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ECE546 - Analog IC Design

10-13-20

Lab3 Differential Amplifier

Question1: Create Schematic

Schematics of the Amplifier Circuit Below:

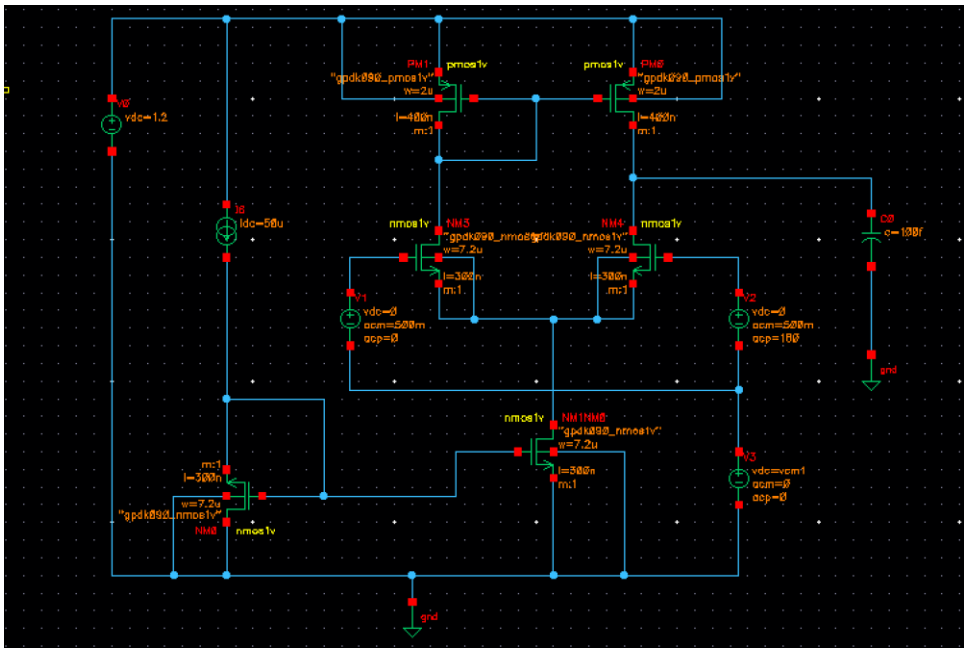
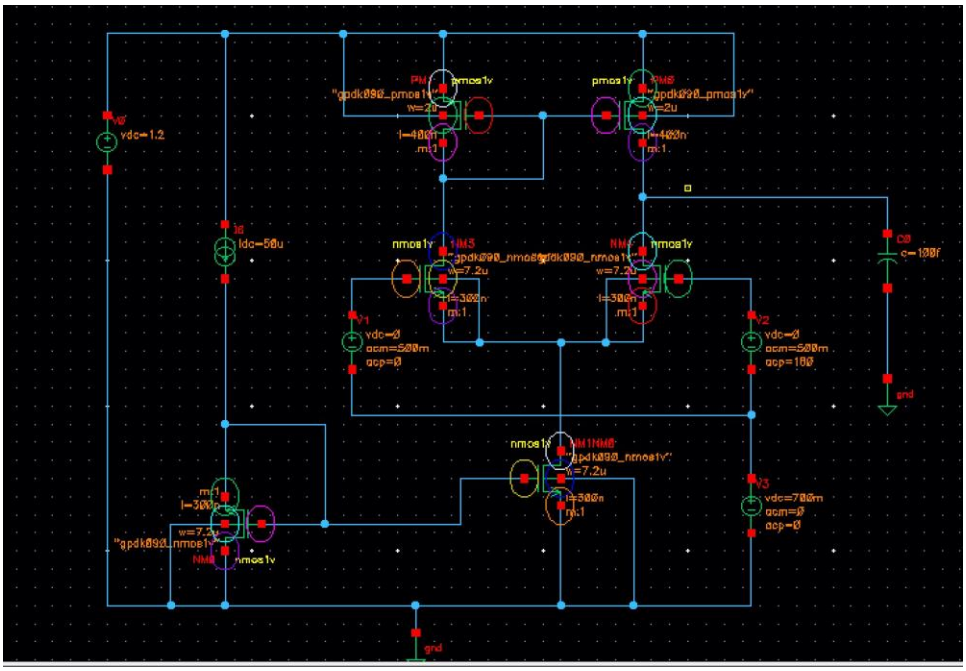


