Calculations

Pre lab 7 Calculations

Jason Gilmer
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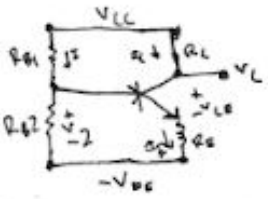
1) NPN



$V_2 = \frac{R_B}{R_{B1}+R_{B2}}(V_{CC}+V_{BE})$ $\quad I_C = \frac{V_2-.7}{R_E}$

$I_B = \frac{I_C}{\beta}$ $\quad I_{R_{B1}} = \frac{V_{CC}+V_{EE}}{R_{B1}+R_{B2}}$

$V_{CE} = V_{CC} + V_{EE} - I_C(R_C+R_E)$

$R_C = \frac{V_{CC}-V_i}{I_C} = \frac{5-3.5}{.001} = 1.5\text{K}\Omega$ $\quad R_E = \frac{2}{.00101} = 1.98\text{K}\Omega$

$I_B = \frac{.001}{106} = .01\text{ mA}$ $\quad V_2 = .7+2 = 2.7\text{V}$

$V_C = 3.5\text{V} - 1.5\text{V} = 2\text{V}$

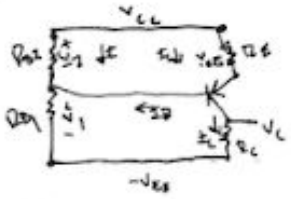
$V_1 = 5-2.7 = 2.3\text{V}$

$I_E = .01+1 = 1.01\text{ mA}$

$R_{B1} = 23\text{K}\Omega$

$R_{B2} = 2.7\text{K}\Omega$

PNP



$R_C = 1.5\text{K}\Omega$

$I_B = .01\text{mA}$

$I_E = 1.01\text{mA}$

$V_{RE} = 5-1.5-1.5 = 2\text{V}$

$R_E = 2/1.01\text{mA} = 1.98\text{K}\Omega$

$V_2 = .7+2 = 2.7\text{V}$

$V_1 = 5-2.7 = 2.3\text{V}$

$I = 2-1.01 = .99\text{mA}$

$R_{B2} = \frac{2.7}{.99} = 2.7\text{K}\Omega$

$R_{B1} = \frac{2.3}{.001} = 2.3\text{K}\Omega$

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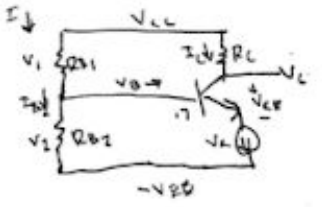
2) NPN



$-V_{CC} + I_C R_C + V_C$

$-5 + .002\, R_C + 3.5 = 0$

$R_C = \frac{1.5}{.002} = .75 k\Omega$

$I_B = \frac{2mA}{100} = 20\,\mu A$

$R_2 = R_1 = 100\Omega$

$R_3 = \frac{2.7 - .7}{2.020mA}$

$R_3 = 891.089$

$I_E = 2mA + 20\mu A = 2.020mA$

$V_x = 1.9V$

$V_2 = .7 + 1.5V = 2.2V$

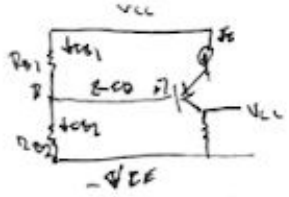
$V_C = 3.5 - 1.5 = 2V$ $\quad V_1 = 2.9V$

$I_{supply} = 5mA - 2mA = 3mA$

$R_{B1} = \frac{2.9}{.003} = .933 k\Omega$ $\quad R_{B2} = \frac{2.2}{2.48m} = .89 k\Omega$

