DESIGN OF COMMON SOURCE AMPLIFIER (REDESIGNED)

AS W/L RATIO WAS VERY HIGH IN PREVIOUS DESIGN APPROACH AND SIMULATIONS RESULT WERE NOT EXACTLY MATCHING THE SPECIFICATION

COMMON SOURCE AMPLIFIER

USING NMOS AND PASSIVE LOAD

MODEL FILE : 180n

SPECIFICATIONS

GBW=800MHz , VDD=1.8V , L=0.36u

CALCULATIONS

GBW=800MHz , L=0.36u , Vdd=1.8V, Model file = 180n

Let GAIN (A) = 10

f(-3db) = $\frac{GBW}{Gain}$ = 80MHz LET Gm=2mS (Practical value range 1-3 S given by Javed Sir)

USING $C_L = \frac{Gm}{2\pi\ GBW}$ C_L =0.397pF (assume 0.3pF)

Now by Back calculation ,

$Gm = 2\pi\ GBW C_L$=1.5mS

Assume Vov=0.2V Vgs=0.65V Id= $\frac{Gm\ Vov}{2}$ =150uA

Then , Gm/Id = 10

R=(1.8 – 0.9)/150uA=6 Kohm

W is calculated by sweeping for 150uA current

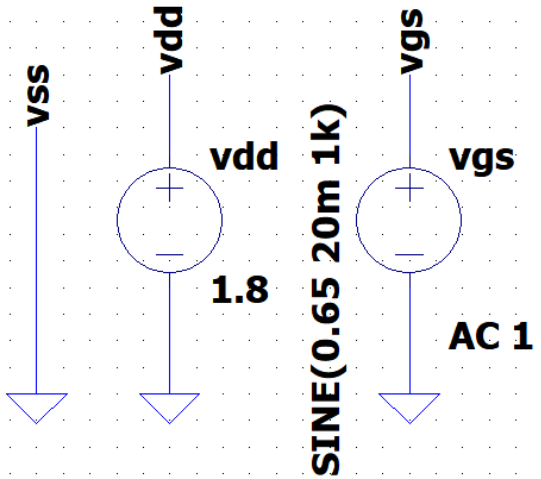
SCHEMATIC IN LT SPICE

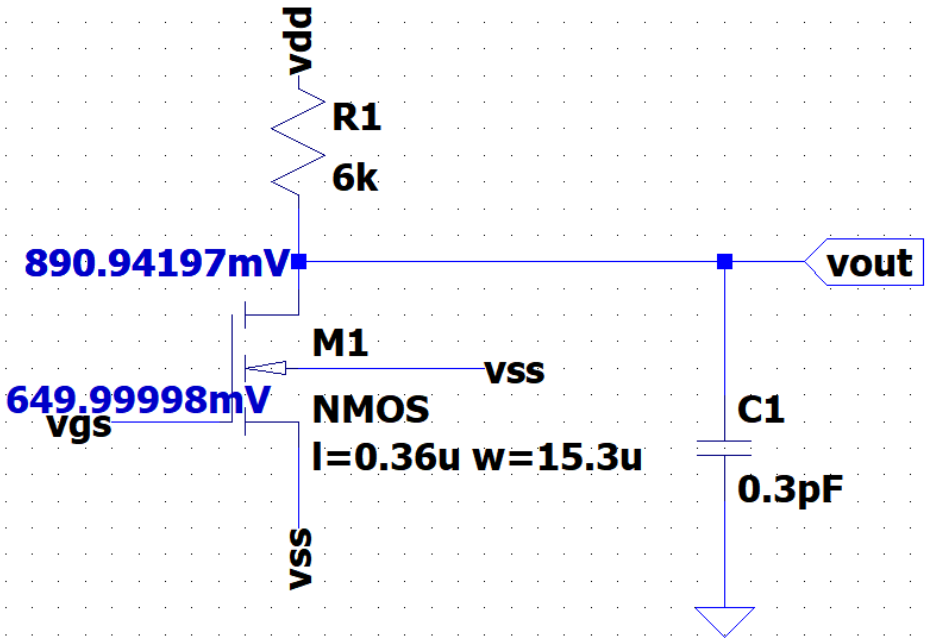
COMMON SOURCE AMPLIFIER DESIGNED USING GM OVER ID new approach METHOD USING NMOS AND RESISTOR for GBW = 800MHz

(SPECIFICATIONS)
GBW=800MHz
vdd=1.8V

```
.include tsmc180.txt
.op
;.tf V(vout) vgs
;.ac dec 100 1Meg 100G
.tran 5m
```

```
;.step param wn 1u 50u 1u
;.param wn=1
```



