Escola do Mar, Ciências e Tecnologias

Curso: Engenharia de Computação

Disciplina: Eletrônica Básica

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Acadêmico: Stephen Michael Apolinário

Objetivo

- Analisar os diferentes tipos de análises AC e DC.
- Realizar as simulações dos circuitos apresentados em aula.
- Observar as características de cada circuito.

Introdução

Existem diferentes tipos de circuitos com divisores de tensão, e cada um possui um funcionamento diferenciado. Neste relatório abordará os tipos de circuitos utilizados nos exercícios propostos em aula da disciplina de eletrônica básica, analisando as característica de cada circuito proposto.

Desenvolvimento

Análise AC emissor comum e polarização fixa

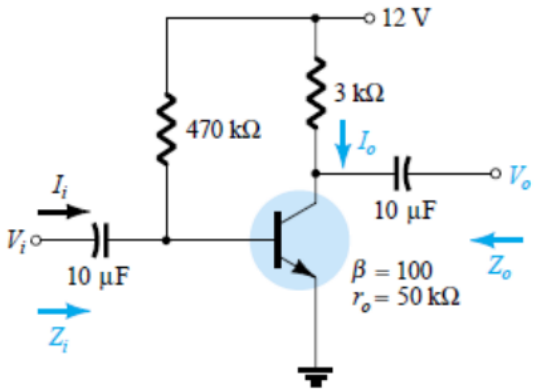
Análise AC – Emissor Comum

Exercício - polarização fixa.

Determine:

a) IB, IC, IE, VB, VE, VC, VCE

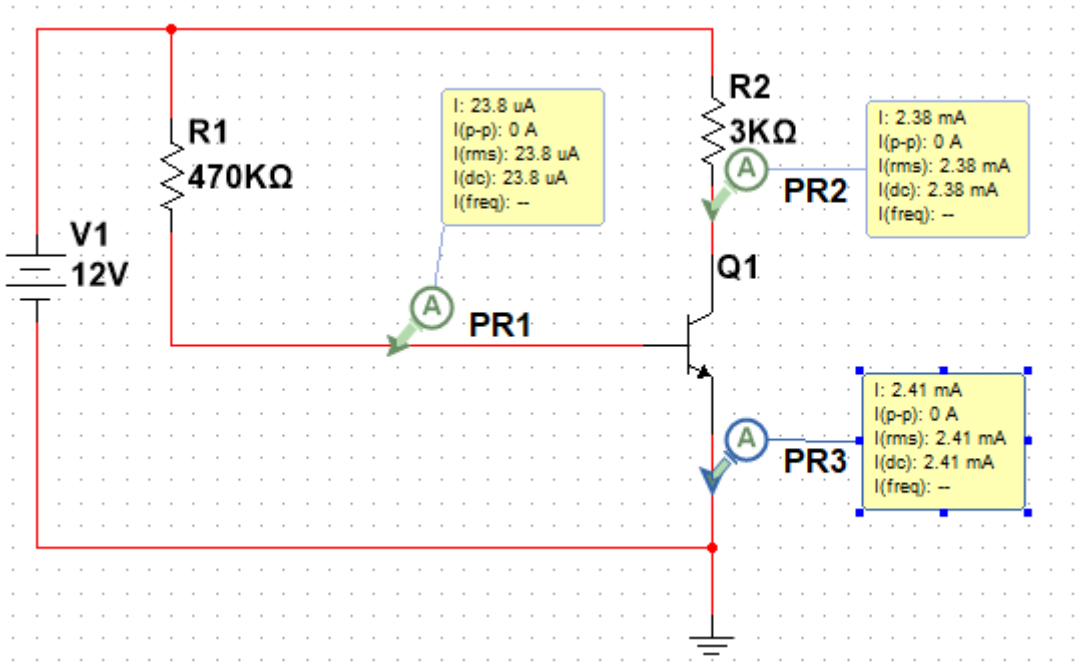
b) Zi, Zo, AV



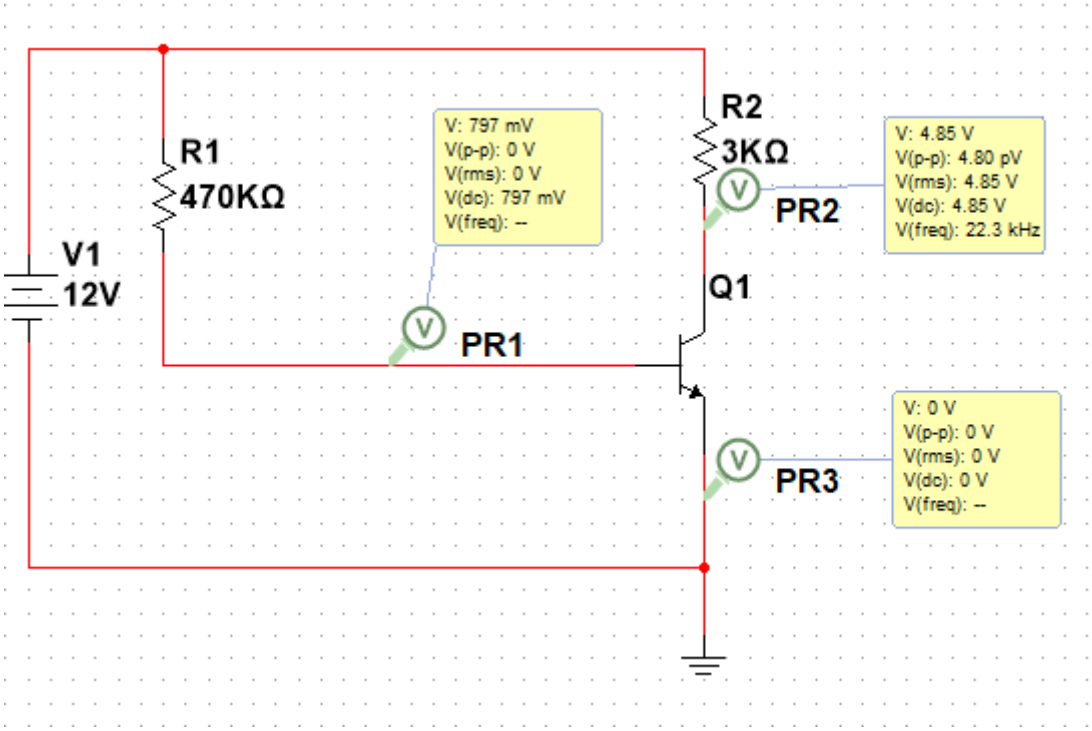
$A)$
$\boldsymbol{Ib} = (Vcc - Vbe) / Rb = (12\,V - 0{,}7\,V) / 470k = 11{,}3\,V / 470k = \mathbf{24{,}04\ uA}$
$\boldsymbol{Ie} = Ic = (\beta + 1) * Ib = (100 + 1) * 24{,}04\,uA = \mathbf{2{,}428\ mA}$
$\boldsymbol{Vb} = 0{,}7\,V\ e\ Ve = 0\,V$
$\boldsymbol{Vc} = Vcc - (Ic * Rc) = 12\,V - (2{,}428\,mA * 3k) = \mathbf{4{,}71\ V}$
$\boldsymbol{Vce} = Vc - Ve = 4{,}71\,V - 0\,V = \mathbf{4{,}71\ V}$
$\boldsymbol{re} = 26mV / Ie = 26mV / 2{,}428mA = \mathbf{10{,}71\ Ohms}$