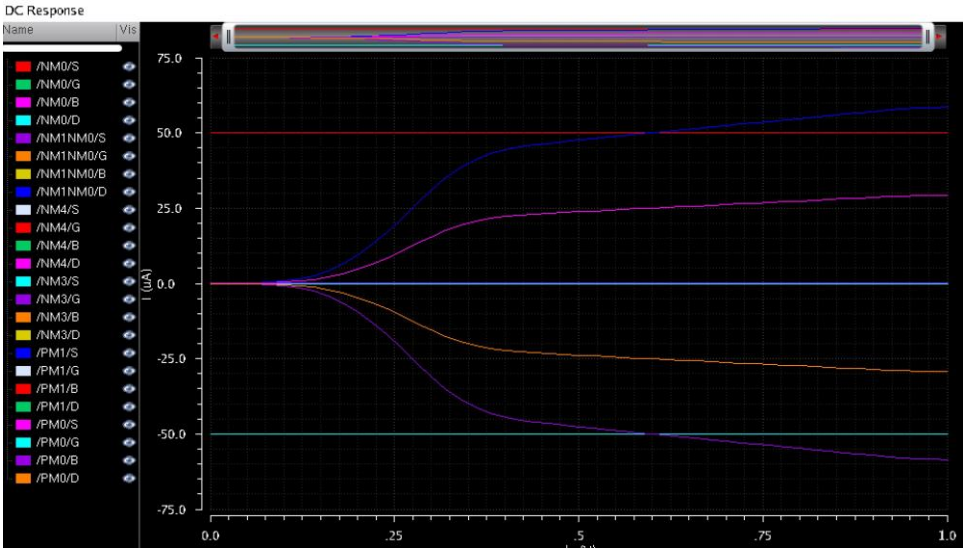
Figure 1: Amplifier Circuit

Question 2: Assign common mode voltage V3 dc=700mV and differential AC input 1V (by V1 dc=0 ac=500mV, phase=0 and V2 dc=0, ac=500mV, phase=180.

a. Selected transistors needed to find the saturation region.



The transistors within the saturation region



b. Spectra Calculator used to find the gain of NM3 and NM4 and the resistance of PMO and NM4.

By applying DC Analysis and the spectra calculator, we were able to find the gains for NM3 & NM4 as shown on the graph and calculations below:

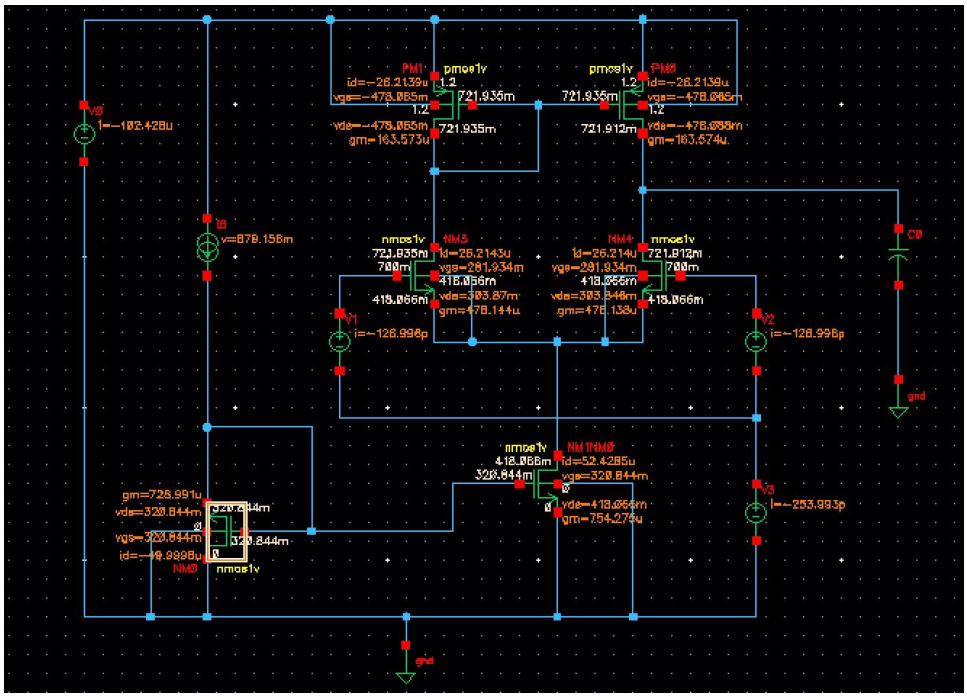


Figure 2

gm (NM3) = 478.144u

gm (NM4) = 478.136u

Now we used the spectra calculator to find the dc operation values of output resistance for NM3, NM4, and PMO.

The output resistance for NM3:

Ro (NM3) = 1/15.4816u = 64.592x10^-3

The output resistance for NM4:

Ro (NM4) = 1/15.4816u = 64.592x10^-3

Ro (PMO) = 281.109x10^-3

Calculating the resistance divider of ro (nm3) ||ro (pmo):

ro (nm3) ||ro (pmo) = r = r1r2/(r1 + r2) = (64.59x10^3)(281.109x10^3)/ (64.59x10^3) + (281.109x10^3) = (18156.81/345.69.699)(10^3) = 52.52x10^3

Calculating the resistance divider of ro (nm4)|| ro (pmo):

ro (nm4) ||ro (pmo) = r = r1r2/(r1 + r2) = (64.59x10^3)(281.109x10^3)/ (64.59x10^3) + (281.109x10^3) = (18156.83/345.699)(10^3) = 52.52x10^3

Calculating the gain(s) of NM3 & NM4:

A = gm(nm3) (ro (nm3)||ro (pmo))

A = 478.144u (0.5252x10^1) = 25.1x10^-5

A = gm(nm4) (ro (nm4)||ro (pmo))

A = 478.136u (0.5252x10^1) = 25.1x10^-5

c. The gain of the amplifier using AC Analysis:

The gain of figure 1 below is about 33.6364db and its –3b bandwidth is about 6.87988MHz.

