EE204: HW 1

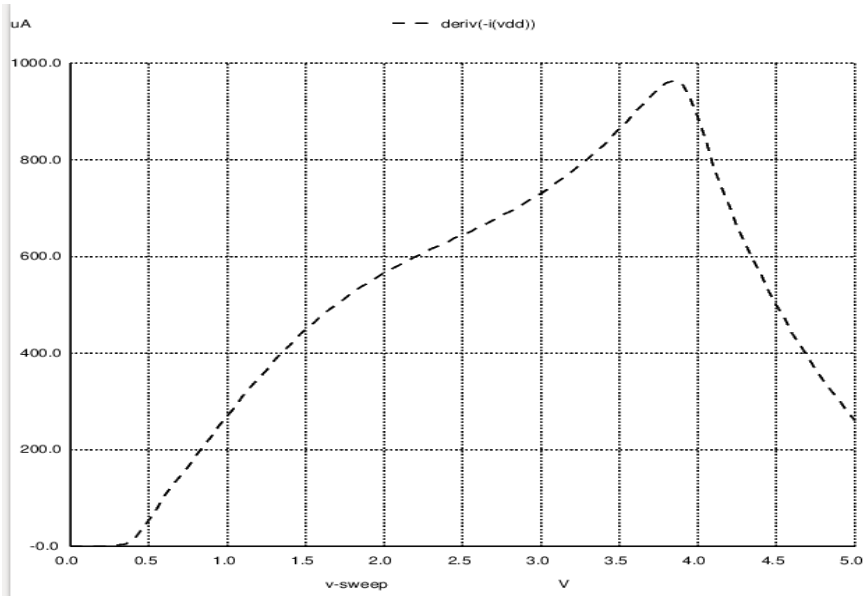
1)
(a)
Code:

```
*Ids-Vds and Ids-Vgs of a n-MOSFET
.include tsmc.txt
M1 2 1 0 0 CMOSN W=10u
VDD 2 0 DC 5v
VGG 1 0 DC 2.5V

*defining the run-time control functions
.dc VGG 0 5 0.05
*VDD 0 5 5
*.dc VDD 0 10 0.05
.control

run
*plotting input and output voltages
*plot -I(vdd)
plot deriv(-I(vdd))
*plot I(vgg) vs v(1)
hardcopy q1 deriv(-I(vdd))
wrdata q2 deriv(-I(vdd))
.endc
.end
```

Plot:



The value of maximum transconductance = 963.45uS

(b) The maxima occurs at Vgs = 3.85V.
Data points:

3.70000000e+00	9.31865918e-04
3.75000000e+00	9.47004724e-04
3.80000000e+00	9.58682182e-04
3.85000000e+00	9.63450498e-04
3.90000000e+00	9.55889418e-04
3.95000000e+00	9.30598946e-04
4.00000000e+00	8.88297865e-04

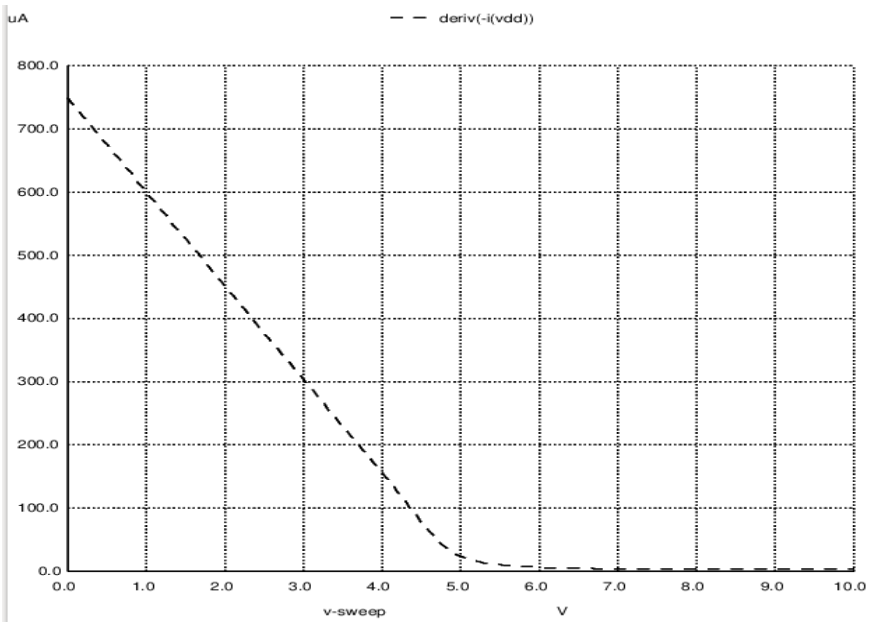
(c) Code:

```
    *Ids-Vds and Ids-Vgs of a n-MOSFET
.include tsmc.txt
M1 2 1 0 0 CMOSN W=10u
VDD 2 0 DC 5v
VGG 1 0 DC 3.85V

*defining the run-time control functions
*.dc VGG 0 5 0.05
*VDD 0 5 5
.dc VDD 0 10 0.05
.control

run
*plotting input and output voltages
*plot -I(vdd)
plot deriv(-I(vdd))
*plot I(vgg) vs v(1)
hardcopy q1 deriv(-I(vdd))
wrdata q2 deriv(-I(vdd))
.endc
.end
```