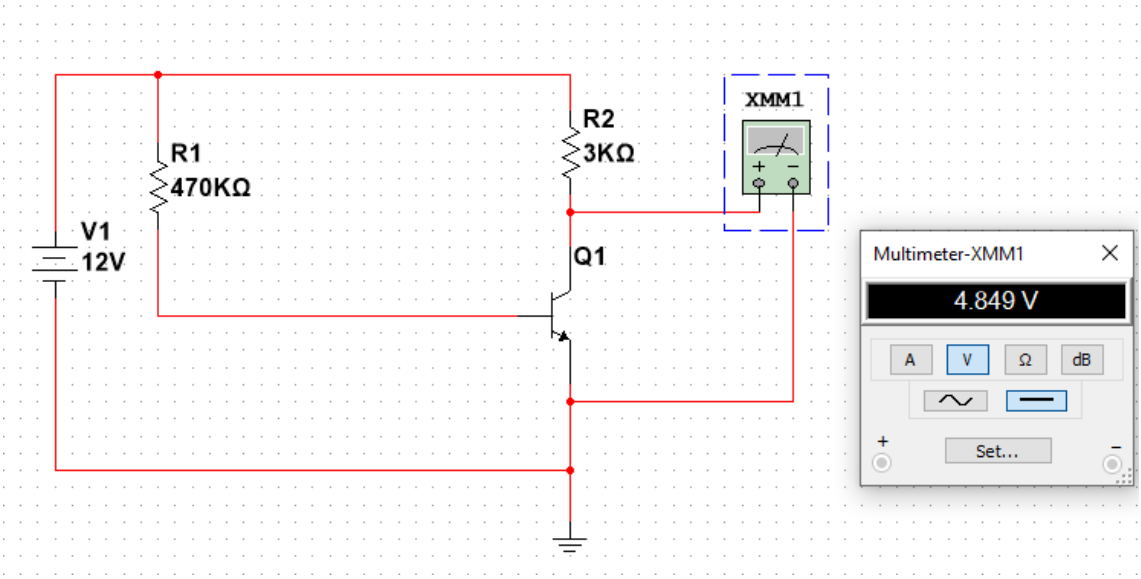
$B)$
$\boldsymbol{Zi} = Rb // \beta * re = 470k\ //\ (100 * 10{,}71) = 470k\ //\ 1071k = \mathbf{1068\ k\ Ohms}$
$\boldsymbol{Zo} = Rc = \mathbf{3k\ Ohms}$
$\boldsymbol{Av} = -(Rc/re) = -(3k/10{,}71) = \mathbf{-280{,}112}$

Simulação Ib, Ic e Ie:

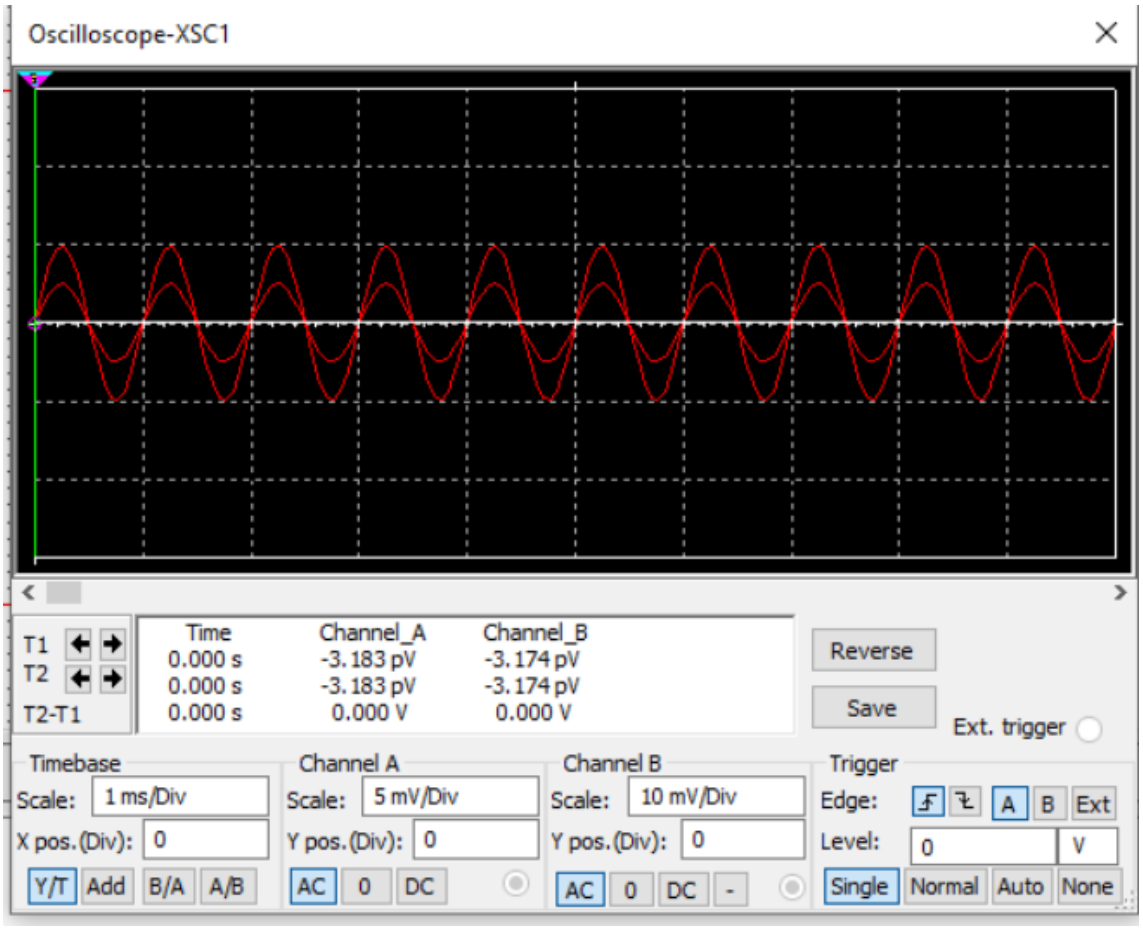


Simulação Vc, Ve, Vb e Vce:





VARIÁVEIS	CALCULADO	SIMULADO
Ic	2,428 mA	2,38 mA
Ie	2,428 mA	2,41 mA
Ib	24,04 uA	23,8 uA
Vc	4,71 V	4,85 V
Vb	0,7 V	0,797 V
Ve	0 V	0 V
Vce	4,71 V	4,849 V


Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
-3.183 pV
-3.183 pV
0.000 V
Channel_B
-3.174 pV
-3.174 pV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 1 ms/Div
X pos.(Div): 0
Y/T
Add
B/A
A/B
Channel A
Scale: 5 mV/Div
Y pos.(Div): 0
AC
0
DC
Channel B
Scale: 10 mV/Div
Y pos.(Div): 0
AC
0
DC
-
Trigger
Edge:
A
B
Ext
Level: 0 V
Single
Normal
Auto
None

Análise AC emissor comum e divisor de tensão

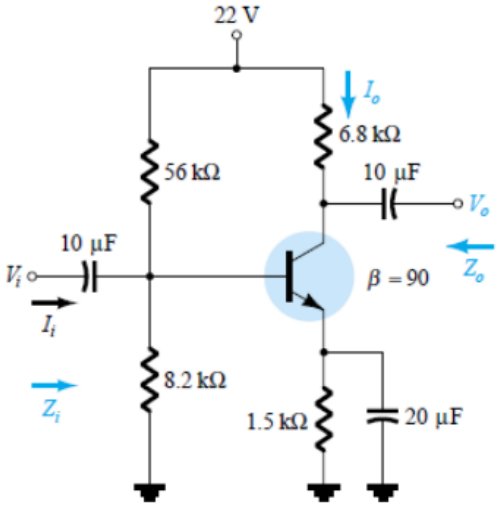
Análise AC – Emissor Comum

Exercício – Divisor de tensão.

Determine:

a) IC, IE, VB, VE, VC, VCE

b) Zi, Zo, AV



β * Re > 10R2 → 90 * 1,5k > 10 * 8,2k → 135k > 82k (condição atendida)

A)

$\boldsymbol{Vb} = (R2/R1 + R2) * Vcc = (8{,}2k/56k + 8{,}2k) * 22 = \mathbf{2{,}81\ V}$

$\boldsymbol{Ve} = Vb - Vbe = 2{,}81\ V - 0{,}7\ V = \mathbf{2{,}11\ V}$

$\boldsymbol{Ic} = Ie = Ve\ /\ Re = 2{,}11\ V\ /\ 1{,}5k = \mathbf{1{,}41\ mA}$

$\boldsymbol{Vc} = Vcc - (Ic * Rc) = 22 - (1{,}4\ mA * 6{,}8k) = \mathbf{12{,}48\ V}$

$\boldsymbol{Vce} = Vc - Ve = 12{,}48\ V - 2{,}11\ V = \mathbf{10{,}37\ V}$

$\boldsymbol{re} = 26\ mV\ /\ 1{,}41\ mA = \mathbf{18{,}44\ Ohms}$

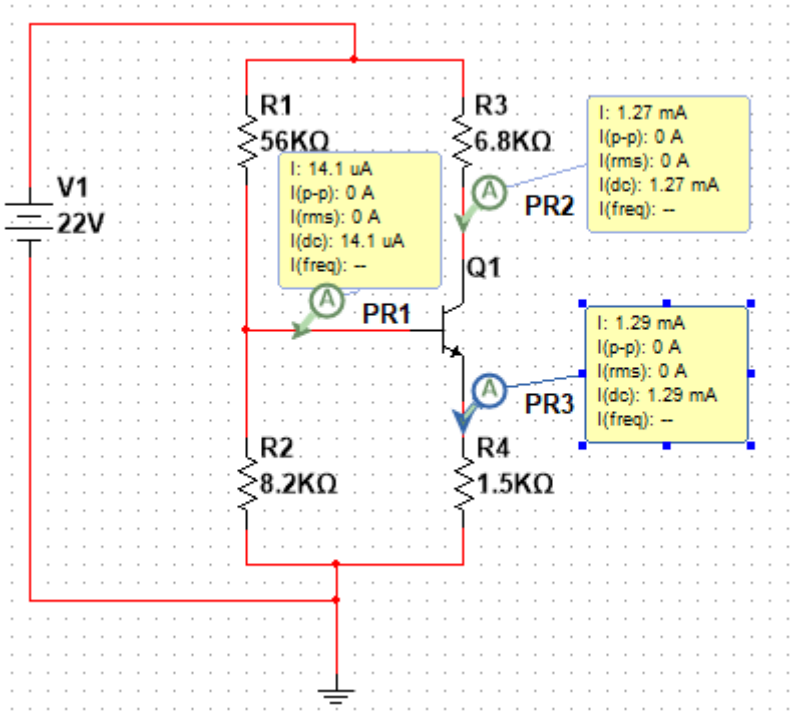
B)

$\boldsymbol{Zi} = (R1//R2)\ //\ \beta * re = 7{,}15k\ //\ (90 * 18{,}44) = 7{,}15k\ //\ 1{,}66k = \mathbf{1{,}35k\ Ohms}$

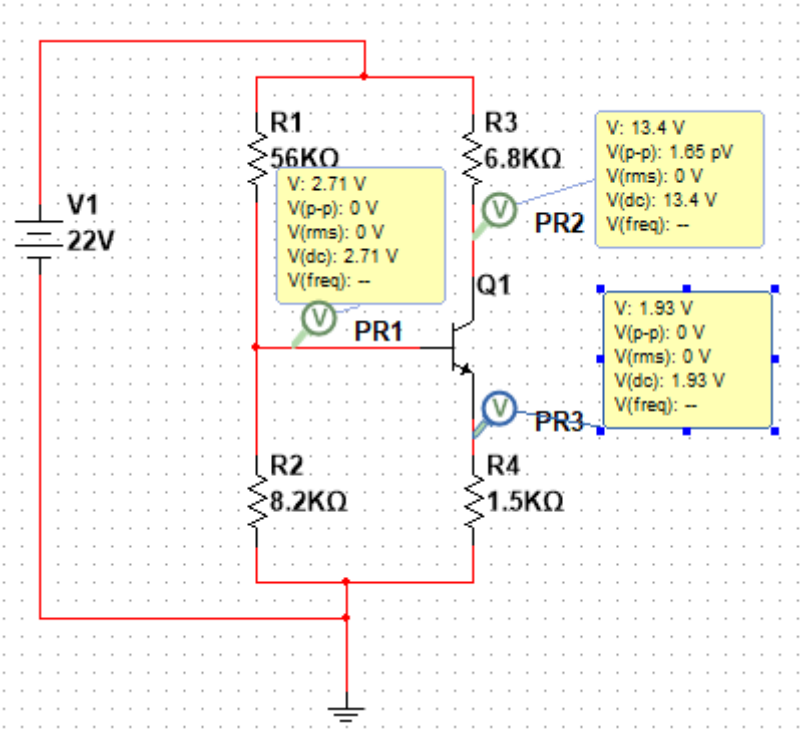
$\boldsymbol{Zo} = Rc = \mathbf{6{,}8\ k}$