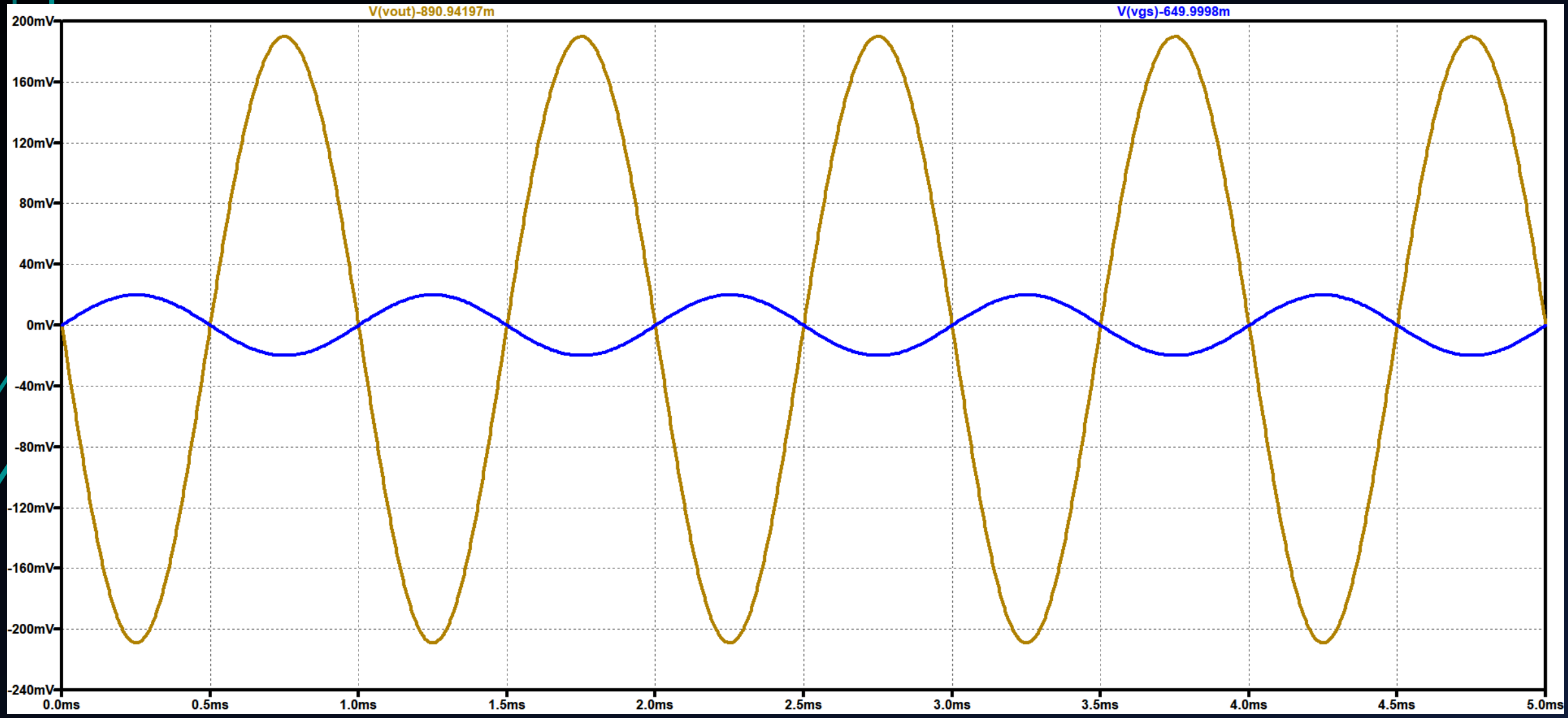


```
        --- Transfer Function ---

Transfer_function:              -10.0208        transfer
vgs#Input_impedance:            1e+020          impedance
output_impedance_at_V(vout):    5453.14         impedance
```

