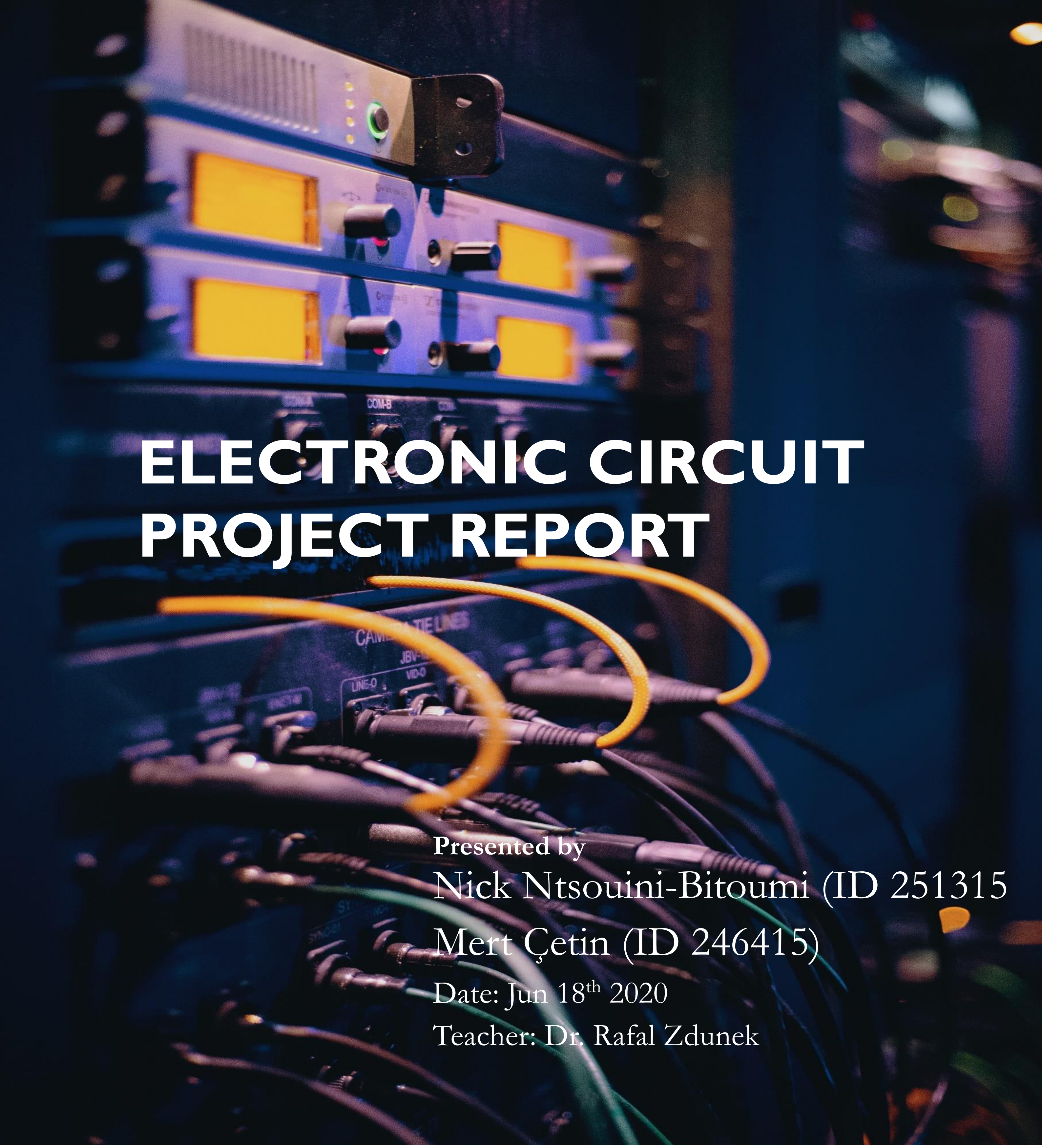

ELECTRONIC CIRCUIT PROJECT REPORT

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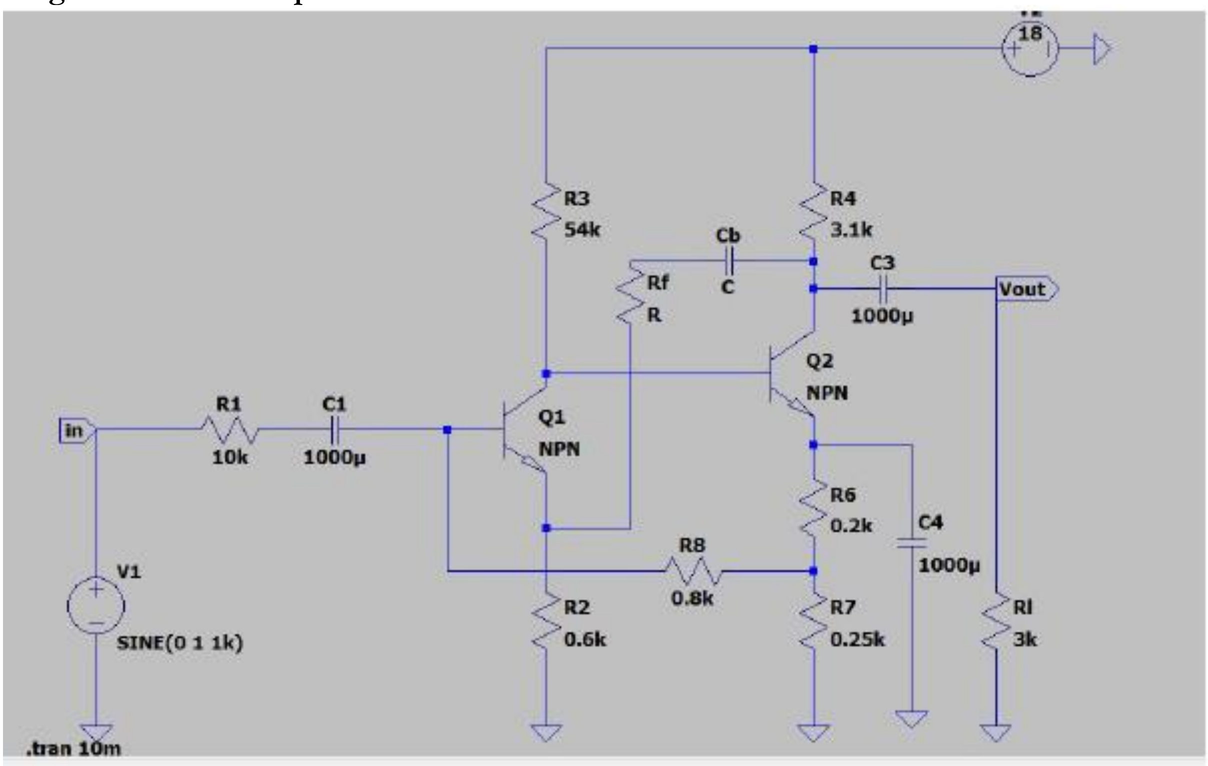
INRODUCTION

An electronic circuit is a closed loop composed of individual electronic components, such as resistors, transistors, capacitors, inductors and diodes, connected by conductive wires or traces through which electric current can flow. During the 4th semester of our engineering formation we have viewed how different component of an electronic circuit work together and more importantly we have learnt how to analyzed them.

In this project report we are presenting our analysis of an electronic circuit (Project n2).

