Common Drain Amplifier - Source Follower

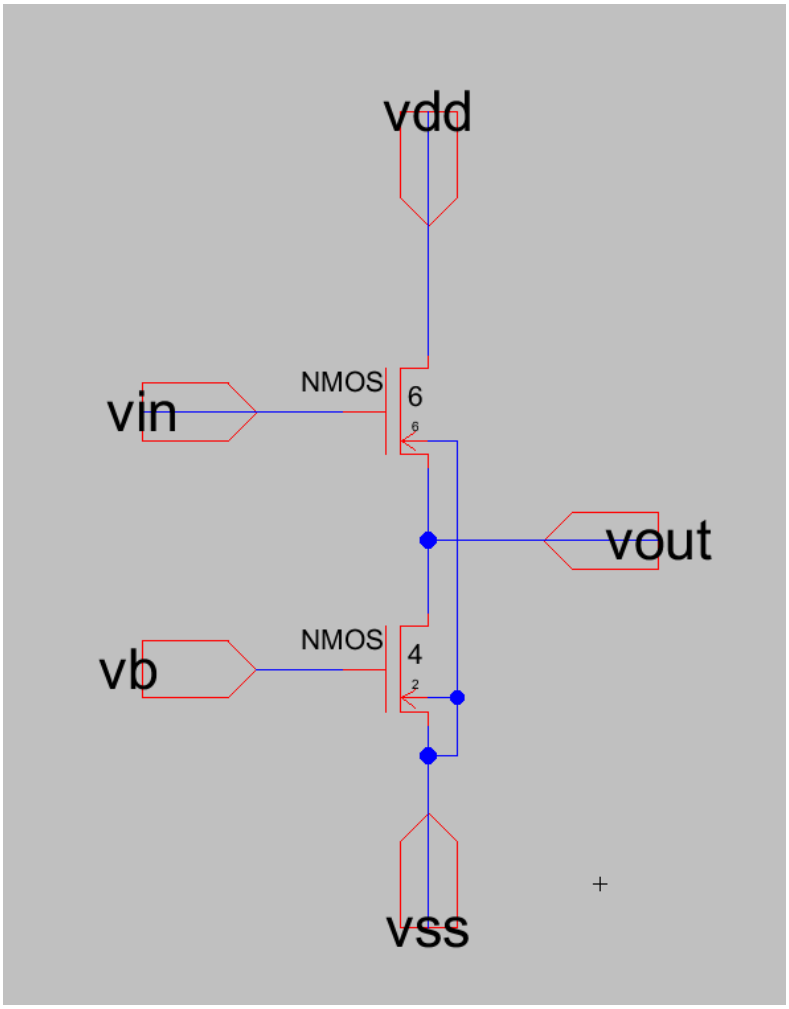
Given

- `Id` = 0.35 mA
- at `Vb` = 1.5V
- `Vout` = 1.82V
- `(W/L)1` = 6/6 = 1
- `(W/L)2` = 1.85 ~= 2
- `W2` = 4
- `l2` = 2

