EE223 Homework 3

Designed of a Beta Multiplier

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10/13/18

1. Run a Dc simulation with VDD = 1V, Temperature = 27c in Typical Corner.

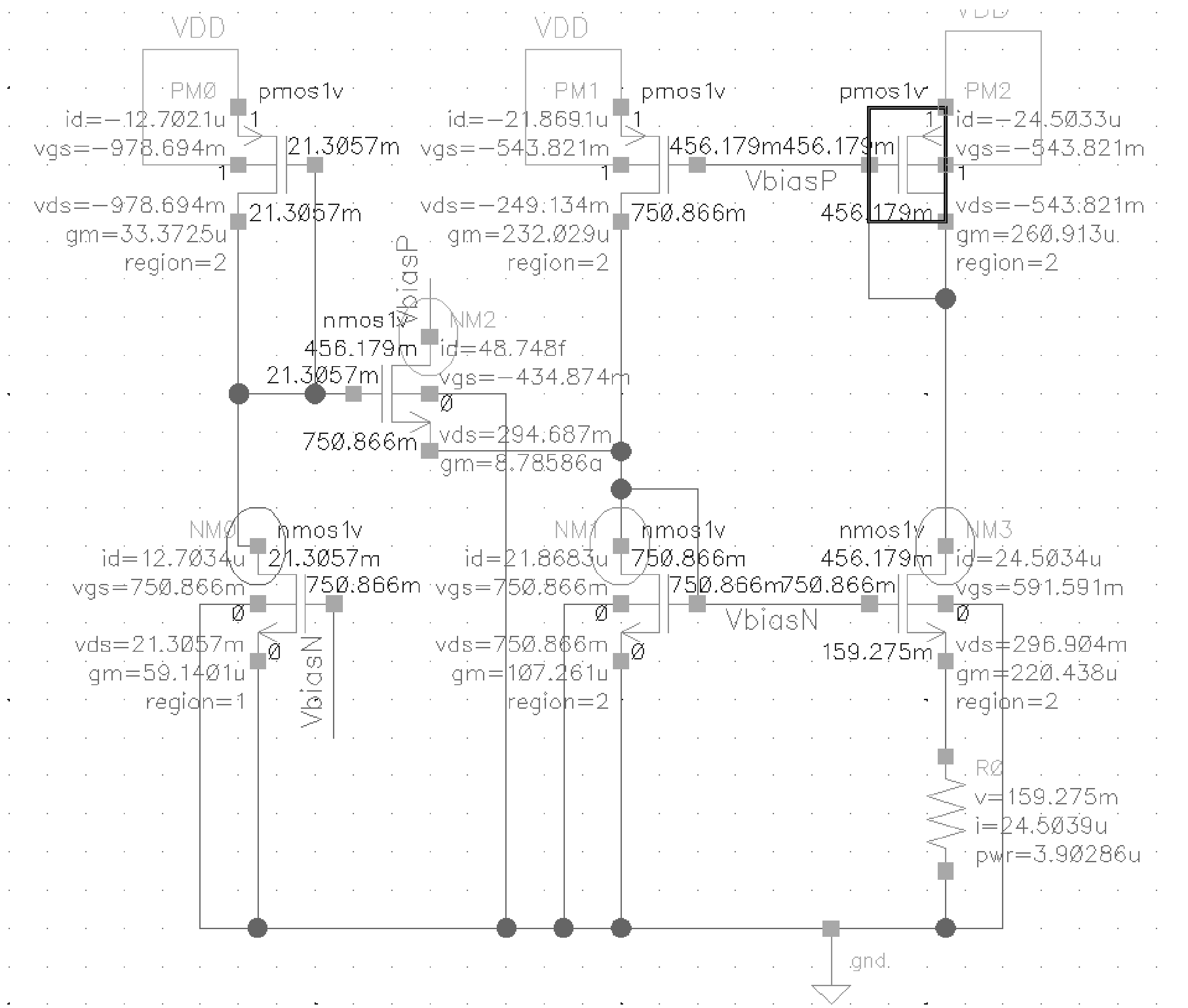

Figure 1: Operating Point information and node voltages

2. ADE-XL transient simulation for 1u

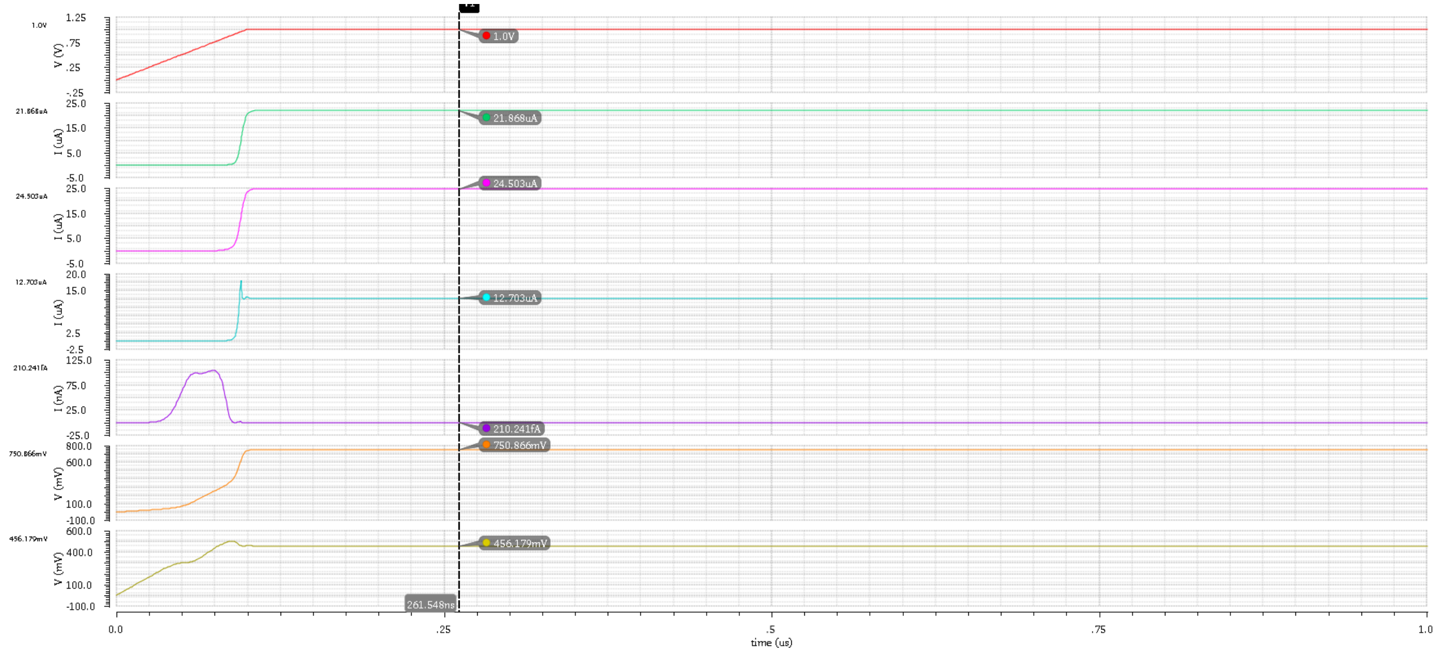

Figure 2: Transient waveforms with startup circuit. (VDD= red trace, Vbiasn =orange trace, Vbiasp=yellow trace, NM1 =green trace, NM3=violate trace, NMo=blue trance, NM2=purple trance)