Plot:

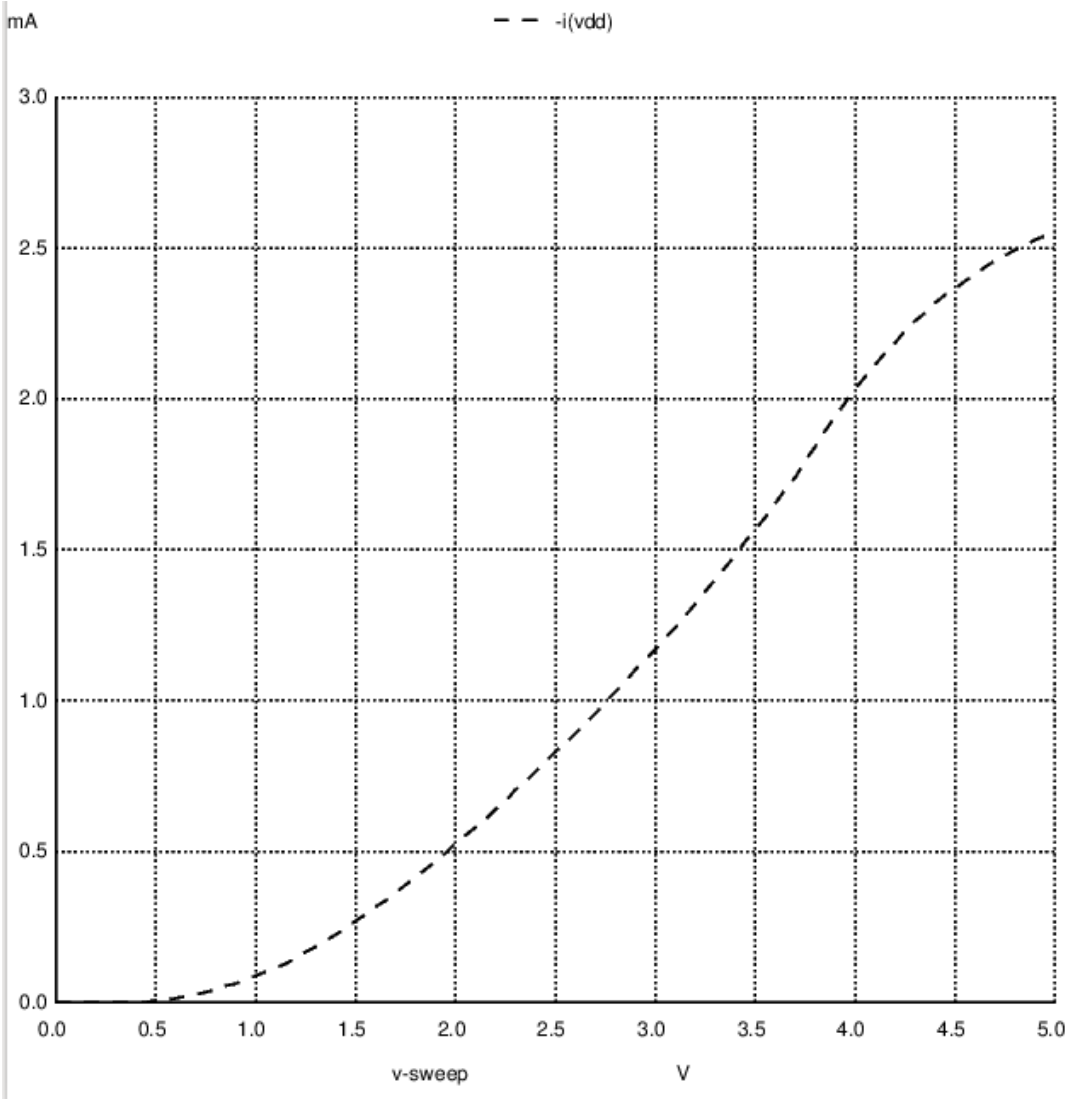


Datapoints:

4.85000000e+00	3.35358530e-05
4.90000000e+00	2.96271736e-05
4.95000000e+00	2.62861055e-05
5.00000000e+00	2.34398827e-05
5.05000000e+00	2.10170516e-05
5.10000000e+00	1.89521737e-05
5.15000000e+00	1.71878491e-05

At Vds=5, 1/ r_0 = 2.344e-5, Thus, the intrinsic output resistance (r_0) = 42.66kohm

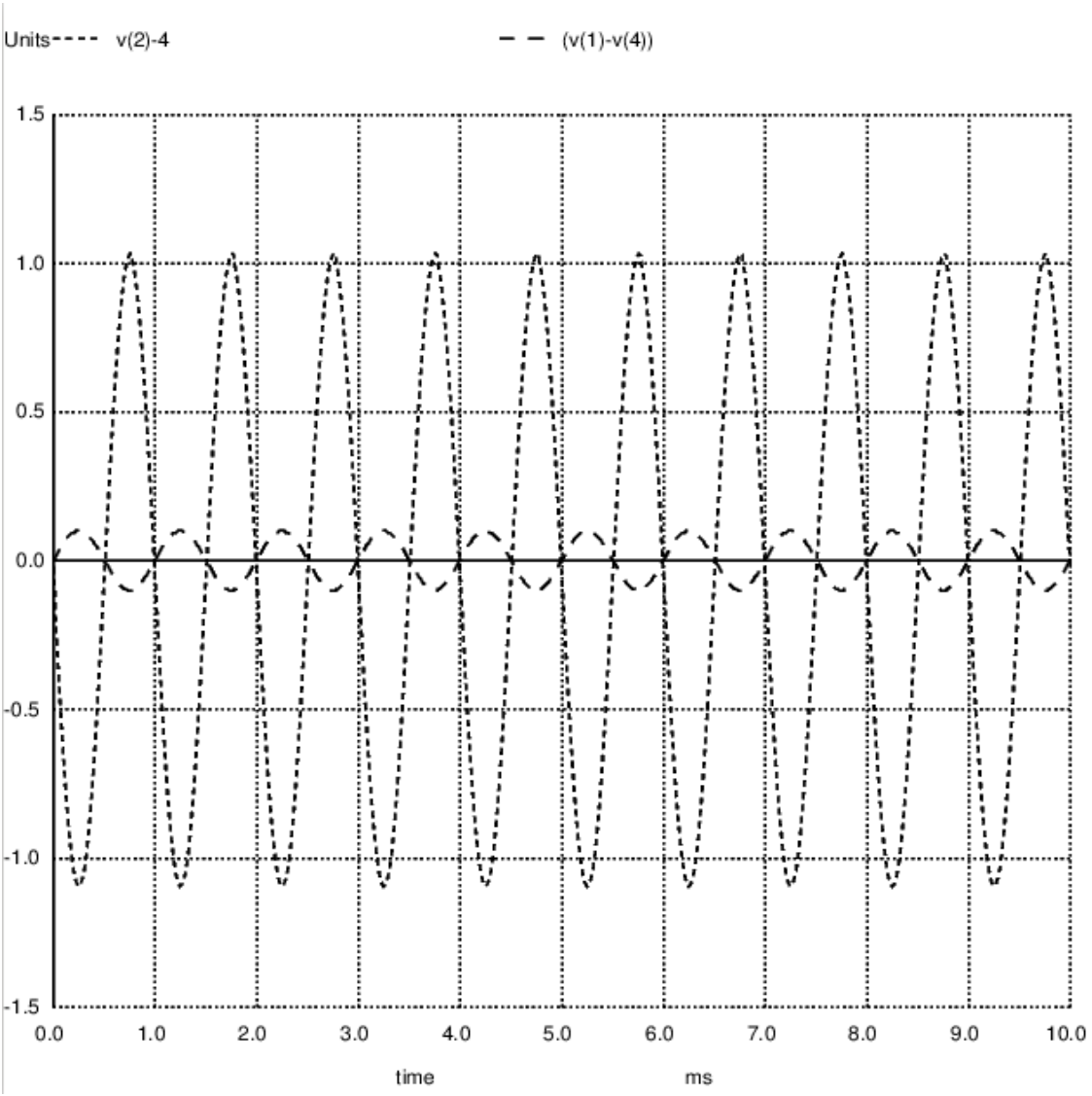
Transfer Characteristics of MOSFET:



The Vt observed here is 0.5V.

