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Lab II

To study high Input Resistance Amplifiers, namely commoncollector amplifier, Darlington mode transistors, bootstrapped emitter follower

Components Required

- DC Voltage source 10 V
- Resistances of values $39k\Omega$, $3.9k\Omega$, $5.6k\Omega$, $47k\Omega$ and $10k\Omega$
- One variable Resistance
- 2 or more Capacitors of values 10 μF.
- AC voltage source (100mV, 1kHz)

Results and Conclusions

1. Common Collector Configuration

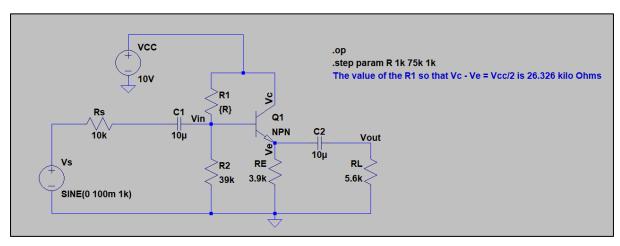


Figure 1.1 - Common Collector Amplifier: Determination of R₁

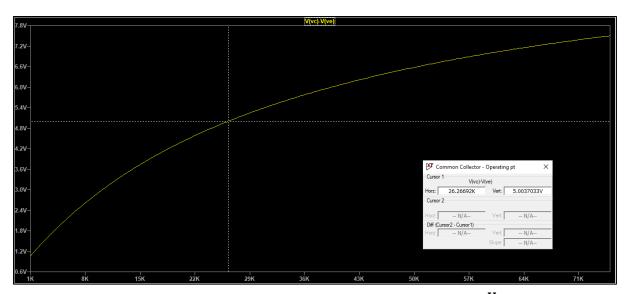


Figure 1.2 – Common Collector Amplifier: R_{1} such that $V_{\text{C}}-V_{\text{E}}=\frac{V_{\text{cc}}}{2}$

For the desired operating point (V $_{C}$ – V $_{E}$ = $^{\mbox{V}_{cc}}\!/_{2}$), R_{1} came out to be 26.326 k $\!\Omega$.

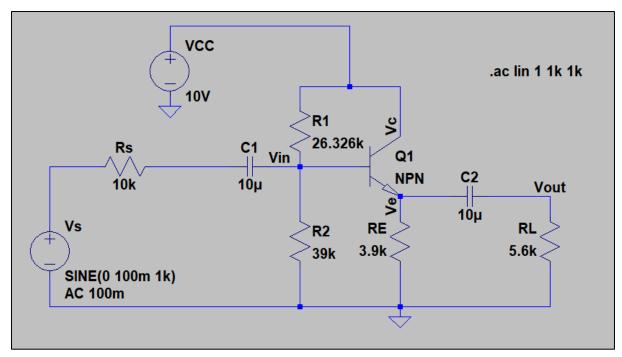


Figure 1.3 - Common Collector Amplifier: Circuit for the determination of Vin, Vout, Iin, Iout and Rin