Original scheme and parameters



RL= 3kΩ

Rg= 10 kΩ

U out max= 5V

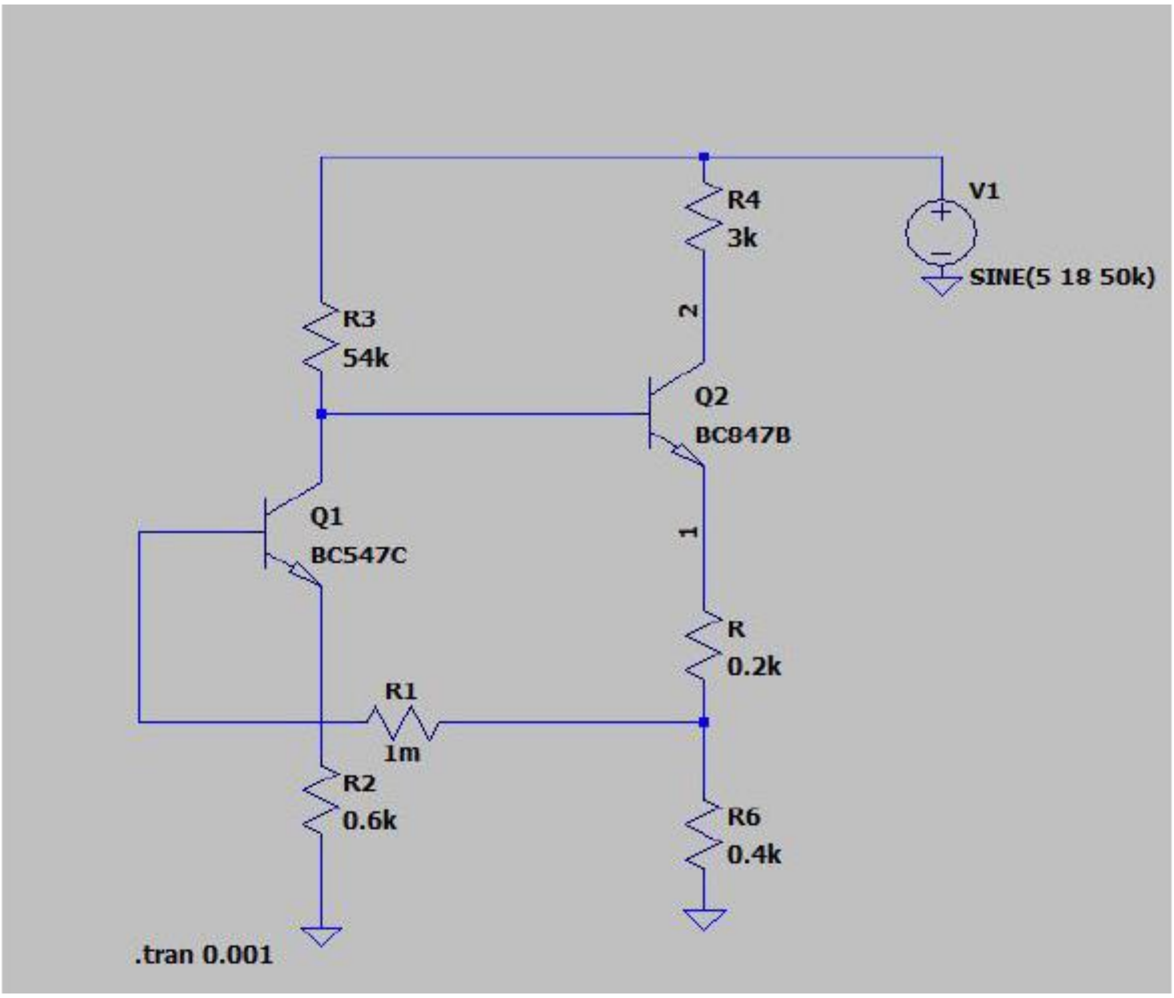
Effective gain= 40dB

Lowpass frequency=40Hz

Hi Pass= 100hz

DC ANALYSIS

DC equivalent circuit



Assumptions:

Assumption U out max (+) = U out max (-) =U out max =5 V

C1=C2=CE=Cb=∞

U CEQ1(SAT) = U CEQ2(SAT) =1 V

$I_{CQ2} = I_{EQ2}$, $I_{CQ1} = I_{EQ1}$

$U_{BEQ1} = 0.6$ V

$R_{C2} = 3$ kΩ

Voltage Calculations:

$V_{CEQ} = V_{OUT} + V_{CESAT} = 5V + 1V = 6V$

$V_{CC} = V_{RE} + V_{CEQ} + V_{RC2}$

$V_{CEQ} = 6V$

$V_{RC2} = I_{RC2} \times R_{C2}$ |

we assumed RC2 = 3.1kΩ and we know IRC2 =3.33mA

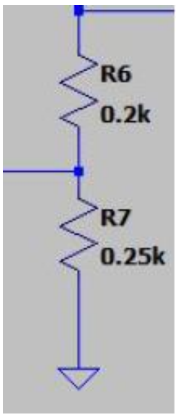
$V_{RC2} = 3.1k\Omega \times 3.33\ mA \approx 10.5V$

