Example Problem Set 1

1. (a)
$$I_{CC} = I_{C2} = 0.5mA$$

$$g_m = \frac{1}{52\Omega}$$

$$\frac{\Delta V_o}{\Delta V_i} = -g_m R_L = -\frac{2000}{52} = -38.5$$

$$R_i = 2r_{\pi 1} = 2\frac{\beta_o}{g_m} = 200 \times 52 = 10.4K\Omega$$

Large signal
$$V_o = (I_{C2} - I_{C1})R_L$$

$$= \alpha_F I_{EE} R_L \tanh\left(\frac{-V_{id}}{2V_T}\right)$$

$$\cong 2 \tanh\left(\frac{-V_{id}}{52mV}\right)$$

(b)
$$HD_{3} = \frac{1}{48} \left(\frac{\hat{V}_{i}}{V_{T}}\right)^{2}$$

$$\hat{V}_{i} = 4mV \rightarrow HD_{3} = \frac{1}{48} \left(\frac{4}{26}\right)^{2} = 0.05\%$$

$$\hat{V}_{i} = 8mV \rightarrow HD_{3} = 0.2\%$$

(c)
$$Im_3 = 3HD_3 = \frac{1}{16} \left(\frac{\hat{V}_i}{V_T}\right)^2 = 0.02$$

 $\therefore \hat{V}_i = 14.7mV$

2. (a) Bias
$$I_C = \frac{V_{CC} - V_{BE}}{R_L} = \frac{5 - 0.8}{5K} = 0.84 mA$$

$$\frac{v_o - v_i}{R_F} + g_m v_i + \frac{v_o}{R_L} = 0$$

$$\therefore v_o \left(\frac{1}{R_F} + \frac{1}{R_L} \right) = -v_i \left(g_m - \frac{1}{R_F} \right)$$

$$\therefore \frac{v_o}{v_i} \cong -g_m (R_L \parallel R_F)$$

$$= -\frac{0.84}{26} \times 2500 = -81$$

$$\begin{split} R_i &= r_{\pi} \, \| \, \frac{R_F}{1 + A_{\nu}} \\ &= \frac{100 \times 26}{0.84} \, \| \, \frac{5000}{82} \\ &= 3.1 K \, \| \, 61 \Omega \\ &= 60 \Omega \end{split}$$

(b)
$$\hat{V}_i = 4\text{mV}$$
 $HD_3 = \frac{1}{24} \left(\frac{\hat{V}_i}{V_T}\right)^2 = \frac{1}{24} \left(\frac{4}{26}\right)^2 = 0.1\%$ $HD_2 = \frac{1}{4} \frac{\hat{V}_i}{V_T} = 3.8\%$

$$\hat{V}_i = 8 \text{mV}$$
 $HD_3 = 0.4\%$ $HD_2 = 7.7\%$

(c)
$$Im_3 = \frac{1}{8} \left(\frac{\hat{V}_i}{V_T}\right)^2$$

= 0.02
for $\hat{V}_i = 10.4 mV$

EFCS 142 P.S.1 SOLN.

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3.7777n
2.6965u
3.8019n
                                                                                                                                                                                                                                                                                                                                                                                                                          1.0000x 306.4153m
2.0000x 3.7632n
3.0000x 620.5145u
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         5.0000x
6.0000x
                                                                                                                                                                                                                                                                                                                                                                                                                                                              4.0000x
                                                                                                                                                                                                                                                                                                                          = -5.0000
                                                                                                                                                                                                                                                                                                                                                                          simulation time is
                                                                                                                                                                                                                                                                                                                                                                                                    5.0000 0:vee
4.0099 0:vo-
                                                                                                                                       vin 0 0 ac (1 0) sin (0 4m 1e6)
                                                                                                                                                                                                                                                                                       vin 0 0 ac (1 0) sin (0 8m 1e6)
                                                                                                                                                                                                                                                                                                                                                                           **** operating point status is all
                                                                                                                                                                                                                                                                                                                                                                                                      11 11
                                                                                                                                                                                                                                                                                                                                                                                                                                         **** bipolar junction transistors
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0:npn
4.9505u
. Hwl, 1: Differential amplifier
                                                                                                                                                              npn npn bf=100 is=1e-16
                                                                                                                                                                                                                                                                                                                                                                                                    =-750.9857m 0:vcc
= 0. 0:vo+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 0:92
                                                                                                                                                                                                               v(vo+,vo-) vin
vin -0.2 0.2 .01
                                                                                                                                                                                                                                                    1e6 v (vo+, vo-)
                                                                          vo+ vin 1 npn
                                                                                      vc- 0 1 npn
vcc vo+ 2k
vcc vo- 2k
                                                                                                                                                                                       option post=2 nomod
                                                                                                                                                                                                                                        .001u 4u
                         vcc 0 5
                                                 1 vee 1m
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  0:91
                                                                                                                                                                                                                                                                                                                                        * Output file
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   element
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model.

