BJT Amplifier
Spice Simulations (H.21)

20170817

References

Based

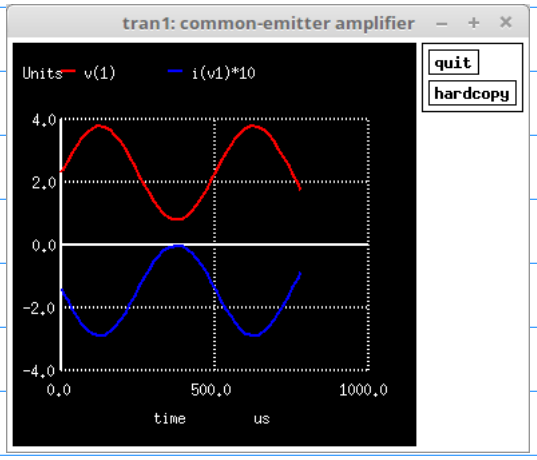
[1] Floyd, Electronic Devices 7th ed
[2] Cook,

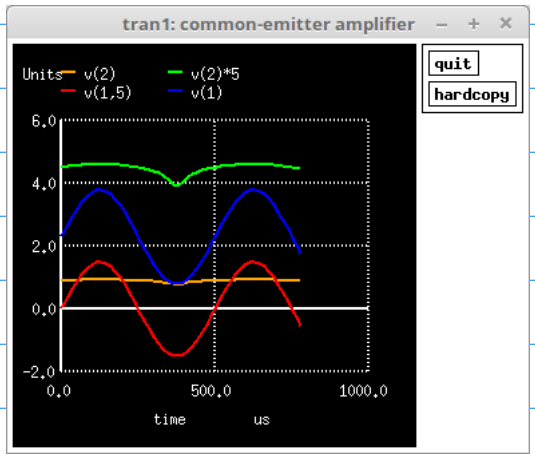
[2] en.wikipedia.org

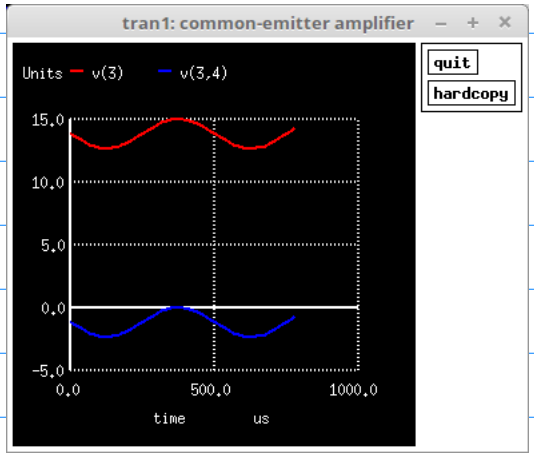
www.allaboutcircuits.com
common emitter
comman collector
common base

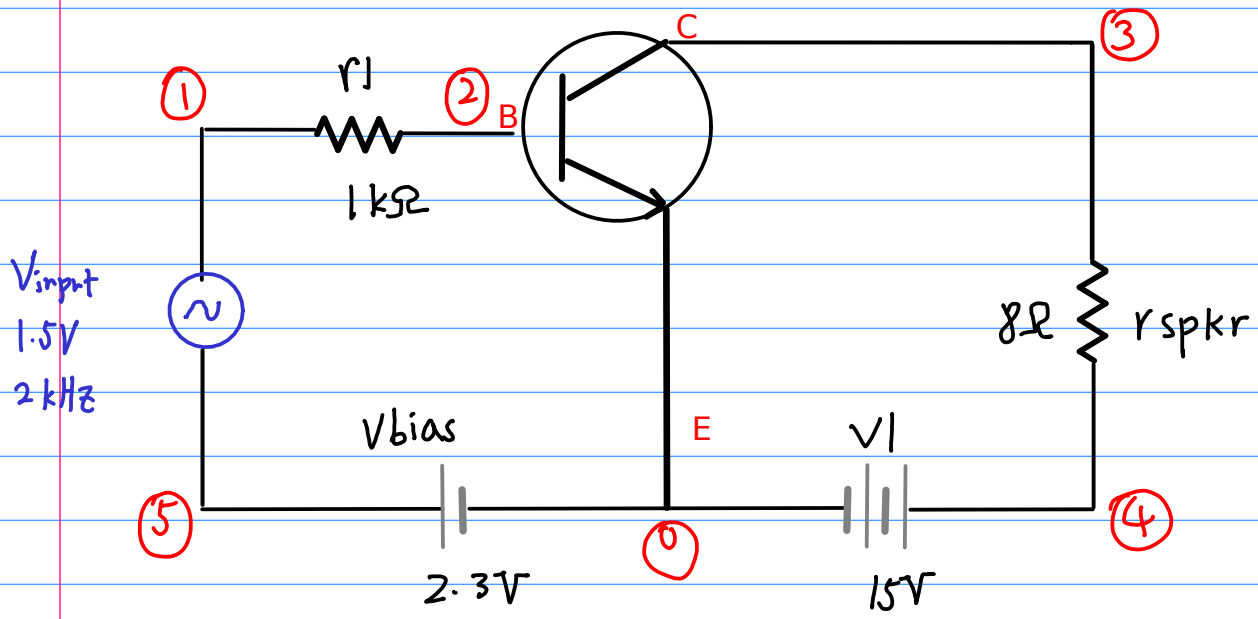
CE

common-emitter amplifier
vinput 1 5 sin (0 1.5 2000 0 0)
vbias 5 0 dc 2.3
r1 1 2 1k
q1 3 2 0 mod1
rspkr 3 4 8
v1 4 0 dc 15
.model mod1 npn
.tran 0.02m 0.78m
.plot tran v(1) i(v1)*10
.end