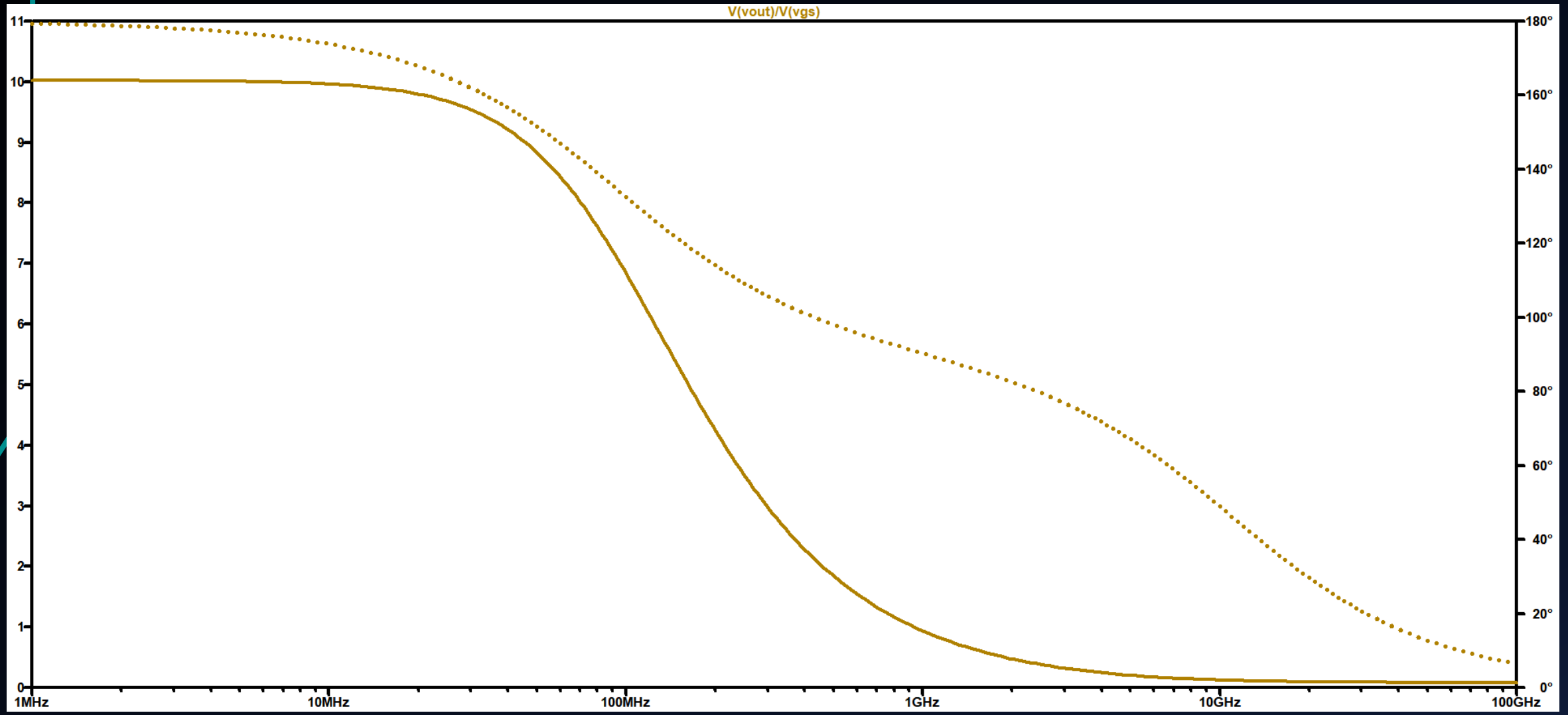
```
        --- Operating Point ---

V(vout):        0.890942        voltage
V(vgs):         0.65            voltage
V(vdd):         1.8             voltage
Id(M1):         0.00015151      device_current
Ig(M1):         0               device_current
Ib(M1):         -9.00942e-013   device_current
Is(M1):         -0.00015151     device_current
I(C1):          2.67283e-025    device_current
I(R1):          0.00015151      device_current
I(Vgs):         0               device_current
I(Vdd):         -0.00015151     device_current
```

```
Semiconductor Device Operating Points:
                                --- BSIM3 MOSFETS ---
Name:          m1
Model:        nmos
Id:         1.52e-04
Vgs:        6.50e-01
Vds:        8.91e-01
Vbs:        0.00e+00
Vth:        4.66e-01
Vdsat:      1.41e-01
Gm:         1.84e-03
Gds:        1.67e-05
Gmb         4.81e-04
Cbd:        0.00e+00
Cbs:        0.00e+00
```

TRANSIENT ANALYSIS IN LT SPICE



FREQUENCY RESPONSE IN LT SPICE



COMMON SOURCE AMPLIFIER

USING PMOS AND PASSIVE LOAD

MODEL FILE : 180n

SPECIFICATIONS

GBW=800MHz , VDD=1.8V , L=0.36u

CALCULATIONS

GBW=800MHz , L=0.36u , Vdd=1.8V, Model file = 180n

LET Gm=3mS (Practical value range 1-3 S given by Javed Sir)

USING $C_L = \frac{Gm}{2\pi\ GBW}$ C_L =0.49pF (assume 0.5pF)