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🍠 * H:\Academics\BITS\Year 4\4 - Semester 2\Analog Electronics\Labs\Lab 2\ASC Files\Common Collector\C...
        --- AC Analysis ---
frequency:
                1000
                               Ηz
                               0 phase:
                                                  o°
V(vc):
               mag:
                                                              voltage
                                                  o°
V(n001):
               mag:
                            0.1 phase:
                                                              voltage
V(n002):
                      0.0595608 phase:
                                         0.0351911°
                                                              voltage
               mag:
V(vin):
               maq:
                      0.0595609 phase: -0.0267222°
                                                              voltage
                      0.0590417 phase:
                                         0.0346084°
V(ve):
                                                              voltage
               mag:
                      0.0590415 phase:
                                          0.197446°
                                                              voltage
V(vout):
               mag:
Ic(Q1):
               mag: 2.54277e-005 phase:
                                             0.101457°
                                                              device current
Ib(Q1):
               mag: 2.54277e-007 phase:
                                             0.101457°
                                                              device current
Ie(Q1):
               mag: 2.5682e-005 phase:
                                            -179.899°
                                                              device current
               mag: 1.05431e-005 phase:
                                             -179.803°
I(C2):
                                                              device current
               mag: 4.04391e-006 phase:
I(C1):
                                             -179.961°
                                                              device current
I(R1):
               mag: 2.26243e-006 phase:
                                             -179.965°
                                                              device current
I(Rl):
               mag: 1.05431e-005 phase:
                                             -179.803°
                                                              device current
I(Re):
               mag: 1.51389e-005 phase:
                                             -179.965°
                                                              device current
I(Rs):
               mag: 4.04391e-006 phase:
                                             -179.961°
                                                              device current
I(R2):
               mag: 1.5272e-006 phase:
                                          0.0351911°
                                                              device_current
               mag: 4.04391e-006 phase:
                                             -179.961°
I(Vs):
                                                              device current
I(Vcc):
               mag: 2.31653e-005 phase:
                                             -179.892°
                                                              device current
```

Figure 1.4 - Common Collector Amplifier: .ac results from Figure 3

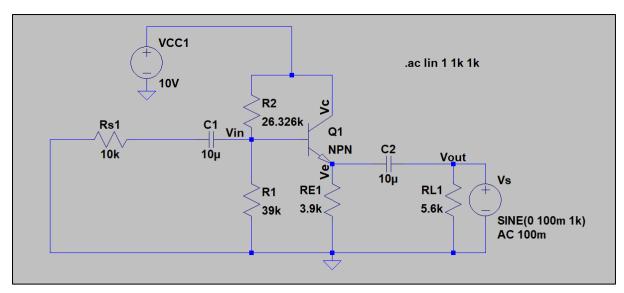


Figure 1.5 - Common Collector Amplifier: Rout calculation

