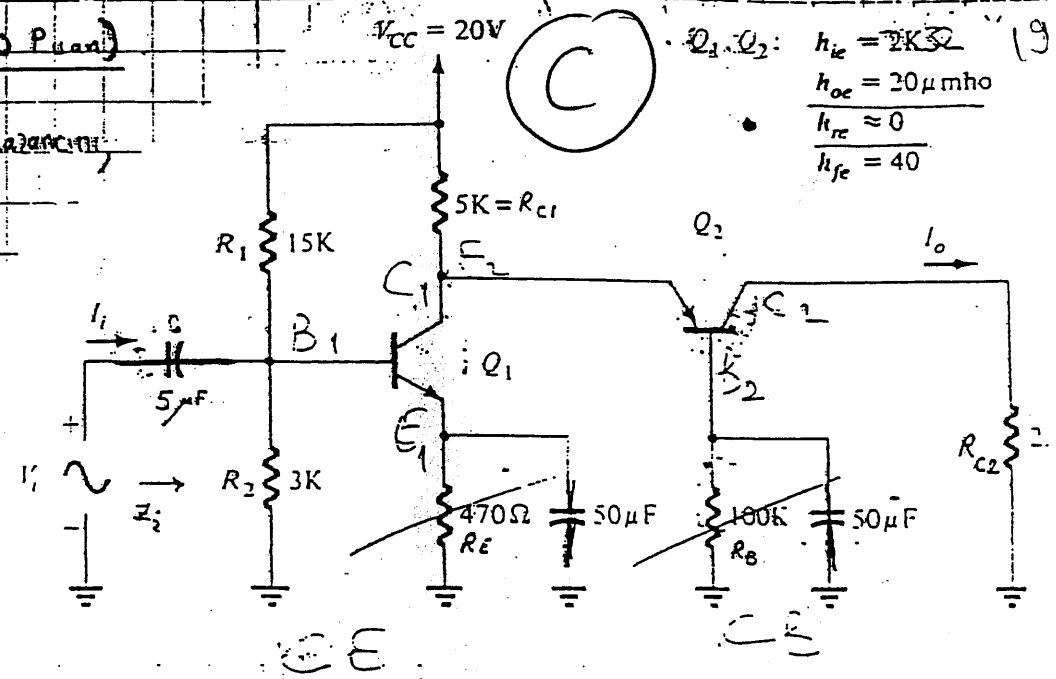
ELEKTRONİK DEVRELER I Bütünleme ARASINAVI

- Sınav süresi 2 saattir
- Kitap ve ders notları kapalıdır BAŞARILAR

Doç. Şefik Tuna Demir

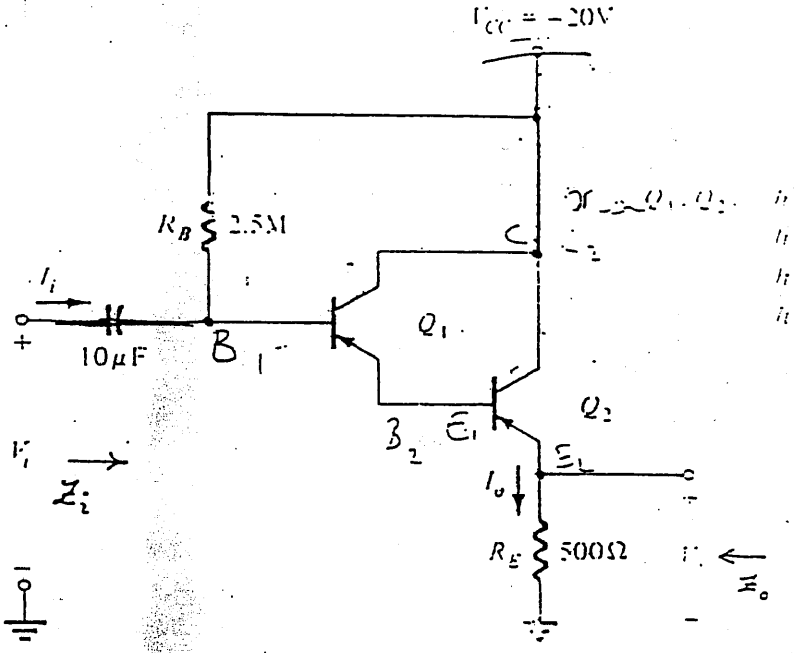
SORU 1. (30 Puan)

Gerilim, akım kazancını, giriş ve çıkış dirençlerini bulunuz.



SORU 2. (30 Puan)

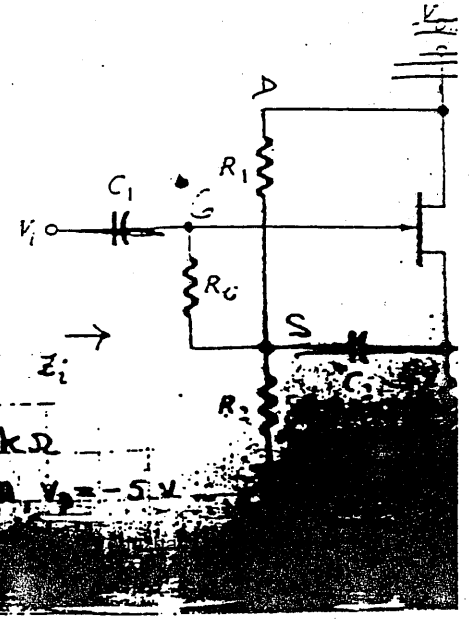
Gerilim, akım kazancını, giriş ve çıkış dirençlerini bulunuz.



SORU 3. (40 Puan)

a) DC çalışma noktasının yaklaşık değerlerini,
b) f = 100 Hz de kapasitelerin etkisini ihmal edecek biçimde C_1 ve C_2 değerlerini seçiniz.
c) Gerilim kazancını,
d) Giriş direncini,
e) Çıkış direncini bulunuz.

$R_1 = 15K\Omega$ $R_2 = 1MA$ $V_{CC} = 8V$ $R_L = 2,7K\Omega$



C

21

SORU 3. (40 puan)

a) DC bakımdan kondansatörler açık-devredir. Gate akımı sıfırdır.

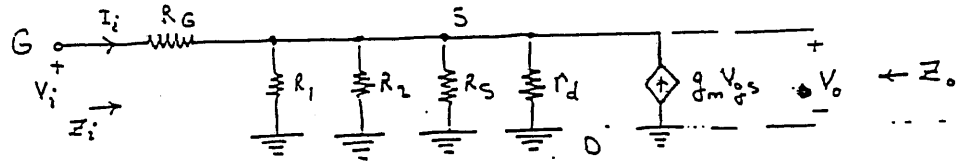
$$V_G = \frac{V_{DD}}{R_1+R_2}\cdot R_2 = \frac{18}{1,5+1}\cdot 1 = 7,2\ V \qquad V_{GS} = 7,2 - I_D\cdot 2,7$$

$$I_D = 10\left(1-\frac{V_{GS}}{-5}\right)^2$$ denklemlerinden $V_{GS} \cong -2\ V$ ve $I_D \cong 3,5\ mA$ bulunur.

b) $X_{C1} \leq \frac{1}{10} R_G \qquad \frac{1}{2\pi\cdot 100\cdot C_1} \leq \frac{1}{10}\cdot 10^6 \qquad C_1 \geq 0,0159\ \mu F \Rightarrow C_1 \approx 0,02\ \mu F$

$X_{C2} \leq \frac{1}{10}(R_1 \| R_2) \qquad \frac{1}{2\pi\cdot 100\cdot C_2} \leq \frac{1}{10}(1,5\|1)\cdot 10^6 \qquad C_2 \geq 0,0265\ \mu F \Rightarrow C_2 \approx$

c)



$R = R_1 \| R_2 \| r_d \| R_S \cong 2,55\ k\Omega$

$I_i + g_m V_{gs} = \frac{V_o}{R}$ düğüm denklemi $I_i = \frac{V_{gs}}{R_G}$ $\qquad V_i = V_{gs} + V_o$ den

$$A_V \equiv \frac{V_o}{V_i} = \frac{R(1+g_m R_G)}{R(1+g_m R_G)+R_G} \cong 0,927$$ gerilim kazancı

d) Yukarıdaki denklemlerden R_i giriş direnci bulunur.

$$R_i \equiv \frac{V_i'}{I_i} = R(1+g_m R_G) + R_G \cong 13,75\ M\Omega$$ giriş direnci

Diğer bir yol $R_i = \frac{R_G}{1-A_V} = \frac{1\ M\Omega}{1-0,927} \cong 13,7\ M\Omega$ bulunur.

e) $V_{gs} = -V$ olur.