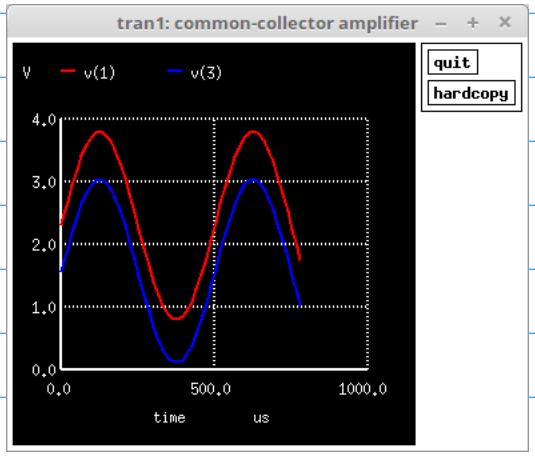


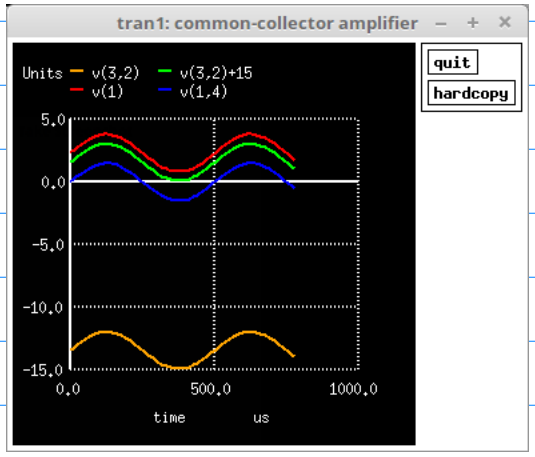


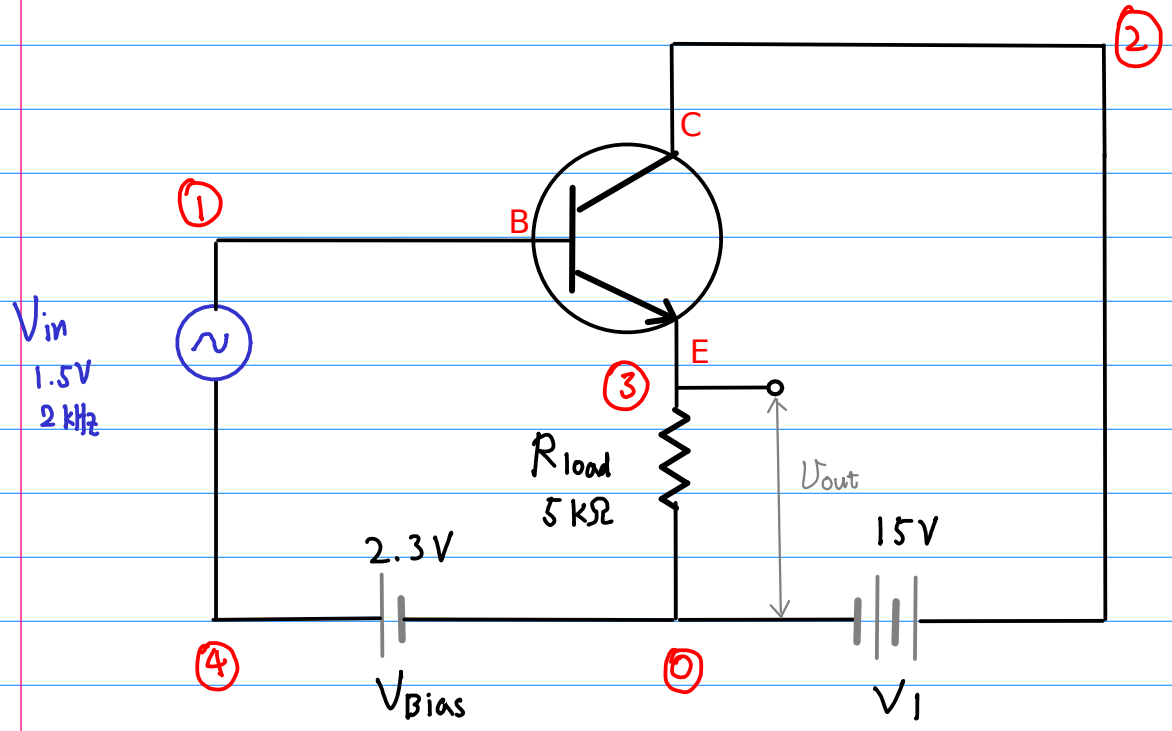


CC

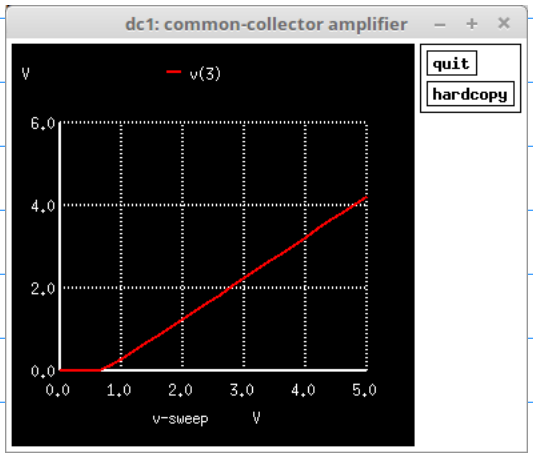
common-collector amplifier
vin 1 4 sin (0 1.5 2000 0 0)
vbias 4 0 dc 2.3
q1 2 1 3 mod1
v1 2 0 dc 15
rload 3 0 5k
.model mod1 npn
.tran .02m .78m
.plot tran v(1) v(3)
.end