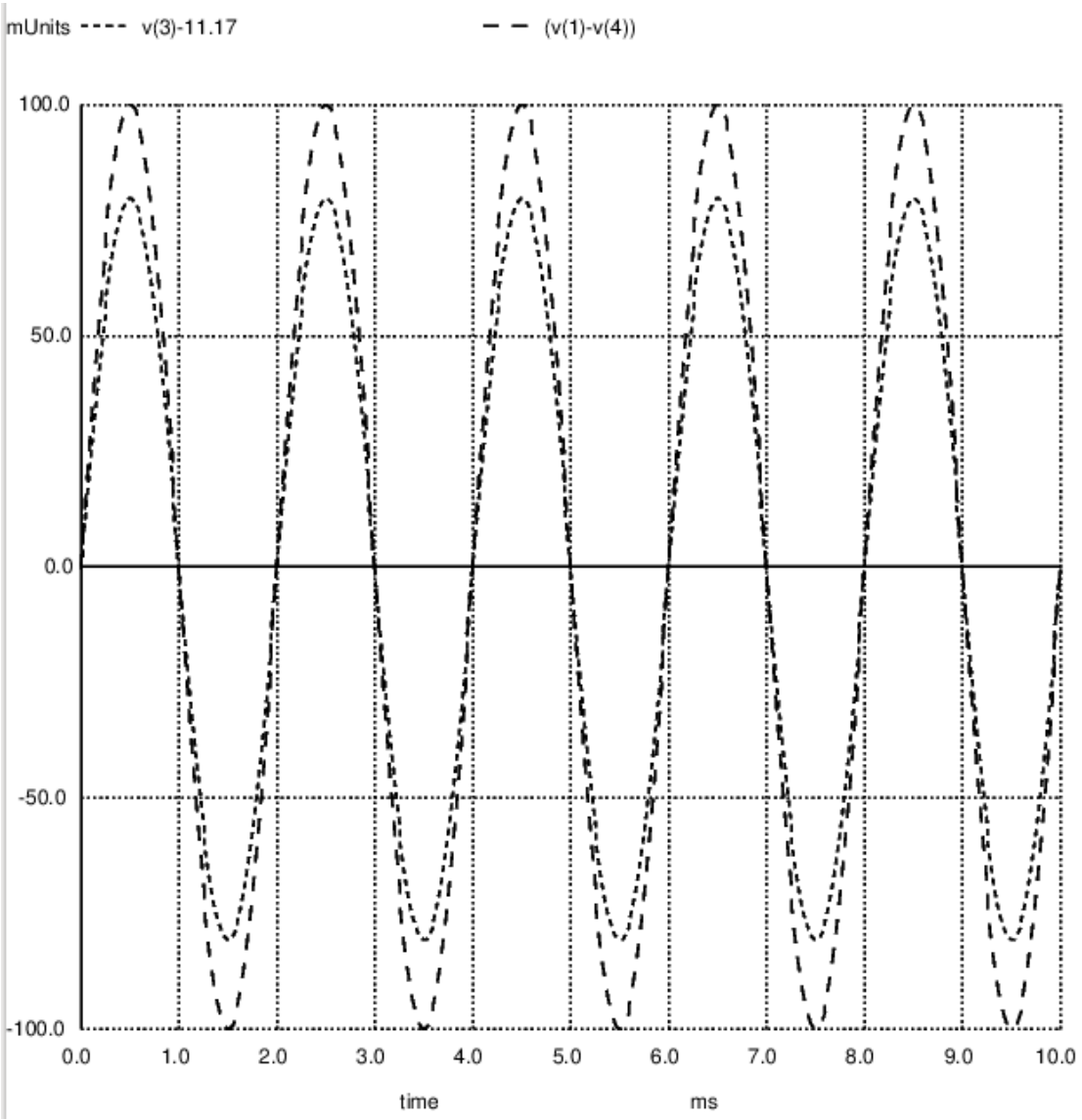
Q2.
(a) code:

```
*Ids-Vds and Ids-Vgs of a n-MOSFET
.include tsmc.txt
M1 2 1 0 0 CMOSN W=10u
VDD 3 0 dc 15v
Vgg 4 0 dc 2.1v
Rd 2 3 19k
Vin 1 4 ac sin(0 100m 1k 0 0)
.tran 0.02m 10m
.control
run
plot (v(1)-v(4)),  v(2)-4
hardcopy q1 (v(1)-v(4)),  v(2)-4
.endc
.end
```