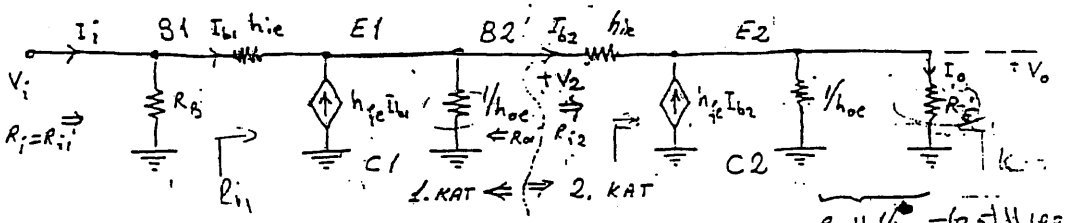
$$I = \frac{V}{R} + \frac{V}{R_G} - g_m V_{gs} = \frac{V}{R} + \frac{V}{R_G} + g_m$$

$$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R} + \frac{1}{R_G} + g_m = \frac{1}{2,55\cdot 10^3} + \frac{1}{1\cdot 10^6} + 5000\cdot 10^{-6} \cong 5,3$$

$$R_o \equiv \frac{V}{I} \cong \frac{1}{5,393\cdot 10^{-3}} \cong 185,4\ \Omega$$ Çıkış direnci

C

SORU 2. (30 puan)



$R_E \| 1/h_{oe} = (0,5) \| 100 \cong 0,495$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot h_{ie} + (1+h_{fe})\, I_{b2}\cdot (R_E \| 1/h_{oe}) \\ V_o &= (1+h_{fe})\, I_{b2}\cdot (R_E \| 1/h_{oe}) \end{aligned}\right\} \quad A_{V2} \equiv \frac{V_o}{V_2} = \frac{(1+h_{fe})(R_E \| 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_E \| 1/h_{oe})} \cong$$

$$R_{i2} \equiv \frac{V_2}{I_{i2}} = h_{ie} + (1+h_{fe})\,(R_E \| 1/h_{oe}) = 2 + (1+60)\cdot 0,4975 \cong \underline{32,35\ k\Omega}$$ ikinci

$$\left.\begin{aligned} V_o &= I_o \cdot R_E \\ V_2 &= I_{i2}\cdot R_{i2} \end{aligned}\right\} \Rightarrow \underline{A_{I2} = A_{V2}\cdot \frac{R_{i2}}{R_E} = (0,938)\cdot \frac{32,35}{0,5} \cong 60,68}$$ ikinci kat akım kaz

$$I = \frac{V}{R_E} + h_{oe}\cdot V + \frac{V}{h_{ie}+R_{o1}} - h_{fe}\, I_{b2} \qquad I_{b2} = \frac{V}{h_{ie}+R_{o1}}$$

$$\frac{1}{R_o} \equiv \frac{I}{V} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie}+R_{o1}} + \frac{h_{fe}}{h_{ie}+R_{o1}}$$ ... R_{o1} ni bulduktan sonra hesaplanır.

$$\frac{V_i'}{I_{b1}} = h_{ie} + (1+h_{fe})\cdot (R_{i2} \| 1/h_{oe}) = 2 + (1+60)\cdot 24,44 = 1492,84\ k\Omega \cong \underline{1,493\ M\Omega}$$ ($R_{i2} \| 1/h_{oe} \cong 24,44\ k\Omega$)

$$R_i' = R_{i1} \equiv \frac{V_i'}{I_i} = R_B \| 1,493 \cong \underline{934,7\ k\Omega}$$ gir

$$\left.\begin{aligned} V_2 &= (1+h_{fe})\, I_{b1}\cdot (R_{i2} \| 1/h_{oe}) \\ V_i' &= h_{ie}\cdot I_{b1} + (1+h_{fe})\, I_{b1}\cdot (R_{i2} \| 1/h_{oe}) \end{aligned}\right\} \Rightarrow A_{V1} \equiv \frac{V_2}{V_i'} = \frac{(1+h_{fe})(R_{i2} \| 1/h_{oe})}{h_{ie} + (1+h_{fe})(R_{i2} \| 1/h_{oe})}$$

$$\left.\begin{aligned} V_2 &= I_{b2}\cdot R_{i2} \\ V_i &= I_i \cdot R_i \end{aligned}\right\} \Rightarrow \underline{A_{I1} \equiv \frac{I_{b2}}{I_i} = A_{V1}\cdot \frac{R_i}{R_{i2}} = (0,998)\cdot \frac{934,7}{32,35} \cong 28,83}$$ Zi

R_{o1} yi bulalım.

$$I = h_{oe} V + \frac{V}{h_{ie}} - h_{fe}\, I_{b1} \qquad I_{b1} = -\frac{V}{h_{ie}} \qquad \frac{1}{R_{o1}} \equiv \frac{I}{V} = h_{oe} + \frac{1}{h_{ie}} + \frac{h_{fe}}{h_{ie}} = 10\cdot 10^{-6} + \frac{1}{2000}$$

$\underline{R_{o1} \cong 32,776\ \Omega}$ Birinci katın çıkış direnci

$$\frac{1}{R_o} = \frac{1}{R_E} + h_{oe} + \frac{1}{h_{ie}+R_{o1}} + \frac{h_{fe}}{h_{ie}+R_{o1}} = \frac{1}{500} + 10\cdot 10^{-6} + \frac{1}{2000+32,776} + \frac{60}{2000+32,776} \cong$$

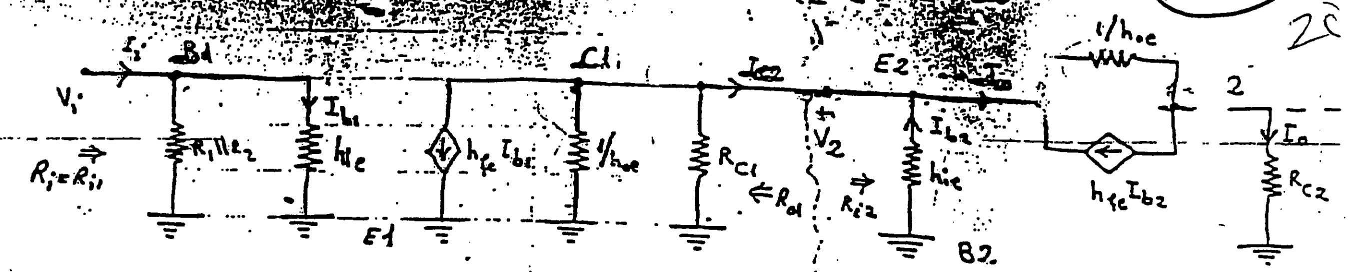
$\underline{R_o \cong 31,23\ \Omega}$ Çıkış direnci $\qquad R_i \cong 934,7\ k\Omega$

$$A_V \equiv \frac{V_o}{V_i'} = \frac{V_o}{V_2}\cdot \frac{V_2}{V_i'} = A_{V2}\cdot A_{V1} = (0,938)(0,998) \cong 0,936$$ Gerilim kazancı

$$A_I \equiv \frac{I_o}{I_i} = \frac{I_o}{I_{b2}}\cdot \frac{I_{b2}}{I_i} = A_{I2}\cdot A_{I1} = (60,68)(28,83) \cong 1749,4$$ Akım kazancı

2003 1.Ara (C)

SORU 1 (30 puan)



$\frac{1}{h_{oe}} = \frac{1}{20 \mu mho} = 50 \, k\Omega$ 1. KAT ⇐ ⇒ 2. KAT $I_o = V_o / R_{C2}$

$V_2 = -I_{b2} h_{ie} = (h_{fe} I_{b2} + I_o) \cdot \frac{1}{h_{oe}} + V_o$ çevre denklemlerinden

$A_{V2} \equiv \frac{V_o}{V_2} = \frac{h_{ie} + \frac{h_{fe}}{h_{oe}}}{h_{ie}\left(1 + \frac{1}{h_{oe} R_{C2}}\right)} = \frac{2 + (40)(50)}{2\left(1 + \frac{50}{2,5}\right)} \cong 47,66$ ikinci katın gerilim kazancı

$\frac{V_2}{I_o} = \frac{h_{ie} \cdot R_{C2}\left(1 + \frac{1}{h_{oe} R_{C2}}\right)}{h_{ie} + \frac{h_{fe}}{h_{oe}}} = \frac{2(2,5)\left(1 + \frac{50}{2,5}\right)}{2 + (40)(50)} = \frac{105}{2002} \cong 52,44 \, \Omega$ (h_{ie} hariç giriş direnci)

$R_{i2} = h_{ie} \| 52,44 = \frac{(2000)(52,44)}{2000 + 52,44} \cong 51,1 \, \Omega$ İkinci katın giriş direnci

