Lab 1, Analog Integrated Circuits

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# 1) Operation point

a) Task: Build up the common source amplfier

Diagram, schematic

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Figure : Common Source amplifier curcuit

b) Task: Determine R\_L value for V\_out=0,9V and Transistor biased for I\_d,dc=16,08µA

c) Task: Perform Bias Point Simulation and show that V\_out = 0,9V

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Description automatically generated

Figure : Curcuit with bias voltages and currents simulated

V\_out settles at 0,9V as expected

d) Task: Determine operation area of Transistor M1 and justify answer

Condition 1 met:

Condition 2 met:

Transistor M1 is in saturation, due to fulfilment on condition 1 and 2

e, g) Task: Determine small-signal DC-gain, in-, output resistance, small signal transconductance and small signal resistance of transistor with bias point simulation

PSpice Output: SMALL-SIGNAL CHARACTERISTICS:

The negativ voltage gain is expected, due to 180° Phase shift of to the common source amplifier.

h) Task: Draw small curcuit equivalent curcuit and calculate small signal voltage gain

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Figure : Common source amplifier with small signal equivalent

The small voltage gain of -6,66 equals the simulated -6,68.

# 2) Transient analysis

b) Task: Perform a transient simulation with shown curcuit and plot in- and outputvoltage



Figure : Transient analysis of in- and output signal

c) Task: Determine the small signal voltages of in- and output and its gain



Figure : Gain, in- and output of small signals

d) Task: Compare small signal voltage gain with bias point simulation

|  |  |  |
| --- | --- | --- |
|  | Bias point simulation | Transient analysis |
| Small signal voltage gain | -6,68 | -6,70 |

The gains are equivalent

e) Task: Calculate the maximum amplitude of the input voltage which results in a ”clipping” of the output voltage and show in the simulation

Limiting factor is V\_ds to stay in saturation:



Figure : Gain of input and output voltage before clipping

The resulting Outputamplitude beträgt:   
The gain isnt constant accross the input voltage range, like shown in the upper plot of figure 6.  
The linearised gain is thereby not more applicable at high input voltages and none linear effects occure which result in not reaching but just .

# 1) AC anlysis

b) Task: Perform an AC analysis of the in- and outputvoltage



Figure : input and output magnitude voltage of ac analysis

The Magnitude of the input is 10mV and of the output 66,8 mV

c) Task: Plot the magnitude and phase of V\_out



Figure : Magnitude and Phase of the output voltage of the common source amplfier in ac simulation

Small changes in amplitude and phase are very small but expected due to low pass effect of capacitances. This results in

d) Task: Compare results of ac analysis with bias point and transient analysis

|  |  |  |  |
| --- | --- | --- | --- |
|  | ac analysis | bias point analysis | transient analysis |
|  | -6,68 | -6,68 | -6,70 |

e) Task: Determine the small signal gain at an input voltage of 1V

At an input voltage of 1V the relation between input and ouput stays the same as in d) due to the linearisation of the curcuit.

Discrepancies between the transient and the ac simulation are a result of neglecting none linearitys at the ac simulation at input voltages other than the input voltage at this bias point.