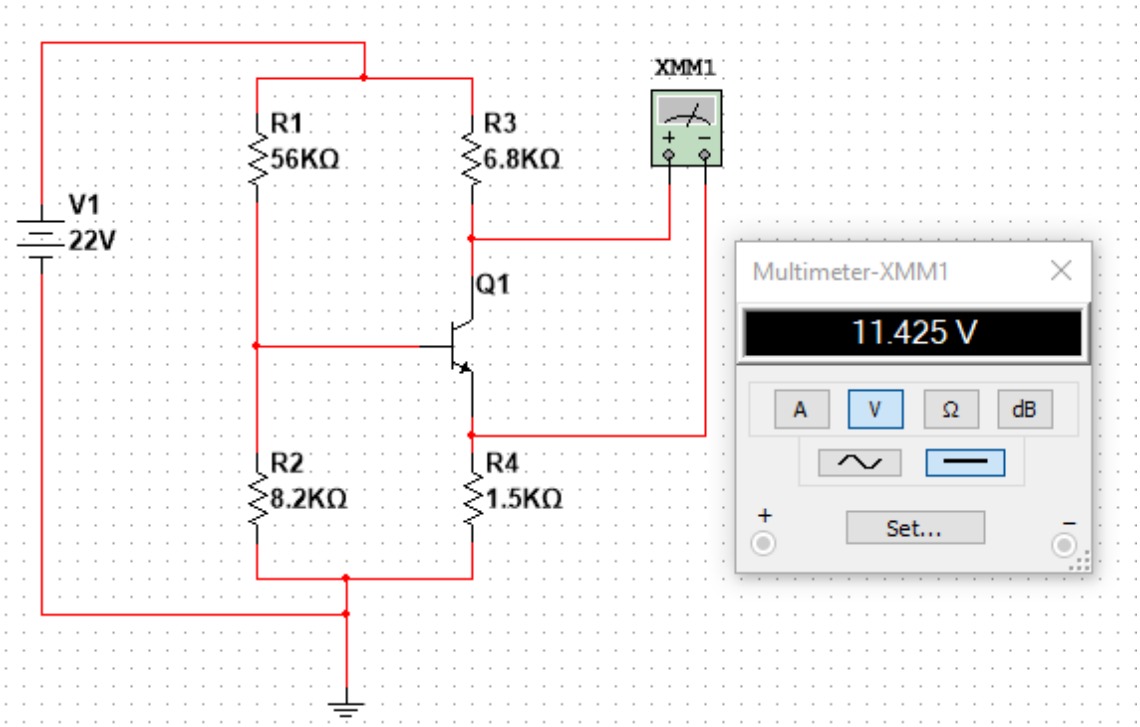
$\boldsymbol{Av} = -(Rc/re) = -(6{,}8k\ /\ 18{,}44) = \mathbf{-368{,}76}$

Simulação Ic e Ie:



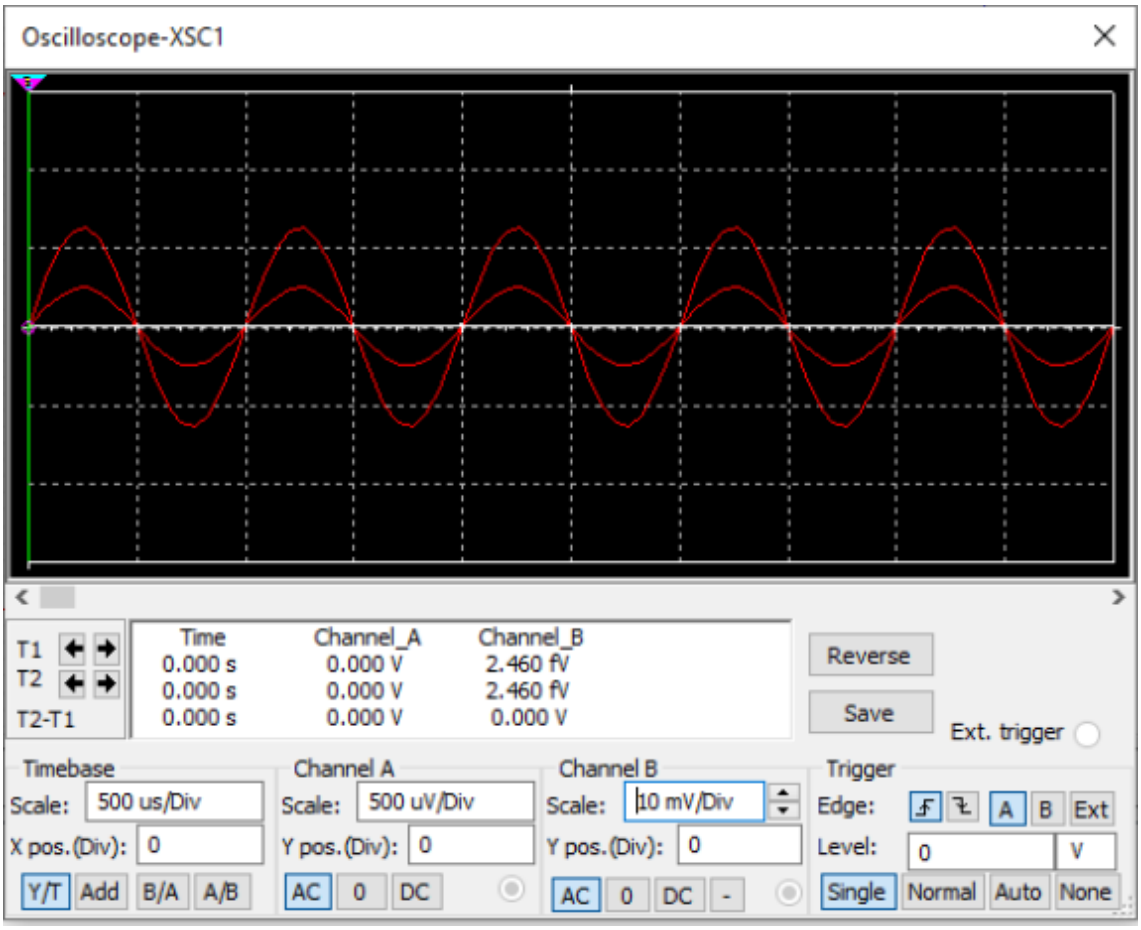
Simulação Vc, Vb, Ve e Vce:





Simulação Vce:

VARIÁVEIS	CALCULADO	SIMULADO
Ic	1,41 mA	1,27 mA
Ie	1,41 mA	1,29 mA
Vc	12,48 V	13,4 V
Vb	2,81 V	2,71 V
Ve	2,11 V	1,93 V
Vce	10,37 V	11,425 V


Oscilloscope-XSC1
T1
T2
T2-T1
Time
Channel_A
Channel_B
0.000 s
0.000 V
2.460 fV
0.000 s
0.000 V
2.460 fV
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Y/T
Add
B/A
A/B
Channel A
Scale: 500 uV/Div
Y pos.(Div): 0
AC
0
DC
Channel B
Scale: 10 mV/Div
Y pos.(Div): 0
AC
0
DC
-
Trigger
Edge:
A
B
Ext
Level: 0 V
Single
Normal
Auto
None

Análise AC emissor comum e divisor de tensão

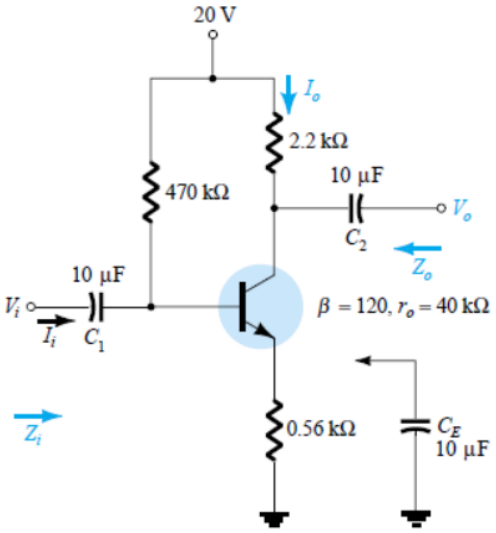
Análise AC – Polarização de emissor

Exercício – Considere sem o capacitor CE

Determine:

a) IB, IC, IE, VB, VE, VC, VCE

b) Zi, Zo, AV



$A)$

$\boldsymbol{Ib} = (Vcc - Vbe) / (Rb + (\beta + 1) * Re)$

$= (20\,V - 0{,}7\,V) / 470k + (121 * 0.56k) = 19{,}3\,V / 537760$

$= \mathbf{35{,}88\,uA}$

$\boldsymbol{Ie} = Ic = (\beta + 1) * Ib = (120 + 1) * 35{,}88\,uA = \mathbf{4{,}342\,mA}$

$\boldsymbol{Vb} = Vcc - (Ib * Rb) = 20\,V - (35{,}88\,uA * 470k) = 20\,V - 16{,}86\,V$

$= \mathbf{3{,}13V}$

$\boldsymbol{Vc} = Vcc - (Ic * Rc) = 20\,V - (4{,}342\,mA * 2{,}2k) = \mathbf{10{,}44\,V}$

$\boldsymbol{Ve} = Vb - Vbe = 3{,}13\,V - 0{,}7\,V = \mathbf{2{,}43\,V}$

$\boldsymbol{Vce} = Vc - Ve = 10{,}44\,V - 2{,}43\,V = \mathbf{8{,}01\,V}$

$\boldsymbol{re} = 26mV / Ie = 26mV / 4{,}342\,mA = \mathbf{5{,}99\,Ohms}$

$B)$

$\boldsymbol{ro} \geq 10(Rc + Re) \rightarrow 40k \geq 10\,(2{,}2k + 0{,}56k) \rightarrow 40k$

$\geq 27{,}6k\,(condição\ atendida)$

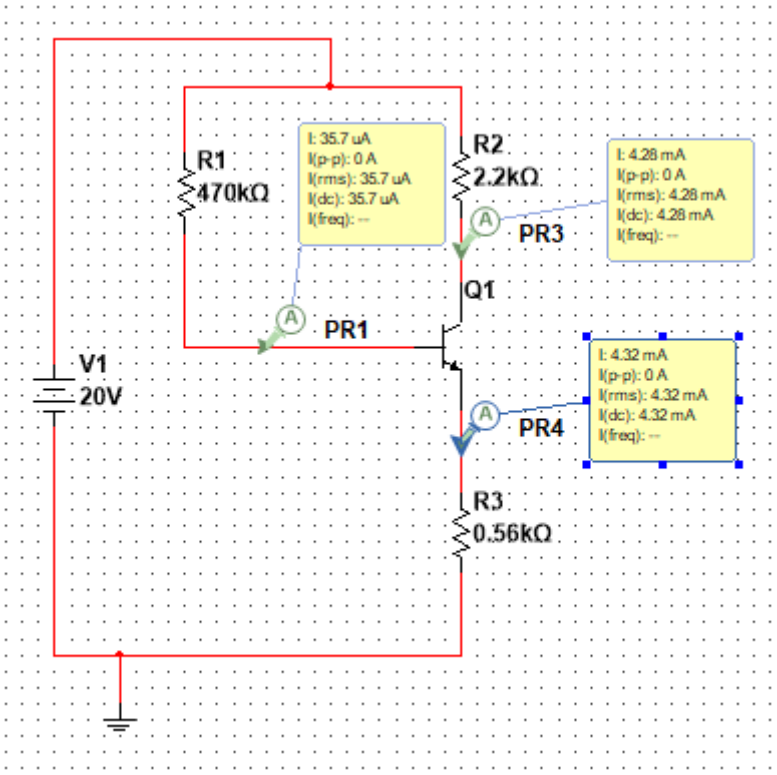
$\boldsymbol{Zi} = Rb//\beta * (re + Re) = 470k\ //\ (120 * (5{,}99 + 560))$