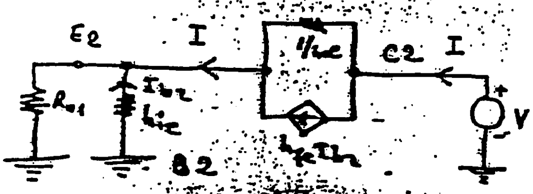
$\left.\begin{array}{l} V_o = I_o \cdot R_{C2} \\ V_2 = I_{e2} \cdot R_{i2} \end{array}\right\} \Rightarrow A_{I2} = A_{V2} \cdot \frac{R_{i2}}{R_{C2}} = (47,66) \frac{51,1}{2500} \cong 0,974$ ikinci katın akım kazancı

$R_i = R_{i1} \equiv \frac{V_i}{I_i} = R_1 \| R_2 \| h_{ie} = 15 \| 2 \| 2 \cong 1,111 \, k\Omega$ giriş direnci

$\left.\begin{array}{l} V_2 = -h_{fe} I_{b1} \cdot \left(R_{i2} \| R_{C1} \| \frac{1}{h_{oe}}\right) \\ V_i = I_{b1} \cdot h_{ie} \end{array}\right\} \Rightarrow A_{V1} \equiv \frac{V_2}{V_i} = -\frac{h_{fe}\overbrace{\left(R_{i2} \| R_{C1} \| \frac{1}{h_{oe}}\right)}^{\cong 50 \Omega}}{h_{ie}} \cong -1$ Birinci katın gerilim kazancı

$\left.\begin{array}{l} V_2 = I_{e2} \cdot R_{i2} \\ V_i = I_i \cdot R_i \end{array}\right\} \Rightarrow A_{I1} = A_{V1} \cdot \frac{R_i}{R_{i2}} = (-1) \frac{1111}{51,1} \cong -21,74$ Birinci katın akım kazancı

$R_{o1} = R_{C1} \| 1/h_{oe} = (2,5) \| 50 \cong 2,38 \, k\Omega$ Birinci katın çıkış direnci



$\left.\begin{array}{l} \frac{(R_{o1} \| h_{ie}) \cdot I}{h_{ie}} = -I_{b2} = \frac{R_{o1} \cdot I}{R_{o1} + h_{ie}} \\ V = (I - h_{fe} I_{b2}) \cdot \frac{1}{h_{oe}} - I_{b2} \cdot h_{ie} \end{array}\right\}$ denklemlerinden

$\frac{V}{I} = \frac{1}{h_{oe}} + \frac{R_{o1}\left(h_{ie} + \frac{h_{fe}}{h_{oe}}\right)}{R_{o1} + h_{ie}} = 50 + \frac{2,38(2 + 40 \cdot 50)}{2,38 + 2} \cong 1137,84 \, k\Omega$

⇒ $R_o \cong 2,49 \, k\Omega$ Çıkış

$\frac{I_{o}}{I_i} = A_{I2} \cdot A_{I1} = (0,974) \ldots$

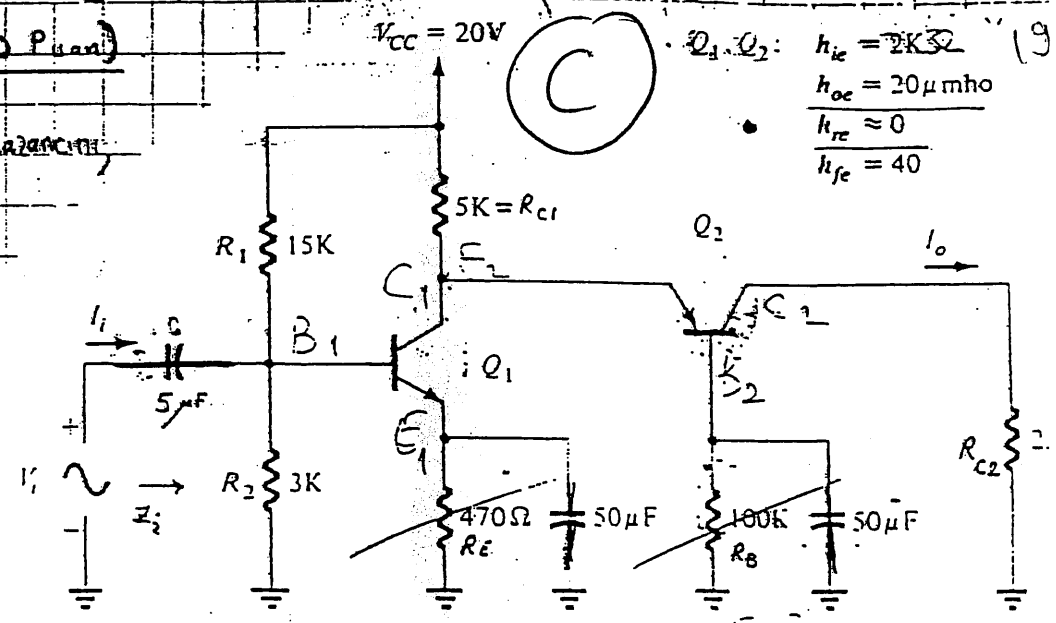
$= -21, \ldots$

ELEKTRONİK DEVRELER I Bütünleme SINAVI

- Sınav süresi 2 saattir
- Kitap ve ders notları kapalıdır BAŞARILAR Öğr. Gör. Şeref Tuncer Demir

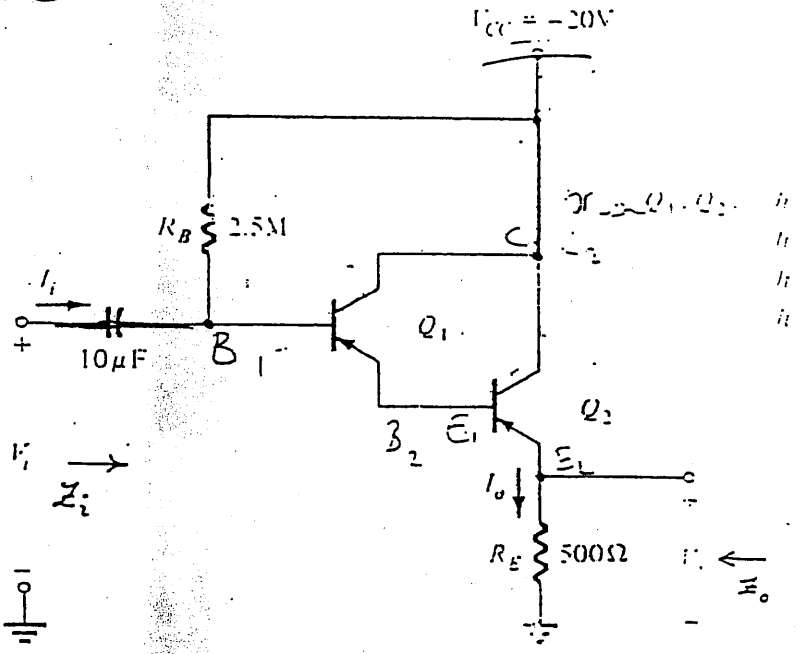
SORU 1. (30 Puan)

Gerilim, akım kazancını, giriş ve çıkış dirençlerini bulunuz.



SORU 2. (30 Puan)

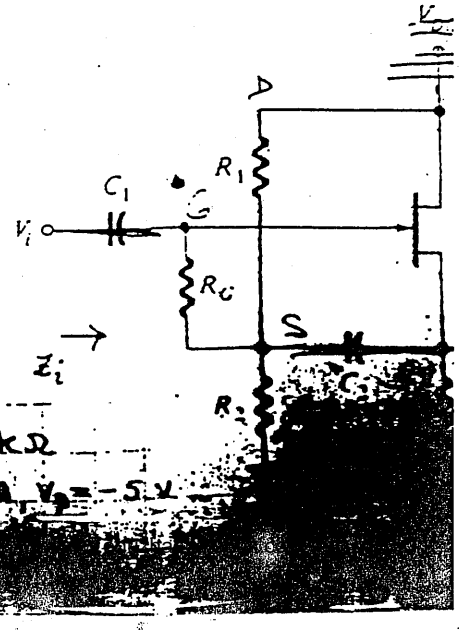
Gerilim, akım kazancını, giriş ve çıkış dirençlerini bulunuz.



SORU 3. (40 Puan)

a) DC çalışma noktasının yaklaşık değerlerini,
b) f = 100 Hz de kapasitelerin etkisini ihmal edecek biçimde C_1 ve C_2 değerlerini seçiniz.
c) Gerilim kazancını,
d) Giriş direncini,
e) Çıkış direncini bulunuz.