$I_{B2} = I - I_B = 2.5mA - 20\mu A = 2.48mA$

2) PNP



$R_C = \frac{1.5}{.002} = .75 k\Omega$

$I_B = I_C/\beta = \frac{2mA}{100} = 20nA$

$I_E = 2mA + 20\mu A = 2.020\,mA$

$V_{EC} = 5 - 1.5 - 1.5 = 3V$

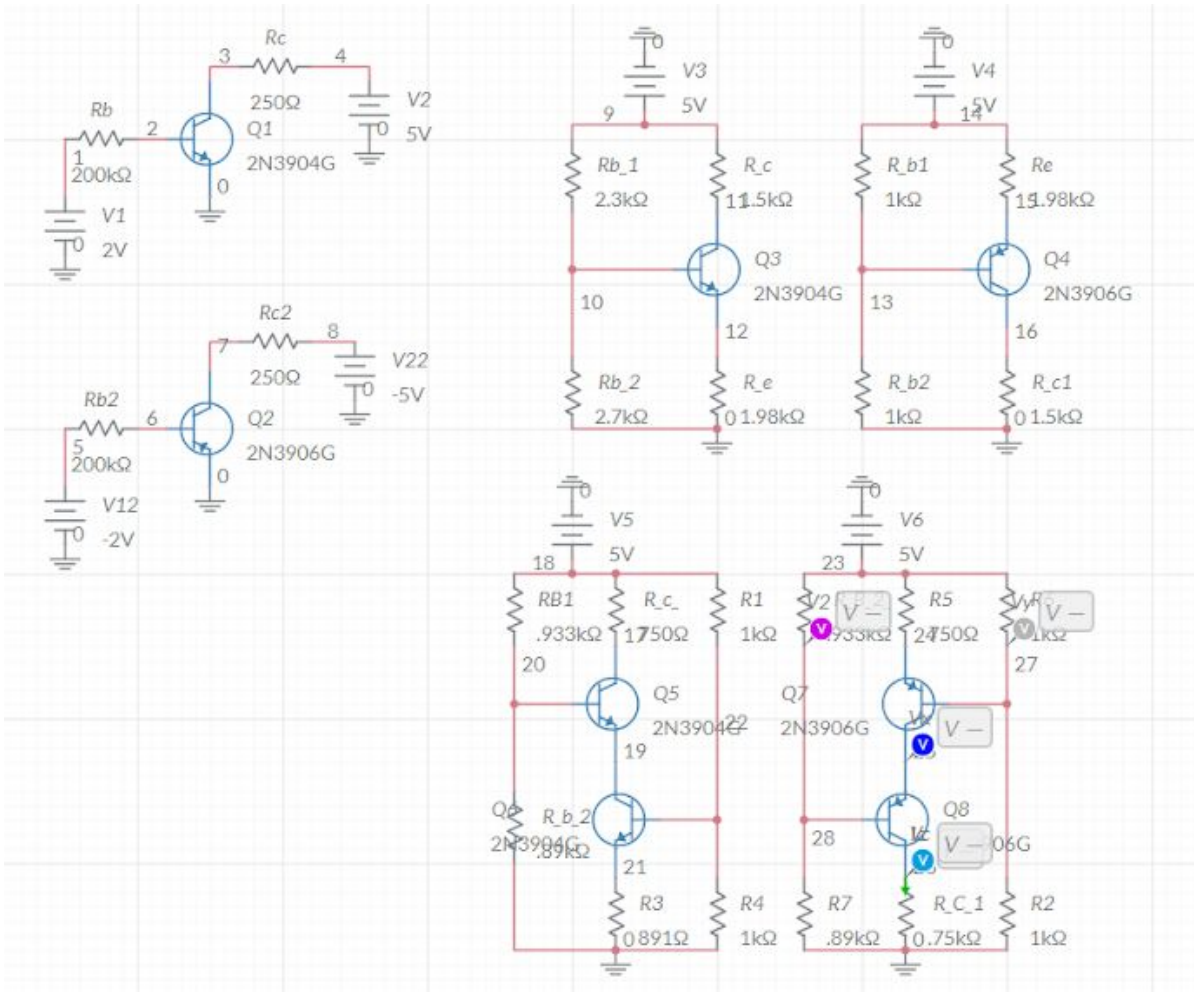
$V_2 = .7 + 1.5 = 2.2V$

$V_1 = 2.9V$

$I_{supp} = $ [redacted] $+ I_C = 3mA$