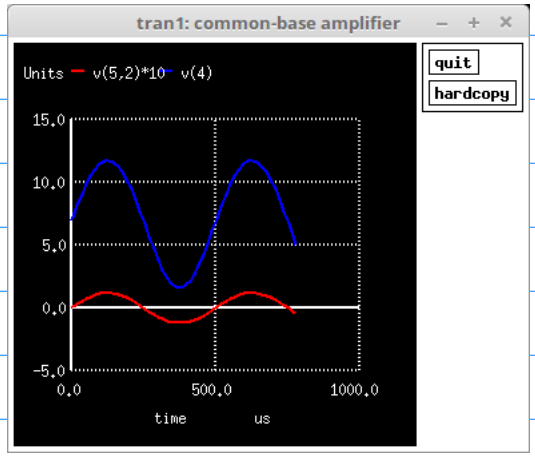


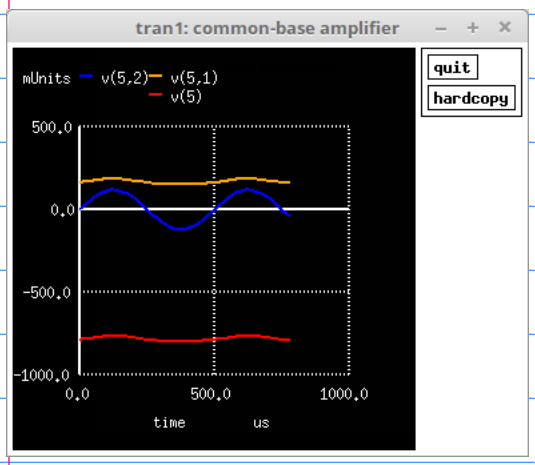
common-collector amplifier
vin 1 0
q1 2 1 3 mod1
v1 2 0 dc 15
rload 3 0 5k
.model mod1 npn
.dc vin 0 5 0.2
.plot dc v(3,0)
.end

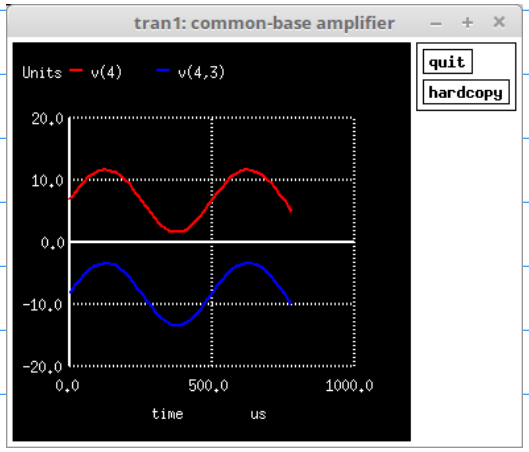


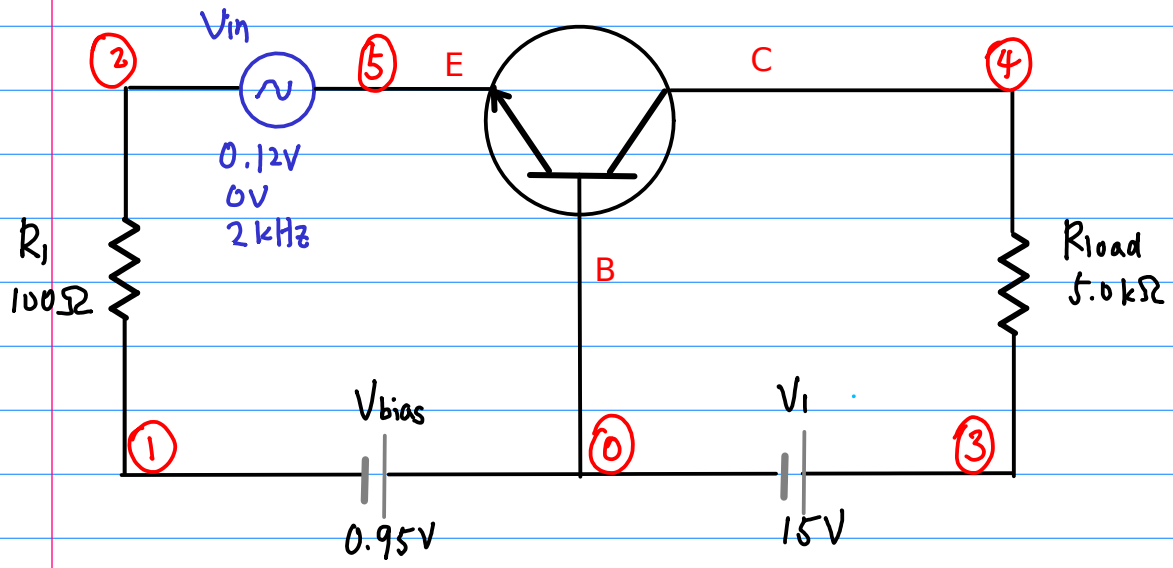
CB

common-base amplifier
vin 5 2 sin (0 0.12 2000 0 0)
vbias 0 1 dc 0.95
r1 2 1 100
q1 4 0 5 mod1
v1 3 0 dc 15
rload 3 4 5k
.model mod1 npn
.tran 0.02m 0.78m
.plot tran v(5,2)*10 v(4)
.end