Observations

- Gain: -1.99 db
- Bandwidth = 4.78GHz

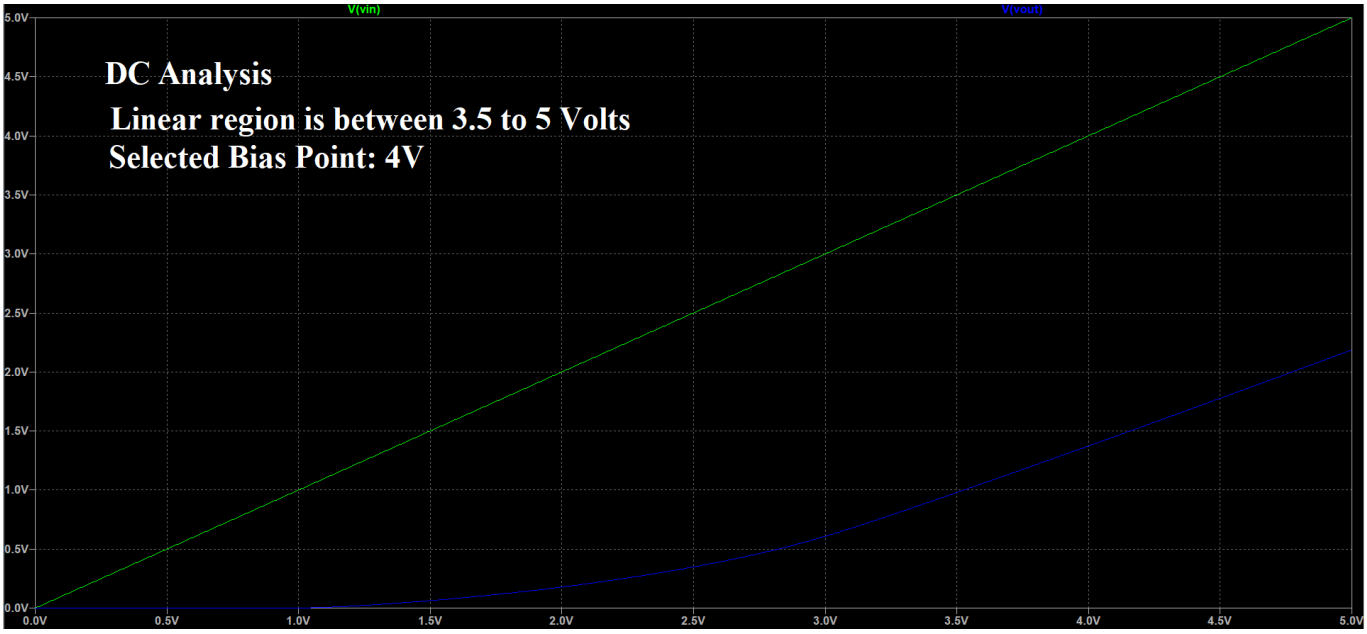
Schematic



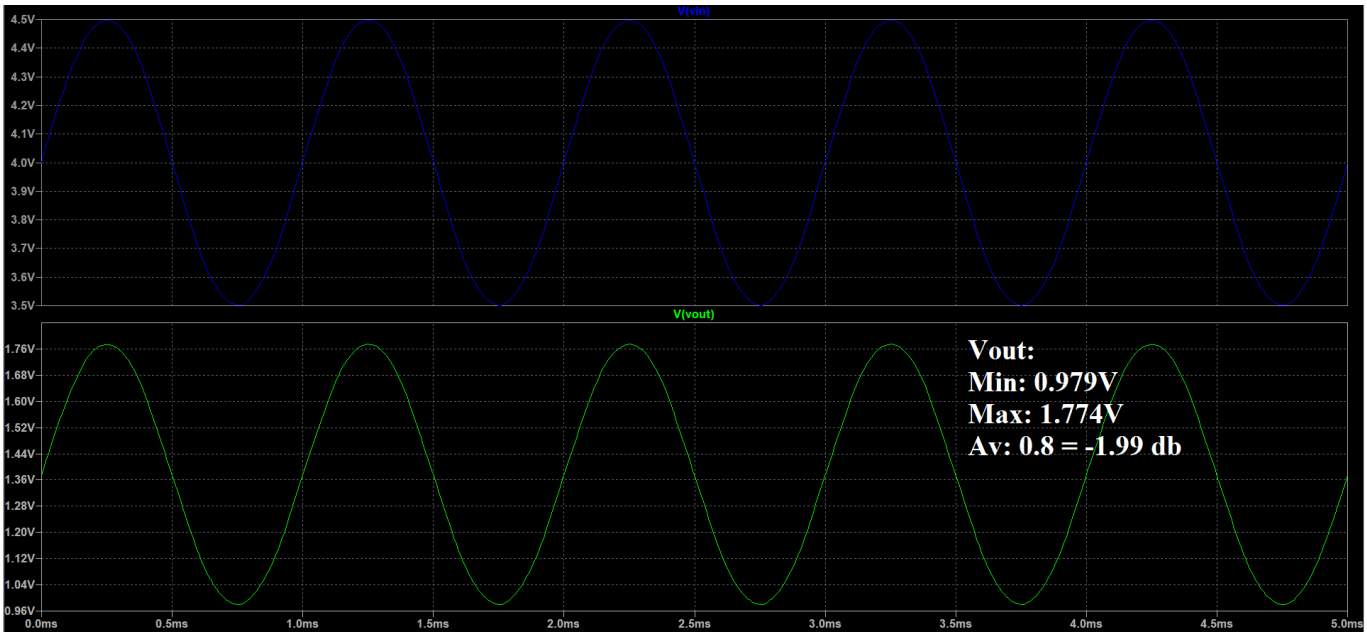
Spice Code

```
.include D:\Electric\C5_models.txt
vdd vdd 0 DC 5
vss vss 0 DC 0
vb vb 0 DC 1.5


#DC
vin vin 0 DC 2
.dc vin 0 5 1m


#TRANS
vin vin 0 sin(4 0.5 1k 0 0 0 0)
.trans 0 5m


#AC
vin vin 0 ac sin(4 0.5 1k 0 0 0 0)
.ac dec 100 100 100G
```