Now by Back calculation ,

$Gm = 2\pi\ GBW C_L$=2.5mS

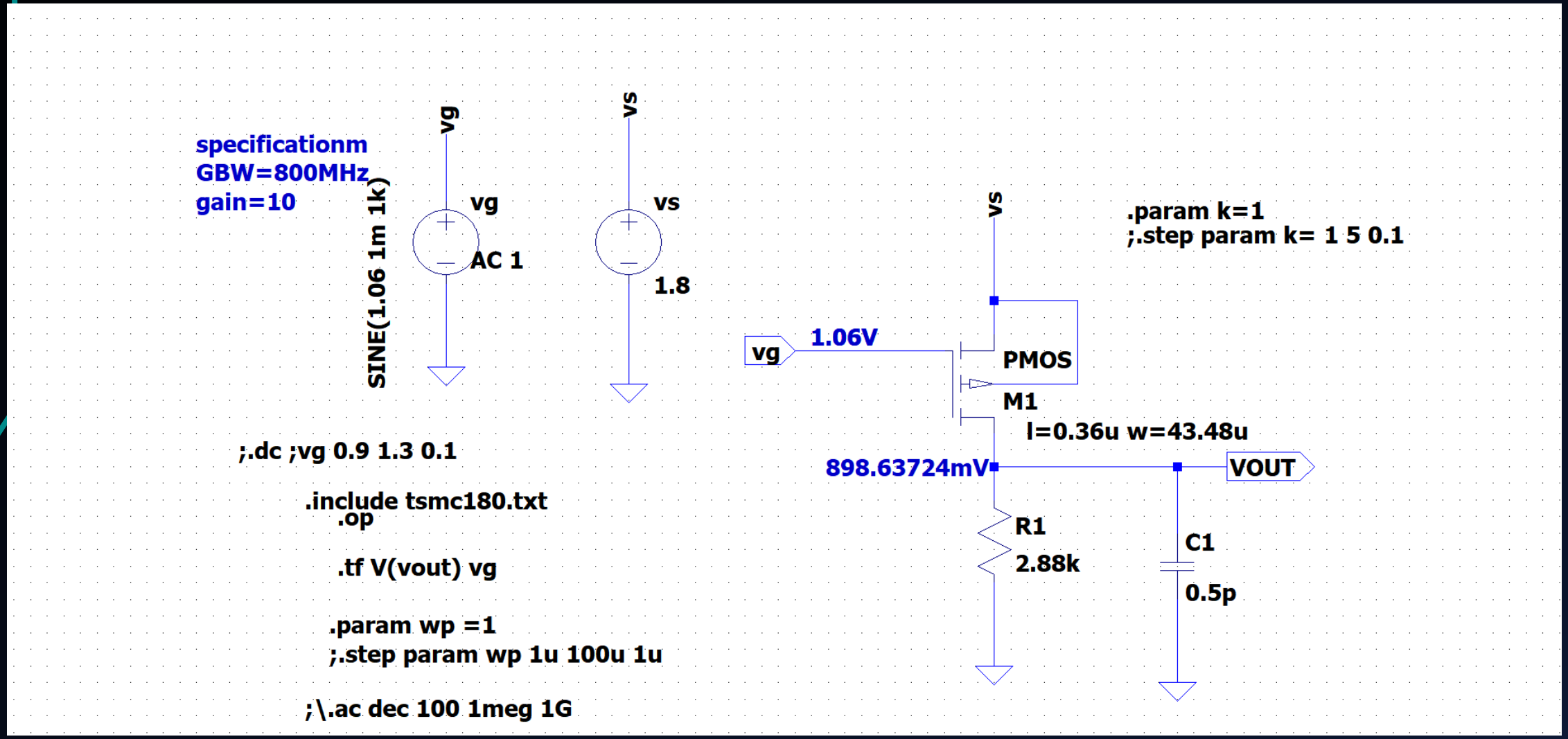
Assume Vov=0.2V Vg=1.1V Id= $\frac{Gm\ Vov}{2}$ =312uA

Then , Gm/Id = 8.01

R=(1.8 – 0.9)/312uA= 2.88 Kohm

W is calculated by sweeping for 312uA current

SCHEMATIC IN LT SPICE

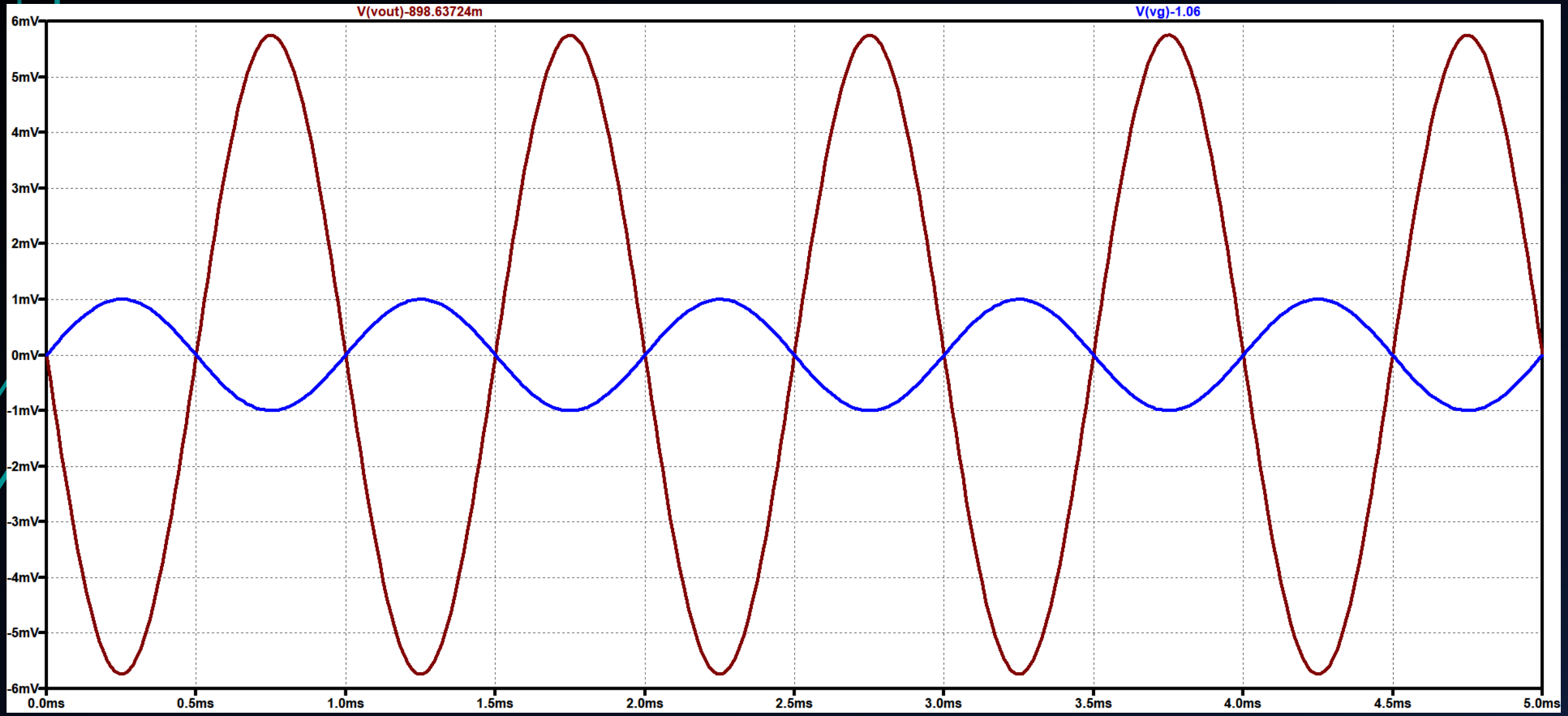


```
        --- Transfer Function ---

Transfer_function:              -5.74605        transfer
vg#Input_impedance:             1e+020          impedance
output_impedance_at_V(vout):    2676.28         impedance
```

```
        --- Operating Point ---

V(vg):          1.06            voltage
V(vs):          1.8             voltage
V(vout):        0.898637        voltage
Id(M1):         -0.000312027    device_current
Ig(M1):         -0              device_current
Ib(M1):         9.11363e-013    device_current
Is(M1):         0.000312027     device_current
I(C1):          4.49319e-025    device_current
I(R1):          0.000312027     device_current
I(Vs):          -0.000312027    device_current
I(Vg):          0               device_current
```

```
Semiconductor Device Operating Points:
                                --- BSIM3 MOSFETS ---
Name:           m1
Model:          pmos
Id:         -3.12e-04
Vgs:        -7.40e-01
Vds:        -9.01e-01
Vbs:         0.00e+00
Vth:        -4.73e-01
Vdsat:      -2.33e-01
Gm:          2.15e-03
Gds:         2.64e-05
Gmb          6.96e-04
Cbd:         0.00e+00
Cbs:         0.00e+00
Cgsov:       3.09e-14
Cgdov:       3.09e-14
```