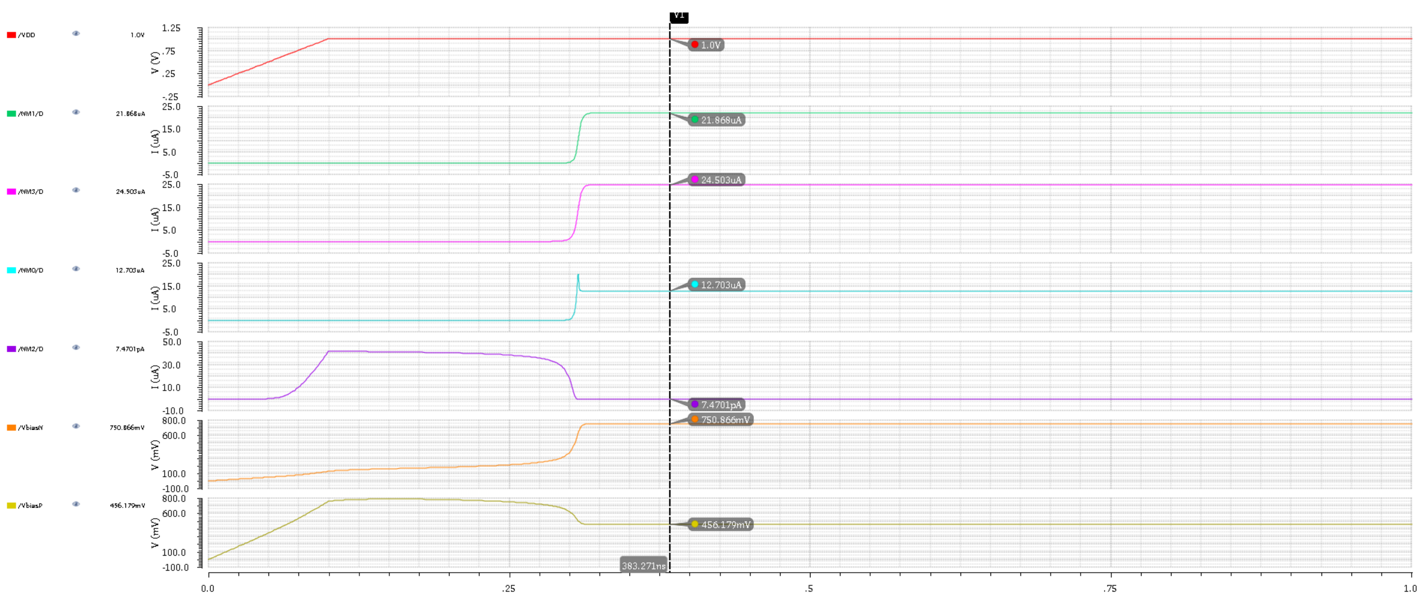

Figure 3: Transient waveforms with startup circuit. (VDD= red trace, Vbiasn =orange trace, Vbiasp=yellow trace, NM1 =green trace, NM3=violate trace, NMo=blue trance, NM2=purple trance)