188

. four

vin

do do

hw1.1.lis

loj ******	fourier analysis	sis	nalysis tnom= 25.	tnom= 25.000) temp= 25.000

fourier components of	onents of	sient	response v(v	(-oa ' +oa) a	
nen	C = 9.113D-10	D-10	Parel Land	- Parke	Post I say
nic	t requency	fourier	normalized	phase	pheno ideal
ou	(hz)	component	component	(ded)	pnase (deg)
1	1.0000x	153.9011m	1.0000	179.9992	0.
2	2.0000x	1.8250n	11.8583n	124.9733	-55.0258
3	3.0000x	80.4130u	522.4976u	-179.0223	-359.0215
4	4.0000x	1.8320n	11.9040n	159.9491	-20.0501
5	5.0000x	719.5668n	4.6755u	-133.2519	-313.2511
9	6.0000x	1.8438n	11.9805n	-165.0701	-345.0693
7	7.0000x	278.7932n	1.8115u	-103.2556	254
8	8.0000x	1.8604n	12.0884n	-130.0821	0.081
6	9.0000x	150.0341n	974.8730n	-73.9375	-253.9366
total h	harmonic dis	distortion =	52.2523m	percent	
:		***************************************		***************************************	*****
* Alter file					
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vin vin 0	0 ac (1	0) sin (0 81	8m 186)		
715					
	fourier analysis	/sis	tr	tnom= 25.00	25.000 temp= 25.000
fourier con	onent		response V(Vo+, Vo-	1-04'+0/	
de component		60-02	Land I amen	- head	normalitad
narmonic	(hz)	component	component	(deg)	phase (deg)
	,	200		170 0001	•
	1.0000x	306.41538		124 6756	-55 0236
2	2.0000x		77	124.919	0070.000
3	3.0000x	62			-359.747
4	4.0000x	3	12	159.9537	
5		2	8		
9		3	-		
7	7.0000x	583	1	-104.2633	-284
80	8.0000x	3.	12.		-31
6	9.0000x	311.5393n		-74.3902	-254.3893

750.9857m 4.7609 -4.0099

495.0495u

4.9505u

ndu:0

model

1b 1c vbe

+0:vin

2.3606m

495.0495u 750.9877m 4.7609 -4.0099 -4.0099 2.3606m 10.0000 19.2687m 5.1898k

100.0000

vs power betad gm rpi

19.2687m 5.1898k

4.009e+16

4.0098+16

LX

cpi cmu cbx

percent

202.5097m

total harmonic distortion =

-38.5375 10.3795k 4.0000k

. . .

output resistance at V(vo+,vo-)