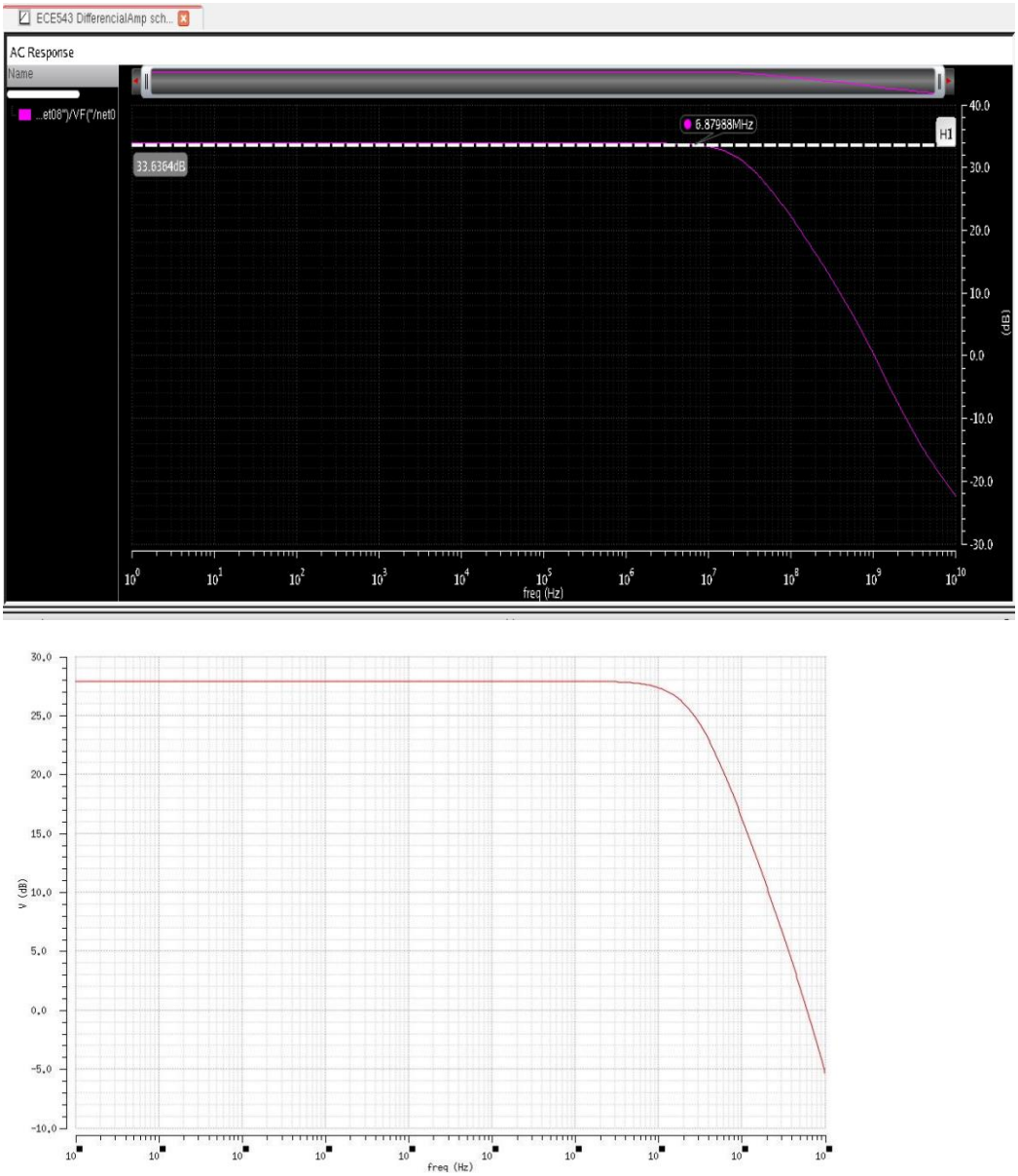


Figure 2: AC analysis result of differential gain.

Comparison of the given AC analysis and the results found:

The results found for the AC Analysis (figure 1) looks very similar to figure 2. The gain in figure 1 and figure 2 is approximately the same, that is by 27dB. However, the –3dB bandwidth of figure1 is significantly lower than figure 2. This can be the result of changes being done to V1 and V3 that in the current slightly higher for the circuit, however, reducing the frequency of the circuit tremendously.

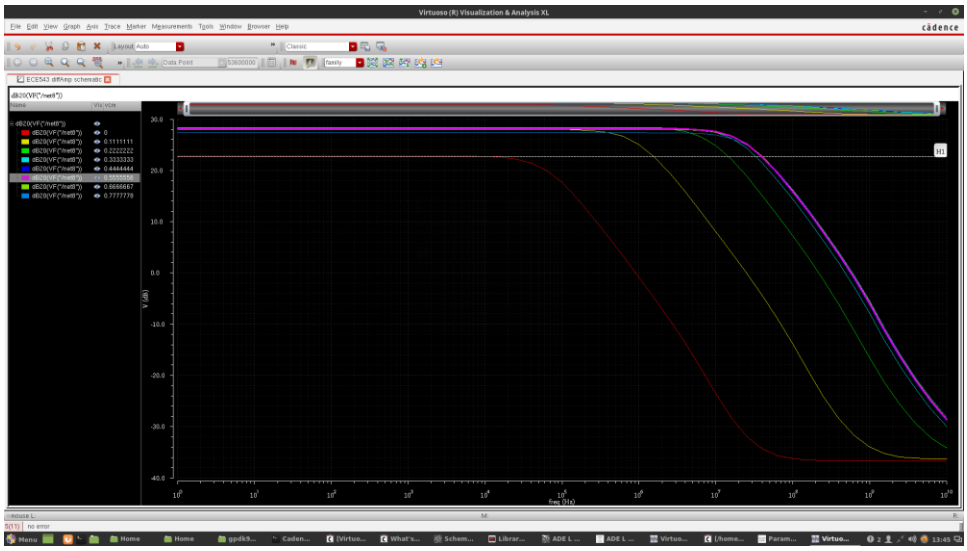
d.