$V_{CC} = V_{RE} + 6V + 10.5V$

We know that $V_{RE} = \{10\text{-}20\}\% \times V_{CC}$ and $V_{cc} = \{6 , 9 , 12 , 15 , 18 ..\}$

$V_{cc} = 18V$ so $V_{RE} = 1.5V$

When we look that part of circuit clearly, we can see Voltage divider



$VB = V_{E2} \times V_{RE22} / (V_{RE22} + V_{RE21})$

$V_B = 2V \times (0.2k\Omega/0.25k\Omega) = 0.8V$

According to given hints:

$V_{RE21} = V_{RE1} + V_{BEQ1} + V_{RB}$

After voltage divider we know that $V_{RE21} = 1.4V$

$1.4V = 0.6V + 0.6V + V_{RE1}$

$V_{RE1} = 0.2V$

Current Calculations:

$I_{CQ2} = V_{OUT} / (R_{C2} // R_L) = 5V/1{,}5k\Omega = 3{,}3$ mA

We assuming that collector current equal to emitter current:

$I_{CQ2} = I_{EQ1} = 3.3mA$

Since we have transistor with 200 beta value:

$I_{BQ2} = I_{CQ2} / 200 = 0.016mA$

And also, we know that $I_{CQ1} = I_{CQ2} / (2\text{-}10)$

$I_{CQ1} = I_{CQ2} / 10 = 3.33/10 = 0.3$ mA

$I_{CQ1} = I_{EQ1} = 0.3mA$

So base current of First transistor (Beta value = 200) is:

$I_{BQ1} = I_{CQ1} / 200 = 0.00165mA$
Resistor Calculations :
We assumed $R_{C2} = 3.1k\Omega$ (Because control the voltage on emitter branch)
At the second emitter branch we ignored the transistors 1's base current branch and we said $R_{E2} = 0.6k\Omega$

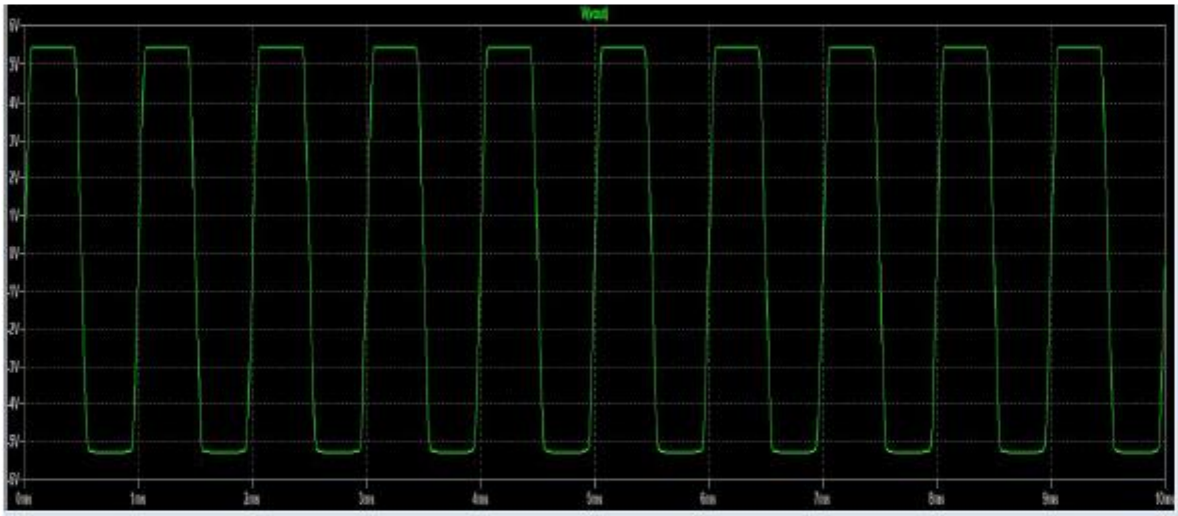
Now depends on proper voltage division divided values like:
$R_{E21} = 0.4k\Omega$