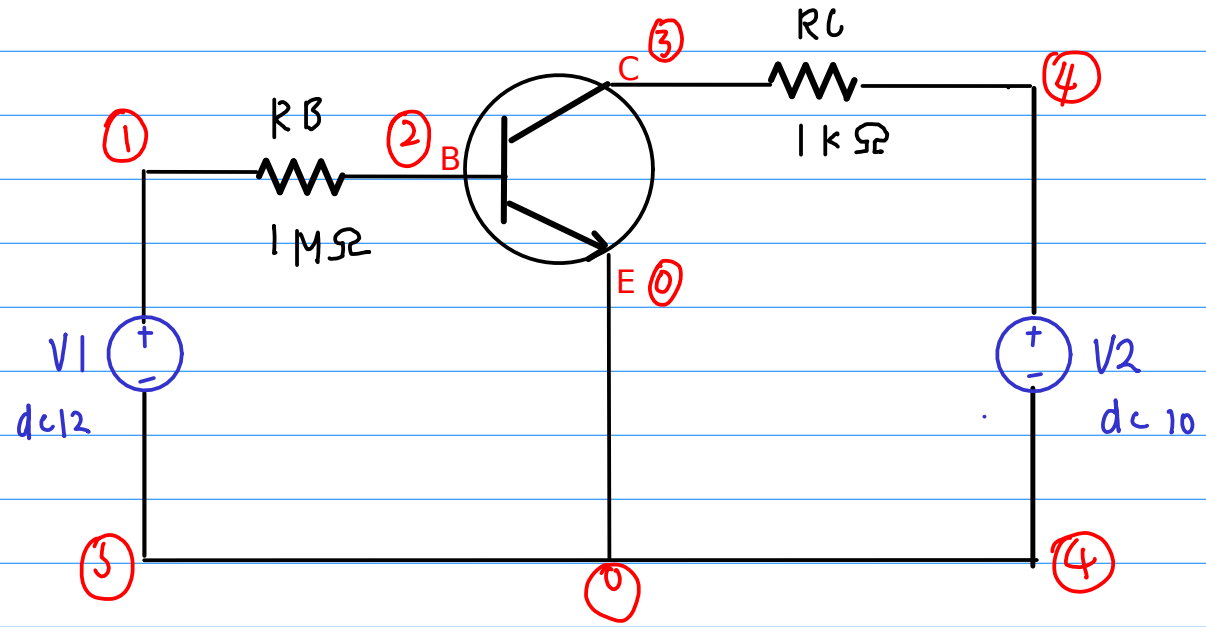








```
* BJT characteristics

RB 1 2 1Meg
RC 4 3 1k
QBJT 3 2 0 2N3904
V1 1 0 dc 12
V2 4 0 dc 10

.model 2N3904   NPN(Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259
+               Ise=6.734f Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1
+               Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75
+               Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)
*               Fairchild       pid=23          case=TO92
*               88-09-08 bam    creation
```