```
🍠 * H:\Academics\BITS\Year 4\4 - Semester 2\Analog Electronics\Labs\Lab 2\ASC Files\Common Collector\C...
       --- AC Analysis ---
frequency:
               1000
                               Ηz
V(vc):
               mag:
                              0 phase:
                                                              voltage
V(n001):
                      0.0734768 phase:
                                           11.3629°
                                                              voltage
               mag:
                      0.0734767 phase:
V(vin):
                                           11.4541°
                                                              voltage
               mag:
V(ve):
               mag:
                       0.098021 phase:
                                           11.3768°
                                                              voltage
V(vout):
                            0.1 phase:
               maq:
                                                              voltage
               mag: 0.00120227 phase:
Ic(Q1):
                                          -168.581°
                                                              device current
               mag: 1.20227e-005 phase:
                                                              device current
Ib(Q1):
                                             -168.581°
Ie(Q1):
               mag: 0.00121429 phase:
                                            11.4186°
                                                              device current
I(C2):
               mag: 0.00123943 phase:
                                            11.4178°
                                                              device current
               mag: 7.34767e-006 phase:
I(C1):
                                              11.4541°
                                                              device_current
I(R2):
               mag: 2.79104e-006 phase:
                                             -168.637°
                                                              device current
               mag: 1.78571e-005 phase:
I(Rl1):
                                                  180°
                                                              device current
I(Re1):
               mag: 2.51336e-005 phase:
                                             -168.623°
                                                              device current
I(Rs1):
               mag: 7.34767e-006 phase:
                                             11.4541°