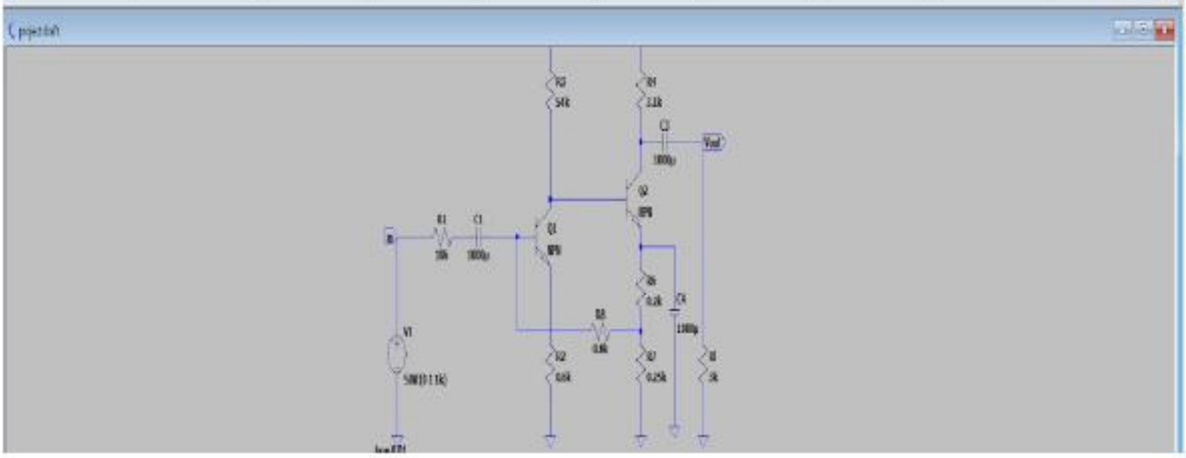
And

$R_{E22} = 0.2k\Omega$

$R_{E1} = V_{RE1} / I_{EQ1} = 0.2V / 0.3mA = 0.6k\Omega$
$R_{C1} = V_{CC} / I_{CQ1} = 18V / 0.33mA = 54k\Omega$

Transient Analysis:





Operational Point Analysis:

```
       --- Operating Point ---

V(in):          0               voltage
V(n005):        0.892101        voltage
V(n004):        8.92101e-12     voltage
V(n003):        2.41689         voltage
V(n008):        0.153403        voltage
V(vout):        2.10445e-11     voltage
V(n002):        7.01484         voltage
V(n006):        1.60993         voltage
V(n001):        18              voltage
V(n007):        0.894126        voltage
Ic(Q2):         0.0035436       device_current
Ib(Q2):         3.5436e-05      device_current
Ie(Q2):         -0.00357903     device_current
Ic(Q1):         0.00025314      device_current
Ib(Q1):         2.5314e-06      device_current
Ie(Q1):         -0.000255672    device_current
I(C4):          1.60993e-15     device_current
I(C3):          -7.01484e-15    device_current
I(C1):          8.92101e-16     device_current
I(R8):          2.5314e-06      device_current
I(R7):          0.0035765       device_current
I(R6):          0.00357903      device_current
I(Rl):          7.01484e-15     device_current
I(R4):          0.0035436       device_current
I(R3):          0.000288576     device_current
I(R2):          0.000255672     device_current
I(R1):          8.92101e-16     device_current
I(V2):          -0.00383217     device_current
I(V1):          8.92101e-16     device_current
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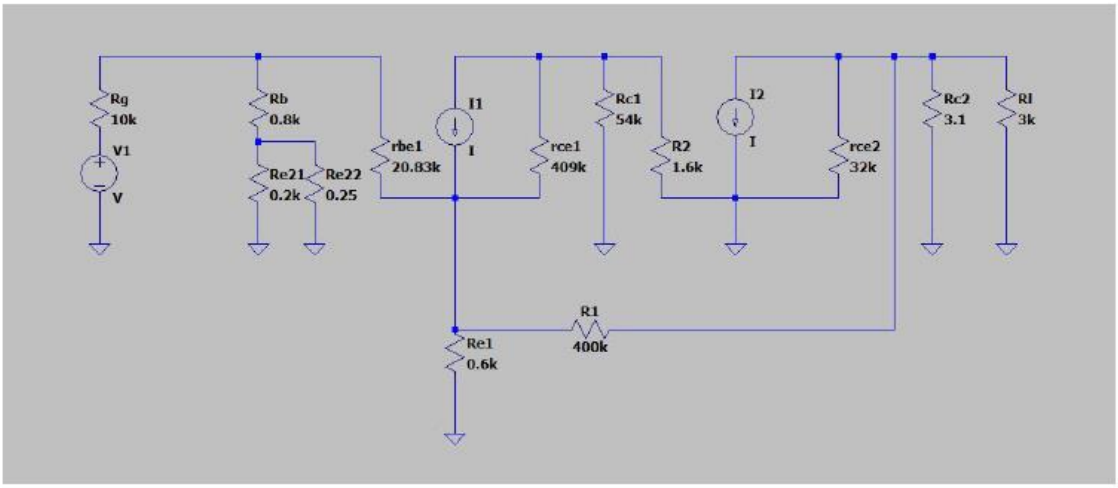
AC ANALYSIS

EQUIVALENT CIRCUIT FOR AC HYBRID-PI MODEL:



ADMITANCE MATRIX

	1	2	3	4
1	$\frac{1}{RB+RE21}+\mathrm{BCQ1}$	0	BCQ1	BEQ1
2	0	$\frac{1}{Rc2}+\frac{1}{Rf}+CCQ2$ (Q2)	BCQ1	-1/Rf
3	CBQ1	BCQ2	$\frac{1}{Rc1}+\mathrm{BCQ1}+\mathrm{CCQ1}$	CEQ1
4	EBQ1	-1/Rf	ECQ1	$CEQ1+\frac{1}{RC}+1/\mathrm{RF}$

Hybrid - pi parameters:

gm2 = ICQ2 / aT (aT value is equal to 26mV at room temperature)

gm2 = 3,3mA / 26mV = 0.12

rbe2 = β / gm

rbe2= 200 / 0.12 = 1,6 kΩ

rce2 = (Va + VCEQ2)/ ICQ2