$R_1 = 15K\Omega$ $R_2 = 1M\Omega$ $V_{CC} = 8V$ $R_L = 2,7k\Omega$



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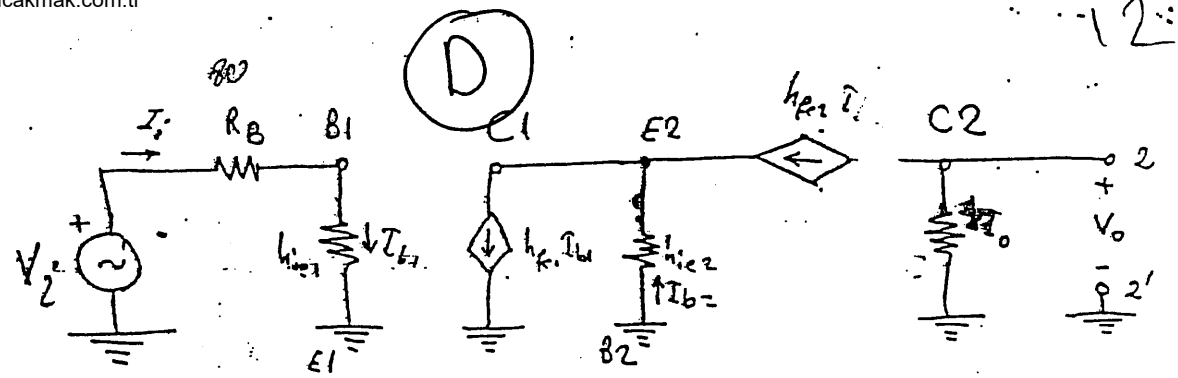
SORU 2.



a) Giriş direnci

$$V_i = (R_B + h_{ie1}) I_i$$

5

$$R_i = \frac{V_i}{I_i} = R_B + h_{ie1} = 80 + 1,5 = 81,5\ k\Omega$$ giriş direnci

b) Akım kazancı

$$h_{fe1} I_{b1} = (1 + h_{fe2}) I_{b2} \qquad I_i = I_{b1}$$

5

$$I_o = -h_{fe2} I_{b2} = -h_{fe2} \cdot \frac{h_{fe1}}{1 + h_{fe2}}$$

Akım kazanç

$$A_I = \frac{I_o}{I_i} = -\frac{h_{fe2} \cdot h_{fe1}}{1 + h_{fe2}} = -\frac{125 \cdot 125}{126} \cong -124$$

$(\cong 41,86\ dB)$

c) Gerilim kazancı

$$V_o = R_C \cdot I_o$$
$$V_i = R_i \cdot I_i$$

5

$$A_V = \frac{V_o}{V_i} = \frac{R_C}{R_i} A_I = \frac{3}{81,5}(-124) \cong -456,4$$

gerilim kaz

$(\cong 53\ dB)$

d) $A_V = \frac{V_o}{V_i}$ Açık-devre gerilimi $V_o = A$

Açık-devre gerilimi

5

$$V_o = \frac{R_C}{R_i} A_I \cdot V_i = -\frac{R_C}{R_i} \cdot \frac{h_{fe2} \cdot h_{fe1}}{1 + h_{fe2}} V_i \quad -\frac{300}{81,5} 124\, V_i \cong \left(\frac{-124}{81,5}\right) 3$$

çık-devre gerilimi $\cong -456,4 V_i$

e) Kısa-devre akımı

$$I_N = -h_{fe2} I_{b2} = -h_{fe2} \frac{h_{fe1}}{1 + h_{fe2}} I_{b1}$$

$$I_i = I_{b1} = \frac{V_i}{R_i} = \frac{V_i}{R_B}$$

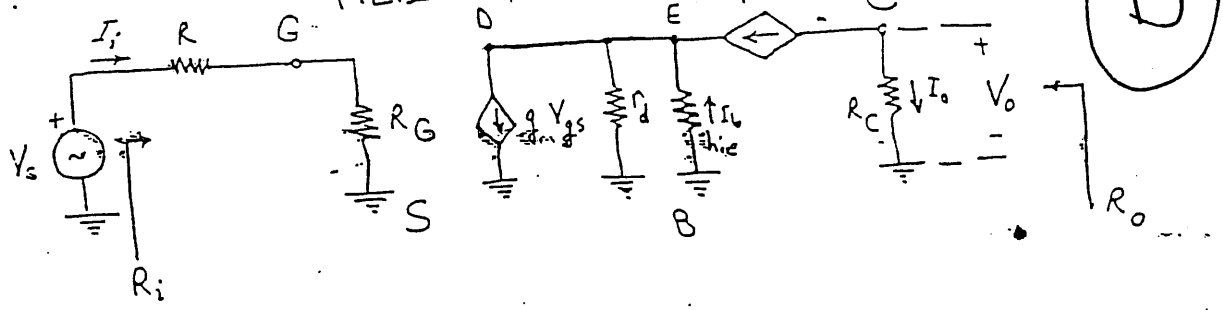
5

$$I_N = -h_{fe2} \cdot \frac{h_{fe1}}{1 + h_{fe2}} \cdot \frac{V_i}{R_B + h_{ie1}}$$

$$R_o = \frac{V_o}{I_d} = \frac{\frac{R_C}{R_i} A_I \cdot V_i}{A_I \frac{V_i}{R_i}} = R_C = 3$$

FİLİZ

3 :



5 $R_i = \frac{V_s}{I_i} = R + R_G = 0{,}6 + 500000 = 500000{,}6\ k\Omega \cong \underline{500\ M\Omega}$ giriş direnci

$g_m V_{gs} = (1+h_{fe}) I_b + \frac{h_{ie} I_b}{r_d}$ $\quad V_{gs} = R_G \cdot I_i$ $\quad I_o = -h_{fe} I_b$ } dönüşümde yerine koyalım

$g_m (R_G \cdot I_i) = (1+h_{fe})\left(-\frac{I_o}{h_{fe}}\right) + \frac{h_{ie}}{r_d}\left(-\frac{I_o}{h_{fe}}\right)$

$A_i = \frac{I_o}{I_i} = -\frac{g_m R_G h_{fe} r_d}{h_{ie} + r_d (1+h_{fe})} = \frac{1 \cdot 500 \cdot 10^3 \cdot 100 \cdot 40}{1 + 40\,(1+100)} \cong -495000$ akım kazancı

$(\approx 113{,}89\ dB)$

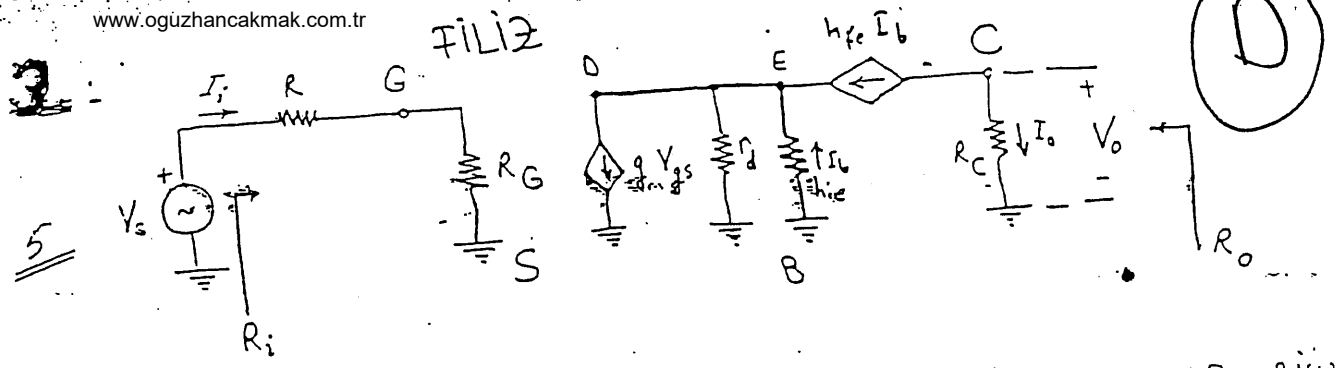
$V_o = R_C I_o$ } $A_V = \frac{V_o}{V_s} = A_I \frac{R_C}{R_i} = (-495000)\frac{3}{500000{,}6} \cong -2{,}97$ gerilim kazancı

$(\approx 9{,}5\ dB)$

$V_s = 0 \qquad V_{gs} = 0 \qquad g_m V_{gs} = 0$

$R_o = \left.\frac{V}{I}\right|_{V_s = 0} = \underline{R_C = 3\ k\Omega}$ Çıkış direnci

FİLİZ



5 $R_i = \frac{V_s}{I_i} = R + R_G = 0{,}5 + 500000 = 500000{,}6\ k\Omega \equiv \underline{500\ M\Omega}$ giriş direnci

$g_m V_{gs} = (1+h_{fe}) I_b + \frac{h_{ie} I_b}{r_d}$ $\quad V_{gs} = R_G \cdot I_i$ $\quad I_o = -h_{fe} I_b$ } doğrusunda yerine koyalım

