DEVICES AND CIRCUITS LAB REPORT – 4

EXPERIMENT NAME : BJT Common Emitter Amplifier Characteristics

ROLL NUMBERS **:** 200020010 , 200020051

Ng Spice Code **:**

#code to find Id vs Vd charcteristics of NMOS

*code1

*I-V Characteristics of CD4007

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

m1 2 1 0 0 MN4007

vin 1 0 dc 0v

vd1 3 2 dc 0v

vds 3 0 dc 0v

*DC analysis to sweep vds from 0 to 5V

.dc vds 0 5 0.01 vin 0 5 0.2

.control

run

*white background

set color0=white

* black grid and text (only needed with X11, automatic with MS Win)

set color1=black

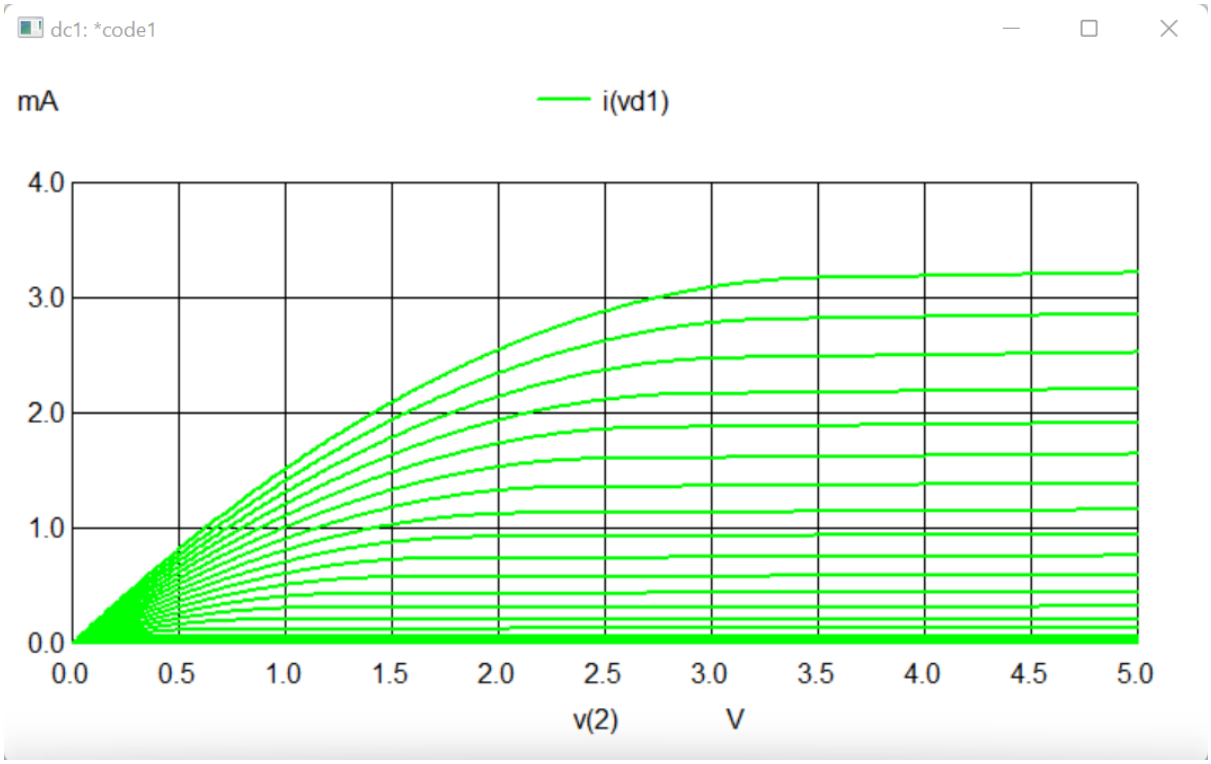
* wider grid and plot lines

set xbrushwidth=2

plot i(vd1) vs v(2)