$= 470k\ //\ 67918{,}8 = \mathbf{59{,}34k\,\Omega}$

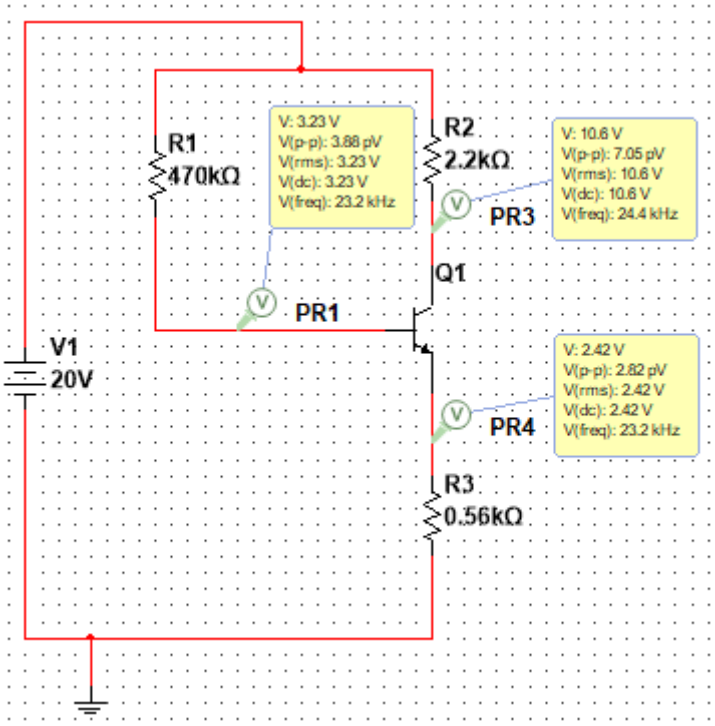
$\boldsymbol{Zo} = Rc = \mathbf{2{,}2k\,Ohms}$

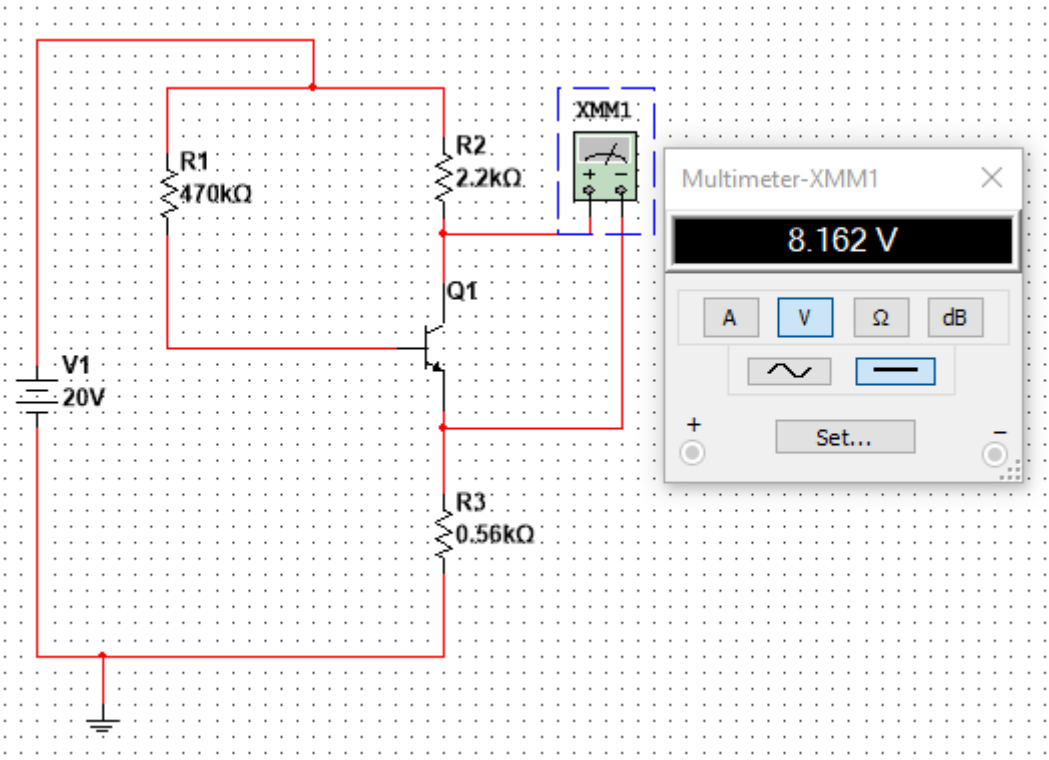
$\boldsymbol{Av} = -(\beta * Rc / Zb) = -(120 * 470k / 67{,}92k) = \mathbf{-3{,}89}$

Simulação Ic e Ie:

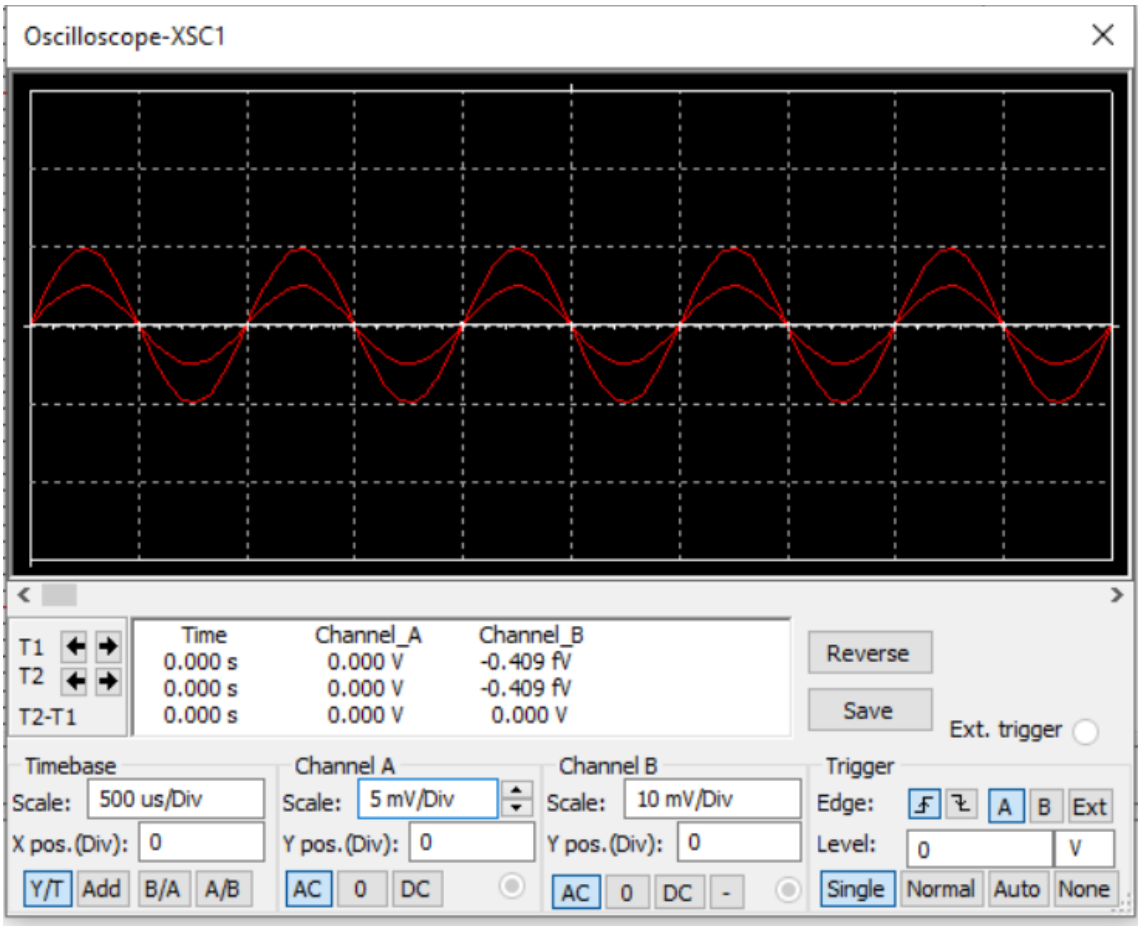


Simulação Vb, Vc, Ve e Vce:





VARIÁVEIS	CALCULADO	SIMULADO
Ic	4,342 mA	4,26 mA
Ie	4,342 mA	4,32 mA
Ib	35,88 uA	35,7 uA
Vc	10,44 V	10,6 V
Vb	3,13 V	3,23 V
Ve	2,43 V	2,42 V
Vce	8,01 V	8,162 V


Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
-0.409 fV
-0.409 fV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Y/T
Add
B/A
A/B
Channel A
Scale: 5 mV/Div
Y pos.(Div): 0
AC
0
DC
Channel B
Scale: 10 mV/Div
Y pos.(Div): 0
AC
0
DC
-
Trigger
Edge:
A
B
Ext
Level: 0 V
Single
Normal
Auto
None

Análise AC polarização de emissor com capacitor CE

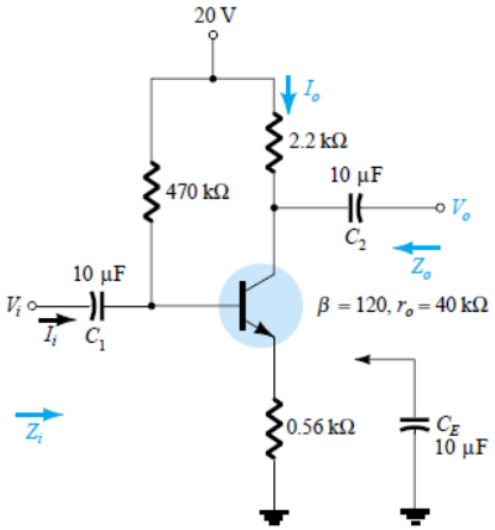
Análise AC – Polarização de emissor

Repita o exercício anterior – Acrescente o capacitor CE

Determine:

a) IB, IC, IE, VB, VE, VC, VCE

b) Zi, Zo, AV

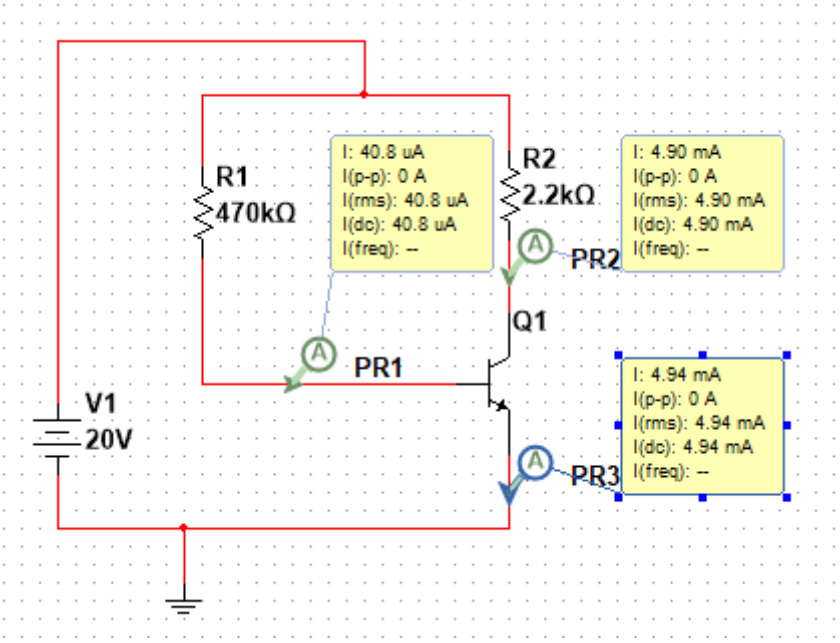


A)

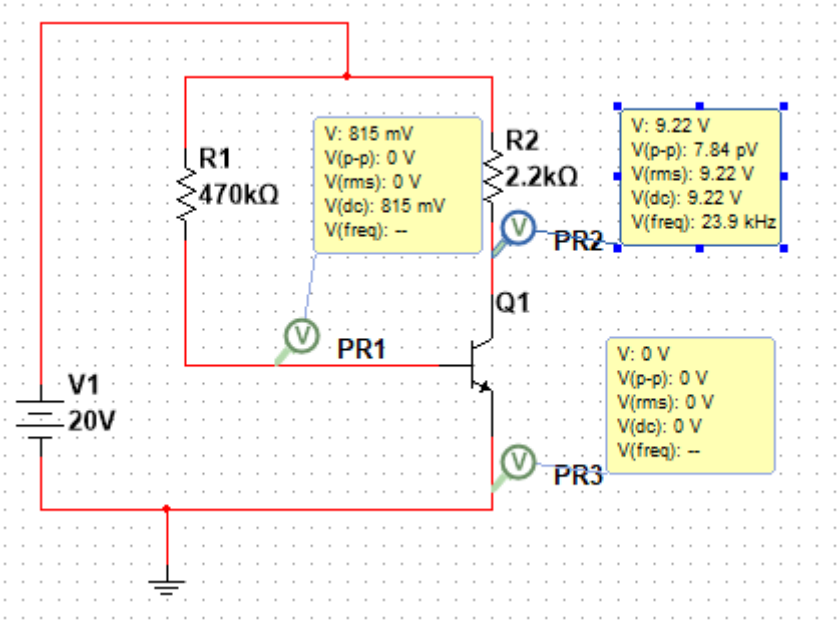
$\boldsymbol{Ib} = (Vcc - Vbe) / Rb = (20\,V - 0{,}7\,V) / 470k = 19{,}3\,V / 470k =$ **$41{,}06\,uA$**
$\boldsymbol{Ie} = Ic = (\beta + 1) * Ib = (120 + 1) * 41{,}06\,uA =$ **$4{,}97\,mA$**
$\boldsymbol{Vb} = 0{,}7\,V$ *e* $Ve =$ **$0\,V$**
$\boldsymbol{Vc} = Vcc - (Ic * Rc) = 20\,V - (4{,}97\,mA * 2{,}2k) =$ **$9{,}06\,V$**
$\boldsymbol{Vce} = Vc - Ve = 9{,}06\,V - 0\,V =$ **$9{,}06\,V$**
$\boldsymbol{re} = 26mV / Ie = 26mV / 4{,}97\,mA =$ **$5{,}23\,Ohms$**