3. From simulation find Kp value

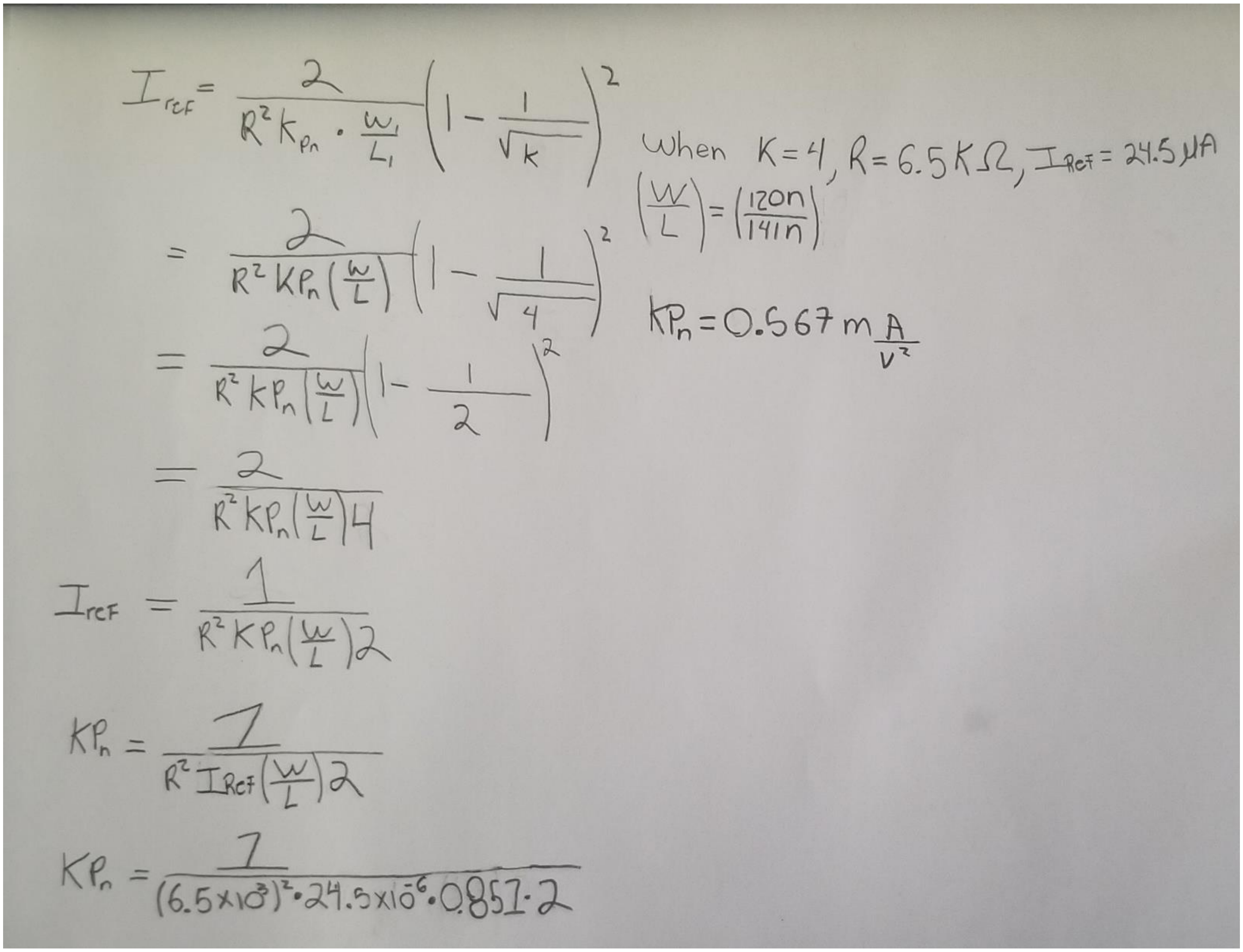

Figure 4: Kp value using simulation Iref

4. Using ADL-XL, simulate the circuit in the fallowing conditions and check if the circuit starts without problem. Measure the current through M4 at 1us and Plot it over the fallowing PVT corners.
   a. Process variation:

Parameter	Min	Max	C5_0	C5_1	C5_2	C5_3	C5_4
VDD			1	1	1	1	1
gpdk045.scs			ff	fs	sf	ss	tt
temperature			27	27	27	27	27
value(IT("/NM3/S") 1e-06)	-2.54E-05	-2.35E-05	-2.54E-05	-2.44E-05	-2.46E-05	-2.35E-05	-2.45E-05

b. Supply variation:

Parameter			C6_0	C6_1	C6_2	C6_3	C6_4
VDD			8.00E-01	9.00E-01	1	1.1	1.2
gpdk045.scs			tt	tt	tt	tt	tt
temperature			27	27	27	27	27
Output	Min	Max	C6_0	C6_1	C6_2	C6_3	C6_4
value(IT("/NM3/S") 1e-06)	-2.96E-05	-1.66E-05	-1.66E-05	-2.10E-05	-2.45E-05	-2.73E-05	-2.96E-05

c. Temperature Variation:

Parameter	Min	Max	C7_0	C7_1	C7_2	C7_3	C7_4
VDD			1	1	1	1	1
gpdk045.scs			tt	tt	tt	tt	tt
temperature			-40	0	25	50	100
value(IT("/NM3/S") 1e-06)	-2.73E-05	-1.85E-05	-1.85E-05	-2.22E-05	-2.44E-05	-2.60E-05	-2.73E-05

d. All PVT variations:

Parameter	Min	Max	C9_0	C9_1	C9_2	C9_3	C9_4	C9_5
VDD			9.00E-01	9.00E-01	9.00E-01	9.00E-01	1	1
gpdk045.scs			ff	ff	ff	ff	ff	ff
temperature			-40	0	50	100	-40	0
value(IT("/PM2/D") 1e-06)	-3.39E-05	-1.55E-05	-1.73E-05	-2.06E-05	-2.35E-05	-2.43E-05	-1.92E-05	-2.30E-05
C9_6	C9_7	C9_8	C9_9	C9_10	C9_11	C9_12	C9_13	C9_14