                                                              device current
               mag: 1.88402e-006 phase:
I(R1):
                                              11.3629°
                                                              device current
                                          -168.743°
I(Vs):
               mag: 0.00125694 phase:
                                                              device current
I (Vcc1):
               mag: 0.00120506 phase:
                                           11.4185°
                                                              device current
```

Figure 1.6 - Common Collector Amplifier: Rout calculation as obtained from .ac analysis

Table 1.1 - Results Summarized for Common Collector Amplifier

Quantities to be determined	Values obtained
V _{in}	0.0595609 V
V _{out}	0.0590415 V
I_{in}	4.04391 μΑ
I _{out}	10.5431 μΑ
$A_{\rm v}$	0.99127
R _{in}	14.728 kΩ
R _{out}	79.55 Ω

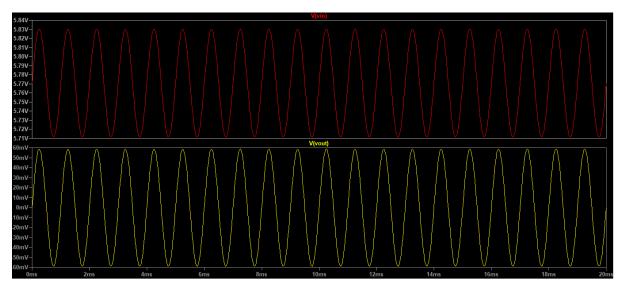


Figure 7 – Output Waveform

2. Darlington Configuration

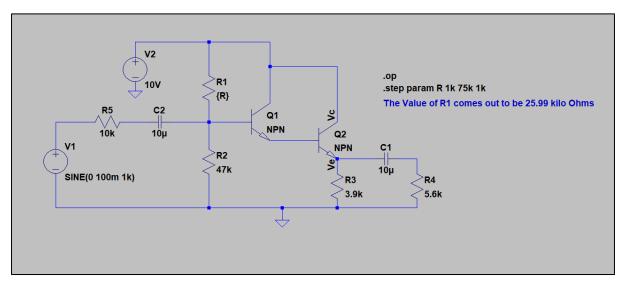


Figure 2.1 – Darlington Configuration: Determination of $R_{\rm 1}$

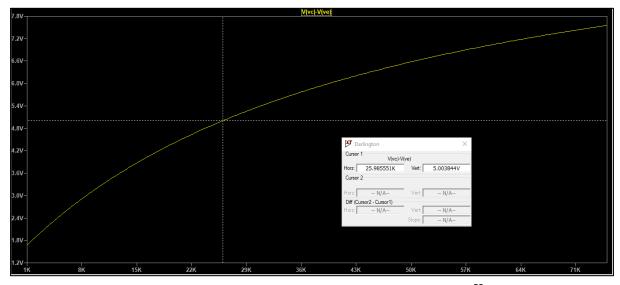
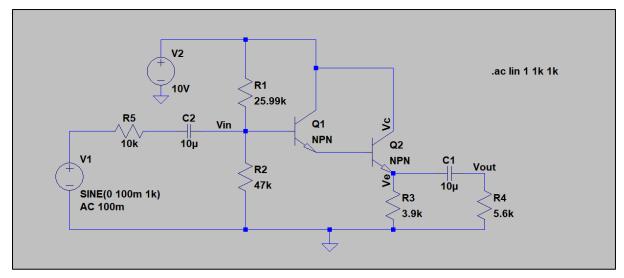


Figure 2.2 – Darlington Configuration: R_{1} such that $V_{\text{C}}-V_{\text{E}}=\frac{V_{\text{cc}}}{2}$

For the desired operating point (V $_{C}$ – V $_{E}$ = $^{\mbox{V}_{cc}}\!/_{2}$), R_{1} came out to be 25.99 k $\!\Omega$.



 $Figure~2.3-Darlington~Configuration:~Circuit~for~the~determination~of~V_{in},~V_{out},~I_{in},~I_{out}~and~R_{in}$

* H:\Academics\BITS\Year 4\4 - Semester 2\Analog Electronics\Labs\Lab 2\ASC Files\Darlington\Darlington ×				
AC Analysis				
frequency:	1000	Hz		
V(n001):	mag:	0.1 phase:	0°	voltage
V(vc):	mag:	0 phase:	O°	voltage
V(vin):	mag:	0.0625802 phase: 0	.0341055°	v oltage
V(ve):	mag:	0.0614999 phase: 0	.0329515°	v oltage
V(vout):	mag:	0.0614997 phase:	0.195789°	voltage
V(n002):	mag:	0.0625803 phase: -0	.0204208°	voltage
V(n003):	mag:	0.0620401 phase: 0	.0335335°	voltage
Ic(Q2):	mag:	2.64864e-005 phase:	0.0998003°	device current
Ib(Q2):	mag:	2.64864e-007 phase:	0.0998003°	device current
Ie(Q2):	mag:	2.67513e-005 phase:	-179.9°	device current
Ic(Q1):	mag:	2.62242e-007 phase:	0.0998003°	device current
Ib(Q1):	mag:	2.62248e-009 phase:	0.0997987°	device current
Ie(Q1):	mag:	2.64864e-007 phase:	-179.9°	device current
I(C2):	mag:	3.74197e-006 phase:	-179.966°	device current
I(C1):	mag:	1.09821e-005 phase:	-179.804°	device_current
I(R5):	mag:	3.74197e-006 phase:	-179.966°	device current
