Common Errors Using Voltage and Current Injection

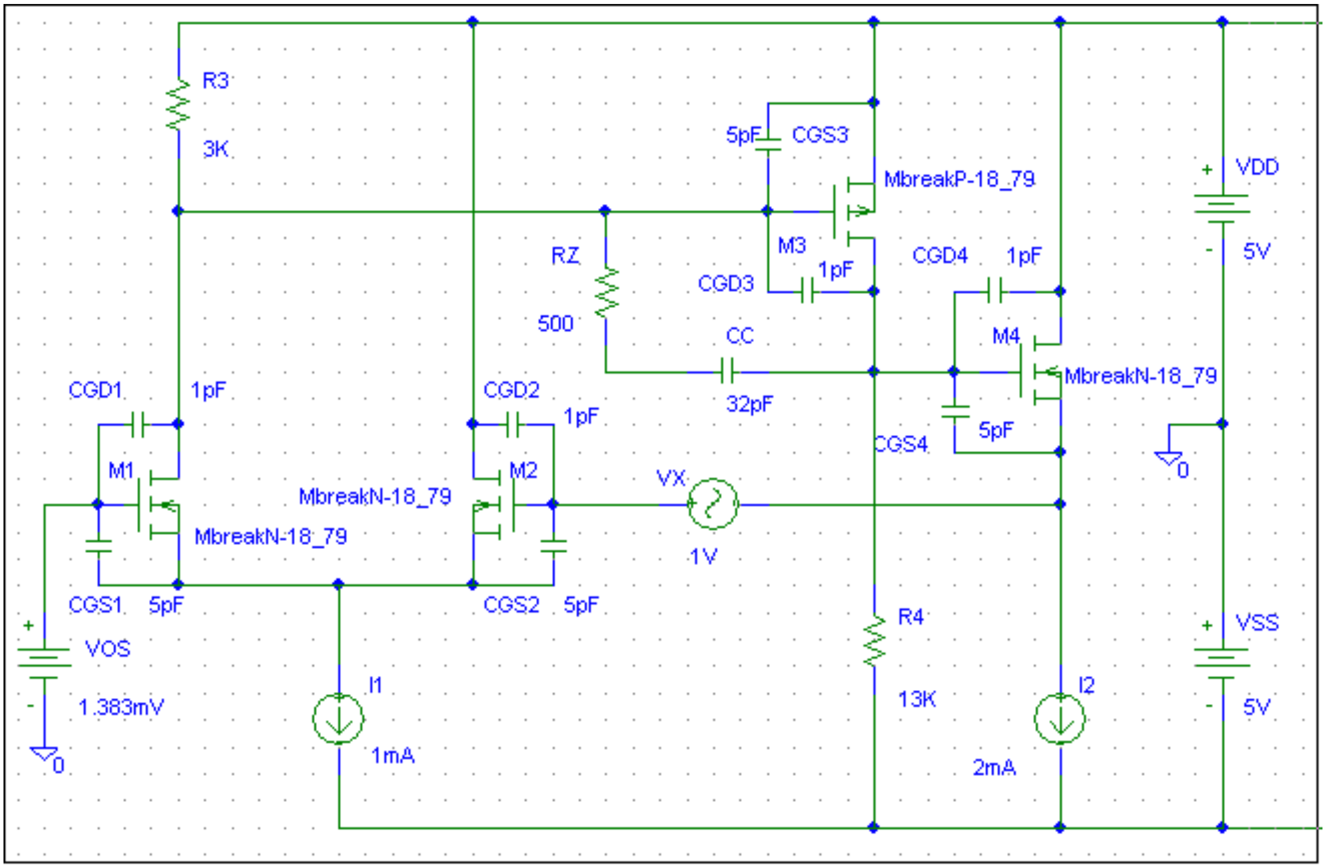

Figure 1 (Fig. 15.19) – Circuit schematic for Prob. 15.122(b) using voltage injection. Assume T = Tv. Tv = (-V(M4:s)/V(M2:g) However, we observe strange behavior above 20 MHz. The curve of Tv crosses at 0 dB at two points!