1	1	1.1	1.1	1.1	1.1	9.00E-01	9.00E-01	9.00E-01
ff	ff	ff	ff	ff	ff	fs	fs	fs
50	100	-40	0	50	100	-40	0	50
-2.72E-05	-2.93E-05	-2.10E-05	-2.51E-05	-3.02E-05	-3.39E-05	-1.64E-05	-1.95E-05	-2.18E-05
C9_15	C9_16	C9_17	C9_18	C9_19	C9_20	C9_21	C9_22	C9_23
9.00E-01	1	1	1	1	1.1	1.1	1.1	1.1
fs	fs	fs	fs	fs	fs	fs	fs	fs
100	-40	0	50	100	-40	0	50	100
-2.20E-05	-1.84E-05	-2.21E-05	-2.59E-05	-2.73E-05	-2.01E-05	-2.42E-05	-2.92E-05	-3.22E-05
C9_24	C9_25	C9_26	C9_27	C9_28	C9_29	C9_30	C9_31	C9_32
9.00E-01	9.00E-01	9.00E-01	9.00E-01	1	1	1	1	1.1
sf	sf	sf	sf	sf	sf	sf	sf	sf
-40	0	50	100	-40	0	50	100	-40
-1.64E-05	-1.94E-05	-2.15E-05	-2.19E-05	-1.86E-05	-2.24E-05	-2.59E-05	-2.71E-05	-2.05E-05
C9_33	C9_34	C9_35	C9_36	C9_37	C9_38	C9_39	C9_40	C9_41
1.1	1.1	1.1	9.00E-01	9.00E-01	9.00E-01	9.00E-01	1	1
sf	sf	sf	ss	ss	ss	ss	ss	ss
0	50	100	-40	0	50	100	-40	0
-2.48E-05	-2.97E-05	-3.22E-05	-1.55E-05	-1.83E-05	-1.98E-05	-1.98E-05	-1.78E-05	-2.15E-05
C9_42	C9_43	C9_44	C9_45	C9_46	C9_47	C9_48	C9_49	C9_50
1	1	1.1	1.1	1.1	1.1	9.00E-01	9.00E-01	9.00E-01
ss	ss	ss	ss	ss	ss	tt	tt	tt
50	100	-40	0	50	100	-40	0	50
-2.45E-05	-2.51E-05	-1.98E-05	-2.41E-05	-2.86E-05	-3.03E-05	-1.64E-05	-1.95E-05	-2.17E-05
C9_51	C9_52	C9_53	C9_54	C9_55	C9_56	C9_57	C9_58	C9_59
9.00E-01	1	1	1	1	1.1	1.1	1.1	1.1
tt	tt	tt	tt	tt	tt	tt	tt	tt
100	-40	0	50	100	-40	0	50	100
-2.21E-05	-1.84E-05	-2.22E-05	-2.60E-05	-2.73E-05	-2.03E-05	-2.45E-05	-2.94E-05	-3.23E-05