$I_{B2} = 2.48mA$ $\quad R_{01} = .89 k\Omega$ $\quad R_{B2} = .933 k\Omega$

Simulations



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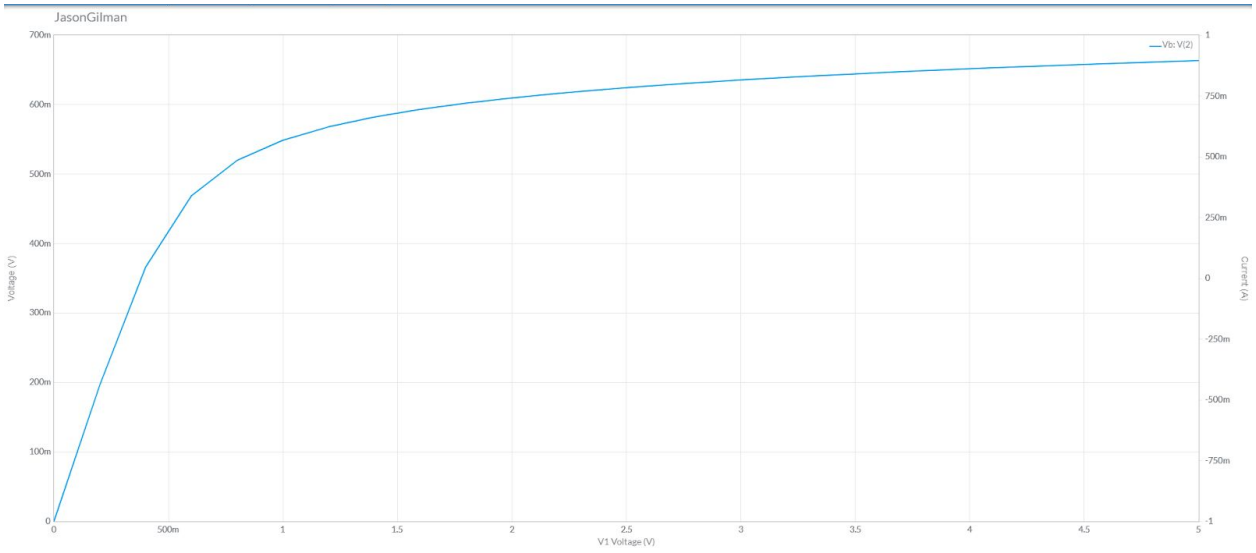
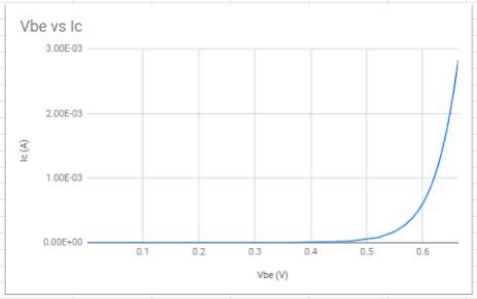
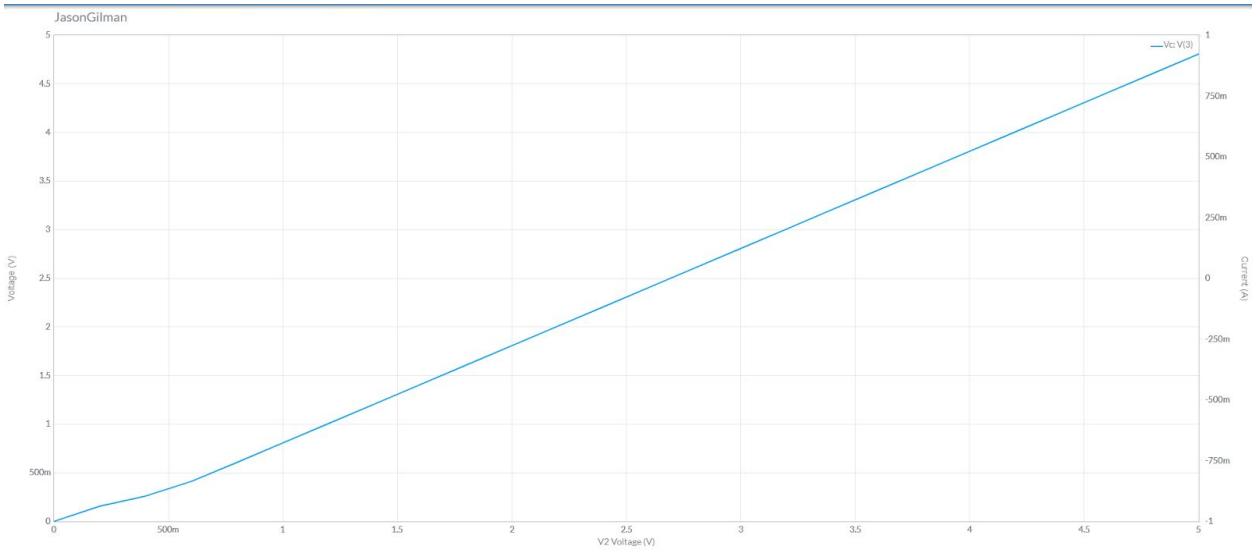
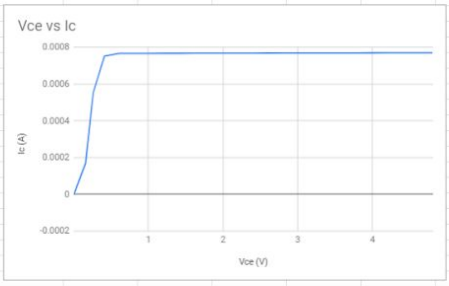


