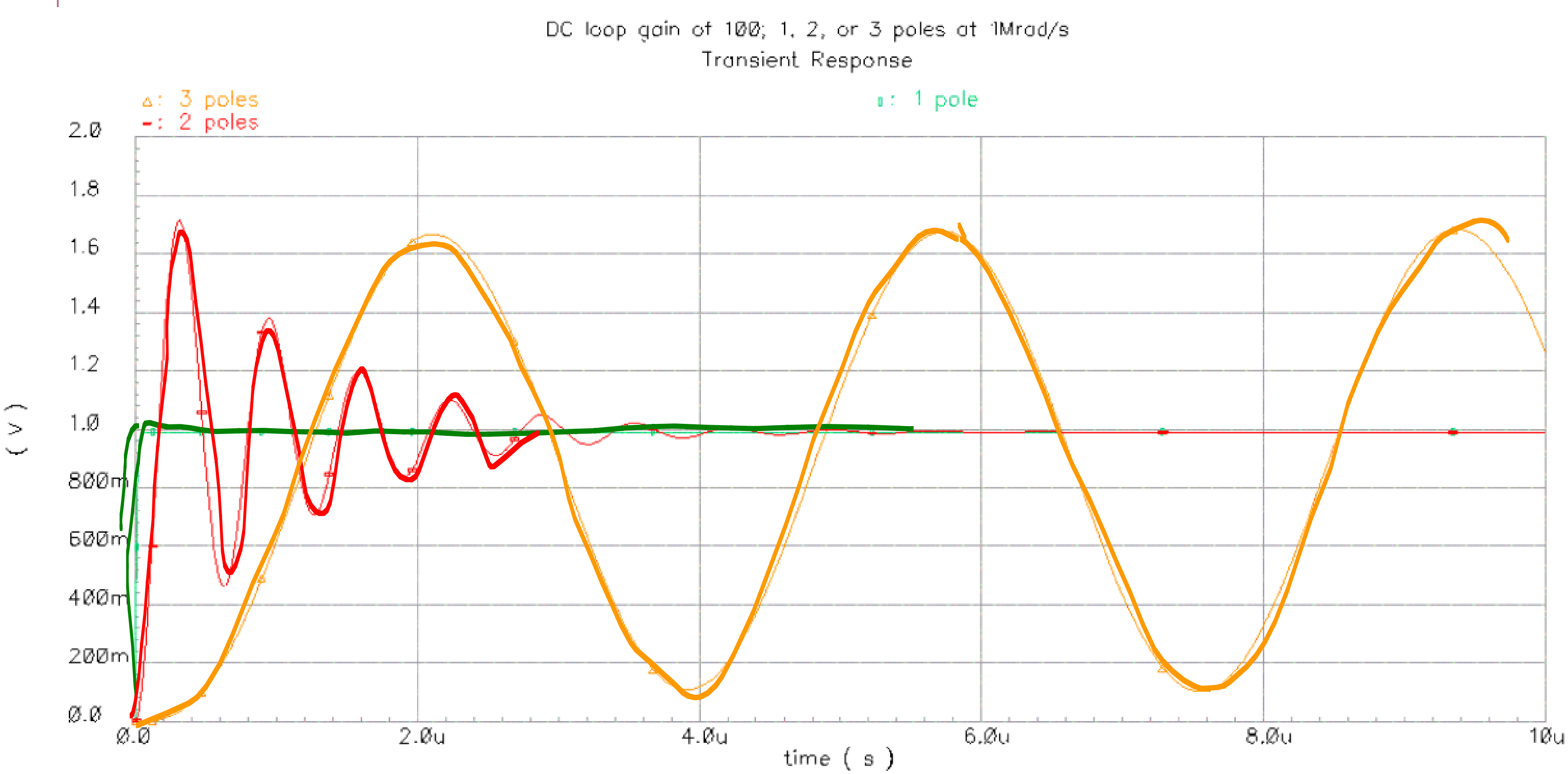