Mean	sum of squares	sum of squares /(n-1)	Mean + sigma	Mean - sigma
-2.33168E-05	1.24249E-09	4.58902E-06	-1.87278E-05	-2.79059E-05

e. Plot Gm vs Temp of Mn1

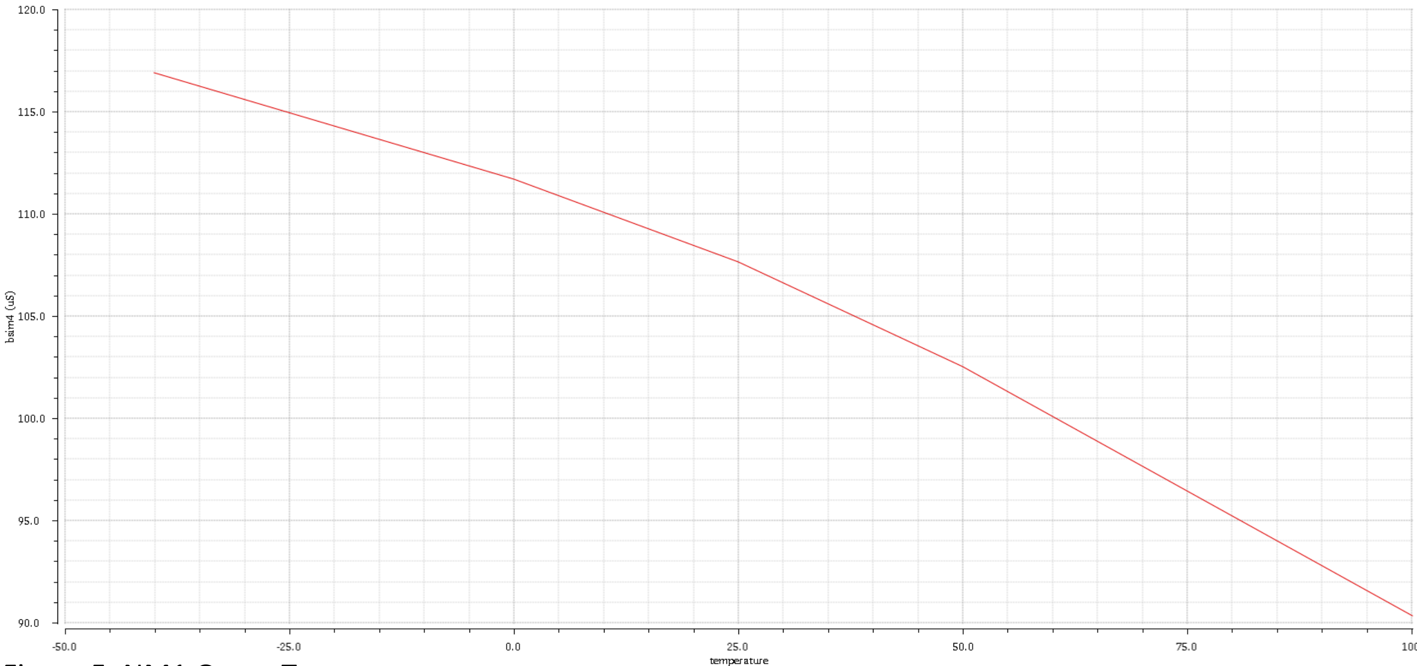

Figure 5: NM1 Gm vs Temp