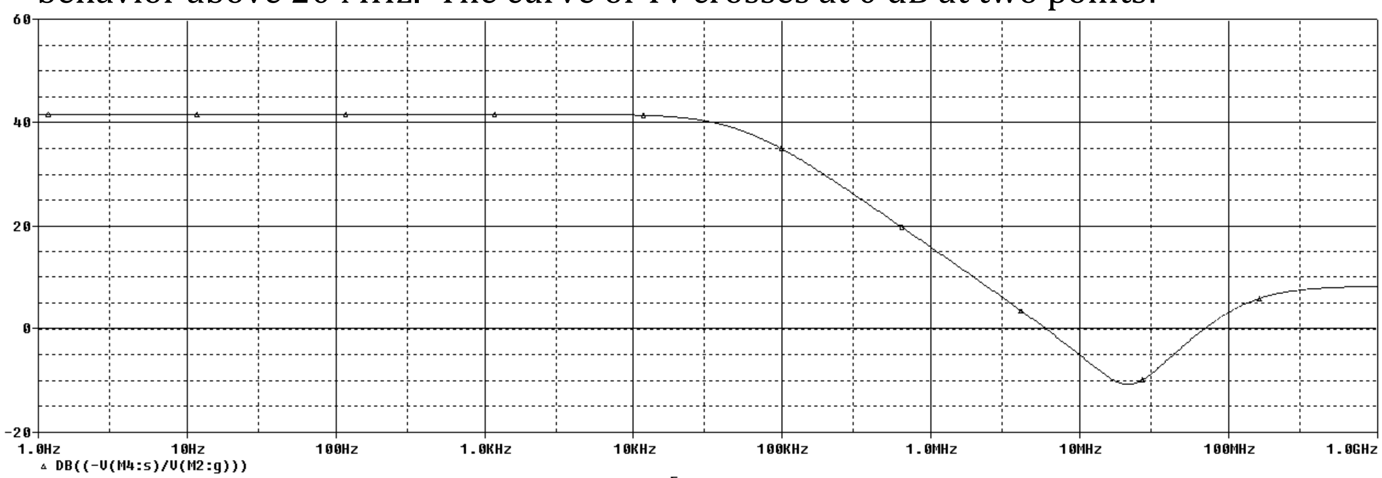

Figure 2 – Loop gain plot assuming that T = Tv.

The problem occurs because we are violating the assumption required for only using voltage injection. Figure 3 plots the current in Vx. The current in Vx is not zero at high frequencies. Thus the assumption that R_A is infinite is being violated at high frequencies! Therefore T ≠ Tv.

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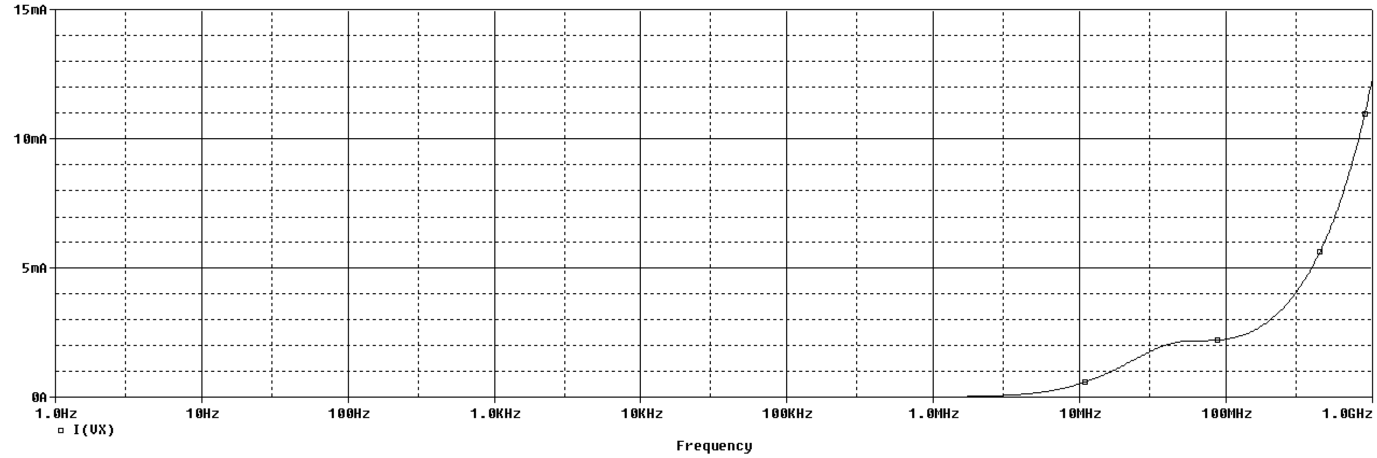