TRANSIENT ANALYSIS IN LT SPICE



COMMON SOURCE AMPLIFIER

USING NMOS AND CURRENT SOURCE LOAD

MODEL FILE : 180n

SPECIFICATIONS

GBW=1GHz , Gain = 10 at 100MHz

CALCULATIONS

GBW=1GHz , Gain = 10 at 100MHz

LET Gm=2mS (Practical value range 1-3 S given by Javed Sir)

USING $C_L = \frac{Gm}{2\pi\ GBW}$ C_L =0.318pF (assume 0.3pF)

Now by Back calculation ,

$Gm = 2\pi\ GBW C_L$ =1.884mS

(For nmos) Vov=0.2V Vgs=0.65V Id= $\frac{Gm\ Vov}{2}$ = 188uA

Then , Gm/Id = 10.021 Id/W = 13.6

W=14u

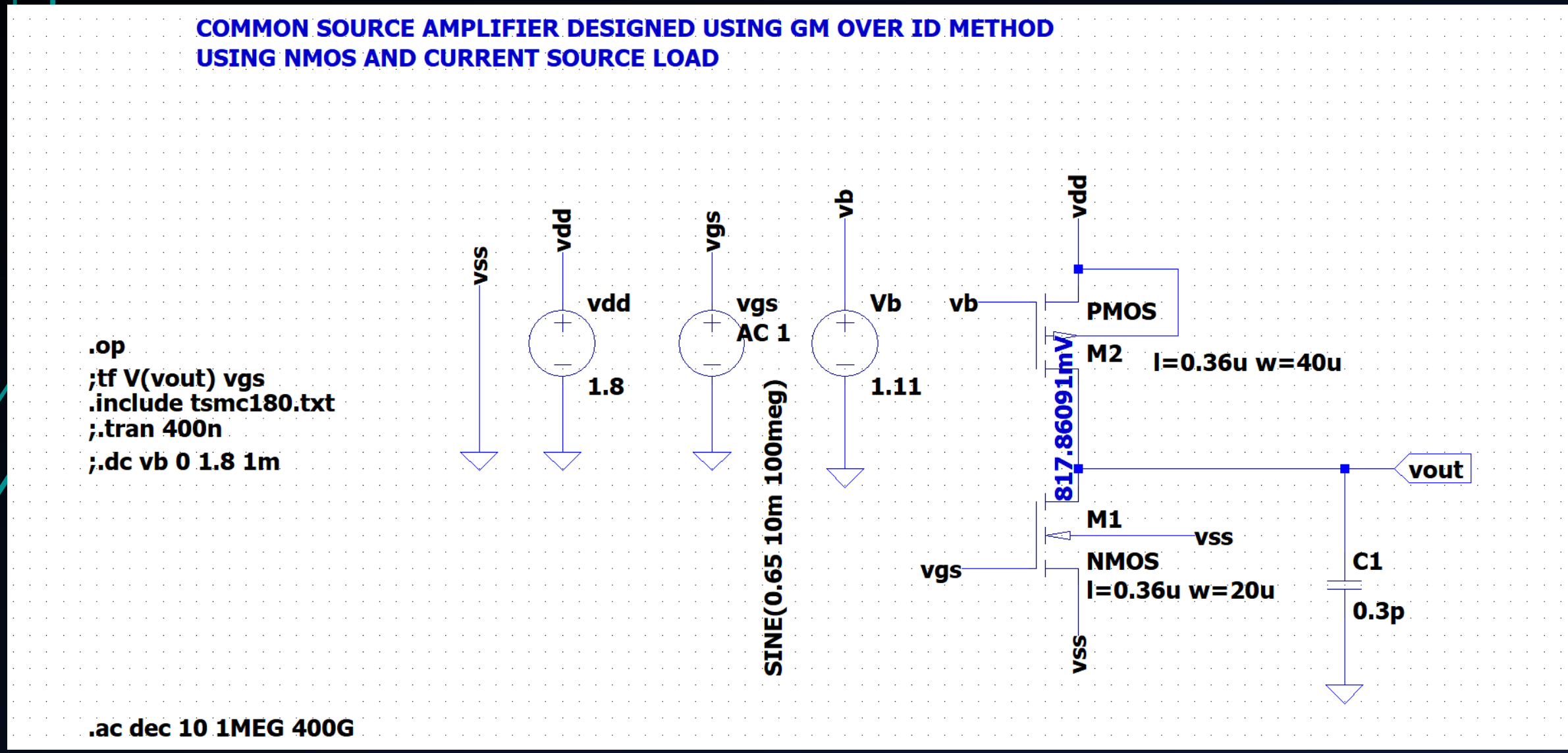
(For pmos) Vg=1.1V

Width of PMOS is taken twice as that of nmos

W=28u

NOTE : Now some manipulations are done in calculations to meet the specifications