$g_m (R_G \cdot I_i) = (1+h_{fe})\left(-\frac{I_o}{h_{fe}}\right) + \frac{h_{ie}}{r_d}\left(-\frac{I_o}{h_{fe}}\right)$

Akım kazancı

$A_i = \frac{I_o}{I_i} = -\frac{g_m R_G h_{fe} \cdot r_d}{h_{ie} + r_d (1+h_{fe})} = \frac{1 \cdot 500 \cdot 10^3 \cdot 100 \cdot 40}{1 + 40\,(1+100)} \cong \underline{-495\,000}$ $(\approx 113{,}89\ dB)$

$V_o = R_C I_o$ $\quad V_s = R_i I_i$ } $A_V = \frac{V_o}{V_s} = A_I \frac{R_C}{R_i} = (-495000)\frac{3}{500000{,}6} \equiv \underline{-2{,}97}$ gerilim kazancı $(\approx 9{,}5\ dB)$

$V_s = 0 \qquad V_{gs} = 0 \qquad g_m V_{gs} = 0$

$R_o = \frac{V}{I}\Big|_{V_s=0} = \underline{R_C = 3\ k\Omega}$ Çıkış direnci

1. b) Giriş empedansı Z_i

$$V_i = r_i I_i + R_b (I_i - I_b)$$

5

$$Z_i = \frac{V_i}{I_i} = r_i + R_b - R_b \frac{I_b}{I_i} = 0,5 + 100 - 100 \cdot (0,6$$

$$Z_i \cong 34,9\ k\Omega$$ giriş empedansı

c) Gerilim kazancı A_V gerilim kaza

$$\frac{V_o}{V_i} = \frac{R_L \cdot I_L}{Z_i \cdot I_i}$$

5

$$A_V = \frac{R_L}{Z_i} \cdot \frac{I_L}{I_i} = \frac{1}{34,9} \cdot 33 \cong 0,9$$ (≈ −1

d) Çıkış empedansı Z_o

$$Z_o = \frac{V}{I} \Big|_{\substack{V_i = 0 \\ R_L = \infty}}$$ bu koşullar altında

10

$$I = \frac{V}{R_e} - I_b (1 + h_{fe})$$ düğüm denklemi

$$I_b = -\frac{V}{h_{ie} + (r_i \parallel R_b)}$$ yukarıda yerine koyalım

$$I = \frac{V}{R_e} + \frac{V}{h_{ie} + (r_i \parallel R_b)} \cdot (1 + h_{fe})$$

$$Y_o = \frac{1}{Z_o} = \frac{I}{V} = \frac{1}{R_e} + \frac{1 + h_{fe}}{h_{ie} + (r_i \parallel R_b)} = \frac{1}{1} + \frac{1+100}{2 + \frac{0,5 \times 100}{0,5 + 100}} \cong 41$$

$$Z_o = \frac{1}{Y_o} = \frac{1}{41,44} \cong 24\ \Omega$$ çıkış empedansı

FİLİZ

I. Arasınav 6.11.2000
Cevapları

(D)

SORU

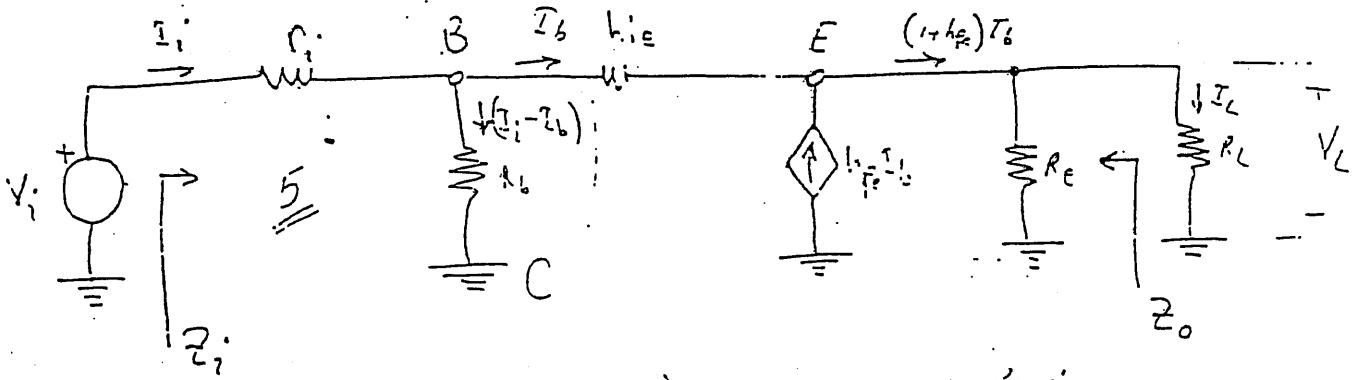
1. $g_m = \dfrac{|I_C|\,(-1)}{26} = \dfrac{1,3}{26} = 0,05\ \text{mho} = 50\ \dfrac{mA}{V}$

5 $h_{ie} \approx r_\pi = 2\,k\Omega$

$h_{fe} \approx g_m r_\pi = \left(\dfrac{50\ mA}{V}\right)(2\,k\Omega) = 100$

$h_{re} \approx h_{oe} \approx 0$ (ihmal)

Eşdeğer devre



5

a) Akım kazancı, A_I $\quad R_L' = (R_E \,||\, R_L) = 500\ \Omega = \dfrac{R_E \cdot R_L}{R_E + R_L}$

$V_L = R_L \cdot I_L = (1+h_{fe})\, I_b\, R_L'$

$\dfrac{I_L}{I_b} = \dfrac{(1+h_{fe})\,R_L'}{R_L} = \dfrac{(1+h_{fe})\,R_E}{R_E + R_L}$

$A_I = \dfrac{I_L}{I_i} = \dfrac{I_L}{I_b} \cdot \dfrac{I_b}{I_i}$

10 $-R_b(I_i - I_b) + h_{ie} I_b + (1+h_{fe}) I_b R_L' = 0$

$I_b \{ R_b + h_{ie} + (1+h_{fe}) R_L' \} = R_b I_i$

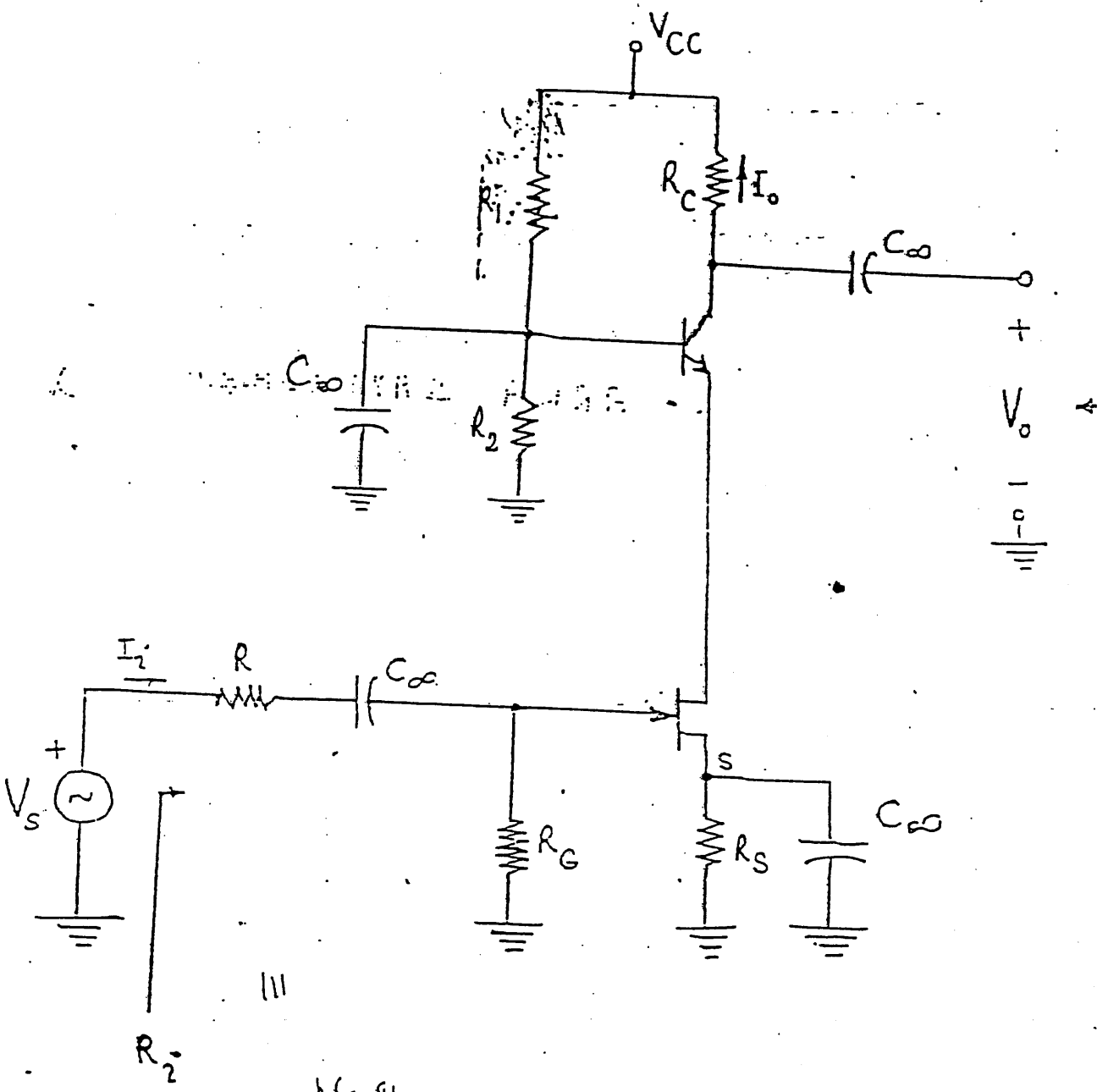
$\dfrac{I_b}{I_i} = \dfrac{R_b}{R_b + h_{ie} + (1+h_{fe}) R_L'} \cong 0,655$?