Figure 3 – Current in Vx is not zero at high frequencies.

However, we duplicate the circuit and calculate Tv, Ti and T at the same time.

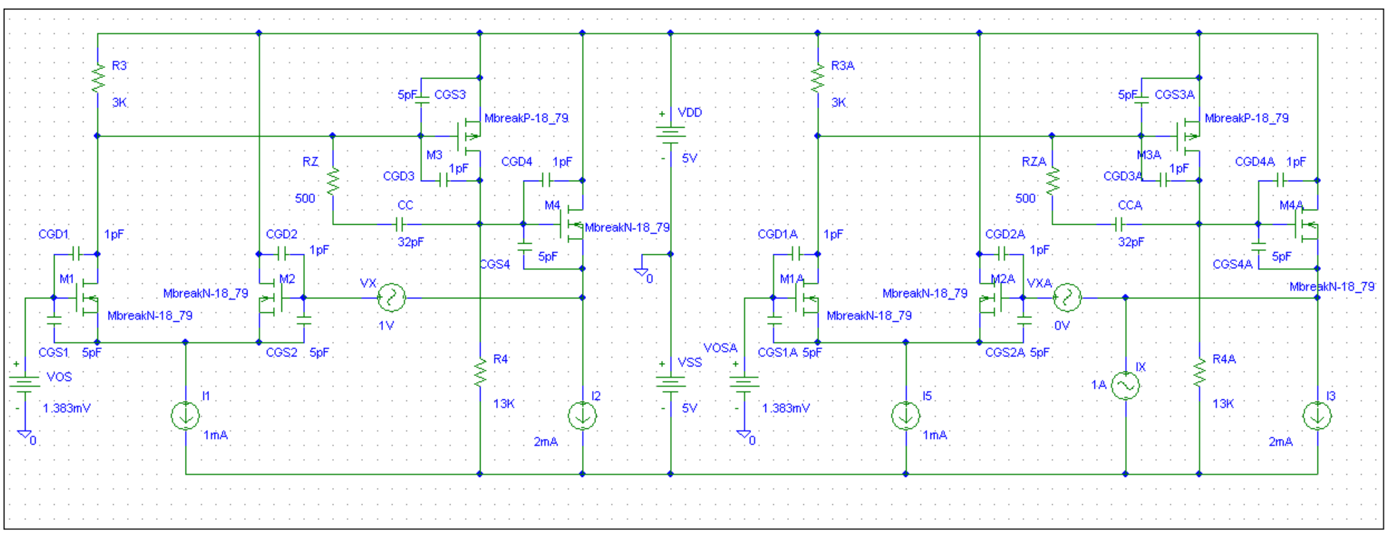

Figure 4 – Duplicated circuit allows simultaneous calculation of both Tv and Ti.

The formulae become more complicated now but can be created with a text editor and pasted into PSPICE.

T = (Tv*Ti-1)/(2+Tv+Ti)

Tv*Ti = ((-V(M4:s)/V(M2:g))*(1 -I(VXA))/I(VXA)-1)

2+Tv+ti = (2+(-V(M4:s)/V(M2:g))+(1-I(VXA))/I(VXA))

T = ((-V(M4:s)/V(M2:g))*(1 -I(VXA))/I(VXA)-1)/ (2+(-V(M4:s)/V(M2:g))+(1-I(VXA))/I(VXA))