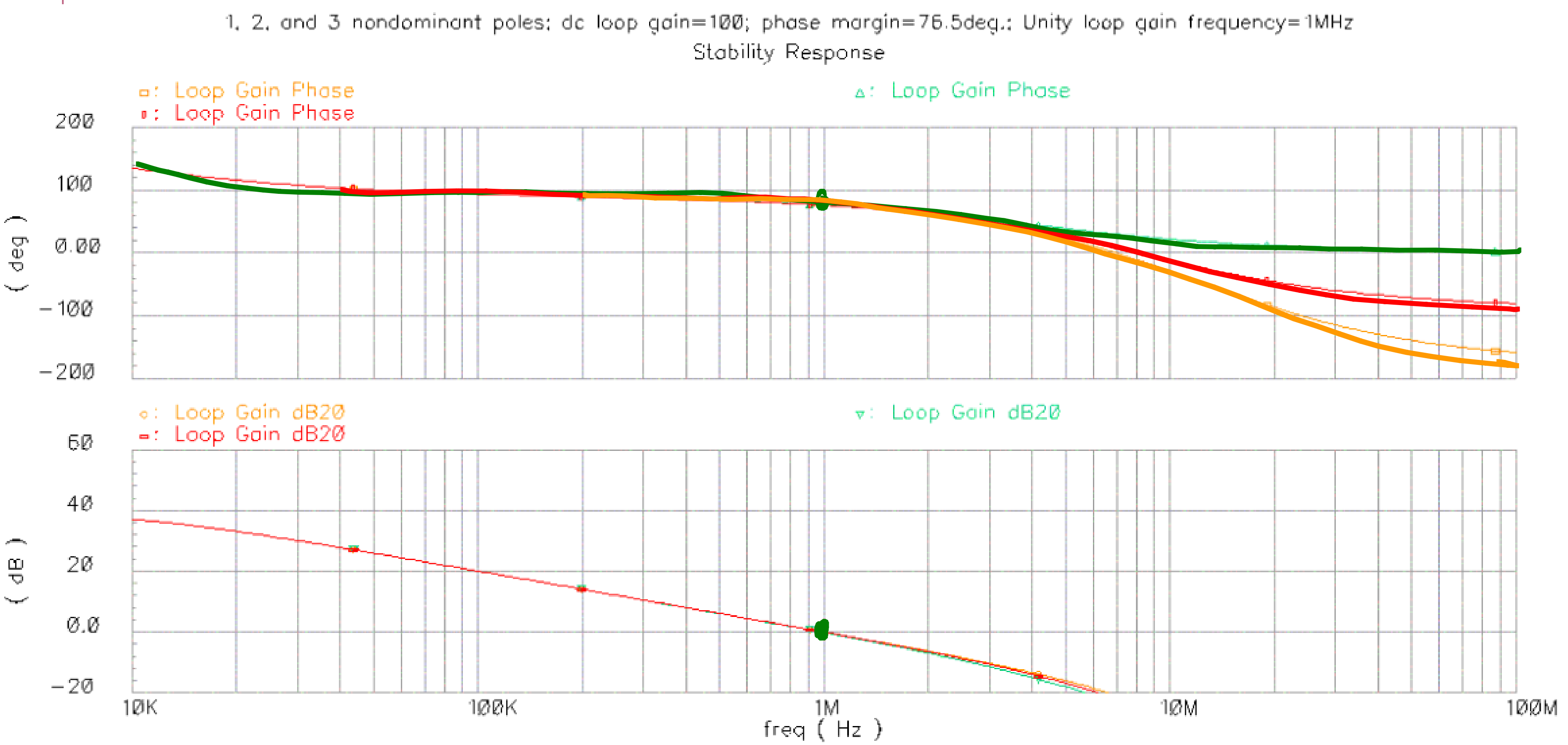