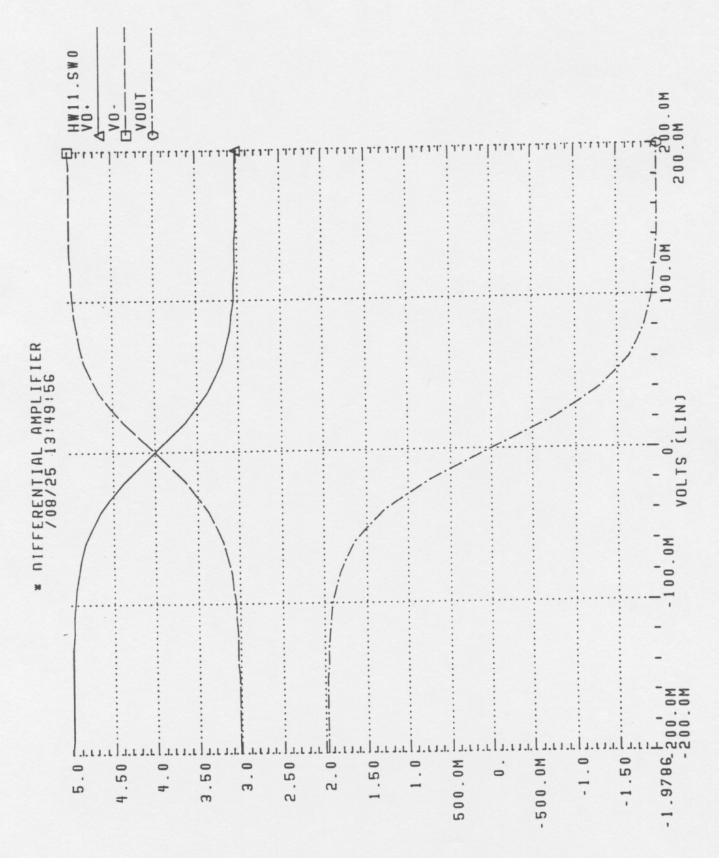
v (vo+, vo-) /vin

small-signal transfer characteristics

3.0668+12 3.0668+12

100.0000

100.0000



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= 805.8072m
                                                                                                                                                                                                                                                                           * Output [1]e
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                                                                                                                                                                                                                                                                                                                              = 764.2789m 0:Vout
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         small-signal transfer characteristics
                                                                                                            * Note: the capacitor can be ignored at f=1Mhz
                                                                                                                                                                                                                          vin vin 0 764.2789m sin(764.2789m 8m 1e6)
                                                                                        vin 0 764.2789m sin(764.2789m 4m 1e6)
                                                                                                                                                                                                                                                                                                           ***** operating point status is all
                                                                                                                                                                                                                                                                                                                                                     **** bipolar junction transistors
                                                                                                                                 .model npn npn bf=100 is=1e-16
                                                                                                                                                                                                                                                                                                                                +0:vcc = 5.0000 0:vin
                                                                                                                                                                                                                                                                                                                                                                                                                 764.2789m
805.8072m
-41.5283m
-805.8072m
675.5970u
100.000
32.3267m
3.0934k
0.
                                                                        vout vin 0 npn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         5.145e+12
                                                                                                                                                                                                                                                                                                                                                                                              8.3053u
                                                                                                                                                                                                                                                                                                                                                                                                        830.5329u
                                                                                                                                                      option post=2 nomod
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                100.0000
                                        vec vout 5k
vout vin 5k
                                                                                                                                                                           v(vout) vin
                                                                                                                                                                                                 186 v (vout)
                                                                                                                                                                                       .001u 4u
* Hw1, problem 2
                                                                                                                                                                                                                                                                                                                                                                                      udu: 0
                    vcc 0 5
                                                                                                                                                                                                                                                                                                                                                                           element 0:q1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               gm
rpi
rx
ro
ro
cpi
cmu
cbx
ccs
                                                                                                                                                                                                                                                                                                                                                                                                                                                 vs
power
betad
                                                                                                                                                                                                                                                                                                                                                                                      model
                                                                                                                                                                                                                                                                                                                                                                                               1b
1c
vbe
vbc
                                                                                                                                                                                        tran.
                                                                                                                                                                                                  four.
                                                                                                                                                                                                                                                    end.
                                                                                              vin
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hw1,2.1is