DC Sweep: VOLTAGE	Vb	DC Sweep: VOLTAGE	Vc	Vbe	Ic
0	0.0004603274109	0	4.999999386	0.0004603274109	2.45E-09
0.2	0.1963337704	0.2	4.99999451	0.1963337704	2.20E-08
0.4	0.3661667912	0.4	4.999616107	0.3661667912	0.000001536755004
0.6	0.4688959237	0.6	4.994648358	0.4688959237	0.00002140979234
0.8	0.5198955766	0.8	4.980238014	0.5198955766	0.0000790599402
1	0.5489340812	1	4.958505316	0.5489340812	0.0001659796996
1.2	0.5681946667	1.2	4.932281572	0.5681946667	0.0002709399032
1.4	0.5822774825	1.4	4.903232511	0.5822774825	0.0003870783043
1.6	0.5932665597	1.6	4.872337334	0.5932665597	0.0005106521644
1.8	0.6022190256	1.8	4.840185594	0.6022190256	0.0006392579851
2	0.6097645641	2	4.807174464	0.6097645641	0.0007717735922
2.2	0.6162273888	2.2	4.773535434	0.6162273888	0.0009061797751
2.4	0.6218891357	2.4	4.739475126	0.6218891357	0.001042298211
2.6	0.6269212037	2.6	4.705129293	0.6269212037	0.001179619481
2.8	0.6314443723	2.8	4.670598564	0.6314443723	0.001317703895
3	0.6355488371	3	4.635960281	0.6355488371	0.001456231209
3.2	0.6393032665	3.2	4.601274516	0.6393032665	0.001594956511
3.4	0.6427610036	3.4	4.56658845	0.6427610036	0.001733688225
3.6	0.6459642581	3.6	4.531939491	0.6459642581	0.001872274976
3.8	0.6489469686	3.8	4.49735751	0.6489469686	0.002010596178
4	0.6517368084	4	4.462866491	0.6517368084	0.002148555189
4.2	0.6543566231	4.2	4.428485759	0.6543566231	0.002286074236
4.4	0.6568254806	4.4	4.394230915	0.6568254806	0.002423090595
4.6	0.6591594538	4.6	4.360114554	0.6591594538	0.002559553662
4.8	0.6613722107	4.8	4.326146827	0.6613722107	0.002695422676
5	0.6634754674	5	4.292335882	0.6634754674	0.00283066493