Va = Early voltage which is 100V for our transistor

rce2 = (100 + 6) / 3.3mA = 32kΩ

gm1 = 0.3mA / 26mV = 0.013

rbe1= 200 / 0.012 = 16,66 kΩ

rce1 = (100 + 2,5) / 0.3mA = 310kΩ

Calculations for Ku **O**

Ku **O** = Ku **O2** * Ku **O1**

Ku **O1** = -gm * R **O** * (Rbe / (Rbe+(201)*R1))

R **O** = Rce(1)//Rc1//Rbe(2)

R **O** = 310kΩ//54kΩ//310kΩ

R **O** = 1548Ω

R1 = Re1 // Rf

R1 = 0.6kΩ // 400kΩ

R1 = 0.6kΩ

Ku **O1** = -0.12*1548*0.14 = - 26.00

Ku **O2** = -gm * R **O2**

R **O2** = Rce(2) // Rc2 // R2 // Rl

R2 = Re1 + Rf

R2 = 400.6 kΩ

R **O2** = 32kΩ // 3.1kΩ // 400.6 kΩ // 3kΩ

R **O2** = 1549 kΩ

Ku **O2** = -0.013 * 1549kΩ

Ku **O2** = 20.137

Small Signal Parameters :

Ku **O** = Ku **O2** * Ku **O1**

Ku **O** = -20.137 * -26.00

Ku **O** = 523.56

We have to apply Miller's theorem and consider Rm resistors. We know that we are eliminating Rm resistor at output of circuit so we only have Rm resistor Series to rbe1 and parallel to Rb, Re21 and Re22 with value of (1+β) RE1. After Miller's theorem our circuit will looking like that:

According that information we can perform calculations:

Rin o = Rbe(1) + (201) * R1

Rin o = 140.6 kΩ

Rout o = rce(2) // Rc2 // R2

Rout o = 2724 Ω

Rinf = Rin o * F

F = 1 +Re1/(Re1+Rf) * Ku o

F = 216kΩ

Rinf = 216kΩ * 120kΩ

Rinf = 45 MΩ

Rin = (Rb+(Re21//Re22)) // Rinf
Rin = 0.9 kΩ

φu = Rin o //(Rb+(Re21//Re22)) / Rin o

//(Rb+(Re21//Re22)) + Rg

φu = 0.08 kΩ

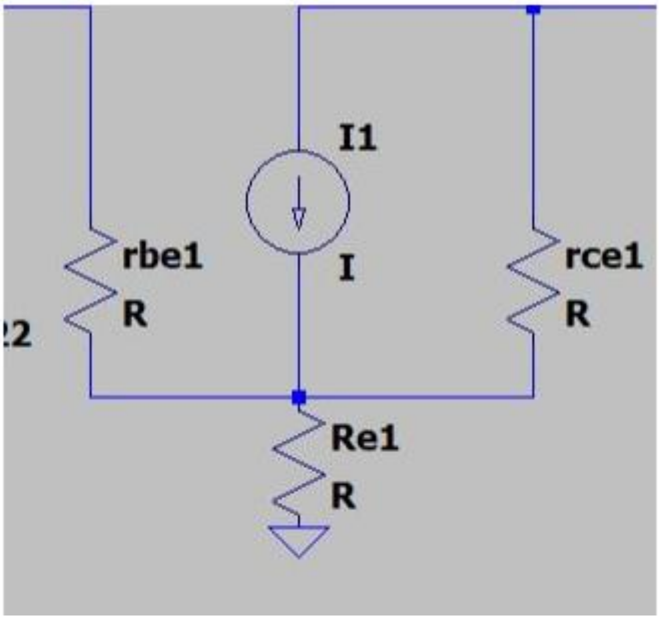
Kuef o = φu * Ku **O * (** Rout o + Rl)/Rl

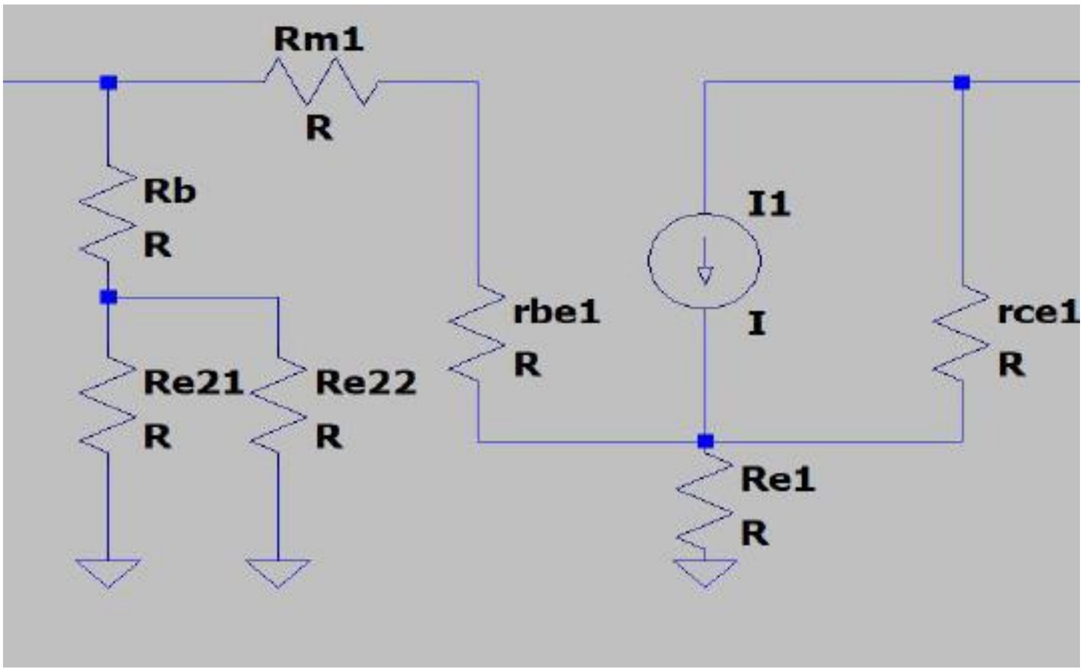
Kuef o = 0.08 * 523.56 * 1.9

Kuef o = 89.68 [V/V]

<u>Kuef o = 39.08 dB</u>

resistor at that point:





Special words to our professor.

Dear Dr. Rafał Zdunek, we would like to thank you for your time and sincere effort throughout this semester that has been particularly challenging for all of us. We would like hereby to express our gratitude for your engagement and support.

Cordially,
Nick Ntsouini-Bitoumi and Mert Çetin.