Courier components of translent response v[vout]	*****					
dc component = 1/321-01 harmonic frequency fourier normalized phase normalized no (hz) component component (deg) phase (deg) 1 1.0000x 322.2146m 1.00000 179.9992 0. 2 2.0000x 12.6038m 39.1163m 90.0014 -89.9978 3 3.0000x 12.6038m 39.1163m 90.0014 -89.9978 4 4.0000x 12.6038m 39.1163m 90.0014 -89.9978 5 5.0000x 12.8040 15.81470 -99.4745 -279.4737 7 7.0000x 556.7984 1.17280u -113.9410 -111.9402 6 6.0000x 356.7987 1.7280u -113.9410 -111.9402 7 7.0000x 556.7987 1.7280u -113.9410 -111.9402 8 8.00000x 165.9884n 515.1487n -145.0233 -2281.0215 8 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 9 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 vin vin 0.764.2789m sin(764.2789m 8m 1e6) ******* fourier analysis trommalized phase normalized normalized normalized harmonic frequency fourier normalized phase (deg) no 1.0000x 637.0103m 1.0000 179.9991 0. 2.0000x 83.7109m 12.9958m 90.0310 -89.9992 2.0000x 83.7109m 12.9958m 90.0310 -89.9992 3.0000x 83.7109m 12.9958m 19.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.0000 179.9991 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	fourier c	onents of	slent	response v(v	out)	
harmonic frequency fourier normalized phase normalized no (hz) component component (dgg) phase (dgg) (hz) component component (dgg) phase (dgg) 2.2.146m 1.0000 179.9992 0. 2 2.0000x 322.2146m 39.1163m 90.014 -89.9978 3.0.0000x 320.7861u 99.5.665u -514.9512m -180.5141 4.0000x 32.2.056n 1.3909u 1.153u 1.311.9410 -311.9402 5.0000x 352.2055n 1.0931u 175.4571 -4.5420 7.0000x 556.7797n 1.7280u -103.0223 -228.0216 8.0000x 165.9884n 515.1487n -445.0923 -325.0914 9.0000x 302.355n 938.3671n -73.4462 -253.4454 5.0000x 302.355n 938.3671n -73.4462 -253.4454 9.0000x 302.355n 938.3671n -73.4462 -253.4454 c.cmponents of translant response v(vout) dcurier components of translant response v(vout) dcurier component component component (dgg) phase (dgg) harmonic frequency fourier normalized phase (dgg) harmonic frequency fourier normalized phase (dgg) phase (dgg) 3.0000x 8.2119m 12.9955m 90.0110 -89.9992 -99.9992 3.00000x 8.2719m 12.9955m 90.0110 -89.9645 -90.0110 -89.96419 90.0000x 2.4412m 3.8008m 179.9995 -90.0119 -90.0199 90.0019 90.0000x 2.28.1506u 358.1585u -543.1837m -180.5423	de compon	11	D-01			
1 1.0000x 322.2146m 1.0000 179.9992 0. 2 2.0000x 12.6038m 39.1163m 90.0014 -89.9978 3 2.0000x 12.6038m 19.1163m 90.0014 -89.9978 5 5.0000x 12.6038m 19.1163m 90.0014 -89.9978 5 5.0000x 12.6038m 19.1163m 90.0014 -89.9978 6 6.0000x 15.2095n 1.0903u 1.15.4010 -311.9402 6 6.0000x 155.2095n 1.0910u 175.4571 -4.5420 7 7.0000x 155.9884n 1.17280u -103.0223 -283.0215 8 8.0000x 165.9884n 1.17280u -103.0223 -283.0215 8 8.0000x 165.9884n 1.17280u -103.0223 -253.4454 9 9.0000x 165.9884n 18.3671n -71.4462 -253.4454 vin vin 0 764.2789m sin (764.2789m 8m 1e6) ****** fourier analysis toutler components of translent response v(vout) dc component = 7.620D-01 harmonic frequency fourier normalized phase normalized harmonic frequency fourier component compo	harmonic	frequency	fourier	normalized	phase	normalized