I(R4):	mag:	1.09821e-005 phase:	0.195789°	device current
I(R3):	mag:	1.57692e-005 phase:	0.0329515°	device current
I(R2):	mag:	1.33149e-006 phase:	0.0341055°	device current
I(R1):	mag:	2.40786e-006 phase:	-179.966°	device current
I(V2):	mag:	2.43408e-005 phase:	-179.894°	device_current
I(V1):	mag:	3.74197e-006 phase:	-179.966°	device_current

Figure 2.4 – Darlington Configuration: .ac results from Figure 3

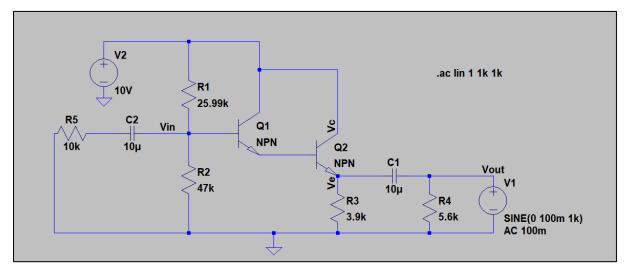


Figure 2.5 – Darlington Configuration: Rout calculation

frequency:	1000	Hz		
V(vout):	maq:	0.1 phase:	0°	voltage
V(vc):	mag:	0 phase:	0°	voltage
V(vin):	mag:	0.00139338 phase:	21.3632°	voltage
V(ve):	mag:	0.0930927 phase:	21.4194°	voltage
V(n001):	mag:	0.00139338 phase:	21.4544°	voltage
V(n002):	mag:	0.047243 phase:	21.4186°	voltage
Ic(Q2):	mag:	0.00224822 phase:	-158.58°	device current
Ib(Q2):	mag:	2.24822e-005 phase:	-158.58°	device current
Ie(Q2):	mag:	0.0022707 phase:	21.4203°	device current
Ic(Q1):	mag:	2.22596e-005 phase:	-158.58°	device current
Ib(Q1):	mag:	2.22596e-007 phase:	-158.58°	device current
Ie(Q1):	mag:	2.24822e-005 phase:	21.4203°	device current
I(C2):	mag:	1.39338e-007 phase:	21.4544°	device current
I(C1):	mag:	0.00229457 phase:	21.4203°	device current
I (R5):	mag:	1.39338e-007 phase:	21.4544°	device current
I(R4):	mag:	1.78571e-005 phase:	0°	device current
I(R3):	mag:	2.38699e-005 phase:	21.4194°	device current
I (R2):	mag:	2.96464e-008 phase:	21.3632°	device current
I(R1):	mag:	5.36121e-008 phase:	-158.637°	device current
I(V2):	mag:	0.00227053 phase:	21.4203°	device_current
I(V1):	mag:	0.00231121 phase:	-158.741°	device current

Figure 2.6 – Darlington Configuration: R_{out} calculation as obtained from .ac analysis

Table 2.1 - Results Summarized for Darlington Configuration

Quantities to be determined	Values obtained
V _{in}	0.0625802 V
V_{out}	0.0614997 V
$ m I_{in}$	3.74197 μΑ
I _{out}	10.9821 μΑ
$A_{ m v}$	0.9827
R _{in}	16.724 kΩ
R _{out}	43.26737 Ω

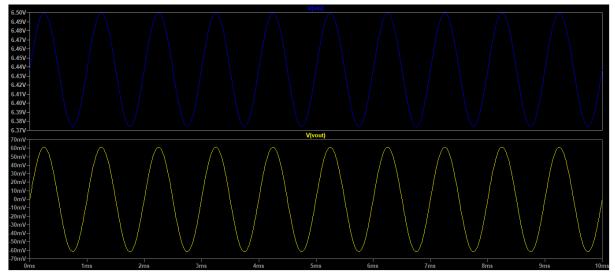


Figure 2.7 – Output Waveform

3. Bootstrap Configuration

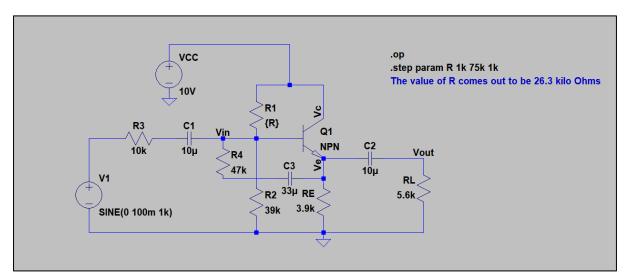


Figure 3.1 – Bootstrap Configuration: Determination of R₁

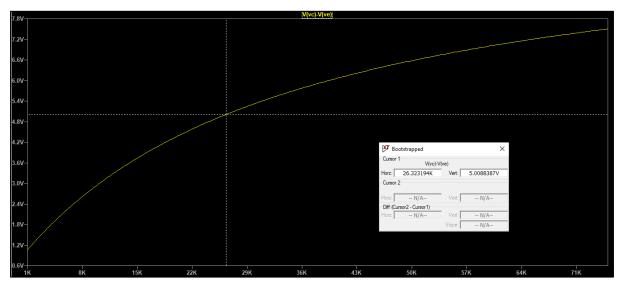


Figure 3.2 – Bootstrap Configuration: R_{1} such that $V_{C}-V_{E}= \frac{V_{cc}}{2}$

For the desired operating point (V $_{C}$ – V $_{E}$ = $^{\mbox{V}_{cc}}\!/_{2}$), R_{1} came out to be 26.323 k $\!\Omega$.

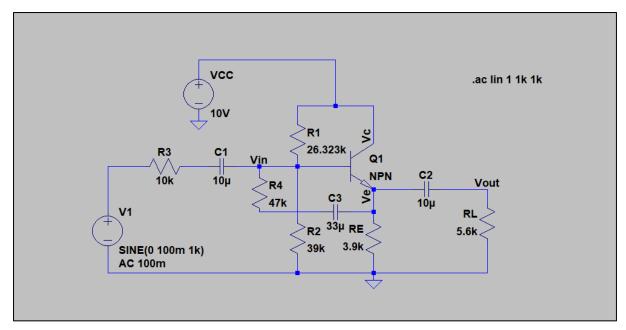


Figure 3.3 - Bootstrap Configuration: Circuit for the determination of Vin, Vout, Iin, Iout and Rin