DC Sweep: VOLTAGE	Vc	DC Sweep: VOLTAGE	Ic	Vce	Ic
0	0.0005048977192	0	-0.000002019590877	0.0005048977192	-0.000002019590877
0.2	0.1576420515	0.2	0.000169431794 2	0.1576420515	0.000169431794 2
0.4	0.2613662902	0.4	0.000554534839	0.2613662902	0.000554534839
0.6	0.4117900616	0.6	0.000752839753 8	0.4117900616	0.000752839753 8
0.8	0.608117892	0.8	0.000767528432 1	0.608117892	0.000767528432 1
1	0.8079882148	1	0.000768047140 8	0.8079882148	0.000768047140 8
1.2	1.007941876	1.2	0.000768232497 6	1.007941876	0.000768232497 6
1.4	1.207900789	1.4	0.000768396843 5	1.207900789	0.000768396843 5
1.6	1.407859737	1.6	0.000768561051 1	1.407859737	0.000768561051 1
1.8	1.607818686	1.8	0.000768725254 7	1.607818686	0.000768725254 7
2	1.807777635	2	0.000768889458 4	1.807777635	0.000768889458 4
2.2	2.007736585	2.2	0.000769053662	2.007736585	0.000769053662
2.4	2.207695534	2.4	0.000769217865 6	2.207695534	0.000769217865 6
2.6	2.407654483	2.6	0.000769382069 2	2.407654483	0.000769382069 2
2.8	2.607613432	2.8	0.000769546272 8	2.607613432	0.000769546272 8
3	2.807572381	3	0.000769710476 4	2.807572381	0.000769710476 4
3.2	3.00753133	3.2	0.000769874680	3.00753133	0.000769874680
3.4	3.207490279	3.4	0.000770038883 7	3.207490279	0.000770038883 7
3.6	3.407449228	3.6	0.000770203087 3	3.407449228	0.000770203087 3
3.8	3.607408177	3.8	0.000770367290 9	3.607408177	0.000770367290 9
4	3.807367126	4	0.000770531494 5	3.807367126	0.000770531494 5
4.2	4.007326075	4.2	0.000770695698 1	4.007326075	0.000770695698 1
4.4	4.207285025	4.4	0.000770859901 8	4.207285025	0.000770859901 8
4.6	4.407243974	4.6	0.000771024105 4	4.407243974	0.000771024105 4
4.8	4.607202923	4.8	0.000771188309	4.607202923	0.000771188309
5	4.807161872	5	0.000771352512 6	4.807161872	0.000771352512 6