****
.control
dc V2 10 0 -0.1 V1 3.0
run

dc V2 10 0 -0.1 V1 3.5
run

dc V2 10 0 -0.1 V1 4.0
run

dc V2 10 0 -0.1 V1 4.5
run

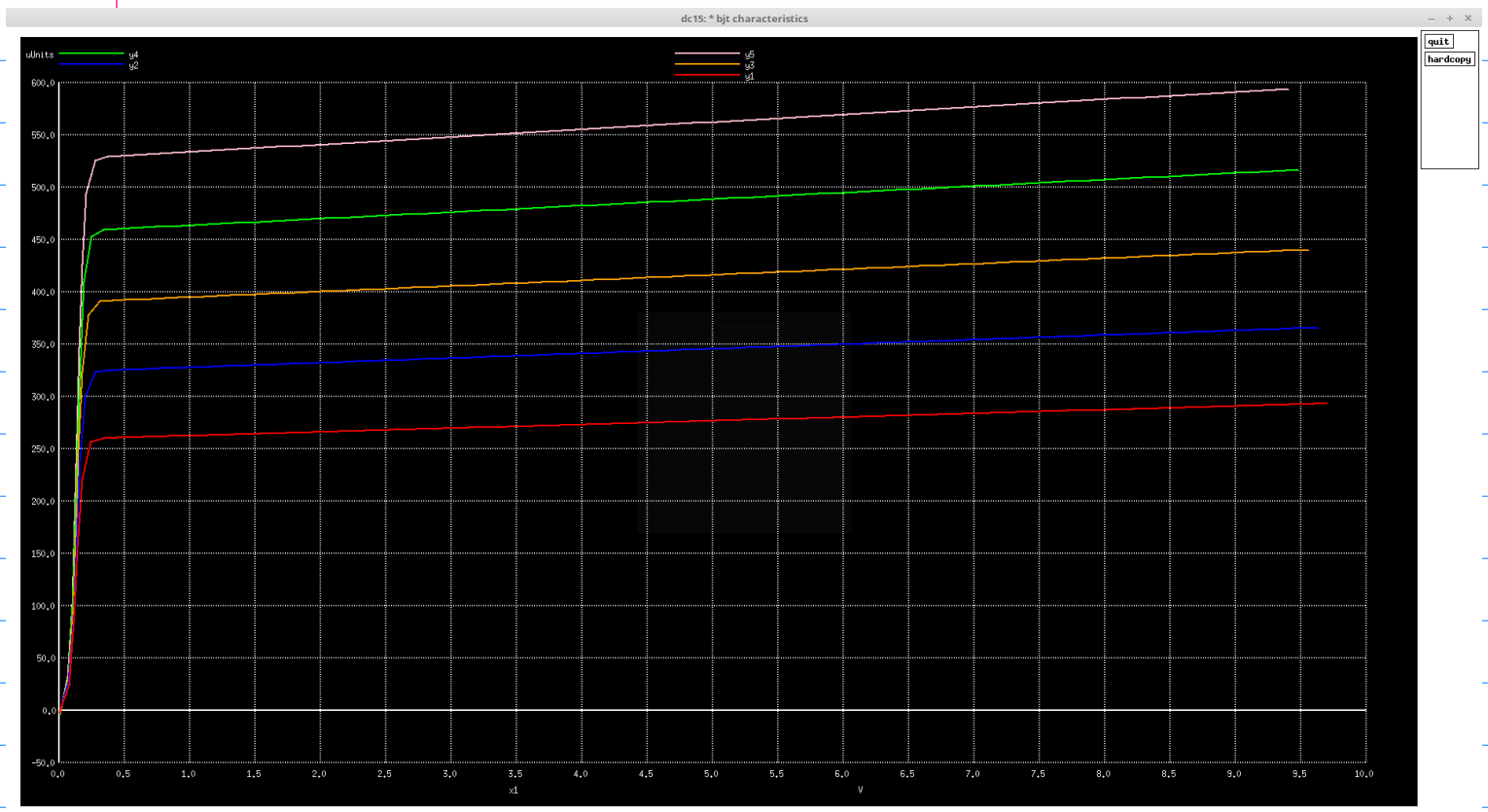
dc V2 10 0 -0.1 V1 5.0
run

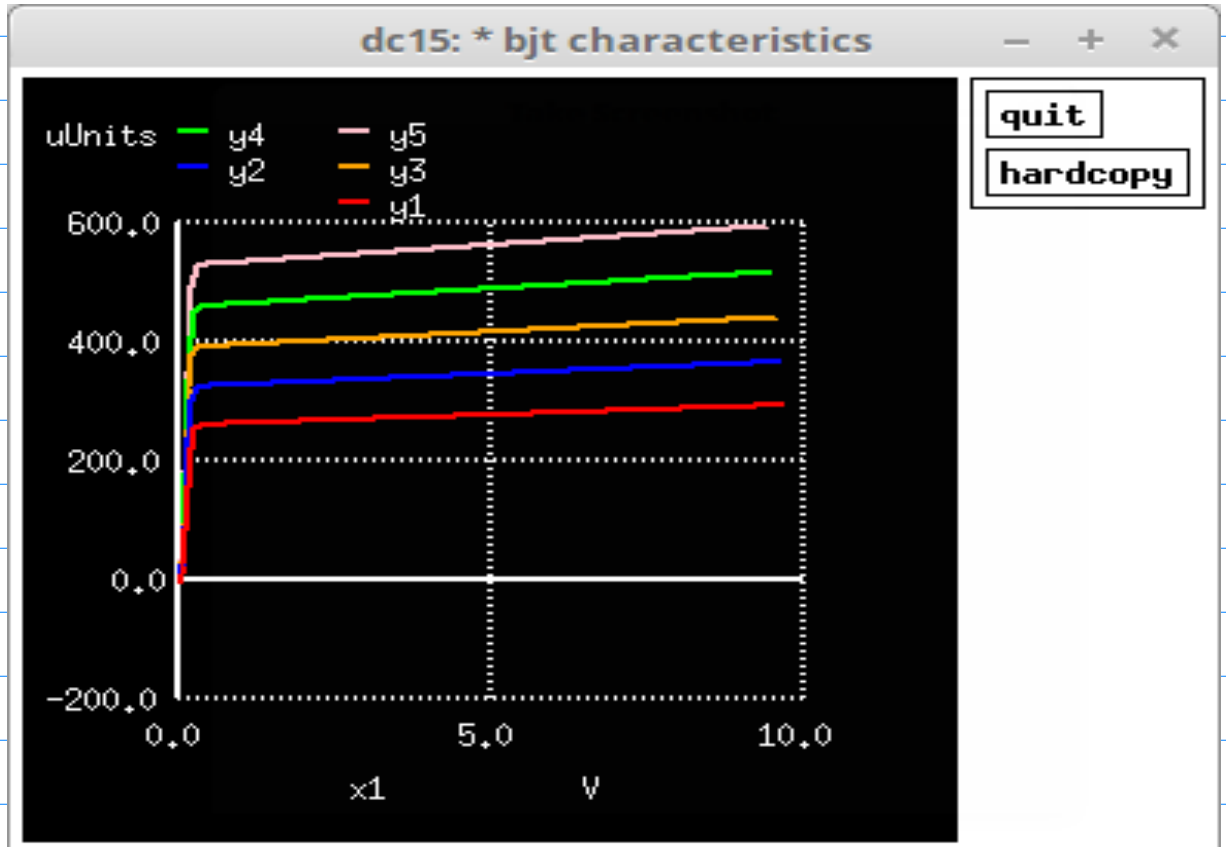
let y1= (dc1.v(4)-dc1.v(3))/1k
let y2= (dc2.v(4)-dc2.v(3))/1k
let y3= (dc3.v(4)-dc3.v(3))/1k
let y4= (dc4.v(4)-dc4.v(3))/1k
let y5= (v(4)-v(3))/1k

let x1= dc1.v(3)
let x2= dc2.v(3)
let x3= dc3.v(3)
let x4= dc4.v(3)
let x5= v(3)

plot y1 vs x1 y2 vs x2 y3 vs x3 y4 vs x4 y5 vs x5
* plot y1 vs x1
* plot y2 vs x2
* plot y3 vs x3
* plot y4 vs x4
* plot y5 vs x5