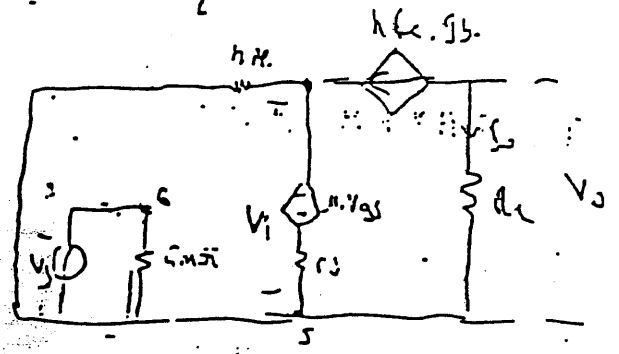
Akım kazancı

$A_I = \dfrac{(1+h_{fe})\,R_E}{R_E + R_L} \cdot \dfrac{R_b}{R_b + h_{ie} + (1+h_{fe}) R_L'} \cong 33\ (\approx 30,4\ dB)$

$= \dfrac{(1+100)\cdot 1}{1+1} \cdot \dfrac{100}{100 + 2 + (1+100)\,0,5} = \dfrac{101}{2} \cdot \dfrac{100}{152,5} = (50,5)(0,65$

3. Soru 3'e ait şekil

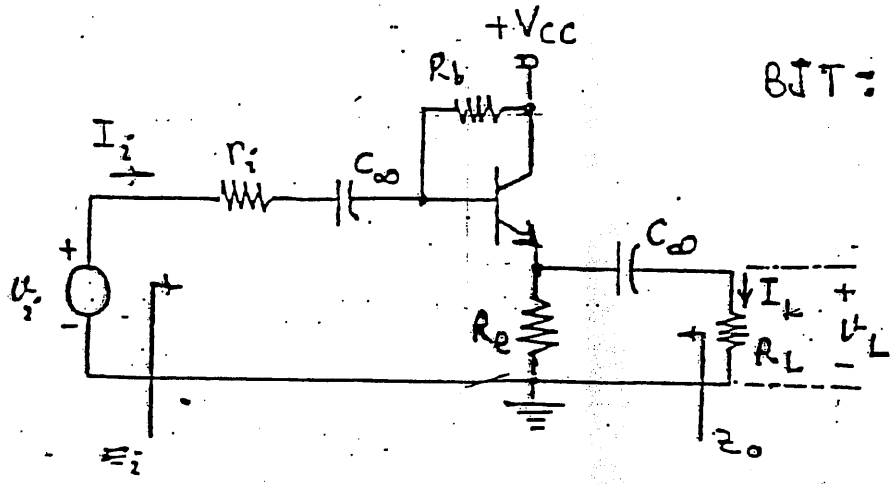




ELEKTRONİK DEVRELER I Birinci ARASINAVI 6.11.2006

1.

40P)



BJT: $I_C = 1{,}3$ mA

$r_\pi = 2$ kΩ

$r_i = 500$ Ω

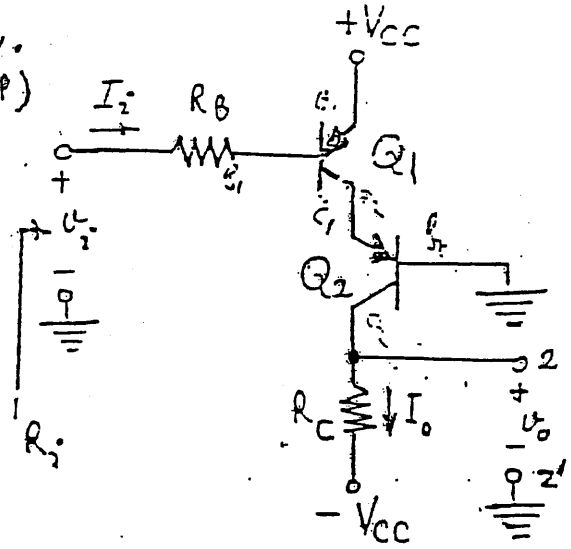
$R_b = 100$ kΩ

$R_e = R_L = 1$ kΩ

Yükselteçin, alçak frekanslarda, küçük genlikli değişimler için gerilim ve akım kazancını, giriş ve çıkış empedansı bulunuz.

2.

20P)



$h_{fe1} = h_{fe2} = 125$

$h_{ie1} = h_{ie2} = 1{,}5$ kΩ

$h_{oe1} = h_{oe2} \cong 0$

$h_{re1} = h_{re2} \cong 0$

$R_B = 80$ kΩ

$R_C = 300$ kΩ

Alçak frekanslarda, küçük genlikli değişimler

a) Akım kazancını,

b) Gerilim "

c) giriş direncini,

d). Çıkıştaki (2-2') açık-devre gerilimini ve kısa-devre akımını bulunuz.

---

3. $R_1 = R_2 = 5$ kΩ, $R_C = 3$ kΩ, $R_G = 500$ MΩ

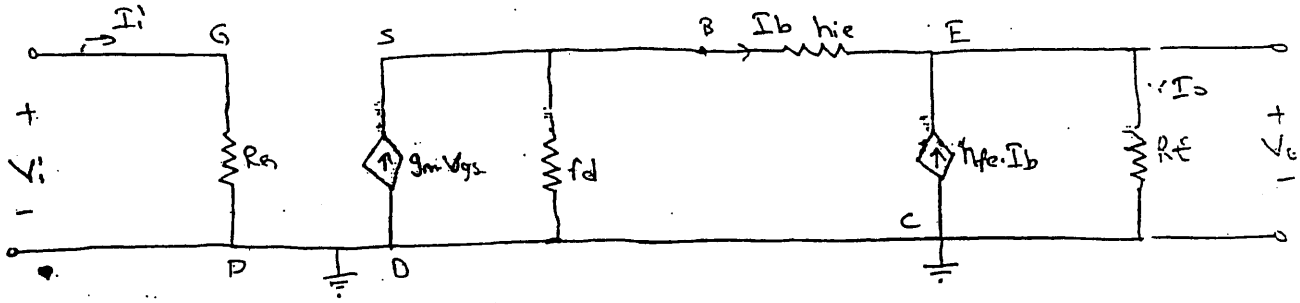
20P): $R_S = 2{,}2$ kΩ, $R = 600$ Ω

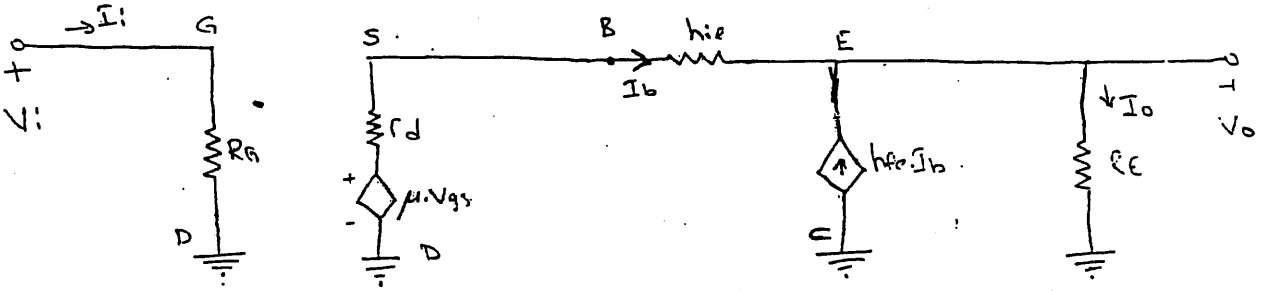
BJT: $h_{ie} = 1$ kΩ, $h_{fe} = 100$, $h_{re} \cong h_{oe} \approx 0$ (ihmal)