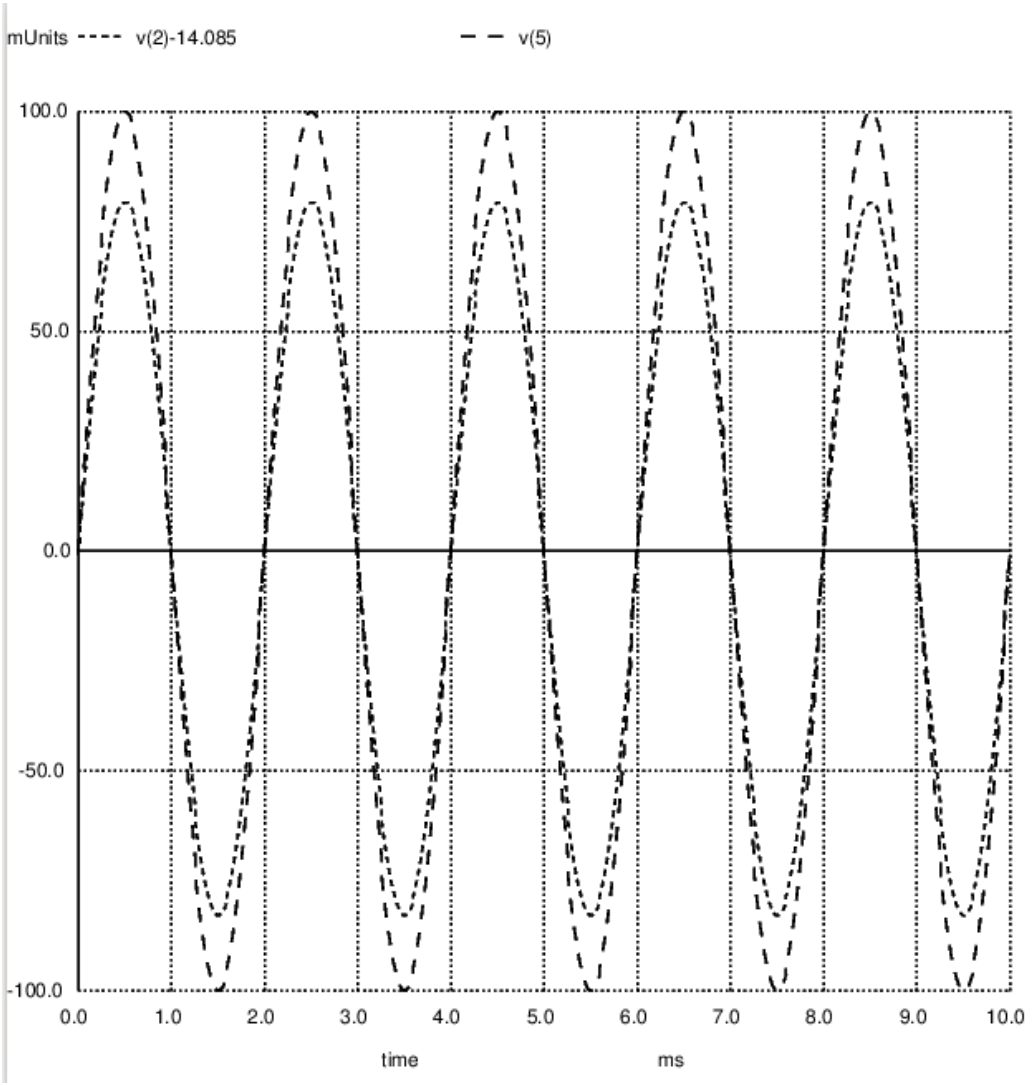
(b) Code:

```
*Ids-Vds and Ids-Vgs of a n-MOSFET
.include tsmc.txt
M1 2 1 3 0 CMOSN W=10u
VDD 2 0 dc 15v
Vgg 4 0 dc 14.9v
Rs 3 0 29.12k
Vin 1 4 ac sin(0 0.1 0.5k 0 0)
.tran 0.02m 10m
.control
run
plot (v(1)-v(4)),  v(3)-11.17
hardcopy q1 (v(1)-v(4)),  v(3)-11.17
.endc
.end
```



(c) Code:

```
*Ids-Vds and Ids-Vgs of a n-MOSFET
.include tsmc.txt
M1 2 1 3 0 CMOSN W=10u
VDD 4 0 dc 15v
Vgg 1 0 dc 2.3v
Rd 4 2 3k
Rs 3 5 1.9k
Vin 5 0 ac sin(0 0.1 0.5k 0 0)
.tran 0.02m 10m
.control
run
plot v(5),  v(2)-14.085
hardcopy q1 v(5),  v(2)-14.085
.endc
.end
```


mUnits
v(2)-14.085
v(5)
100.0
50.0
0.0
-50.0
-100.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
time
ms