.endc

.end



*code2 to find out Rds and ro for different values of Vgs

*I-V Characteristics of CD4007

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

m1 2 1 0 0 MN4007

vin 1 0 dc 0v

vd1 3 2 dc 0v

vds 3 0 dc 0v

*DC analysis to sweep vds from 0 to 5V

.dc vds 0 5 0.01 vin 0 5 1

.control

run

*white background

set color0=white

* black grid and text (only needed with X11, automatic with MS Win)

set color1=black

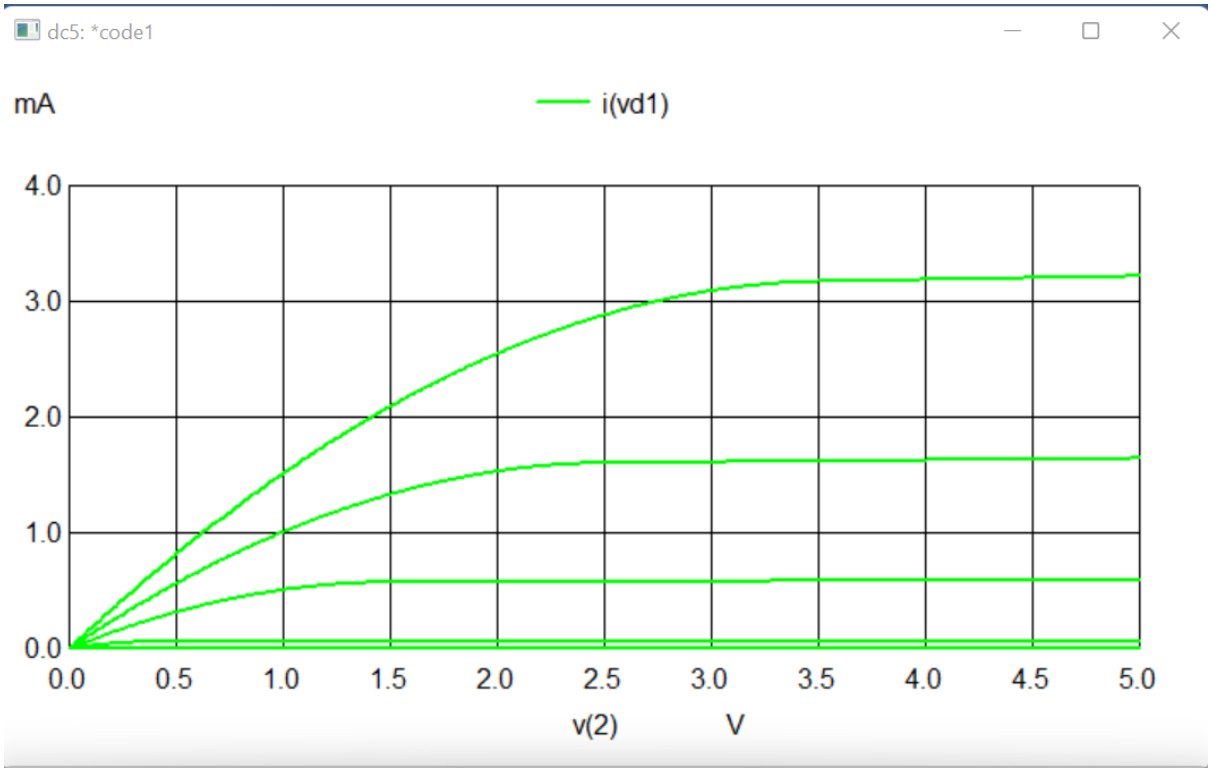
* wider grid and plot lines

set xbrushwidth=2

plot i(vd1) vs v(2)

.endc

.end



From the plot :