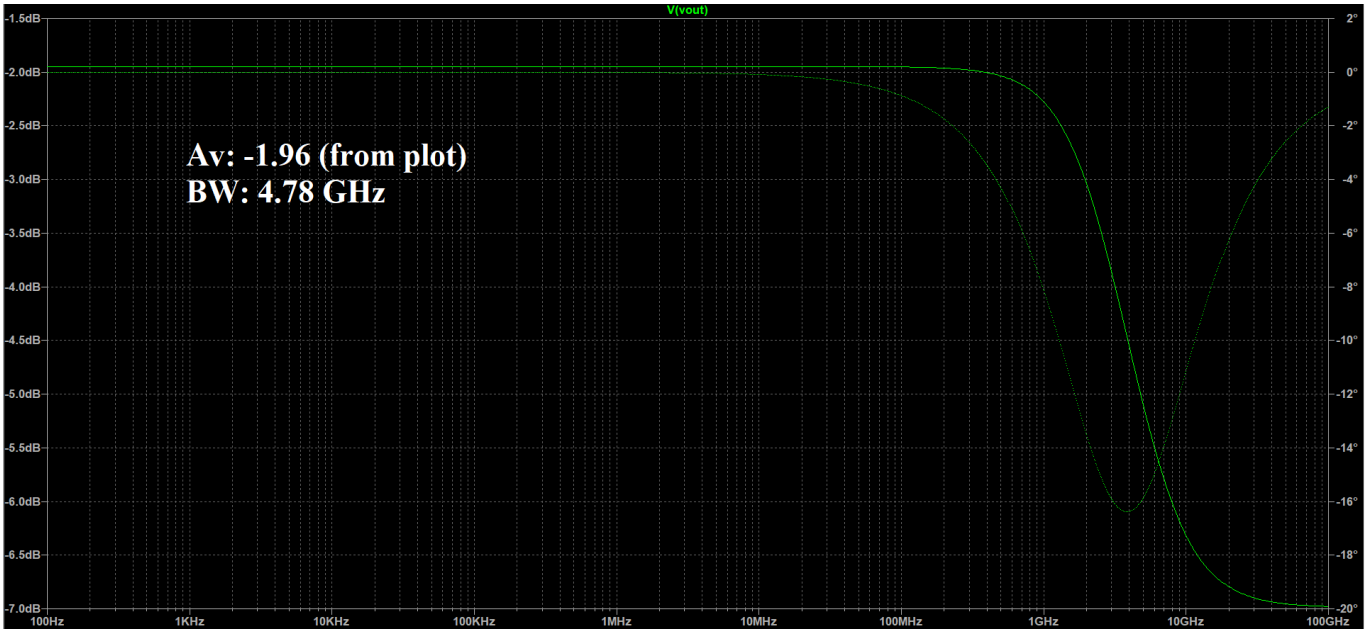
DC Analysis



Transient Analysis


V(vin)
4.5V
4.4V
4.3V
4.2V
4.1V
4.0V
3.9V
3.8V
3.7V
3.6V
3.5V
V(vout)
1.76V
1.68V
1.60V
1.52V
1.44V
1.36V
1.28V
1.20V
1.12V
1.04V
0.96V
0.0ms
0.5ms
1.0ms
1.5ms
2.0ms
2.5ms
3.0ms
3.5ms
4.0ms
4.5ms
5.0ms
Vout:
Min: 0.979V
Max: 1.774V
Av: 0.8 = -1.99 db

AC Analysis


V(vout)
-1.5dB
-2.0dB
-2.5dB
-3.0dB
-3.5dB
-4.0dB
-4.5dB
-5.0dB
-5.5dB
-6.0dB
-6.5dB
-7.0dB
2°
0°
-2°
-4°
-6°
-8°
-10°
-12°
-14°
-16°
-18°
-20°
100Hz
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz
1GHz
10GHz
100GHz
Av: -1.96 (from plot)
BW: 4.78 GHz

For a drain Current $I_{DS} = 0.35mA$.

$V_{in} = 0.5\ V$. $V_{th} = 0.7V$.

$C_{ox} = 2.484 \times 10^{-3} F$ $\mu_n = 0.045843\ mm^2$

$\left(\frac{W}{L}\right)_1 = \frac{6}{6} = 1$

(1) $V_{out} = V_{DD} - V_{th} - \sqrt{\frac{2 I_{DS}}{\mu_n C_{ox} \left(\frac{W}{L}\right)_1}}$

$V_{out} = 5 - 0.7 - \sqrt{\frac{2 \times 0.35 \times 10^{-3}}{0.045843 \times 2.484 \times 10^{-3} \times 1}}$

$\boxed{V_{out} = 1.8206\ V.}$

(2) $\left(\frac{W}{L}\right)_2 = \frac{2 I_{D2}}{\mu_n C_{ox} (V_{out})^2} = \frac{2 \times 0.35 \times 10^{-3}}{\mu_n C_{ox} (1.82)^2}$

$\left(\frac{W}{L}\right)_2 = 1.85 = \frac{37}{20} \simeq \frac{19}{10} \approx \boxed{\frac{4}{2.}}$

$V_{in} = 1$

$V_{out} = 1.774 - 0.979 \cdot 0.8 = -1.99\ dB.$

$A_V = \frac{V_{out}}{V_{in}} = 0.8 = -1.99 dB.$

From AC-analysis. (Plot).

$A_V = -1.95 dB.$

$BW = 4.78\ GHz.$