```
🍠 * H:\Academics\BITS\Year 4\4 - Semester 2\Analog Electronics\Labs\Lab 2\ASC Files\Bootstrap\Bootstrapp...
        --- AC Analysis ---
frequency:
               1000
                               Ηz
V(vc):
               mag:
                              0 phase:
                                                  O°
                                                              voltage
V(n001):
                                                  o°
               mag:
                            0.1 phase:
                                                              voltage
V(vin):
                      0.0594943 phase:
                                         0.0351749°
                                                              voltage
               mag:
V(n002):
                      0.0594943 phase: -0.0269097°
                                                              voltage
               mag:
V(ve):
                       0.058976 phase:
                                         0.0345926°
                                                              voltage
               mag:
V(vout):
                      0.0589758 phase:
                                           0.19743°
                                                              voltage
               mag:
V(n003):
                       0.058976 phase:
                                         0.0345409°
               mag:
                                                              voltage
               mag: 2.53885e-005 phase:
                                                              device current
Ic(Q1):
                                            0.101439°
               mag: 2.53885e-007 phase:
Ib (Q1):
                                            0.101439°
                                                              device current
               mag: 2.56424e-005 phase:
Ie(Q1):
                                            -179.899°
                                                              device current
               mag: 1.10271e-008 phase:
I(C3):
                                            -179.893°
                                                              device current
I(C2):
               mag: 1.05314e-005 phase:
                                            -179.803°
                                                              device current
                                                              device current
I(C1):
               mag: 4.05057e-006 phase:
                                             -179.96°
I(R4):
               mag: 1.10271e-008 phase:
                                            0.107318°
                                                              device current
               mag: 2.26016e-006 phase:
                                            -179.965°
I(R1):
                                                              device current
               mag: 1.05314e-005 phase:
                                            -179.803°
I(R1):
                                                              device current
               mag: 1.51221e-005 phase:
I(Re):
                                            -179.965°
                                                              device current
               mag: 4.05057e-006 phase:
I(R3):
                                             -179.96°
                                                              device current
               mag: 1.52549e-006 phase:
I(R2):
                                           0.0351749°
                                                              device_current
I(V1):
               mag: 4.05057e-006 phase:
                                             -179.96°
                                                              device_current
I(Vcc):
               mag: 2.31283e-005 phase:
                                            -179.892°
                                                              device_current
```

Figure 3.4 – Bootstrap Configuration: .ac results from Figure 3

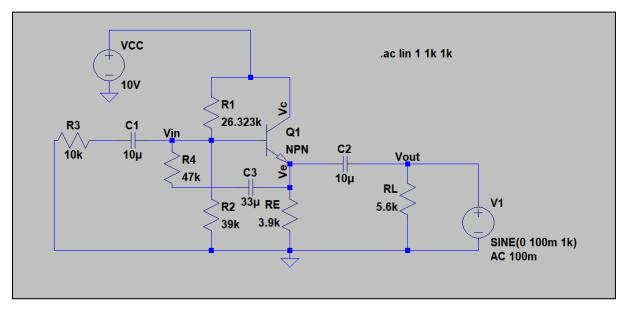


Figure 3.5 – Bootstrap Configuration: Rout calculation

🍠 * H:\Academics\BITS\Year 4\4 - Semester 2\Analog Electronics\Labs\Lab 2\ASC Files\Bootstrap\Bootstrapp... --- AC Analysis ---1000 frequency: Ηz n۰ V(vc): mag: 0 phase: voltage o° 0.1 phase: V(vout): mag: voltage 0.0743383 phase: 11.0256° V(vin): mag: voltage V(n001): 0.0743382 phase: 11.1168° mag: voltage 0.0981359 phase: 11.0391° V(ve): mag: voltage V(n002): 0.0981359 phase: 11.0405° mag: voltage mag: 0.00116577 phase: -168.919° Ic(Q1): device current mag: 1.16577e-005 phase: -168.919° Ib(Q1): device_current mag: 0.00117742 phase: 11.0811° Ie(Q1): device_current mag: 5.06333e-007 phase: 11.087° I(C3): device_current I(C2): mag: 0.00120309 phase: 11.0802° device_current mag: 7.43382e-006 phase: 11.1168° I(C1): device_current mag: 5.06333e-007 phase: -168.913° I(R4): device_current mag: 2.82408e-006 phase: -168.974° I(R1): device_current mag: 1.78571e-005 phase: 180° I(R1): device_current mag: 2.51631e-005 phase: -168.961° I(Re): device_current mag: 7.43382e-006 phase: 11.1168° I(R3): device_current mag: 1.90611e-006 phase: 11.0256° I(R2): device_current mag: 0.00122062 phase: -169.081° I(V1): device_current I(Vcc): mag: 0.00116859 phase: 11.081° device_current

Figure 3.6 – Bootstrap Configuration: Rout calculation as obtained from .ac analysis

Table 3.1 - Results Summarized for Bootstrap Configuration

Quantities to be determined	Values obtained
V _{in}	0.0594943 V
V _{out}	0.0589758 V
I_{in}	4.057 μΑ
I _{out}	10.5314 μΑ
$A_{\rm v}$	0.9913
R _{in}	14.688 kΩ
R _{out}	81.9255 Ω

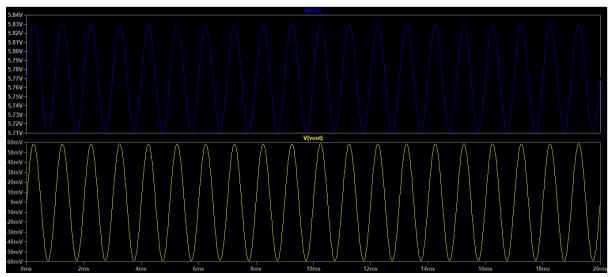


Figure 3.7 – Output Waveform