For

Vgs (inv)	Rds (in ohms)
5	639
4	1041
3	2086
2	11408

And r0 = 1.6k

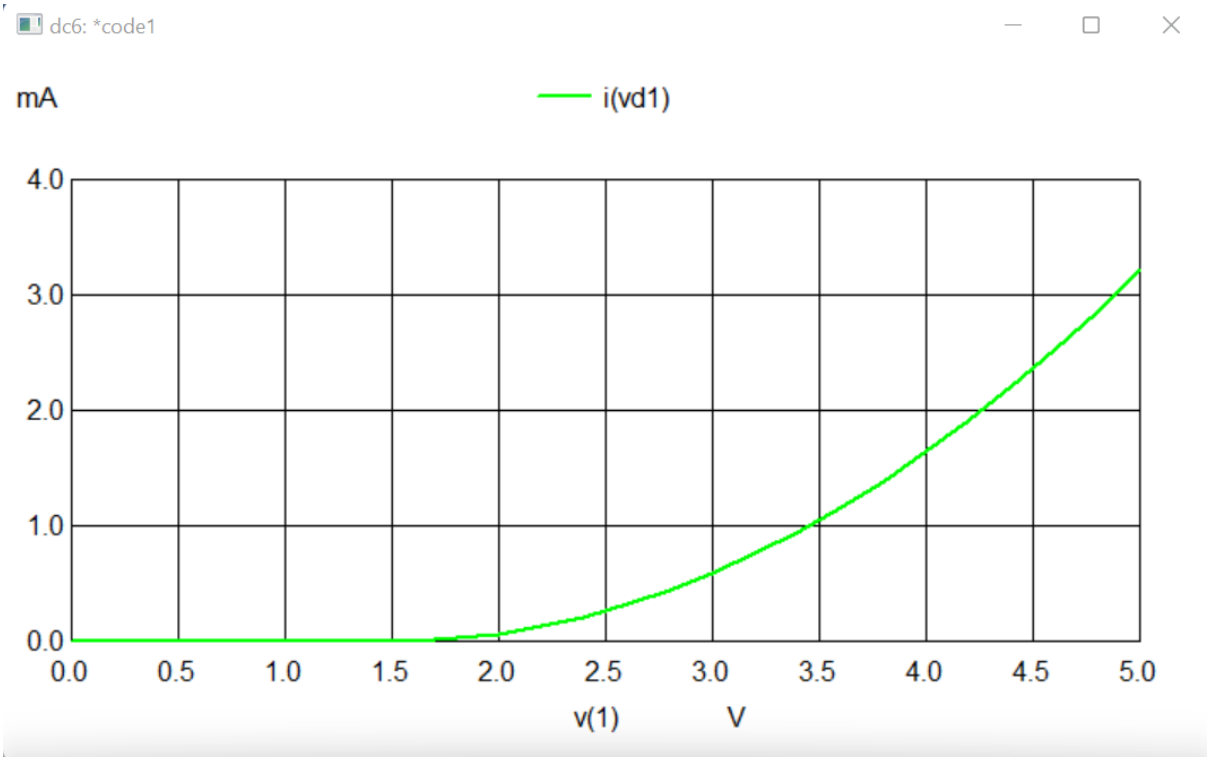
#code to find Vth

*code1

*I-V Characteristics of CD4007

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

```
m1 2 1 0 0 MN4007

vin 1 0 dc 0v

vd1 3 2 dc 0v

vds 3 0 dc 5v


.dc vin 0 5 0.2

.control

run

*white background

set color0=white

* black grid and text (only needed with X11, automatic with MS Win)

set color1=black

* wider grid and plot lines

set xbrushwidth=2


plot i(vd1) vs v(1)

.endc

.end
```



Here from plot Vth = 2.3V(approx..)

*For given values of Id, Vds, Vgs, R1 for the circuit , the calculated values are:

Rd=4k ohm and R2 = 3.125kohm

*code to verify the values

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

m1 2 1 0 0 MN4007

vdd 3 0 dc 10

r1 3 1 7.5k

r2 1 0 3.215k

rd 3 4 4k

vd1 4 2 0

.dc vdd 0 10 10

.control

run

*white background

set color0=white

* black grid and text (only needed with X11, automatic with MS Win)

set color1=black

* wider grid and plot lines

set xbrushwidth=2

print i(vd1) v(2) v(1)