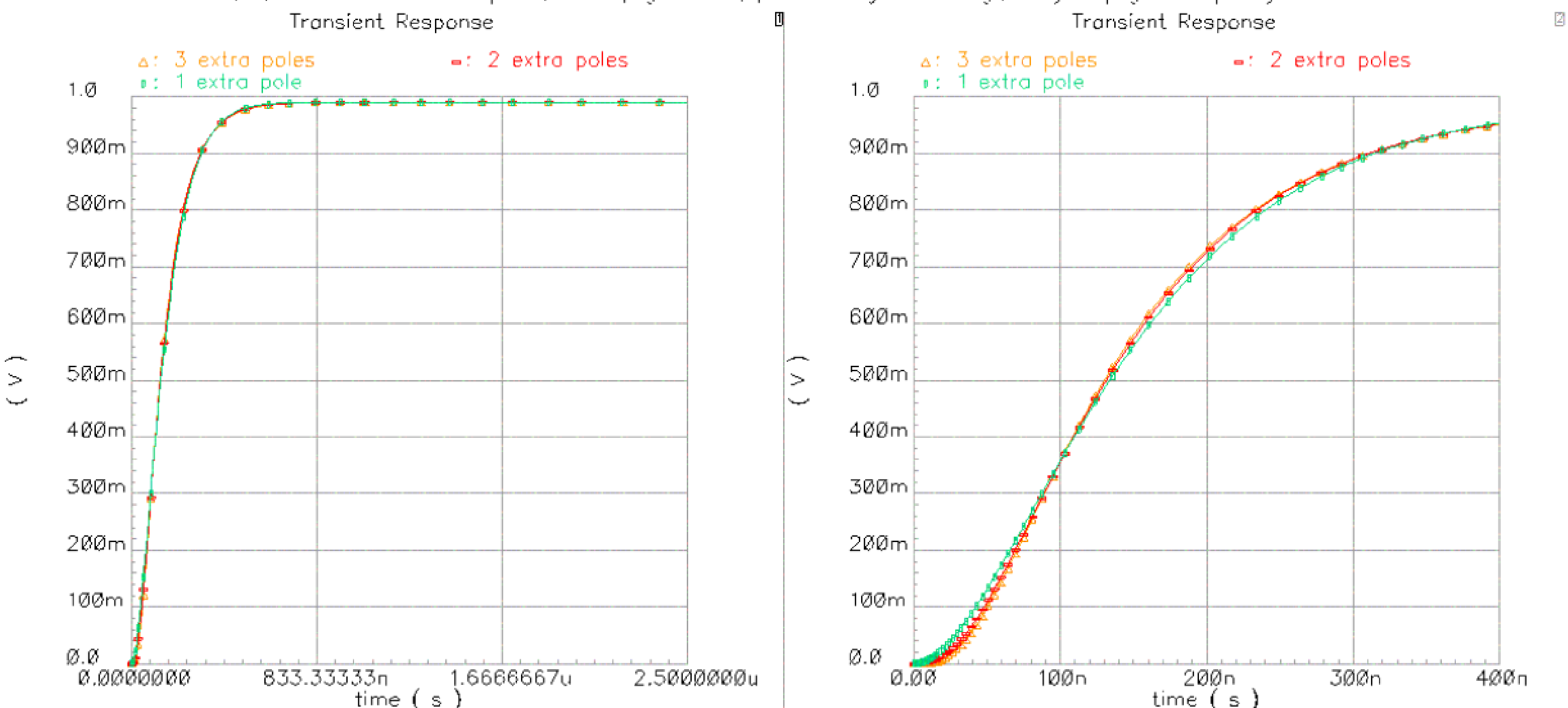
Lecture 12