After parametric Analysis Vcm ranges from 0 to 1.

25dB and –3dB bandwidth of 20MHz

Common mode range => 330mV < Vcm < 430mV

Ag = out/in = 20log(ΔVout/Δin) = 27.01

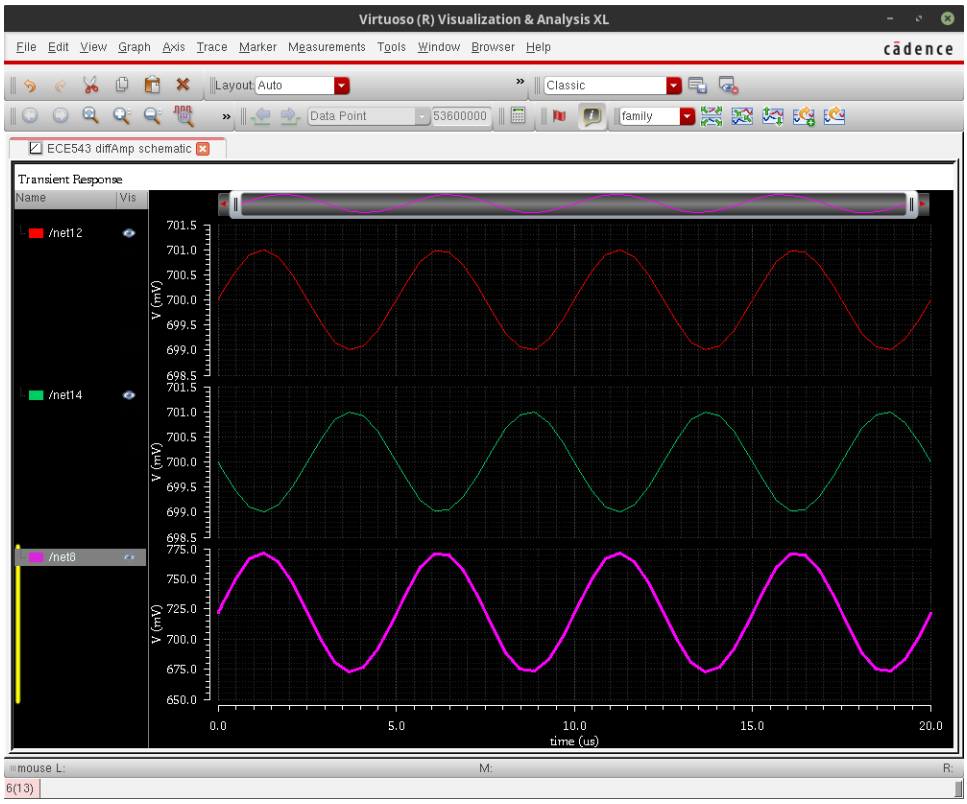


From the graph shown, the gain ranged anywhere from 0.333mV to 0.555mV.