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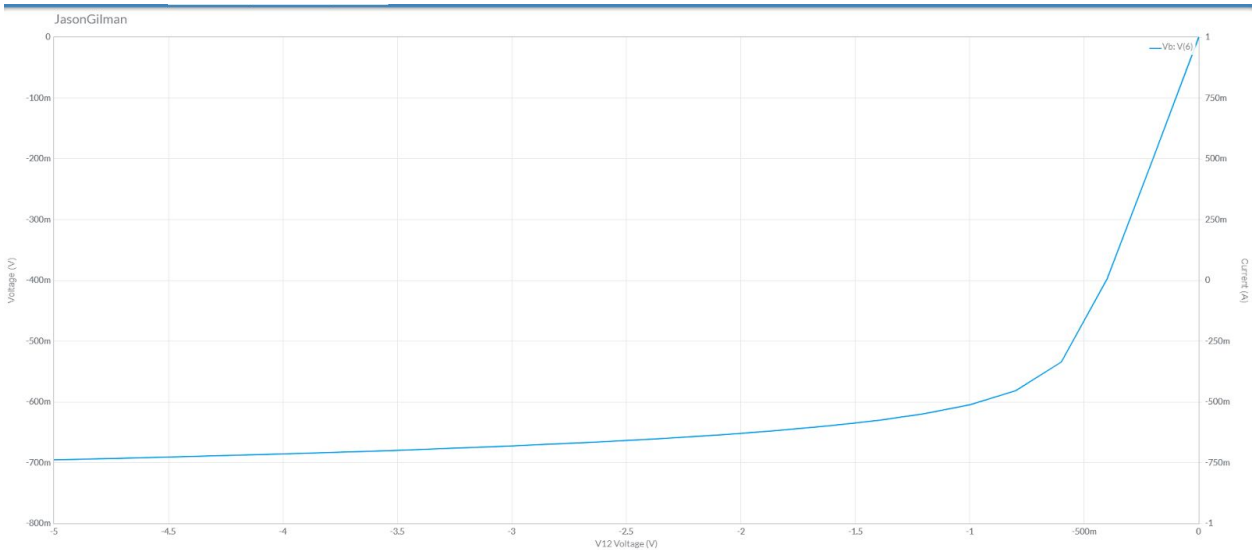
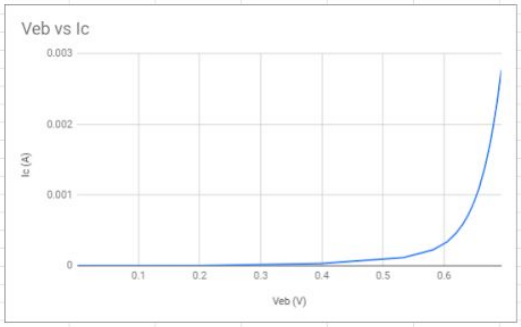
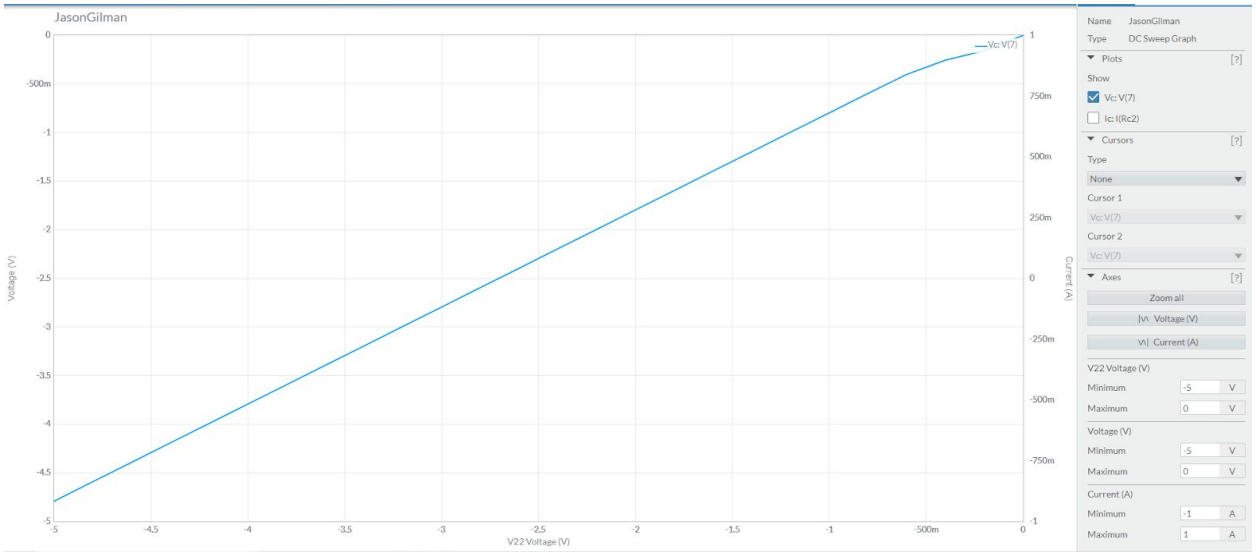
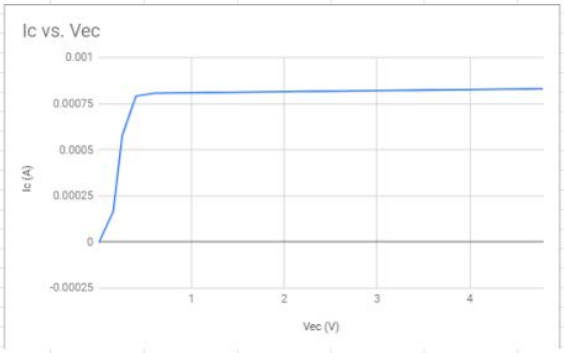