JFET: $g_m = 1 \frac{mA}{V}$, $r_d = 40$ kΩ

Alçak frekanslarda, küçük genlikli değişimler için yükselteçin, akım, gerilim kazancını, giriş, çıkış direncini bulunuz. [SORU 3 İÇİN ŞEKİL]

3)





$$V_i = V_{gs} + h_{ie}\cdot I_b + \underbrace{R_E\cdot I_b\cdot(1+h_{fe})}_{V_o}, \quad I_b = \frac{V_o}{R_E\cdot(1+h_{fe})}$$

$$\mu\cdot V_{gs} = (r_d+h_{ie})\cdot I_b + V_o = \frac{(r_d+h_{ie})\cdot V_o}{R_E\cdot(1+h_{fe})} + V_o = V_o\cdot\frac{(r_d+h_{ie})+R_E(1+h_{fe})}{R_E\cdot(1+h_{fe})}$$

$$V_{gs} = \frac{(r_d+h_{ie})+R_E\cdot(1+h_{fe})}{\mu\cdot R_E\cdot(1+h_{fe})}\cdot V_o \qquad \mu = g_m\cdot r_d = 25\cdot 1$$

$$V_i = \left(\frac{(r_d+h_{ie})+R_E(1+h_{fe})}{\mu\cdot R_E(1+h_{fe})} + \frac{h_{ie}}{R_E(1+h_{fe})} + 1\right)\cdot V_o$$

$$A_V = \frac{V_o}{V_i} = \left(\frac{(50+2)+0,5\cdot(61)}{250\cdot 0,5\cdot(61)} + \frac{2}{0,5\cdot(61)} + 1\right)^{-1} \cong \boxed{0,929 \cong -0,639\ dB = A_V}$$

$$\boxed{R_i = R_G = 10M\Omega}$$

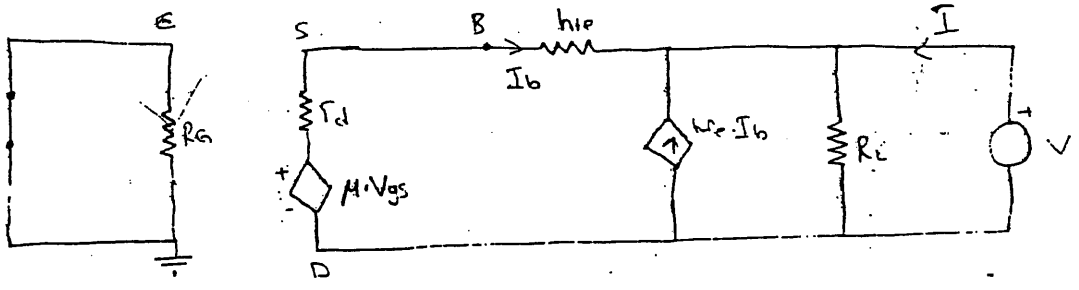
$$A_I = \frac{I_o}{I_i}, \quad I_i = \frac{V_i}{R_i} = \frac{V_i}{R_G}$$

$$I_o = \frac{V_o}{R_E} = \frac{A_V\cdot V_i}{R_E} \Rightarrow A_I = \frac{I_o}{I_i} = \frac{A_V\cdot R_G}{R_E} = 0,929\cdot\frac{10.000}{0,5}$$

$$\boxed{A_I = -18580 \cong 85,38\ dB}$$

$$A_p = A_v \cdot A_I = 0{,}929 \cdot 18580 = \boxed{17\,260{,}8 \approx 42{,}37\ dB}$$

$V_i = 0$ için



$$I = \frac{V}{R_L} - I_b - h_{ie} \cdot I_b = \frac{V}{R_L} - I_b(1 + h_{ie})$$

$$V_{gs} - h_{ie} \cdot I_b + V = 0 \quad , \quad \mu V_{gs} = r_d \cdot I_b - V_{gs}$$

$$V_{gs}(1+\mu) = r_d \cdot I_b \Rightarrow V_{gs} = \frac{r_d \cdot I_b}{(1+\mu)}$$

$$\frac{r_d \cdot I_b}{(1+\mu)} + h_{ie} \cdot I_b + V = 0$$

$$\frac{r_d \cdot I_b + h_{ie}(1+\mu) \cdot I_b}{(1+\mu)} + V = 0$$

$$I_b \cdot \frac{r_d + h_{ie}(1+\mu)}{(1+\mu)} = -V \Rightarrow I_b = \frac{-V \cdot (1+\mu)}{r_d + h_{ie}(1+\mu)}$$

$$I = \frac{V}{R_L} + \frac{V(1+\mu) \cdot (1+h_{ie})}{r_d + h_{ie}(1+\mu)}$$

$$R_o = \frac{V}{I} = \left(\frac{1}{R_E} + \frac{(1+\mu)(1+h_{ie})}{r_d + h_{ie}(1+\mu)} \right)^{-1} = \frac{1}{\cdots} + \frac{\cdots \cdot (\cdots)}{50 + 2 \cdot (\cdots)}$$

$$\boxed{R_o \cong 33{,}63\ \Omega}$$

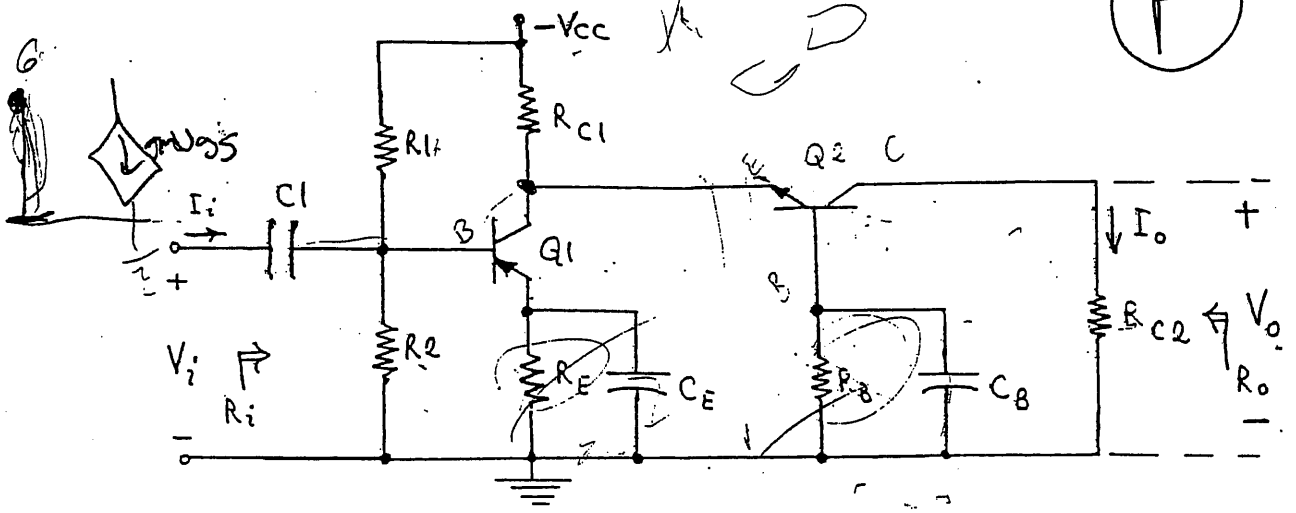
K.T.Ü. Elektrik-Elektronik Müh. Bölümü 05.11.2004

ELEKTRONİK DEVRELER I Birinci ARASINAVI

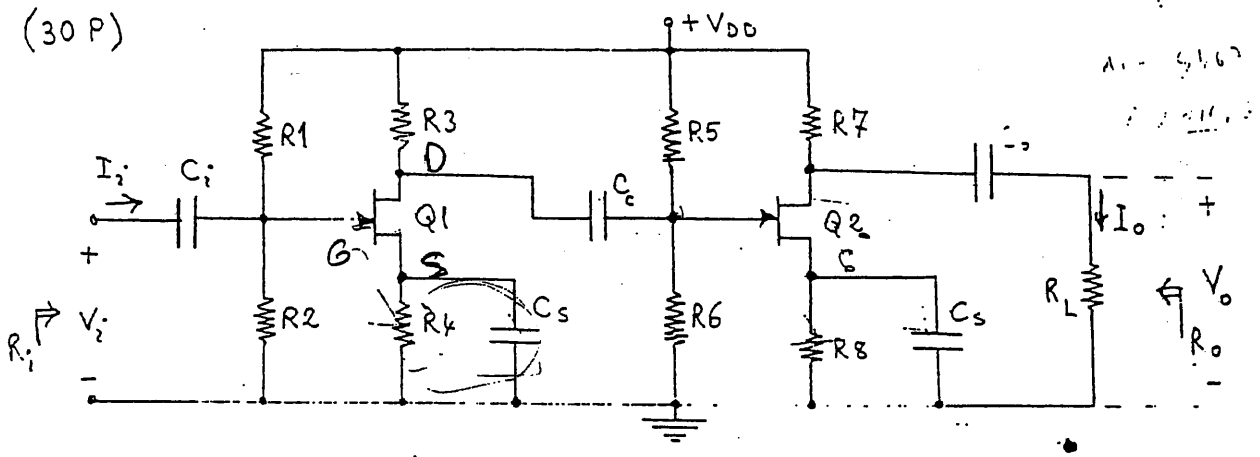
Ders sorumlusu : Öğr. Gör. Türen Demircioğlu