1 1.0000x 322.2146m 1.0000 179.9992 0. 2 0.0000x 12.6038m 39.1163m 90.0014 -89.9988 4.0000x 320.7861u 15817u -99.4745 -279.4737 4.0000x 35.7861u 15817u -99.4745 -279.4737 5.0000x 15.909u 1.3165u -131.9410 -311.9402 6.0000x 155.2095n 1.0931u 175.4571 -4.5420 7.0000x 55.7797n 1.7280u -103.0223 -283.0215 8 8.0000x 165.9884n 51.7280u -103.0223 -253.4454 9 9.0000x 165.9884n 8 13651 -73.4462 -253.4454 e.e.e.e.e.e.e.e.e.e.e.e.e.e.e.e.e.e.e.	no	(hz)	component	component	(deg)	phase (deg)
2 0.0000x 12.6038m 39.1163m 90.0014 -89.9978 3 10000x 320.7861u 995.5655u -514.5512m -180.5141 5 5.0000x 130.095u 15.8147u -99.4745 -279.4737 6 6.0000x 352.2095n 1.0931u 175.4571 -4.5420 7 7.0000x 352.2095n 1.0931u 175.4571 -4.5420 8 8.0000x 155.9884n 515.1487n -145.0923 -325.0914 9 9.0000x 302.3556n 938.3671n -73.4662 -253.4454 total harmonic distortion = 3.9129 percent ****** fourier analysis thomas in (764.2789m 8m 1e6) ****** fourier analysis thomas in (764.2789m 8m 1e6) ****** fourier components of translent response v(vout) dc component = 7.620D-01 harmonic frequency fourier normalized phase normalized harmonic frequency fourier component (deg) phase (deg) no (hz) component component (deg) phase (deg) 1 1.0000x 617.0103m 1.0000 179.9991 0. 2 2.0000x 8.2119m 12.3036m -179.9474 -359.9465 4 4.0000x 8.2119m 12.3058m 99.0310 -89.5682 5 5.0000x 6.1863m 9.7115m -15.9811m 180.0151 6 6.0000x 2.4112m 3.8008m 179.9895 -9.6436m 8 8.0000x 1.1068m 1.7375m 89.9373 -90.0619 9 9.0000x 2.28.1506u 358.1585u -5431.8837m -180.5423	1		322.2146m	1.0000	179.9992	0.
3 3.0000x 320.7861u 995.566Su -514.9512m -180.5141 4 4.0000x 352.2095n 1.0931u 175.471 -4.5420 5 5.0000x 352.2095n 1.0931u 175.471 -4.5420 7 7.0000x 352.2095n 1.0931u 175.471 -4.5420 7 7.0000x 352.2095n 1.0931u 175.471 -4.5420 8 8.0000x 165.9884n 515.1487n -146.0923 -325.0914 9 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 total harmonic distortion = 3.9129 percent Alter file ******* fourier analysis thomas in (764.2789n 8m 1e6) ******* fourier analysis thomas in (764.2789n 8m 1e6) ******* fourier analysis thomas in (764.2789n 8m 1e6) ****** fourier components of translent response v(vout) dc component = 7.6200-01 no (hz) component component (deg) phase (deg) no (hz) component component (deg) phase (deg) 1 1.0000x 617.0103m 1.0000 179.9991 0. 2 2.0000x 38.5415m 60.5018m 89.9999 -89.999 89.9996 3 3.0000x 7.8376m 12.3085m -179.9474 -359.9465 4 4.0000x 8.2119m 12.3085m -179.9414 -359.9465 7 7.0000x 6.1863m 9.7115m -15.9811m 180.0151 8 8.0000x 1.1068m 1.7375m 89.9373 -90.0619 9 9.0000x 2.28.1506u 358.1585u -543.1837m -180.5423	2		12.6038m	39.1163m	90.0014	-89.9978
4 4.0000x 5.4180u 16.8147u -99.4745 -279.4737 5.0000x 1.3999u 4.3162u 131.9410 -111.9402 4.54.0000x 352.2095n 1.0931u 175.4571 -4.5420 7.0000x 352.2095n 1.0931u 175.4571 -4.5420 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 9.0000 vin of 764.2789m sin(764.2789m 8m 1e6)	3	3.0000x	320.7861u	995.5665u	-514.9512m	-180.5141
5 5.0000x 1.3909u 4.3165u -131.9410 -311.9402 6 6.0000x 352.205n 1.0931u 175.4571 -4.5420 7 7 00000x 556.7797n 1.7280u -103.0223 -283.0215 8 8.0000x 302.3556n 938.3671n -73.4462 -253.4454 9 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 **Alter file **Alter file ****** fourier analysis tronmalized phase normalized components of translent response v(vout) dc components of translent component (deg) phase (deg) no file 1 1.0000x 637.0103m 1.0000 179.9991 0.2 2 2.0000x 38.5415m 60.5038m 89.999 -89.9992 3 3 1.0000x 637.0103m 12.9855m 99.0310 -89.965 4 4.0000x 637.0103m 12.9855m 99.0310 -89.9982 5 5.0000x 6.1863m 9.7115m -15.9811m 180.0151 6 6.0000x 4.1485m 6.5125m 99.0310 -89.90019 8 8.0000x 11.1068m 11.315m 19.9895 -9.6435m 9 9.0000x 228.1506u 358.1585u -543.1837m -180.5423	*	4.0000x	5.4180u	8	-99.4745	-279.4737