SCHEMATIC IN LT SPICE

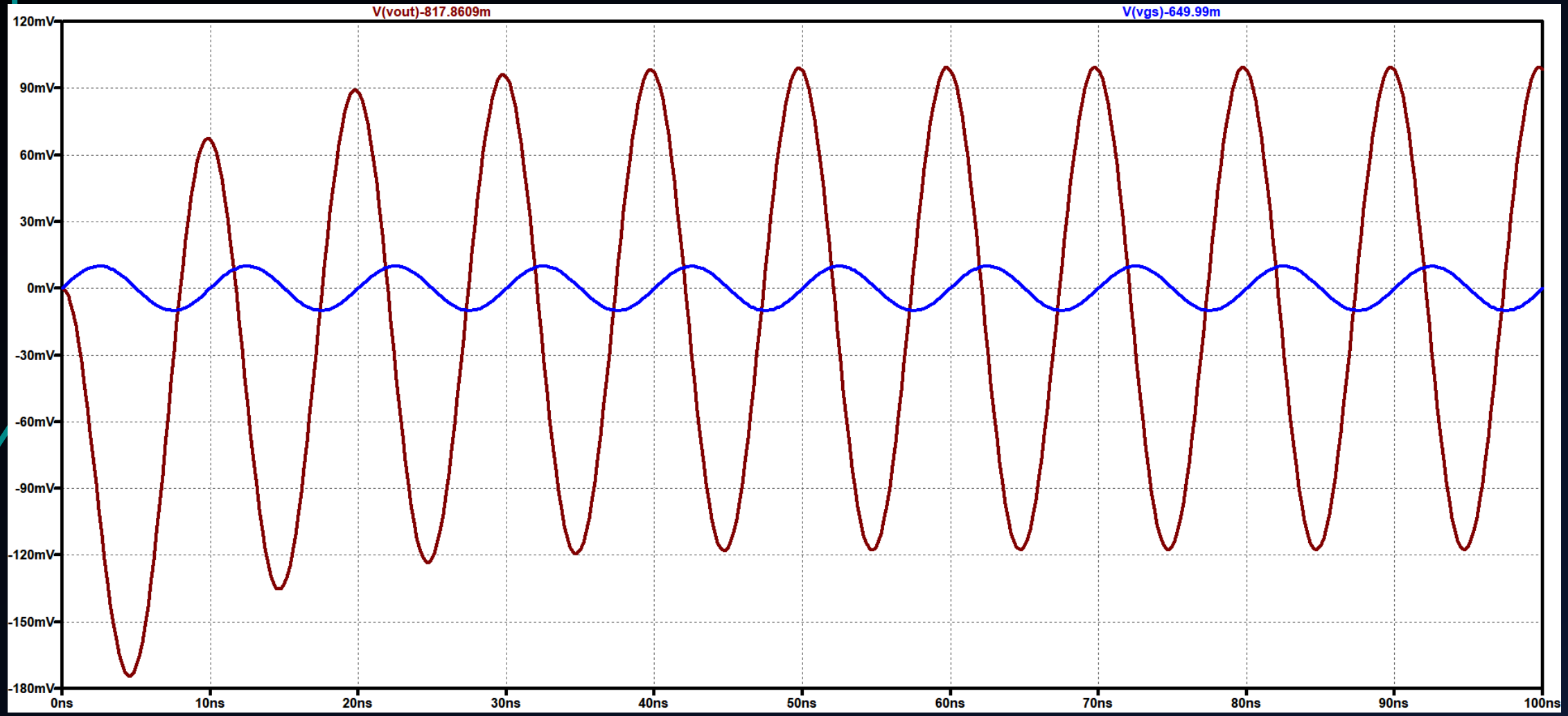


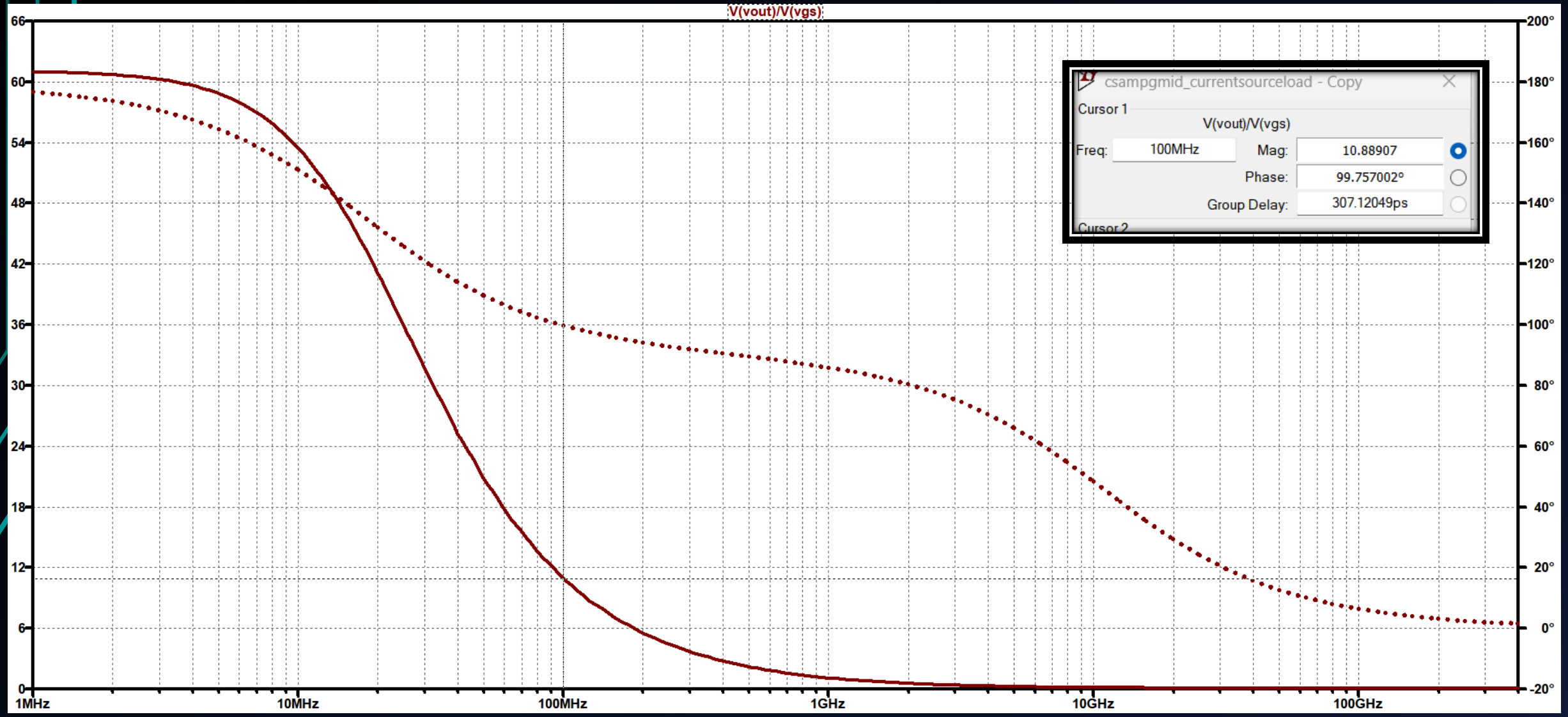
```
      --- Operating Point ---

V(vout):        0.817861        voltage
V(vgs):         0.65            voltage
V(vdd):         1.8             voltage
V(vb):          1.11            voltage
Id(M2):         -0.000197001    device_current
Ig(M2):         -0              device_current
Ib(M2):         9.92139e-013    device_current
Is(M2):         0.000197001     device_current
Id(M1):         0.000197001     device_current
Ig(M1):         0               device_current
Ib(M1):         -8.27861e-013   device_current
Is(M1):         -0.000197001    device_current
I(C1):          2.45358e-025    device_current
I(Vb):          0               device_current
I(Vdd):         -0.000197001    device_current
I(Vgs):         0               device_current
```