13

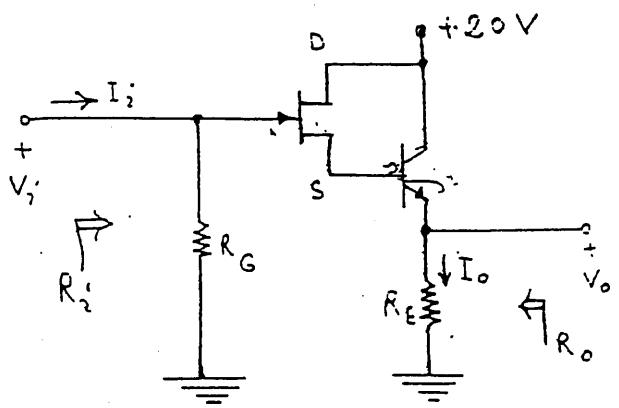
SORU 1. Q1,Q2 : $h_{ie} = 2\,k\Omega$, $h_{fe} = 40$, $h_{re} \approx h_{oe} \approx 0$, R1=15 kohm, R2 = 3 kohm
(30 P) $R_{C1} = 5$ kohm, $R_E = 470$ ohm, $R_B = 100$ kohm, $R_{C2} = 2.5$ kohm
Bütün kapasiteler yeterli büyüklükte seçilmiştir.



SORU 2. Fetler özdeştir. $g_m = 1000\,\mu$ mho, $r_d \approx \infty$, R1 = R2 =50 kohm,
R3 = 5 kohm R4 = R8 = 1 kohm, R5 = R6 = 20 kohm, R7 = R_L = 10 kohm
(30 P)

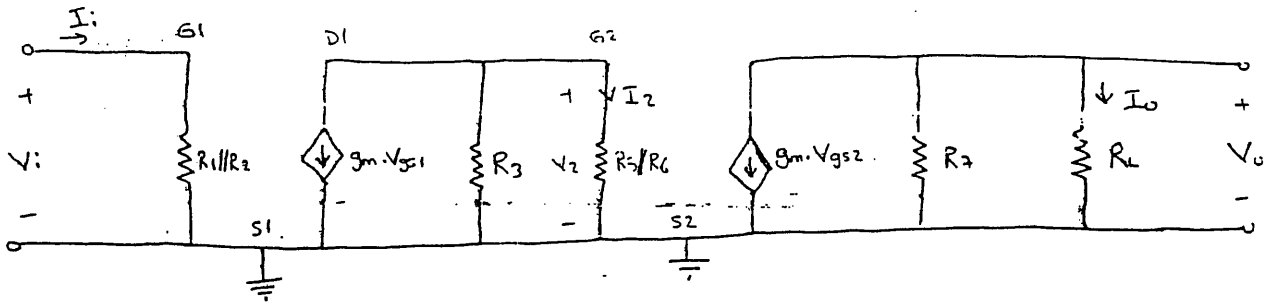


SORU 3. JFET : $g_m = 5\,\frac{mA}{V}$, $r_d = 50\,k\Omega$, BJT : $h_{ie} = 2\,k\Omega$, $h_{fe} = 60$, $h_{re} \approx h_{oe} \approx 0$
(40 P) $R_G = 10\,M\Omega$, $R_E = 500\Omega$



Yükselteçlerin, alçak frekanslarda küçük genlikli işaretler için a) Gerilim kazancını (dB)
b) Giriş direncini, c)Akım kazancını (dB) ve güç kazancını, d) Çıkış direncini bulunuz.

2)



$V_i = V_{gs1}$

$g_m . V_i \cdot (R_3 // R_5 // R_6) = V_2$

$V_o = g_m . V_{gs2} \cdot (R_7 // R_L) = g_m . V_2 . (R_7 // R_L)$

$V_o = g_m \cdot [g_m . V_i (R_3 // R_5 // R_6)] \cdot (R_7 // R_L)$

$A_V = \frac{V_o}{V_i} = g_m^2 \cdot (R_3 // R_5 // R_6) \cdot (R_7 // R_L) = 10^{-6} \cdot (5k // 20k // 20k) \cdot (10k // 10k)$

$\boxed{A_V \cong 16,67 \cong 24,44\ dB}$

$R_i = \frac{V_i}{I_i} = R_1 // R_2 = 50k // 50k = \boxed{25k\ \Omega = R_i}$

$I_o = \frac{V_o}{R_L} = g_m^2 . V_i \cdot (R_3 // R_5 // R_6) \cdot \frac{R_7}{R_7 + R_L}$

$I_i = \frac{V_i}{R_i} = \frac{V_i}{(R_1 // R_2)}$

$A_I = \frac{I_o}{I_i} = \frac{g_m^2 . V_i (R_3 // R_5 // R_6)(R_7 // R_L) \cdot (R_1 // R_2)}{V_i . R_L} = A_V \cdot \frac{R_i}{R_L}$

$A_I = 16,67 \cdot \frac{25}{10} \cong \boxed{41,68 \approx 32,4\ dB = A_I}$

$R_o = R_7 // R_L = 10k // \infty = \boxed{10k\ \Omega}$

$A_P = A_V \cdot A_I = (16,67) \cdot (41,68) = \boxed{694,8 \cong 28,42\ dB = A_P}$

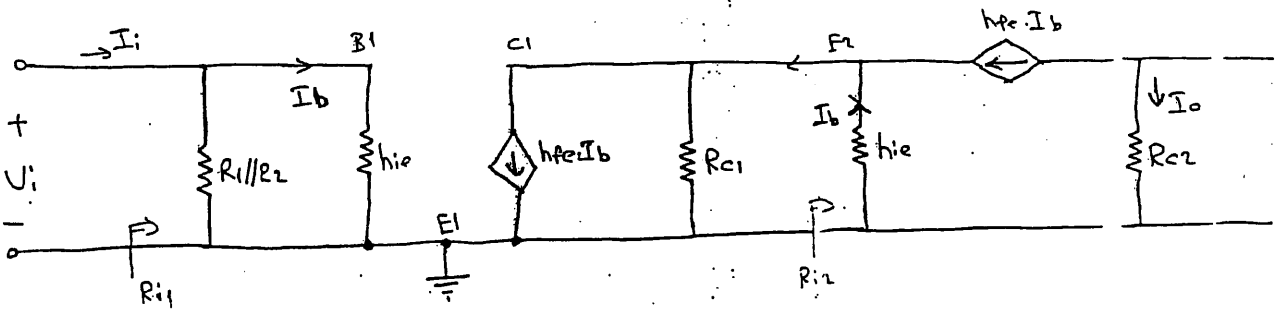
ELEKTRONİK DEVRELER-1

1. A.S.

- Çözümleri -

F

1)



$A_V = \frac{V_o}{V_i} = \frac{-h_{fe} \cdot I_b \cdot R_{c2}}{-h_{ie} \cdot I_b} \cdot \frac{-h_{fe} \cdot I_b (R_{c1} // R_{i2})}{h_{ie}}$, $R_{c1} // R_{i2} = 5k\Omega // 0,0483k\Omega$

$= 0,0483 k\Omega$

$R_{i2} = \frac{h_{ie}}{1+h_{fe}} = \frac{2}{41} = 0,0488 k\Omega$

$A_V = \frac{-40 \cdot (2,5)}{2} \cdot \frac{40 (0,0483)}{2} = \boxed{-48,3 = A_V}$

$R_i = R_1 // R_2 // h_{ie} = 15 // 3 // 2 = \boxed{1,11 k\Omega = R_i}$

$R_o = R_{c2} = \boxed{2,5 k\Omega}$

$A_I = A_V \cdot \frac{R_i}{R_o} = -48,3 \cdot \frac{1,11}{2,5} = \boxed{-21,46 = A_I}$

$A_P = A_V \cdot A_I = (-48,3) \cdot (-21,46) = \boxed{1036,5 \approx 30,16 \text{ dB} = A_P}$