Lab 01

spice

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[1 Write a SPICE subcircuit that describes an op-amp with an open-loop gain of 1e4 and a UGF of 10MHz. Use comments generously to describe every line of the netlist. Report the SPICE subcircuit and explain how you chose the circuit parameters. 8](#_Toc172461367)

[2 Use the previous subcircuit to write a netlist of a non-inverting amplifier. The feedback resistance is 9kOhm and the other resistance is 1kOhm. Use a 1V DC input. Use comments generously to describe every line of the netlist. Run transfer function (TF) nalysis. Report a snapshot of the SPICE output file. Justify the output. 9](#_Toc172461368)

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Part 1 (prelab)

# Complete and run “vdivider.cir”. Report the netlist and the results.

A screenshot of a computer program

Description automatically generated

A screenshot of a computer

Description automatically generated

# Complete and run “simple\_rc\_tran”. Report the netlist and the results.

A white background with text and numbers

Description automatically generated A screenshot of a computer program

Description automatically generated

A graph of a graph on a black background

Description automatically generated

# Complete and run “simple\_rc\_ac.cir”. Report the netlist and the results.

A screenshot of a computer program

Description automatically generated

A black screen with green lines

Description automatically generated A white screen with black text

Description automatically generated

Part 2

# Write a SPICE subcircuit that describes an op-amp with an open-loop gain of 1e4 and a UGF of 10MHz. Use comments generously to describe every line of the netlist. Report the SPICE subcircuit and explain how you chose the circuit parameters.

A computer screen shot of a program

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3

4

A diagram of a circuit

Description automatically generatedA diagram of a circuit

Description automatically generated

1

2

AS in comments the:

, I=10m,

# Use the previous subcircuit to write a netlist of a non-inverting amplifier. The feedback resistance is 9kOhm and the other resistance is 1kOhm. Use a 1V DC input. Use comments generously to describe every line of the netlist. Run transfer function (TF) analysis. Report a snapshot of the SPICE output file. Justify the output.

A screenshot of a computer

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Description automatically generated

Input impedance is very high as it ideally equals infinity, output impedance equals 0 as it has ideal output buffer.

# Change the input to be a sine, Run transient analysis for two complete periods. Use a time step = period/50. Report RESULTS, CLEARLY annotate the peak value

A computer screen shot of a program

Description automatically generated

A graph with green and blue lines

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A screenshot of a computer

Description automatically generated

# How much is the voltage gain? Compare the voltage gain acquired from hand analysis, TF analysis, and TRAN analysis in a table. Comment.

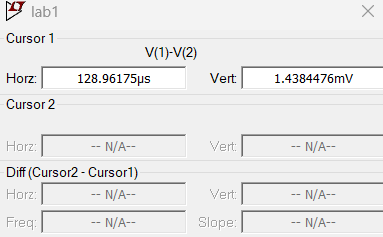
|  |  |  |
| --- | --- | --- |
| Hand Analysis | TF analysis | TRAN analysis |
| 9.99 | 9.99 | 9.985 |

TF analysis is same as hand analysis as it calculates dc gain at 0 frequency, but Tran analysis is at 1khz (which is not the as bandwidth extension happened) but anyway the gain slightly decreased.

# Report the waveform of the differential input of the op-amp. Clearly annotate the peak value in the figure. What is the amplitude of this signal? Why (explain with hand-analysis)?

A screen shot of a graph

Description automatically generated



A diagram of a customer feedback

Description automatically generated

The Trans gain is not super exact equals 9.985 at 1k , but approximately would equal 1.5mv and the result from the simulator of .

# Repeat the previous step but with input frequency equal to the UGF. What is the amplitude of this signal? Why (explain with hand-analysis)?

A screen shot of a computer

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A screenshot of a computer

Description automatically generated

At UGF the gain equals 0 db=1, so:

# Run AC analysis to plot the frequency response of the previous non-inverting amplifier (use an AC source). Use parametric sweep for the feedback resistance with two values (9k and 4k). Report the gain in dB vs frequency (log-log scale). Clearly annotate the DC gain, the 3dB high cutoff frequency, and the GBW (UGF) in the figure

A screenshot of a computer code

Description automatically generated

## dc gain

A screenshot of a computer screen

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Description automatically generated

## 3db high cutoff frequency

A screen shot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

## gbw

A computer screen shot of a white square with text

Description automatically generated

A screenshot of a computer

Description automatically generated

# If you increase the input amplitude in AC analysis and transient analysis, do you expect to see clipping in the output? Why?

We could see clipping only in transient analysis as the circuit is solved in nonlinear domain but anyway in our case the opamp has infinite headroom so no clipping would happen, but in ac analysis the circuit is linearized so the nonlinear effects have no meaning.

# Compare the DC gain, the 3dB high cutoff frequency, and the GBW (UGF) from hand analysis and AC analysis in a table. Comment.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | DC GAIN (db) | | BW  (Mhz) | | UGF  (MHZ) | |
| 4K | 9K | 4K | 9K | 4K | 9K |
| HA | 13.97 | 19.99 | 1 | 2 | 10 | 10 |
| SPICE | 13.97 | 19.99 | .995 | 1.986 | 9.81 | 9.95 |

## HAND ANALYSIS:

### DC GAIN

#### FOR 4K:

20log() = 13.97

#### FOR 9K:

20log() = 19.99

### BW

#### FOR 4K

#### FOR 9K

### UGF

UGF doesn’t change with feedback, as gain decreases the bandwidth increases so UGF remains the same.

UGF in HA is the product of the BW and GAIN but more accurate definition is in the simulator: the frequency when the gain equals 0db

## Final comment :

The results in spice are accurate and matches the hand analysis.