.endc
****


dc15: * bjt characteristics
uUnits
y4
y2
y5
y3
y1
quit
hardcopy
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
x1
V

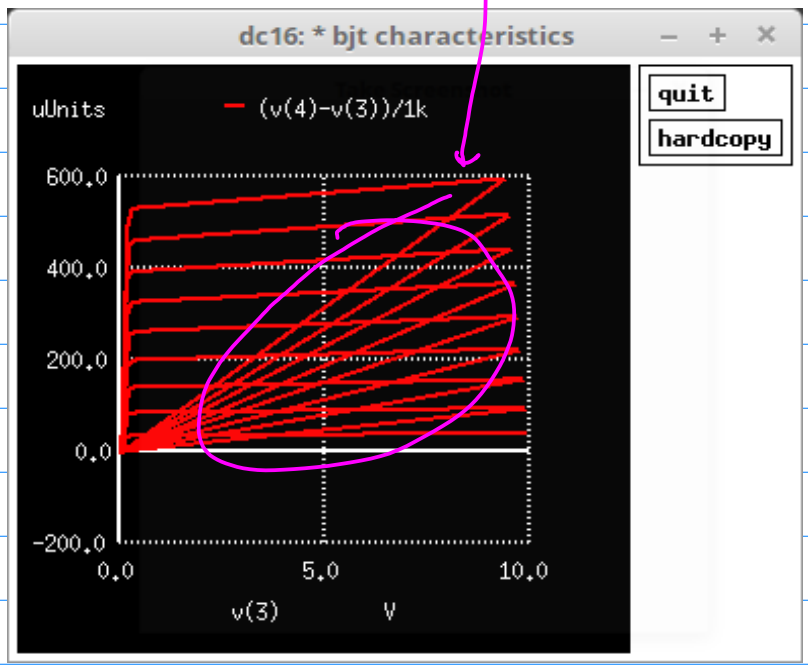

dc15: * bjt characteristics
uUnits
y4
y2
y5
y3
y1
quit
hardcopy
600.0
400.0
200.0
0.0
-200.0
0.0
5.0
10.0
x1
V

CE Characteristics Curves

```
************
.control
dc V2 10 0 -0.1 V1 1.0 5.0 0.5
run

plot (v(4)-v(3))/1k vs v(3)



.endc
************
```

may be different # of data points

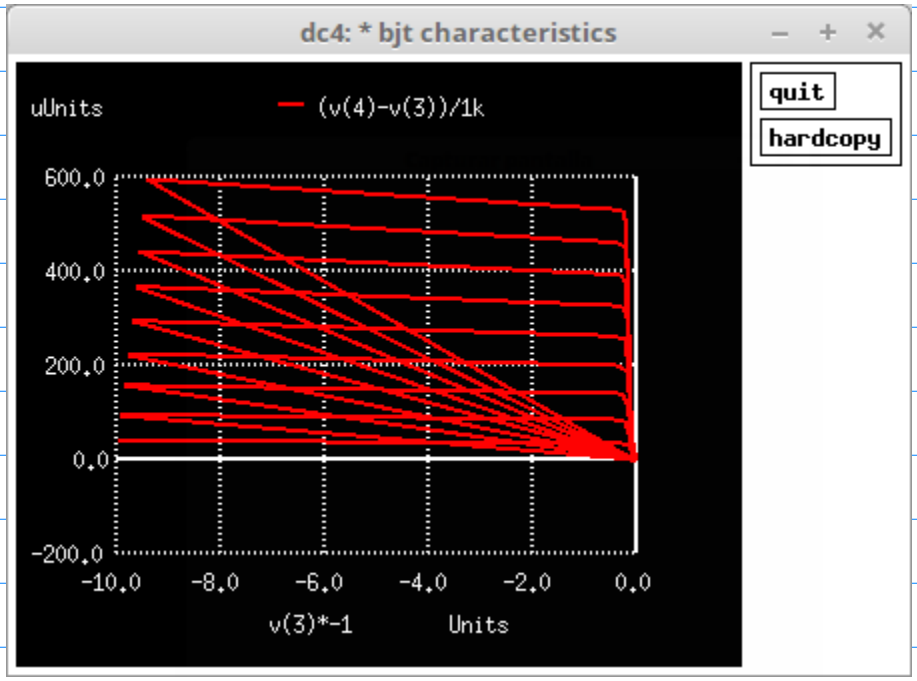
v(3)



https://electronics.stackexchange.com/questions/185756/ngspice-messing-up-bjt-characteristics