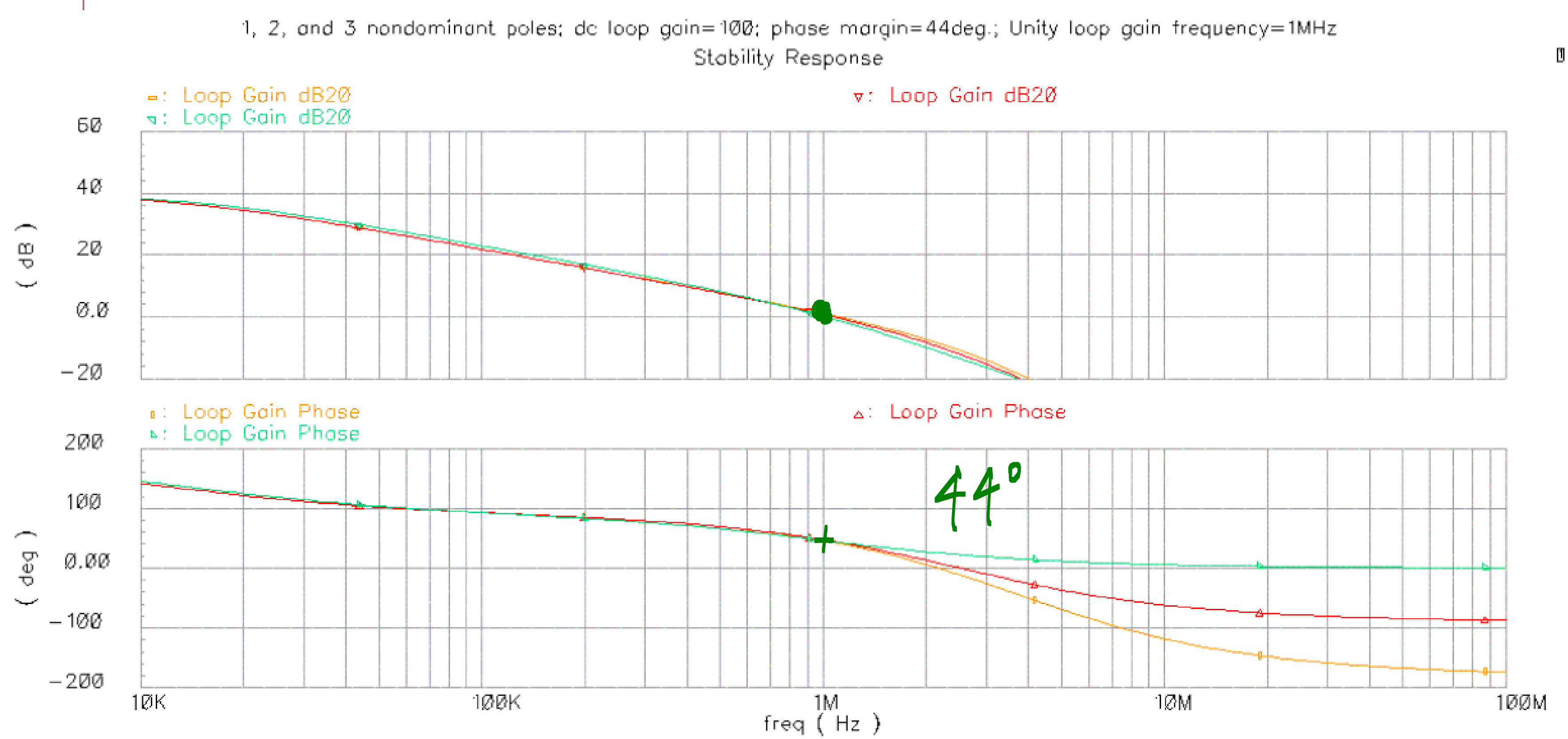


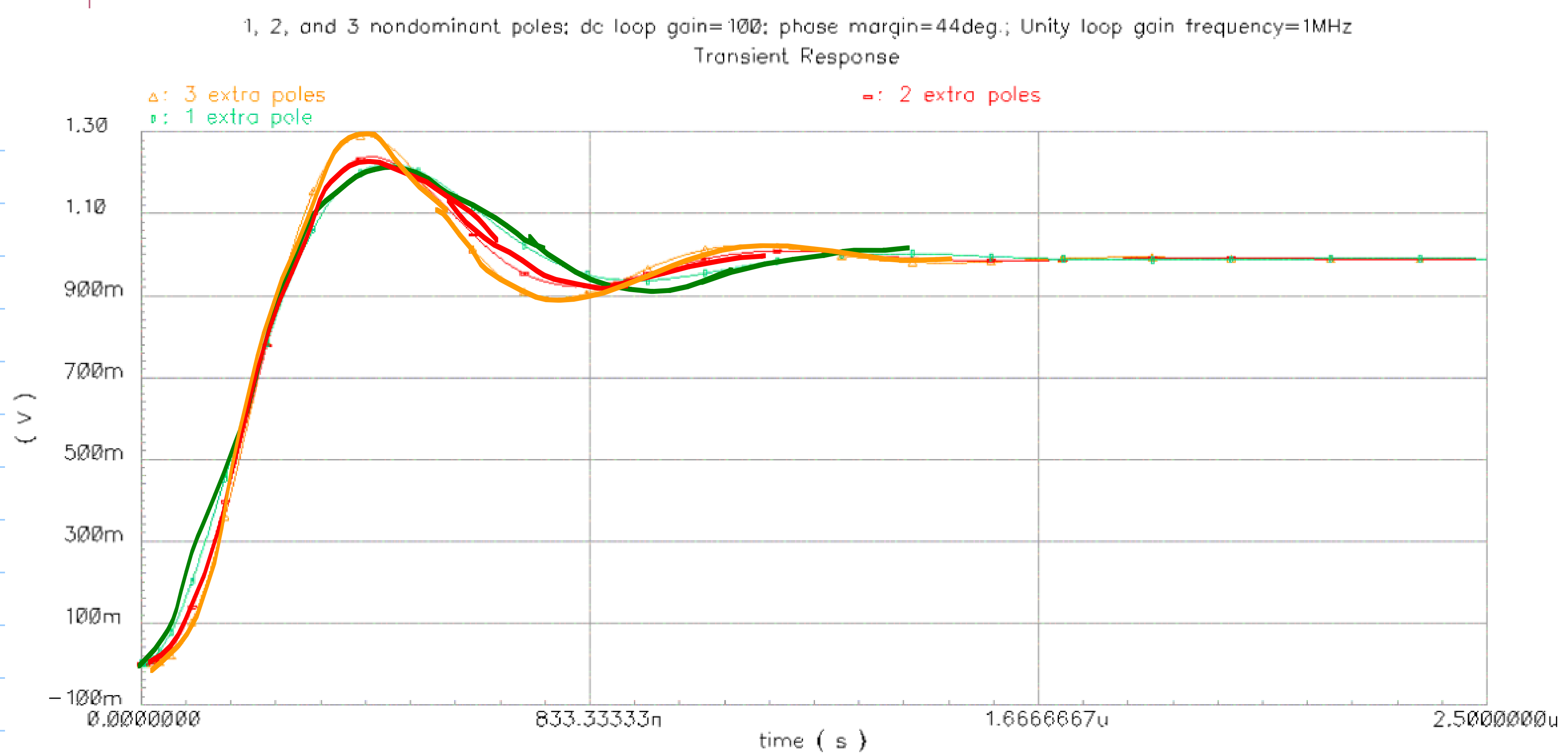
DC loop gain of 100; 1, 2, or 3 poles at 1Mrad/s
Transient Response
△: 3 poles
-: 2 poles
▯: 1 pole
2.0
1.8
1.6
1.4
1.2
1.0
800m
600m
400m
200m
0.0
(V)
0.0
2.0u
4.0u
6.0u
8.0u
10u
time (s)


1, 2, and 3 nondominant poles; dc loop gain=100; phase margin=76.5deg.; Unity loop gain frequency=1MHz
Stability Response
Loop Gain Phase
Loop Gain Phase
Loop Gain Phase
(deg)
200
100
0.00
−100
−200
Loop Gain dB20
Loop Gain dB20
Loop Gain dB20
(dB)
60
40
20
0.0
−20
10K
100K
1M
10M
100M
freq (Hz)