6 6.0000x 352.2095n 1.0931u 175.4571 -4.5420 7 7.0000x 556.7797n 1.7280u -103.0223 -283.0215 8 8.0000x 165.9884n 515.1487n -145.0923 -125.0914 9 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 total harmonic distortion = 3.9129 percent **Alter file ***********************************	2	5.0000x	1.3909u	4.3165u	-131.9410	-311.9402
7 7.0000x 556.7797n 1.7280u -103.0223 -283.0215 8 8.0000x 166.9884n 515.1887n -145.0923 -225.0914 9 .0000x 302.3556n 938.3671n -73.4462 -253.4454 total harmonic distortion = 3.9129 percent *Alter file ***** fourier analysis tnom= 25.000 temp= 25.00 dc components of translent response v(vout) dc components of translent component (deg) phase normalized no (hz) component component (deg) phase (deg) 1 1.0000x 637.0103m 1.0000 179.9991 0. 2 2.0000x 38.5415m 60.5038m 89.9999 -89.9992 3 3.0000x 7.8376m 12.3038m -179.9991 0. 5 5.0000x 4.1485m 6.5125m -90.0296 -270.0287 6.0000x 2.4212m 3.8008m 179.9895 -9.6436m 8 8.0000x 228.1506u 358.1585u -543.1837m -180.5423	9		352.2095n	1.0931u	175.4571	-4.5420
8 8.0000x 165.9884n 515.1487n -145.0923 -125.0914 9 9.0000x 302.3556n 938.3671n -73.4462 -253.4454 total harmonic distortion = 3.9129 percent **Alter file ******** fourier analysis thom= 25.000 temp= 25.00 ******* fourier analysis thom= 25.000 temp= 25.00 ******* fourier analysis thom= 25.000 temp= 25.00 ****** fourier components of transient response v(vout) dc component = 7.620D-01 harmonic frequency fourier normalized phase normalized no (hz) component component (deg) phase (deg) 1 1.0000x 637.0103m 1.0000 179.9991 0. 2 2.0000x 38.5415m 60.5038m 89.9999 -89.9992 3 3.0000x 6.18633m 9.71115m -15.9811m 180.0151 6 6.0000x 4.1485m 6.5125m 90.0130 -89.9682 7 7.0000x 2.2412m 3.8008m 179.9895 -9.6436m 8 8.0000x 1.1068m 1.7375m 89.9373 -90.0619 9 9.0000x 228.1506u 358.1585u -543.1837m -180.5423	7	7.0000x	556.7797n	1.7280u	-103.0223	-283.0215
total harmonic distortion = 3.9129 percent **Alter file **Alter file **Alter fourier analysis translent response v(vout) dc component = 7.620D-01 harmonic frequency fourier normalized phase normalized 1 1.0000x 637.0103m 1.0000 179.9991 0.2 2 2.0000x 38.5415m 60.5038m 89.999 -89.9992 4 4.0000x 6.1863m 9.7115m -15.9811m 180.0151 6 6.0000x 4.1485m 6.5125m -90.0296 -270.0287 7 7.0000x 22.4212m 3.8008m 199.9855 -9.6436m 8 8.0000x 11.006m 173.75m 99.9373 -90.0619 9 9.0000x 228.1506u 358.1585u -543.1837m -180.5423	8	8.0000x		515.1487n	-145.0923	-325.0914
total harmonic distortion = 3.9129 percent ***********************************	6		.355		446	-253.4454
vin vin 0 764.2789m sin(764.2789m 8m 1e6) ****** fourier analysis thom= 25.000 temp= 25.00 temp= 25.0	total			3.9129	percent	
######################################					:	
vin 0 764.2789m sin(764.2789m 8m 1e6) **** fourier analysis there components of translent response v(vout) component = 7.620D-01 monic frequency fourier normalized phase normalized (hz) component component (deg) phase (c) 1 1.0000x 637.0103m 1.0000 179.9991 0. 2 2.0000x 38.5415m 60.5038m 89.9999 -89.999 4 4.0000x 7.8376m 12.3038m -179.9474 -159.949 5 5.0000x 6.1863m 9.7115m -15.9811m -180.011 6 6.0000x 2.4212m 3.8008m 179.9895 -9.643 8 8.0000x 2.4212m 3.8008m 179.9895 -9.643	Alcer I	116				