CC Characteristics Curves

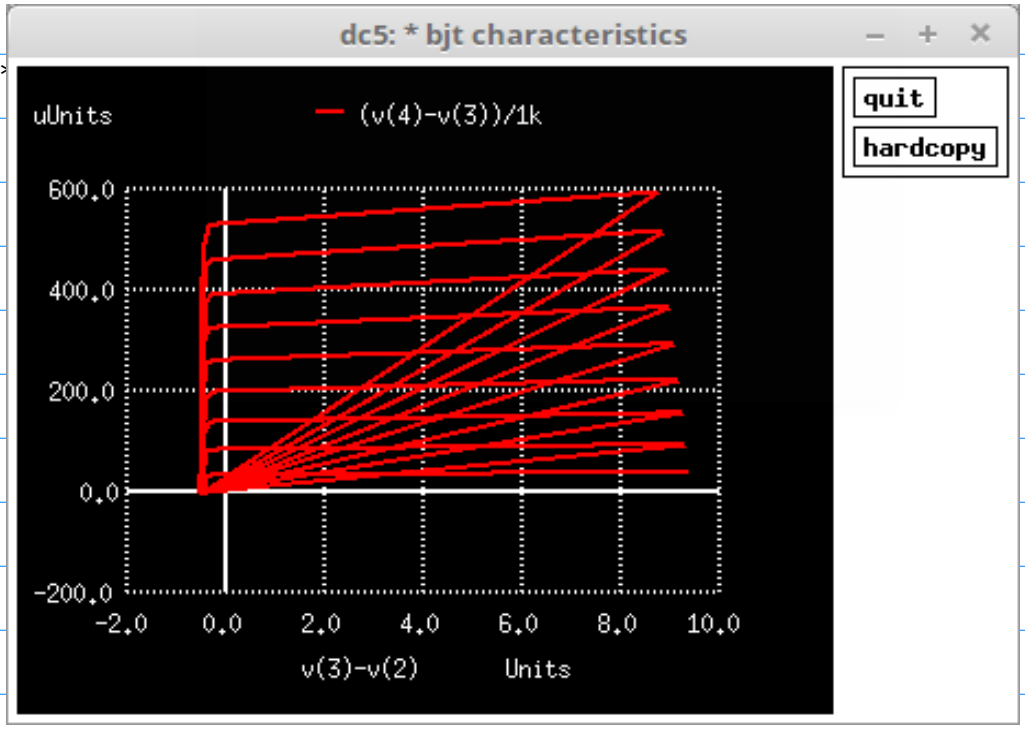
```
* BJT characteristics

RB 1 2 1Meg
RC 4 3 1k
QBJT 3 2 0 2N3904
V1 1 0 dc 12
V2 4 0 dc 10

.model 2N3904   NPN(Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259
+               Ise=6.734f Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1
+               Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75
+               Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)
*               Fairchild       pid=23          case=TO92
*               88-09-08 bam    creation


************
.control
dc V2 10 0 -0.1 V1 1.0 5.0 0.5
run

plot (v(4)-v(3))/1k vs v(3)*-1
```



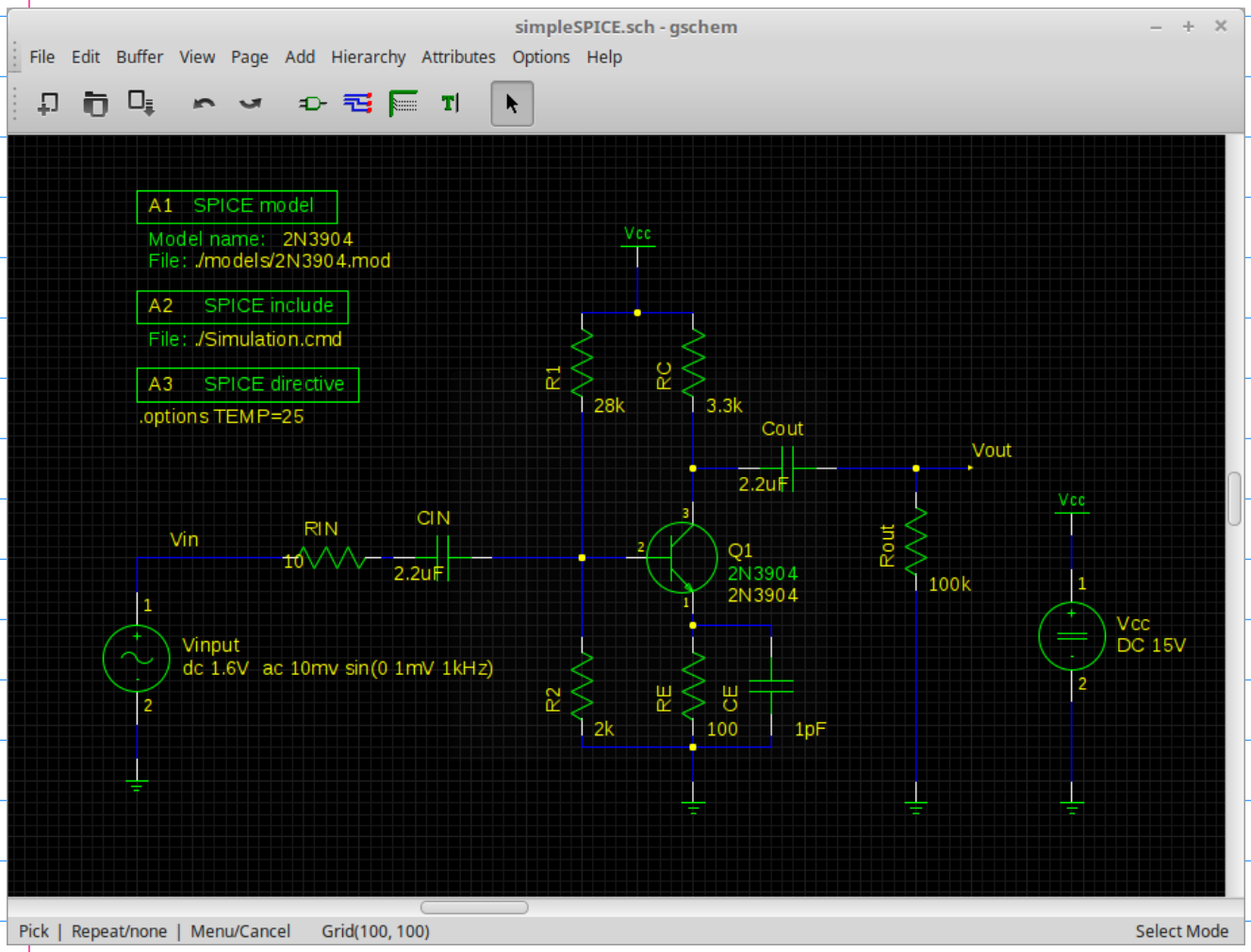

```
.endc
************
```

CB Characteristics Curves

```
* BJT characteristics

RB 1 2 1Meg
RC 4 3 1k
QBJT 3 2 0 2N3904
V1 1 0 dc 12
V2 4 0 dc 10

.model 2N3904   NPN(Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259
+               Ise=6.734f Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1
+               Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75
+               Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)
*              Fairchild       pid=23          case=TO92
*              88-09-08 bam    creation


************
.control
dc V2 10 0 -0.1 V1 1.0 5.0 0.5
run

plot (v(4)-v(3))/1k vs v(3)-v(2)



.endc
**********
```