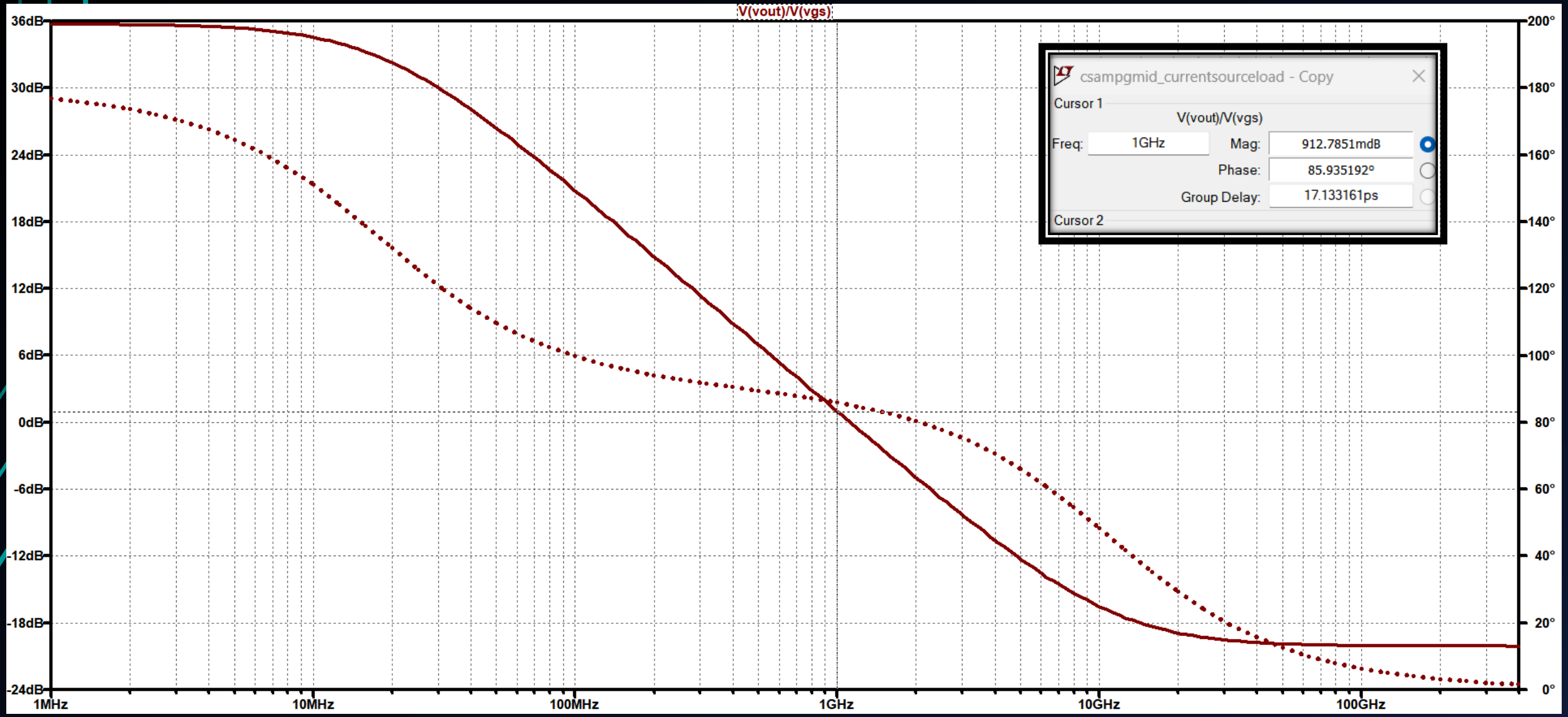
```
Semiconductor Device Operating Points:
                                --- BSIM3 MOSFETS ---
Name:          m2           m1
Model:       pmos         nmos
Id:       -1.97e-04    1.97e-04
Vgs:      -6.90e-01    6.50e-01
Vds:      -9.82e-01    8.18e-01
Vbs:       0.00e+00    0.00e+00
Vth:      -4.73e-01    4.65e-01
Vdsat:    -1.94e-01    1.41e-01
Gm:        1.68e-03    2.39e-03
Gds:       1.69e-05    2.22e-05
Gmb        5.39e-04    6.26e-04
Cbd:       0.00e+00    0.00e+00
Cbs:       0.00e+00    0.00e+00
Cgsov:     2.84e-14    1.54e-14
Cgdov:     2.84e-14    1.54e-14
```

```
      --- Transfer Function ---

Transfer_function:              -61.0818        transfer
vgs#Input_impedance:            1e+020          impedance
output_impedance_at_V(vout):    25549.1         impedance
```

TRANSIENT ANALYSIS IN LT SPICE




V(vout)/V(vgs)
66
60
54
48
42
36
30
24
18
12
6
0
200°
180°
160°
140°
120°
100°
80°
60°
40°
20°
0°
-20°
1MHz
10MHz
100MHz
1GHz
10GHz
100GHz
csampgmid_currentsourceload - Copy
Cursor 1
V(vout)/V(vgs)
Freq:
100MHz
Mag:
10.88907
Phase:
99.757002°
Group Delay:
307.12049ps
Cursor 2


V(vout)/V(vgs)
36dB
30dB
24dB
18dB
12dB
6dB
0dB
-6dB
-12dB
-18dB
-24dB
200°
180°
160°
140°
120°
100°
80°
60°
40°
20°
0°
1MHz
10MHz
100MHz
1GHz
10GHz
100GHz
csampgmid_currentsourceload - Copy
Cursor 1
V(vout)/V(vgs)
Freq: 1GHz
Mag: 912.7851mdB
Phase: 85.935192°
Group Delay: 17.133161ps
Cursor 2

THANK YOU