	DC Sweep: VOLTAGE	Vb	Veb	temp	Ic
2	-5	-0.6954383451	0.6954383451	-0.002766605834	0.002766605834
3	-4.8	-0.6936746566	0.6936746566	-0.002638302783	0.002638302783
4	-4.6	-0.6918237232	0.6918237232	-0.002509750404	0.002509750404
5	-4.4	-0.6898764021	0.6898764021	-0.00238096856	0.00238096856
6	-4.2	-0.6878222614	0.6878222614	-0.00225198073	0.00225198073
7	-4	-0.685649006	0.685649006	-0.002122814131	0.002122814131
8	-3.8	-0.6833421031	0.6833421031	-0.001993500642	0.001993500642
9	-3.6	-0.680884208	0.680884208	-0.001864077817	0.001864077817
10	-3.4	-0.6782543926	0.6782543926	-0.001734590196	0.001734590196
11	-3.2	-0.6754270922	0.6754270922	-0.001605091028	0.001605091028
12	-3	-0.6723706349	0.6723706349	-0.001475644581	0.001475644581
13	-2.8	-0.6690451439	0.6690451439	-0.001346329324	0.001346329324
14	-2.6	-0.6653994582	0.6653994582	-0.001217242376	0.001217242376
15	-2.4	-0.661366473	0.661366473	-0.00108850597	0.00108850597
16	-2.2	-0.6568558189	0.6568558189	-0.0009602770988	0.0009602770988
17	-2	-0.6517418421	0.6517418421	-0.000832762576	0.000832762576
18	-1.8	-0.6458427777	0.6458427777	-0.0007062436844	0.0007062436844
19	-1.6	-0.6388821772	0.6388821772	-0.0005811191095	0.0005811191095
20	-1.4	-0.6304111401	0.6304111401	-0.0004579857633	0.0004579857633
21	-1.2	-0.6195641804	0.6195641804	-0.0003378924818	0.0003378924818
22	-1	-0.6047478673	0.6047478673	-0.0002225360974	0.0002225360974
23	-0.8	-0.5816694225	0.5816694225	-0.0001159231995	0.0001159231995
24	-0.6	-0.5342151252	0.5342151252	-0.00003026126773	0.00003026126773
25	-0.4	-0.3976899004	0.3976899004	-6.32E-07	6.32E-07
26	-0.2	-0.2001248104	0.2001248104	-3.12E-09	3.12E-09
27	0	-0.0001536717604	0.0001536717604	-7.92E-10	7.92E-10





	DC Sweep: VOLTAGE	Vc	Vec	Ic
2	-5	-4.791807748	4.791807748	0.0008327689978
3	-4.8	-4.592099323	4.592099323	0.0008316027433
4	-4.6	-4.392388528	4.392388528	0.0008304458773
5	-4.4	-4.192678919	4.192678919	0.0008292843171
6	-4.2	-3.992969309	3.992969309	0.0008281227569
7	-4	-3.793259699	3.793259699	0.0008269611967
8	-3.8	-3.593550089	3.593550089	0.0008257996365
9	-3.6	-3.393840479	3.393840479	0.0008246380764
10	-3.4	-3.194130869	3.194130869	0.0008234765162
11	-3.2	-2.994421259	2.994421259	0.0008223149561
12	-3	-2.79471165	2.79471165	0.000821153396
13	-2.8	-2.59500204	2.59500204	0.000819991836
14	-2.6	-2.39529243	2.39529243	0.0008188302759
15	-2.4	-2.19558282	2.19558282	0.0008176687159
16	-2.2	-1.99587321	1.99587321	0.0008165071559
17	-2	-1.7961636	1.7961636	0.0008153455959
18	-1.8	-1.59645399	1.59645399	0.000814184036
19	-1.6	-1.39674438	1.39674438	0.000813022476
20	-1.4	-1.19703477	1.19703477	0.0008118609161
21	-1.2	-0.9973251843	0.9973251843	0.0008106992608
22	-1	-0.7976168705	0.7976168705	0.0008095325162
23	-0.8	-0.5979789813	0.5979789813	0.0008080841213
24	-0.6	-0.4019141439	0.4019141439	0.0007924650849
25	-0.4	-0.2551533671	0.2551533671	0.0005794895192
26	-0.2	-0.1582328386	0.1582328386	0.0001671173595
27	0	-0.001306749915	0.001306749915	-0.00000522673839



NPN Resistive DC Biasing

JasonGilman

Signal	Value
Vc: V(11)	3.4472V
Vre: V(12)	2.0672V
V2: V(10)	2.6890V
Ic: I(R_c)	1.0352mA

PNP Resistive DC Biasing

JasonGilman

Signal	Value
Vc: V(16)	1.3826V
Vre: V(15)	3.1599V
V2: V(13)	2.5038V
Ic: I(Q4:C)	921.76µA

NPN DC Biasing

JasonGilman

Signal	Value
Vc: V(17)	3.7322V
Vx: V(19)	1.7930V
V2: V(20)	2.4349V
Vy: V(22)	2.3803V
Ic: I(R_c_)	1.6905mA

PNP DC Biasing

JasonGilman

Signal	Value
Vc: V(26)	1.6479V
Vx: V(25)	3.1367V
V2: V(28)	2.4490V
Vy: V(27)	2.5592V
Ic: I(Q8:C)	2.1972mA