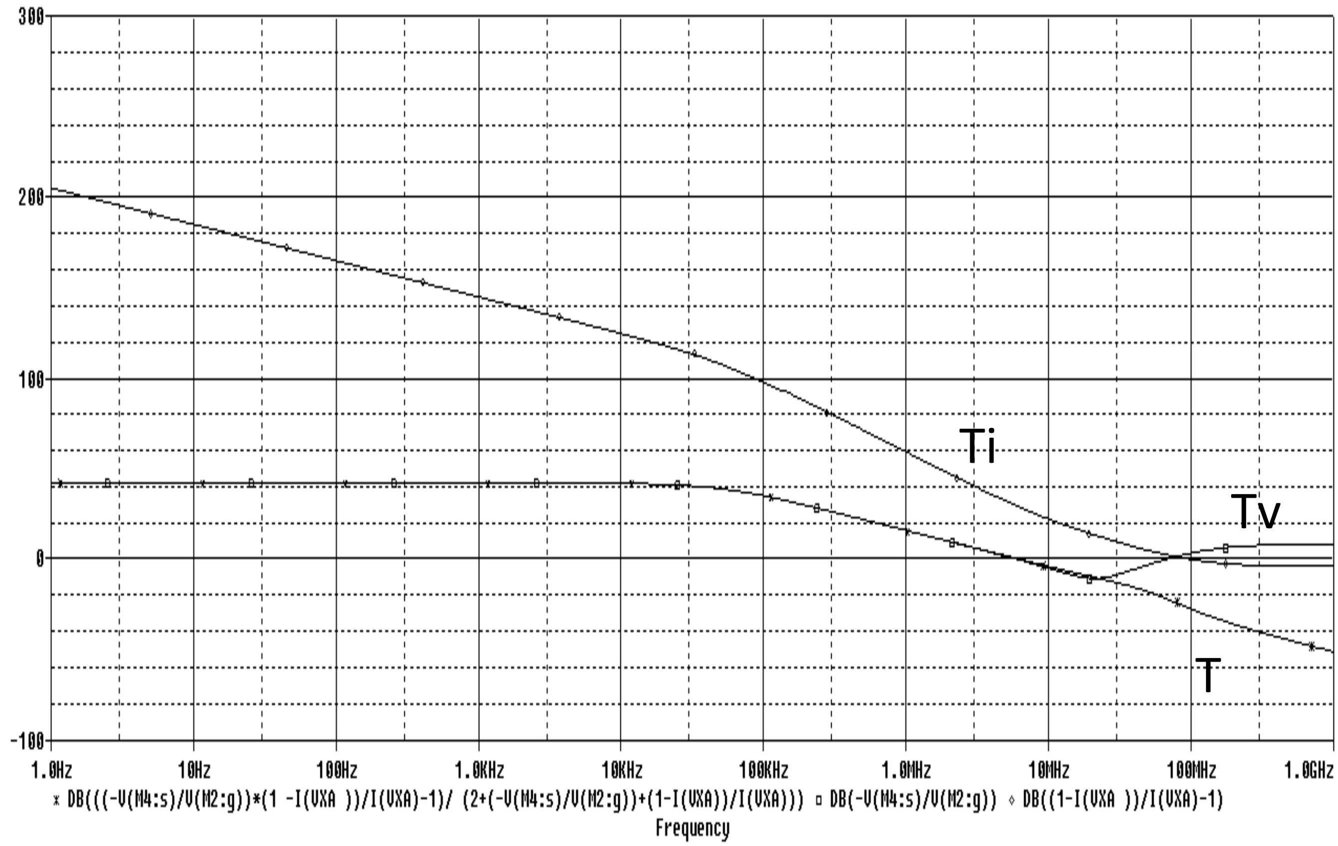

Figure 5 – Plots of Tv, Ti and T. Loop gain T now appears more reasonable with a continuous roll off at high frequencies

The general expression for loop gain is: $T = \dfrac{T_v T_i - 1}{2 + T_V + T_i}$

As long as $T_i >> 2 + T_v$, $T \cong T_v - \dfrac{1}{T_i} \cong T_v$

We see this in Fig. 5 in which $T \cong T_v$ for $f < 20MHz$.

Similarly, for $T_v >> 2 + T_i$, $T \cong T_i - \dfrac{1}{T_v} \cong T_i$