gschem



http://wiki.geda-project.org/geda:ngspice_and_gschem

```
gnetlist -g spice-sdb -o spice.net simpleSPICE.sch

ngspice -b spice.net > result.txt


'./Simulation.cmd'
 .OP
 .AC DEC 20 1Hz 100MegHz
 * .DC VINPUT 0 5 .01
 * .DC VINPUT 1 2 .01
 .plot ac v(Vout) v(Vin)
 .print ac v(Vout) v(Vin)



  './models/2N3904.mod'

.model 2N3904   NPN(Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259
+            Ise=6.734f Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1
+            Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75
+            Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)
*           Fairchild       pid=23          case=TO92
*           88-09-08 bam    creation
```

```
* gnetlist -g spice-sdb -o spice.net simpleSPICE.sch
************************************************************
* Spice file generated by gnetlist                         *
* spice-sdb version 4.28.2007 by SDB --                    *
* provides advanced spice netlisting capability.           *
* Documentation at http://www.brorson.com/gEDA/SPICE/      *
************************************************************
*vvvvvvvv  Included SPICE model from ./models/2N3904.mod vvvvvvvv
.model 2N3904   NPN(Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259
+              Ise=6.734f Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1
+              Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75
+              Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)
*             Fairchild        pid=23          case=TO92
*             88-09-08 bam    creation
*^^^^^^^^^  End of included SPICE model from ./models/2N3904.mod ^^^^^^^
*
*==============  Begin SPICE netlist of main design ============
Vcc Vcc 0 DC 15V
Vinput Vin 0 dc 1.6V  ac 10mv sin(0 1mV 1kHz)
.options TEMP=25
.INCLUDE ./Simulation.cmd
Q1 3 1 2 2N3904
CE 0 2 1pF
Cout 3 Vout 2.2uF
CIN 4 1 2.2uF
RIN Vin 4 10
Rout 0 Vout 100k
RC 3 Vcc 3.3k
RE 0 2 100
R2 0 1 2k
R1 1 Vcc 28k
.end
```

Circuit: * gnetlist -g spice-sdb -o spice.net simplespice.sch

Doing analysis at TEMP = 25.000000 and TNOM = 27.000000

No. of Data Rows : 161

No. of Data Rows : 1

Node	Voltage
V(4)	1.600000e+00
vout	0.000000e+00
V(2)	2.735815e-01
V(1)	9.675157e-01
V(3)	6.029239e+00
vin	1.600000e+00
vcc	1.500000e+01

Source	Current
vcc#branch	-3.21957e-03
vinput#branch	0.000000e+00

BJT models (Bipolar Junction Transistor)
model 2n3904
...
Capacitor models (Fixed capacitor)
...
Resistor models (Simple linear resistor)
...
BJT: Bipolar Junction Transistor
...
Capacitor: Fixed capacitor
...
Resistor: Simple linear resistor
...
Resistor: Simple linear resistor
...
Vsource: Independent voltage source

```
--------------------------------------------------------------------------------
          * gnetlist -g spice-sdb -o spice.net simplespice.sch
               AC Analysis Sat Aug 12 22:41:43  2017

Legend:  + = v(vout)         * = v(vin)
--------------------------------------------------------------------------------
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01
----------------------|-----------|-----------|-----------|-----------|
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01
^L
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01
----------------------|-----------|-----------|-----------|-----------|
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01
^L
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01
----------------------|-----------|-----------|-----------|-----------|
 frequency  v(vout) -3.00e-01   -2.00e-01   -1.00e-01    0.00e+00    1.00e-01

            * gnetlist -g spice-sdb -o spice.net simplespice.sch
            AC Analysis  Sat Aug 12 22:41:43  2017
--------------------------------------------------------------------------------
Index   frequency       v(vout)
--------------------------------------------------------------------------------

Index   frequency       v(vout)
--------------------------------------------------------------------------------

Index   frequency       v(vout)
--------------------------------------------------------------------------------
160     1.000000e+08    4.637889e-03,   6.081329e-02
^L
            * gnetlist -g spice-sdb -o spice.net simplespice.sch
            AC Analysis  Sat Aug 12 22:41:43  2017
--------------------------------------------------------------------------------
Index   frequency       v(vin)
--------------------------------------------------------------------------------

Index   frequency       v(vin)
--------------------------------------------------------------------------------

Index   frequency       v(vin)
--------------------------------------------------------------------------------

CPU time since last call: 0.020 seconds.

Total CPU time: 0.020 seconds.

Total DRAM available = 7961.742188 MB.
DRAM currently available = 5046.386719 MB.
Total ngspice program size = 14.780273 MB.
Resident set size = 1.942383 MB.
Shared ngspice pages = 1.708008 MB.
Text (code) pages = 1.333008 MB.
Stack = 0 bytes.
Library pages = 411.000 kB.
```