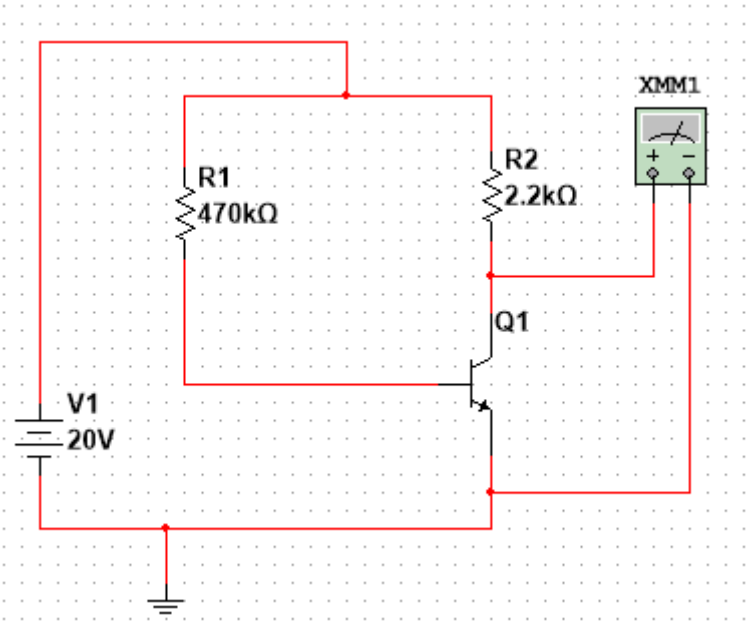
B)
$\boldsymbol{Zi} = Rb // \beta * re = 470k\,//\,(120 * 5{,}23) = 470k\,//\,627 =$ **$749\,Ohms$**
$\boldsymbol{Zo} = Rc =$ **$2{,}2k\,Ohms$**
$\boldsymbol{Av} = -(Rc/re) = -(2{,}2k / 5{,}23) =$ **$-420{,}65$**

Simulação Ic, Ib e Ie:

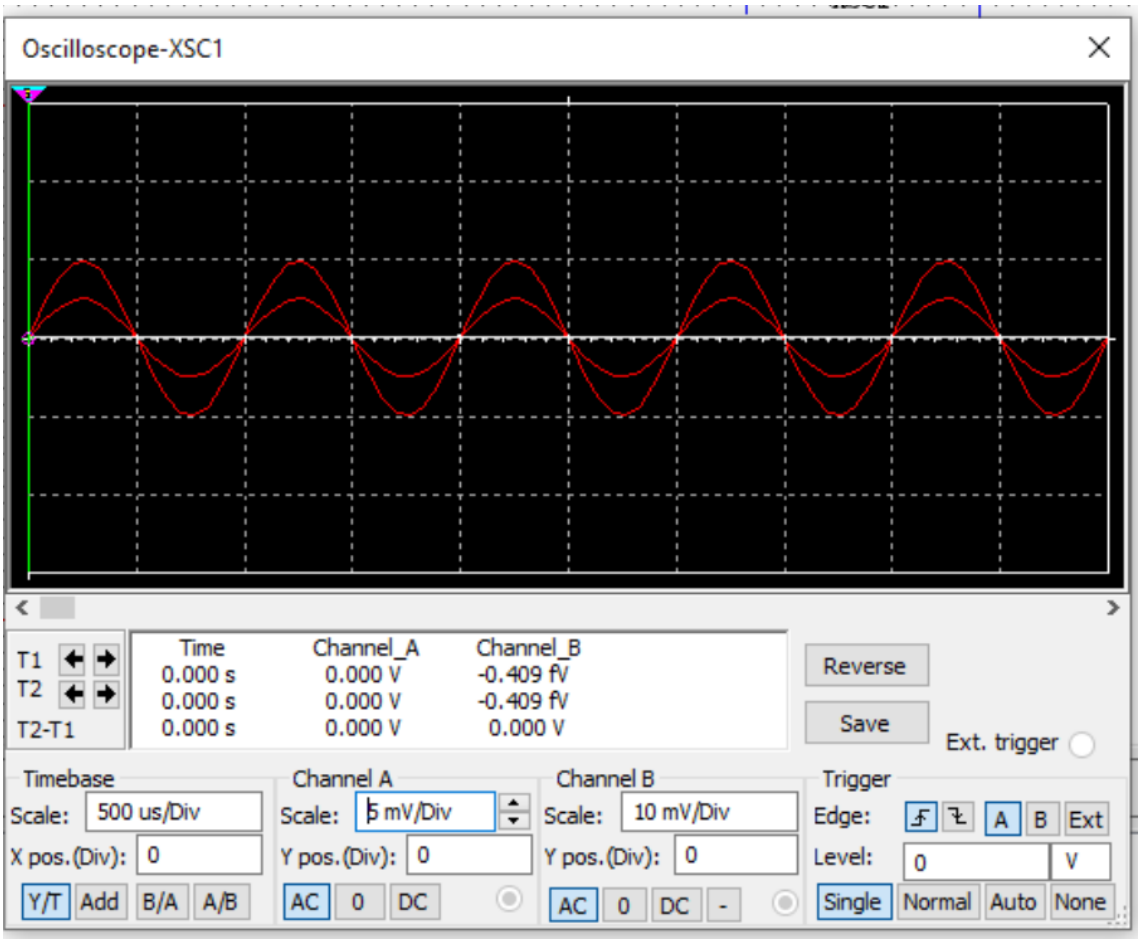


Simulação Vc, Vb, Ve e Vce:





VARIÁVEIS	CALCULADO	SIMULADO
Ic	4,97 mA	4,90 mA
Ie	4,97 mA	4,94 mA
Ib	41,06 uA	40,8 uA
Vc	9,06 V	9,22 V
Vb	0,7 V	0,815 V
Ve	0 V	0 V
Vce	9,06 V	9,224 V


Oscilloscope-XSC1
T1
T2
T2-T1
Time
0.000 s
0.000 s
0.000 s
Channel_A
0.000 V
0.000 V
0.000 V
Channel_B
-0.409 fV
-0.409 fV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 mV/Div
Y pos.(Div): 0
AC 0 DC
Channel B
Scale: 10 mV/Div
Y pos.(Div): 0
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None