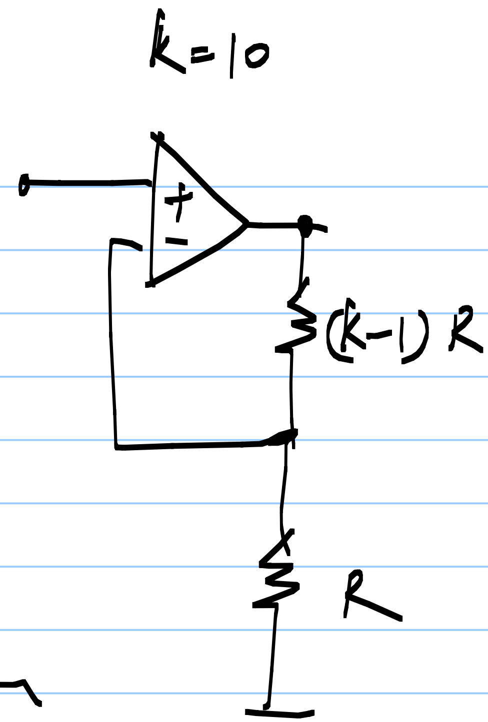
1, 2, and 3 nondominant poles; dc loop gain=100; phase margin=76.5deg.; Unity loop gain frequency=1MHz

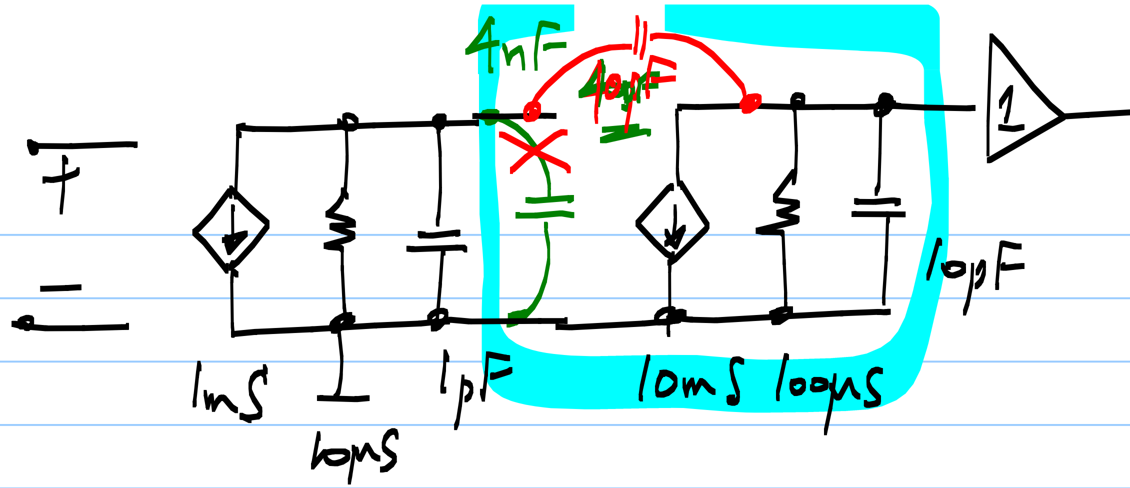



1, 2, and 3 nondominant poles; dc loop gain=100; phase margin=44deg.; Unity loop gain frequency=1MHz
Stability Response
Loop Gain dB20
Loop Gain dB20
Loop Gain dB20
60
40
20
0.0
-20
(dB)
Loop Gain Phase
Loop Gain Phase
Loop Gain Phase
200
100
0.00
-100
-200
(deg)
10K
100K
1M
10M
100M
freq (Hz)
44°



1, 2, and 3 nondominant poles; dc loop gain=100; phase margin=44deg.; Unity loop gain frequency=1MHz
Transient Response
△: 3 extra poles
▫: 1 extra pole
▭: 2 extra poles
1.30
1.10
900m
700m
500m
300m
100m
−100m
(V)
0.0000000
833.33333n
1.6666667u
2.5000000u
time (s)