thoms 25.000 temps through the series of translent response v(vout) 7.6200-01 Tromalized phase normalized (hz) component component (deg) phase (deg) component component (deg) phase (deg) 1.0000x 617.0103m 1.0000 179.9991 0.0000x 18.2415m 12.3038m 179.9999 -89.9999 1.00000x 1.8376m 12.3038m -179.9474 -159.946 -179.9474 1.199.9999 1.00000x 6.1863m 9.7115m -15.9811m 180.0119 6.0000x 4.1485m 6.5125m 90.0296 -270.0219 1.0000x 1.1068m 1.7375m 89.9373 -90.06			n sin(764.2	789m 8m 1e6)		
7.620D-01 7.620D-01 Justicy fourier normalized phase (hz) 1.0000x 677.0103m 1.0000 179.9991 2.0000x 38.5415m 60.5038m 89.9999 3.0000x 38.5415m 60.5038m 89.9999 5.0000x 38.5415m 60.5038m 89.9999 5.0000x 4.1485m 6.5125m 90.0110 6.0000x 4.1485m 6.5125m -90.0296 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373	:	fourier analy	rsis	4		temp=
7.620D-01 Tuency fourier normalized phase This component component (dag) Tuency fourier normalized phase Tuency function		•				
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(hz) component component (deg) 1.0000x 637.0103m 1.0000 179.9991 2.0000x 38.5415m 60.5038m 89.9999 3.0000x 7.8376m 12.3038m -179.9474 4.0000x 8.2719m 12.9855m 90.0310 5.0000x 6.1863m 9.7115m -15.9811m 6.0000x 4.1485m 6.5125m -90.0296 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 9.0000x 228.1506u 358.1585u -543.1837m	harmonic	frequency	fourier	normalized	phase	normalized
1.0000x 617.0103m 1.0000 179.9991 2.0000x 18.5415m 60.5018m 89.9999 3.0000x 7.8376m 12.3018m -179.9474 -1 5.0000x 6.1863m 9.7115m -15.9811m -1 6.0000x 4.1485m 6.5125m -90.0296 -2 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 -90.0000x 228.1506u 358.1585u -543.1837m -1	no		component	component	(deb)	phase (deg)
2.0000x 38.5415m 60.5038m 89.9999 3.0000x 7.8376m 12.038m -179.9474 4.0000x 8.2715m 12.9855m 90.0310 5.0000x 6.1863m 9.7115m -15.9811m 1. 6.0000x 4.1485m 6.5125m -90.0296 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 9.0000x 228.1506u 358.1585u -543.1837m	1	1.0000×		1.		0.
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4.0000x 8.2719m 12.9855m 90.0310 5.0000x 6.1863m 9.7115m -15.9811m -1 6.0000x 4.1485m 6.5125m -90.0296 -2 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 9.0000x 228.1506u 358.1585u -543.1837m -1	-	3.0000x	7	12		-359.9465
5.0000x 6.1863m 9.7115m -15.9811m 1 6.0000x 4.1485m 6.5125m 90.0296 -7 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 -9.0000x 228.1506u 358.1585u -543.1837m -1	4	4.0000x	8	12.	90.0310	
6.0000x 4.1485m 6.5125m -90.0296 -2 7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 - 9.0000x 228.1506u 358.1585u -543.1837m -1	5	S.0000x	9	6	-15.98111	
7.0000x 2.4212m 3.8008m 179.9895 8.0000x 1.1068m 1.7375m 89.9373 9.0000x 228.1506u 358.1585u -543.1837m	9	6.0000x	4			-270.0287
8.0000x 1.1068m 1.7375m 89.9373 9.0000x 228.1506u 358.1585u -543.1837m -	7	7.0000x	2			-9.6436m
9.0000x 228.1506u 358.1585u -543.1837m -180.542	8	8.0000×	1	1.1		
	6		228	358.1	-5	-180.542

6.4304 percent

total harmonic distortion =

tnom= 25.000 temp= 25.000

-80.3168 60.2895 2.5000k

output resistance at v(vout)

Input resistance at

v (vout) /vin

***** fourier analysis

