İTÜ
ELEKTRİK - ELEKTRONİK FAKÜLTESİ

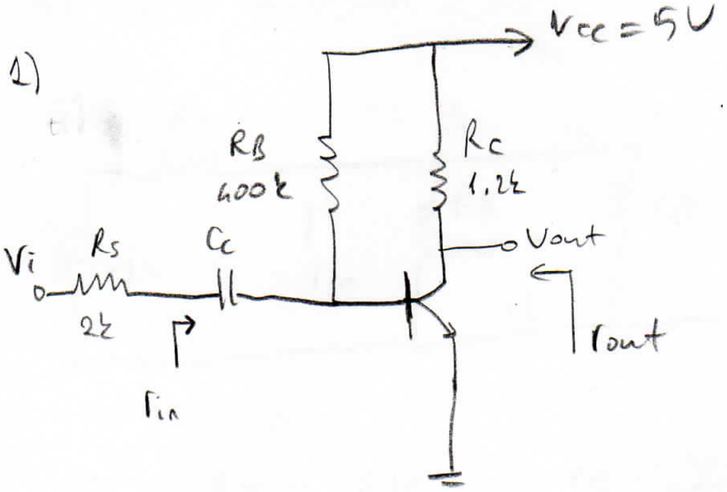
Soru	1	2	3	4	5	6	7	8	Toplam
Not									

Tarih : ..../..../....
Bölüm :
Ders :
No :
Adı Soyadı :
İmzası :

(1)

HW-3

1)



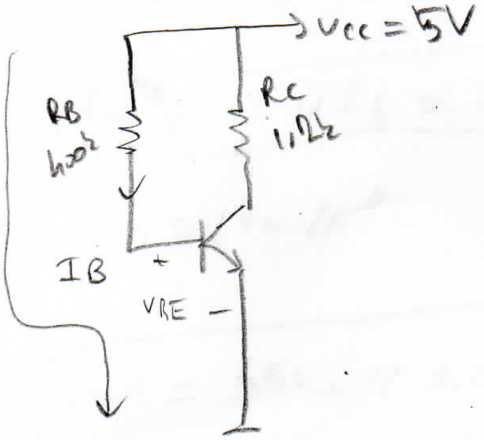
$\beta = 200$

$V_{BE} = 0,7$

$V_T = 0,025V$

$V_A = 100V$

a) DC Analysis



loop equation in the direction of arrow;

$V_{CC} - I_B \cdot R_B - V_{BE} = 0$

$5 - I_B \cdot 400k - 0,7V = 0 \Rightarrow I_B = \frac{4,3V}{400k} \cong 0,011mA$

$\boxed{V_B = 0,7} \Rightarrow V_B - V_E = V_{BE}$ ($V_E = 0$)

$I_C = \beta \cdot I_B = 200 \cdot 0,011mA = 2,2mA$

$V_C = V_{CC} - R_C \cdot I_C = 5 - 1,2k \cdot 2,2mA = 2,36V$

$\boxed{V_C = 2,36V}$

(10)

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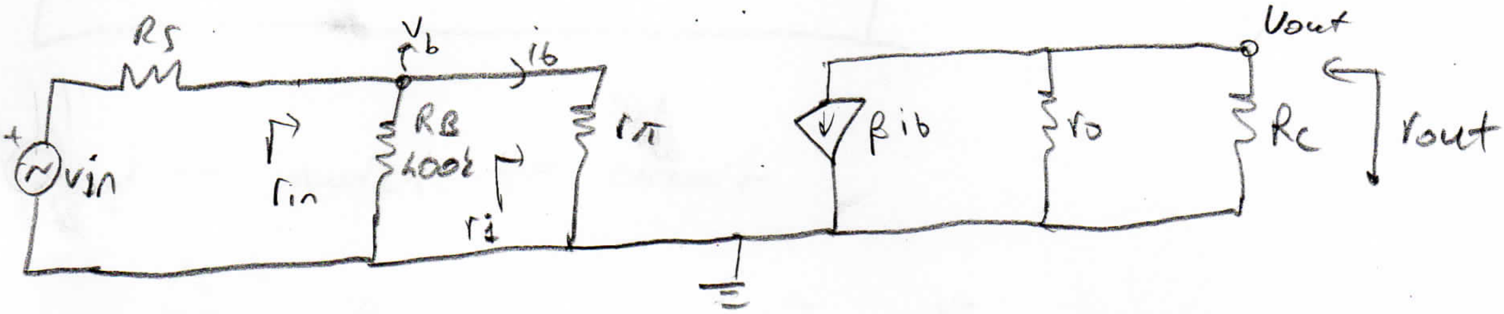
b) AC analysis