.endc

.end

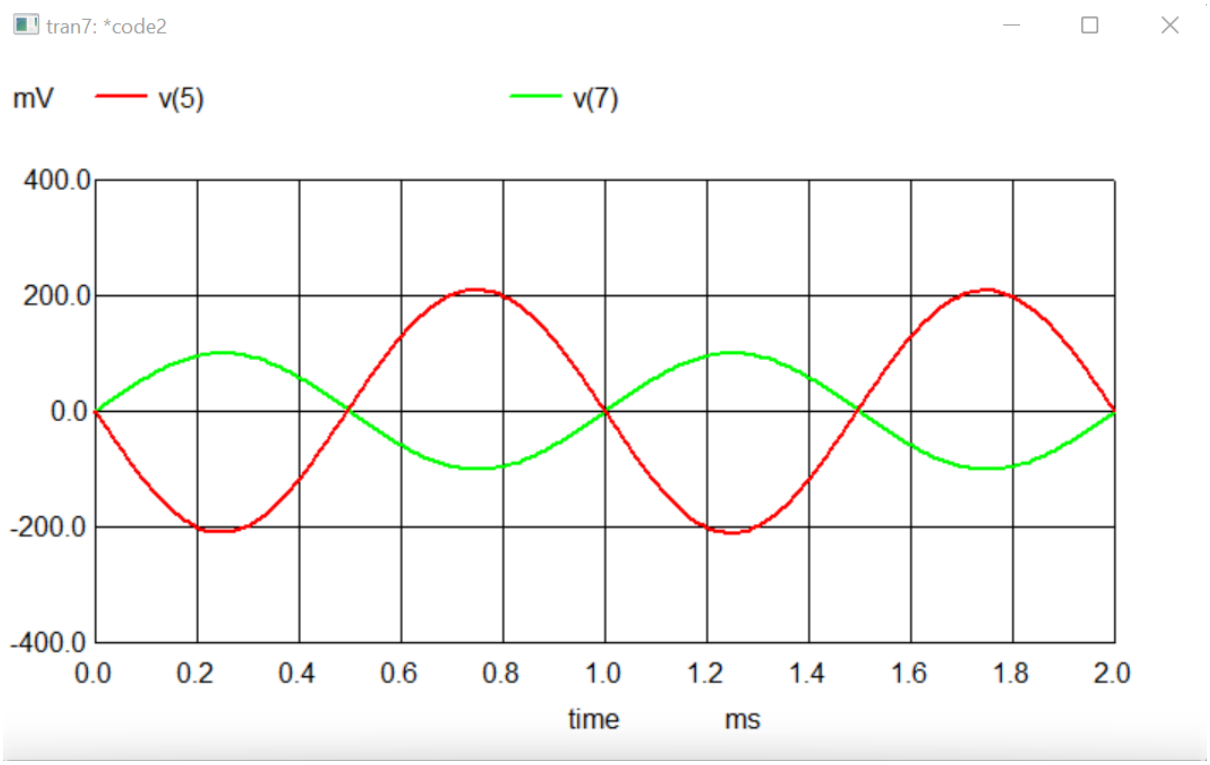
```
--------------------------------------------------------------------------------
Index   v-sweep         i(vd1)          v(2)            v(1)
--------------------------------------------------------------------------------
0       0.000000e+00    1.417864e-28    -5.67146e-25    0.000000e+00
1       1.000000e+01    6.055028e-04    7.577989e+00    3.000467e+00
ngspice 8 ->
```

*code to see the output vs input for a nmos common amplifier:

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

m1 2 1 0 0 MN4007

```
vdd 3 0 10
r1 3 1 7.5k
r2 1 0 3.215k
rd 3 2 4k
rg 6 7 1k
c1 1 6 2.2u
c2 2 5 2.2u
rl 5 0 100k

vin 7 0 sin(0 0.1 1k 0 0 0)
.tran 0.01m 2ms
.control
run
*white background
set color0=white
* black grid and text (only needed with X11, automatic with MS Win)
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot v(7) v(5)

.endc
.end
```



*code for frequency response of an amplifier:

.model MN4007 NMOS (Kp=500u Vto=1.5 Lambda=0.01 Gamma=0.6+ Xj=0 Tox=1200n Phi=.6 Rs=0 Rd=0 Cbd=2.0p Cbs=2.0p Pb=.8 Cgso=0.1p Cgdo=0.1p Is=16.64p N=1)

m1 2 1 0 0 MN4007

vdd 3 0 10

r1 3 1 7.5k

r2 1 0 3.215k

rd 3 2 4k

rg 6 7 1k

c1 1 6 2.2u

c2 2 5 2.2u

rl 5 0 100k

vin 7 0 dc 0 ac 1

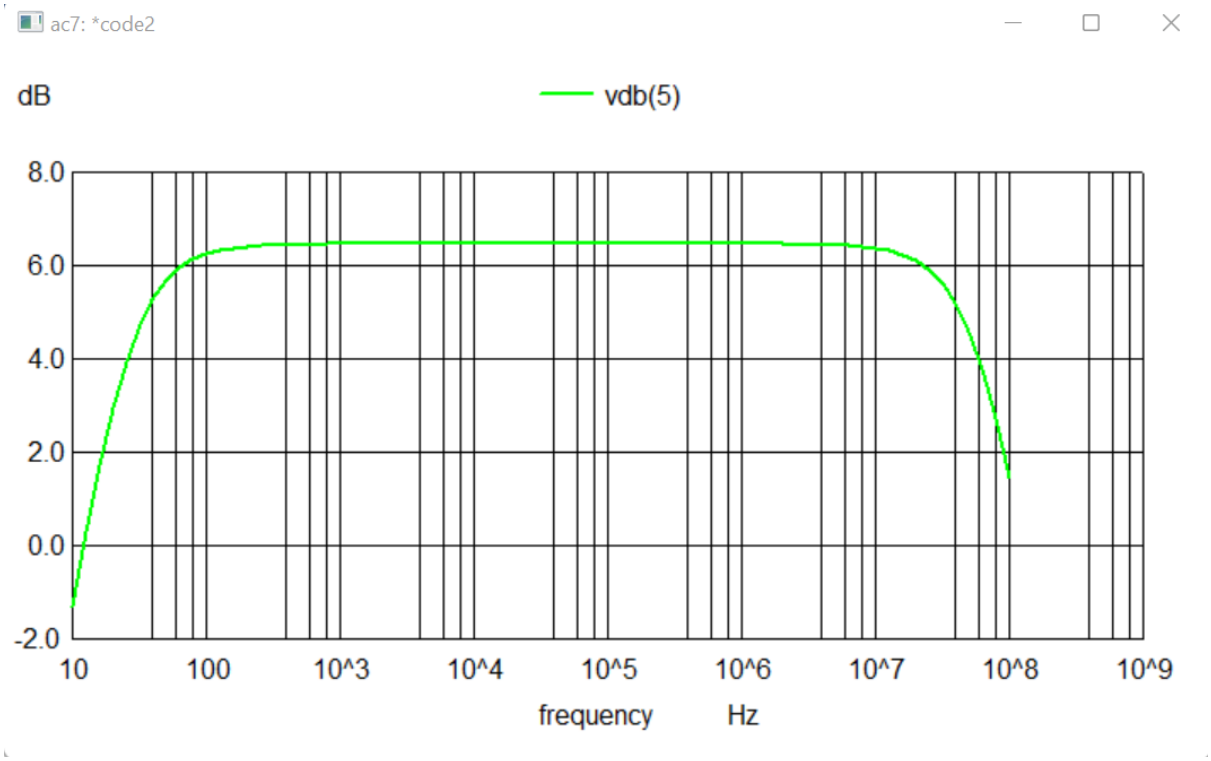
.ac dec 10 10 100Meg

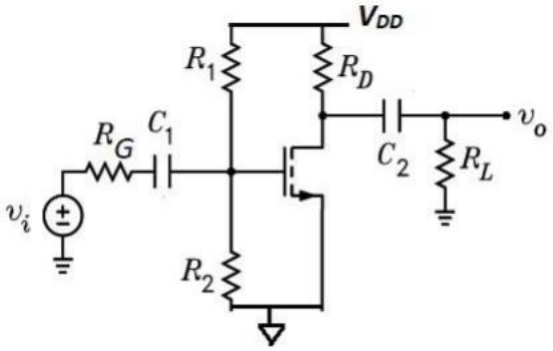
.control

run

*white background

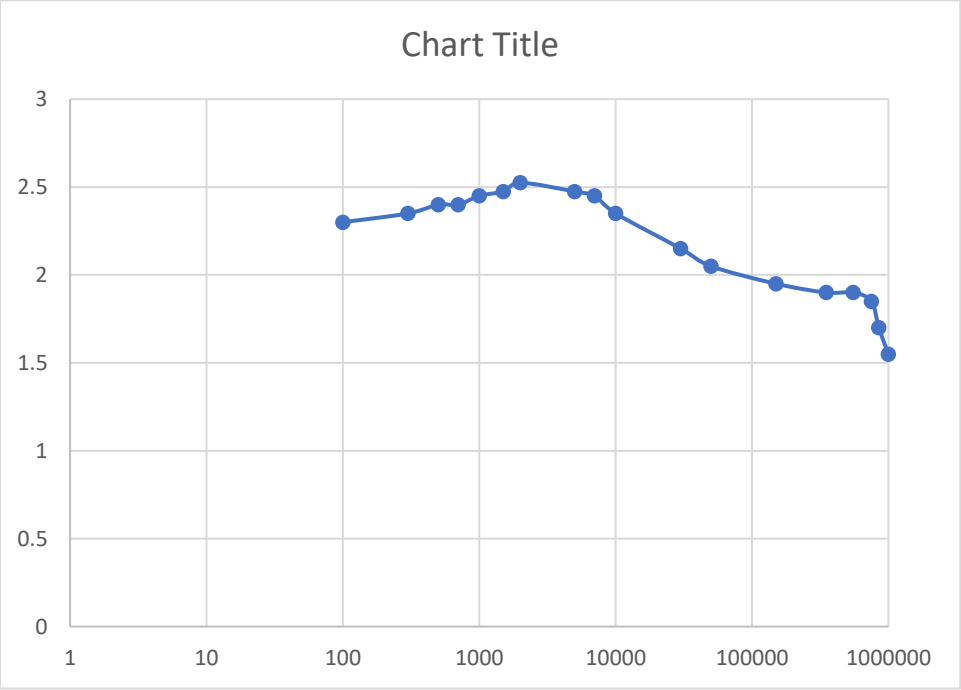
```
set color0=white
* black grid and text (only needed with X11, automatic with MS Win)
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot vdb(5) xlog

.endc
.end
```





1. We have made the hardware setup as shown in the above figure
2. We observed that we got the output shown in oscilloscope is nearly same like which we got in simulation
3. When we varied frequencies from 100hz to 1.5Meg Hz we got different gains for different frequencies and the data is given below

freq	vin	vout	gain
100	400	920	2.3
300	400	940	2.35
500	400	960	2.4
700	400	960	2.4
1000	400	980	2.45
1500	400	990	2.475
2000	400	1010	2.525
5000	400	990	2.475
7000	400	980	2.45
10000	400	940	2.35
30000	400	870	2.175
50000	400	820	2.05
150000	400	780	1.95
350000	400	760	1.9
550000	400	760	1.9
750000	400	780	1.85
850000	400	680	1.7
1000000	400	620	1.55



Graph: gain vs frequency

4. When we increased the input voltage to 200 mVp-p and 2 Vp-p then the clipping will happen to the output signal because the NMOS will go to saturation after certain voltage that leads to clipping

The frequency response plot depicts that upto some frequency the gain is increasing and in the mid region the gain is constant and then again it starts decreasing as increase in frequency

Discussion :

200020051:

In lab 4 we did simulation of NMOS to understand common emitter amplifier properties and we observed the gains at different frequencies and we observed the frequency response

In this lab the values which are calculated are not matching with the model values, please verify it and modify it.

200020010:

Today in lab 4 we have done simulation and hardware excercise of NMOS Common Emitter Amplifier. We understood about its frequency response and it's gain and also about mid-band region.

In hardware excercise we understood how to connect NMOS with loads and power supply and with the help of oscilloscope , DSO we could compare the results we got in simulation with that of hardware results.