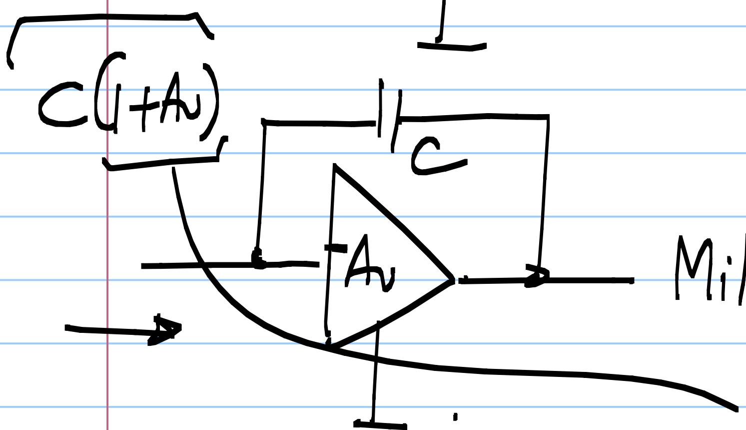


4nF across stage 1:

$\omega_{n,loop} \rightarrow 2.5$ Mrad/s

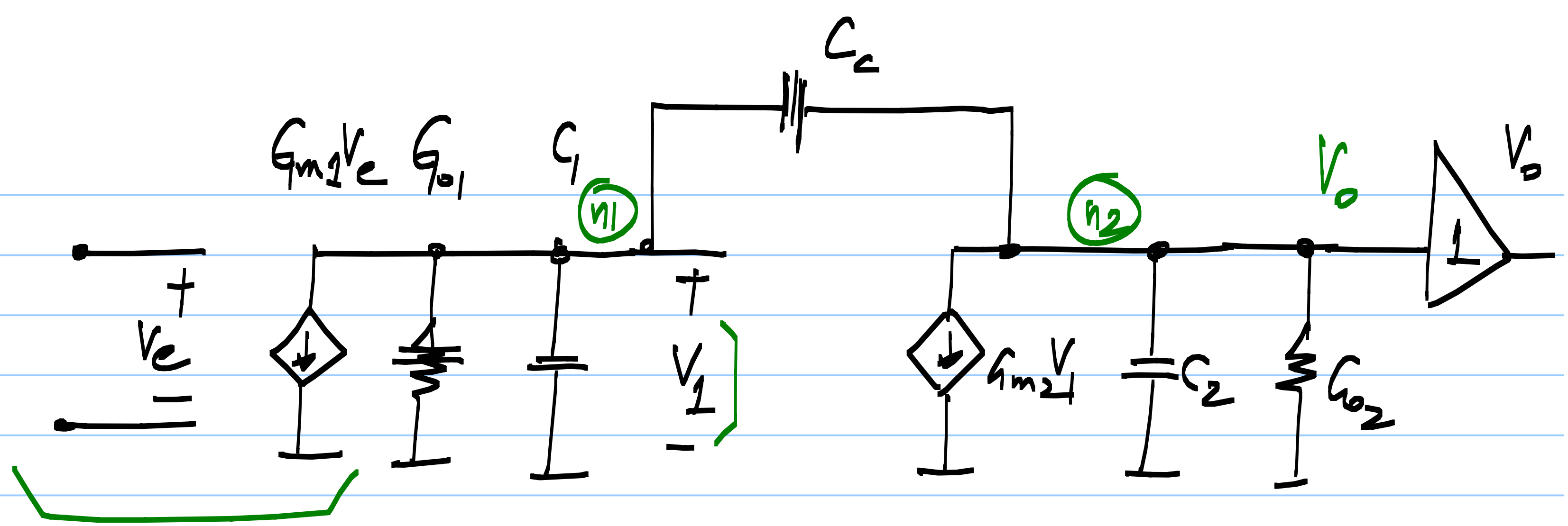
p_2 : 10 Mrad/s

$\zeta = 1 \left(Q = \frac{1}{2}\right)$



Miller effect

Miller multiplication



$$\begin{bmatrix} G_{o1} + s(C_1 + C_c) & -sC_c \\ G_{m2} - sC_c & G_{o2} + s(C_2 + C_c) \end{bmatrix} \begin{bmatrix} V_1 \\ V_o \end{bmatrix} = \begin{bmatrix} -G_{m1}V_e \\ 0 \end{bmatrix}$$