3.

a. Ag = out/in = 20log(ΔVout/ΔVin)

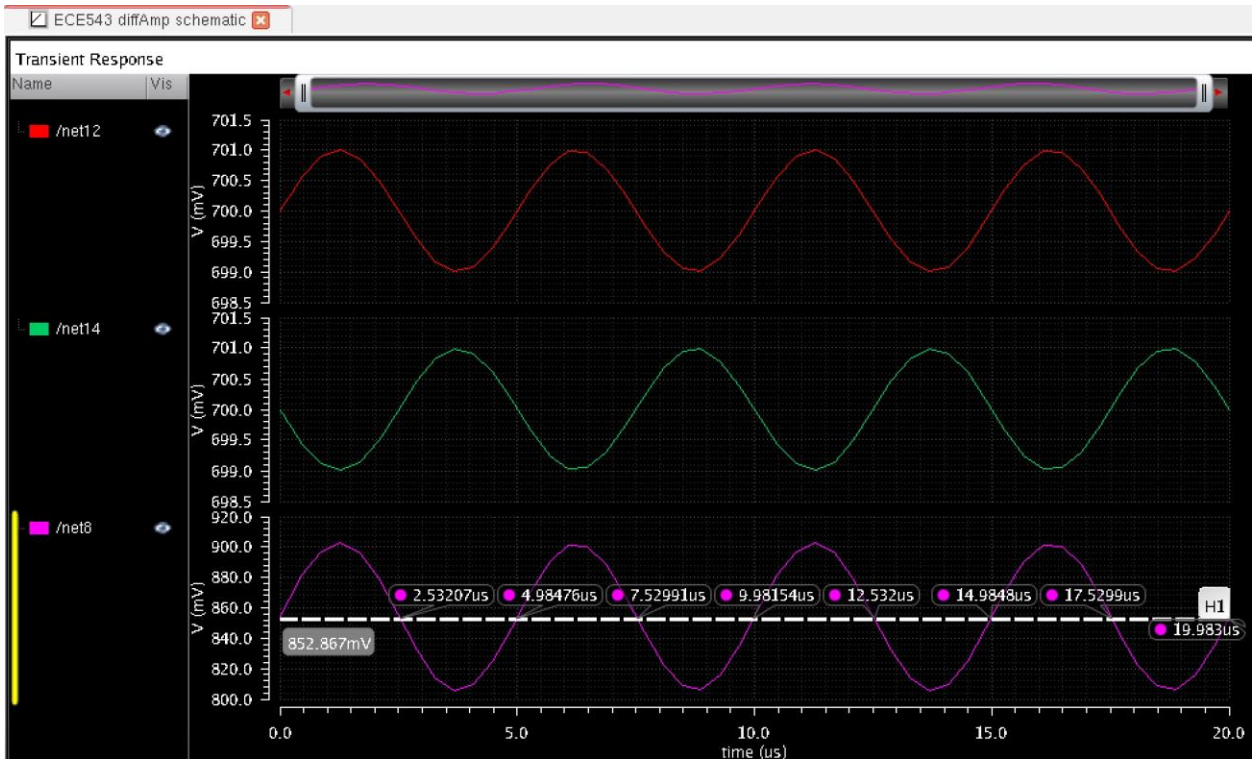
= 20log((771.09-672.37)/701-699) = 20log(98.72/2) = 20log(49.36) = 33.88



The graph shows the frequency gain of V1 and V2, as well as the output for the circuit.

b. The quiescent level of the amplifier is 721.9612mV.

The displays an increase in voltage when PM1 and PM0 width is increases to 5u and the idc is decreased to 40u instead of 50u. Therefore, increasing the output to 852.867mV.


ECE543 diffAmp schematic
Transient Response
Name
Vis
/net12
/net14
/net8
V (mV)
701.5
701.0
700.5
700.0
699.5
699.0
698.5
920.0
900.0
880.0
860.0
840.0
820.0
800.0
2.53207us
4.98476us
7.52991us
9.98154us
12.532us
14.9848us
17.5299us
H1
19.983us
852.867mV
0.0
5.0
10.0
15.0
20.0
time (us)