$r_i = r_\pi = \beta r_e$, $r_e = \frac{V_T}{I_c} = \frac{25mV}{2,2mA} = 11,4\,\Omega$

$r_i = \beta \cdot r_e = 2,3\,k\Omega$

$r_{in} = r_i \,//\, R_B \cong 2,2k\Omega$

$r_{out} = r_o \,//\, R_C \Rightarrow r_o = \frac{V_A}{I_c} = \frac{100V}{2.2mA} \simeq 45\,k\Omega$

$r_{out} = 45k\Omega \,//\, 1,2k\Omega = 1,17k\Omega$

$\frac{V_{out}}{V_{in}} = \frac{V_b}{V_{in}} \cdot \frac{V_{out}}{V_b}$

$\frac{V_{out}}{V_b} = -g_m(R_C \,//\, r_o) \rightarrow g_m = 1/r_e \Rightarrow A_o = \frac{V_{out}}{V_b} = -\frac{1,17k\Omega}{11,4\Omega} = -102,6$

$\frac{V_b}{V_{in}} = \frac{r_{in}}{r_{in}+R_S} = \frac{2,2k}{2,2k+2k} = 0,52$

İTÜ

ELEKTRİK - ELEKTRONİK FAKÜLTESİ

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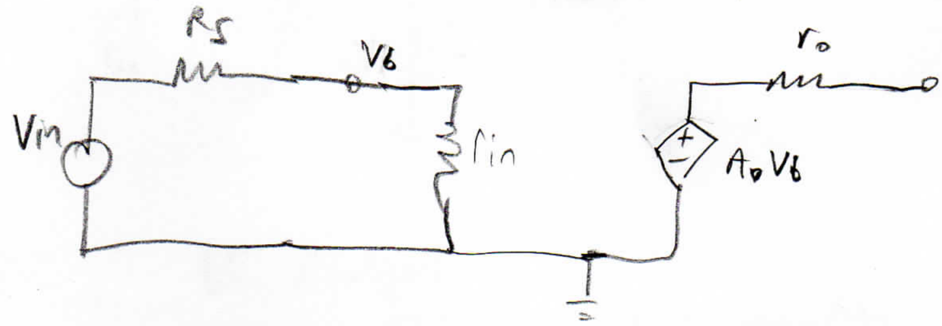
Ders :
No :
Adı Soyadı :
İmzası :

(3)

$$\frac{V_{out}}{V_{in}} = -102,6 \times 0,52 = -53,7$$

c) linear model for circuit



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A_o is the gain of transistor ($\frac{V_{out}}{V_b}$ in (b))

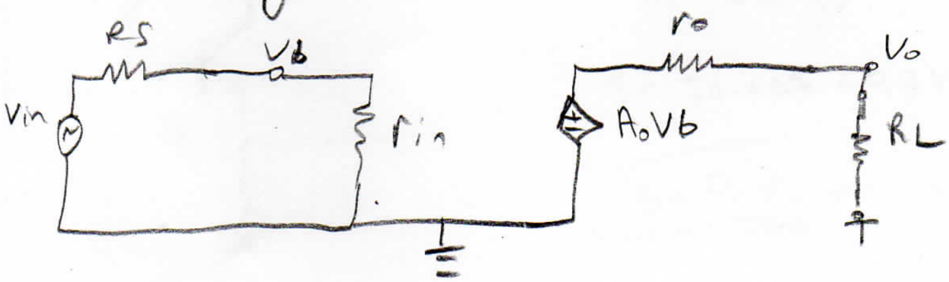
$A_o = -102,6$

$r_{in} = 2,2k\Omega$

$r_o = 1,17k\Omega$

$R_S = 2k\Omega$

d) According to linear model



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$$\frac{V_o}{V_{in}} = \frac{V_b}{V_{in}} \times \frac{V_o}{V_b} = \frac{r_{in}}{r_{in}+R_S} \times A_o \cdot \frac{R_L}{R_L+r_o} = G_{RL}$$

Gain without R_L, $G_o = \frac{V_o}{V_{in}} = \frac{r_{in}}{r_{in}+R_S} \times A_o$ (assumming open circuit).

$$G_{RL} \geq 0,9\, G_o \Rightarrow \frac{R_L}{R_L+r_o} \geq 0,9 \Rightarrow R_L \geq 0,9(R_L+r_o)$$

$$0,1 R_L \geq 0,9\, r_o$$

$$\boxed{R_L \geq 9 r_o}$$