$$\frac{V_o}{V_e} = \frac{\begin{vmatrix} G_{o_1} + s(C_1 + C_c) & -G_{m_1} V_e \\ G_{m_2} - sC_c & 0 \end{vmatrix}}{\begin{vmatrix} G_{o_1} + s(C_1 + C_c) & -sC_c \\ G_{m_2} - sC_c & G_{o_2} + s(C_2 + C_c) \end{vmatrix}}$$

$C_1 = 1pF$

$C_2 = 10pF$

$C_c = 40pF$

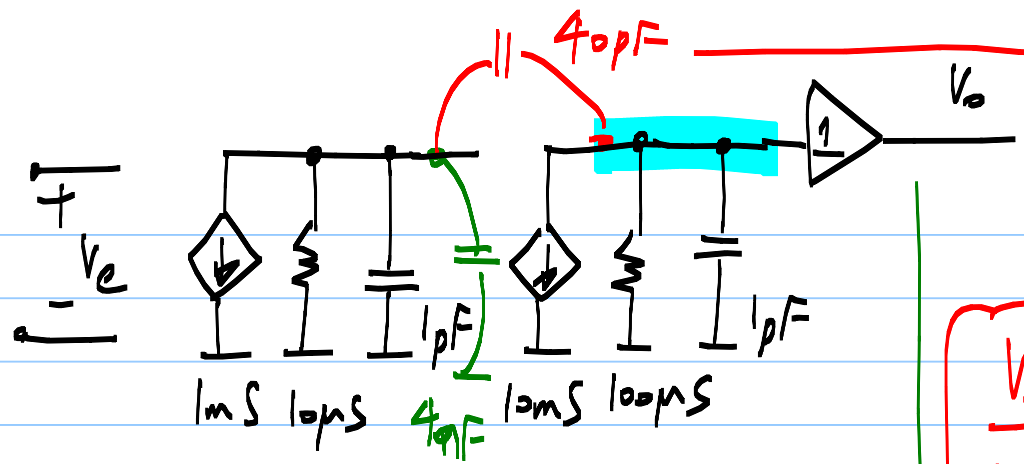
$G_{m_1} = 1mS$

$G_{m_2} = 10mS$

$G_{o_1} = 10\mu S$

$G_{o_2} = 100\mu S$

$$= \frac{G_{m_1}(G_{m_2} - sC_c)}{s^2(C_1C_2 + C_2C_c + C_cC_1) + s\left(G_{m_2}C_c + G_{o_1}(C_2 + C_c) + G_{o_2}(C_1 + C_c)\right) + G_{o_1}G_{o_2}}$$



4nF @ first stage o/p.

$$\frac{V_o}{V_e} = \frac{10^4}{\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)}$$

p_1: 2.5×10^3 rad/s

p_2: 10 Mrad/s

Miller compensation

40pF across the 2nd stage.

$$\frac{V_o}{V_e} = \frac{10^4\left(1-\frac{s}{z_1}\right)}{\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)}$$

k=10

p_1: 2.5×10^3 rad/s

p_2: 840 Mrad/s

z_1: 250 Mrad/s (RHP)

$\omega_{u,loop}$ 2.5 Mrad/s

(pole splitting)

$$as^2 + bs + c = 0 \qquad s_1, s_2$$

$$as_1^2 + bs_1 + c = 0 \qquad |s_1| \ll |s_2|$$

$$as_2^2 + bs_2 + c = 0$$

$$s_1 \simeq -\frac{c}{b}$$

$$s_2 \simeq -\frac{b}{a}$$