

EE236: Experiment No. 9

Mobility of Charge Carriers in N-channel MOSFET and Temperature Dependence

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1 Lab Experiment

1.1 Characterizing the NMOS

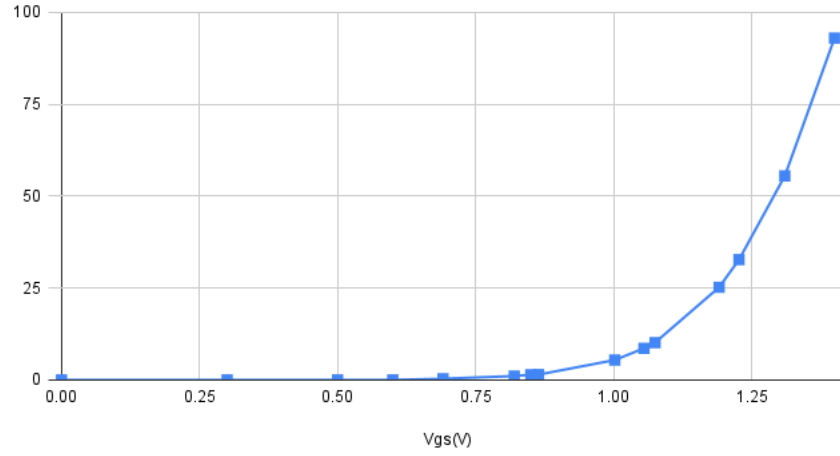
I_D was measured varying V_{GS} from 0 to 2.5V with a V_{DS} of 5V at 25 ° C

The voltage at which NMOS started conducting $V_T = 0.691$ V
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1.1.1 I-V Characteristics and β Calculation

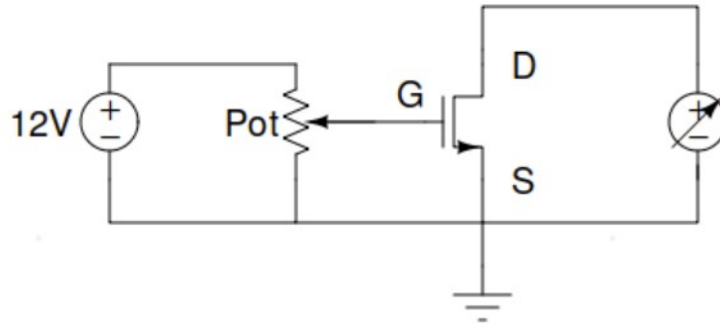
Vgs(V)	Id(uA)	Root(Ids)	Slope	Beta (in SI)
0	0	0		
0.3	0	0		
0.5	0	0		
0.6	0	0		
0.691	0.1	0.316227766	3.475030396	0.0241516725
0.82	1.1	1.048808848	5.678923117	0.06450033555
0.85	2	1.414213562	12.18015714	0.2967124559
0.864	2.1	1.449137675	2.494579446	0.01244585323
1.002	29.1	5.394441584	28.58915876	1.634679997
1.055	74	8.602325267	60.52610723	7.326819314
1.075	103	10.14889157	77.3283149	11.95933657
1.191	635	25.19920634	129.7440929	33.66705926
1.227	1070	32.71085447	208.6568925	87.0753976
1.31	3080	55.4977477	274.5408823	150.7453922
1.4	8650	93.00537619	416.7514276	347.3635049

Sqrt(I_{ds}) vs V_{gs}



1.2 Mobility Extraction

1.2.1 Circuit Used



V_{DS} was fixed as 0.6V and V_{GS} was varied from $0.6 + V_T$ to 10V and I_D was tabulated. The same thing was performed for different temperatures varying from 30, 50 and 70 ° C. β was evaluated as follows

$$\beta = \frac{I_D}{V_{DS}(V_{GS} - V_T - 0.5V_{DS})}$$

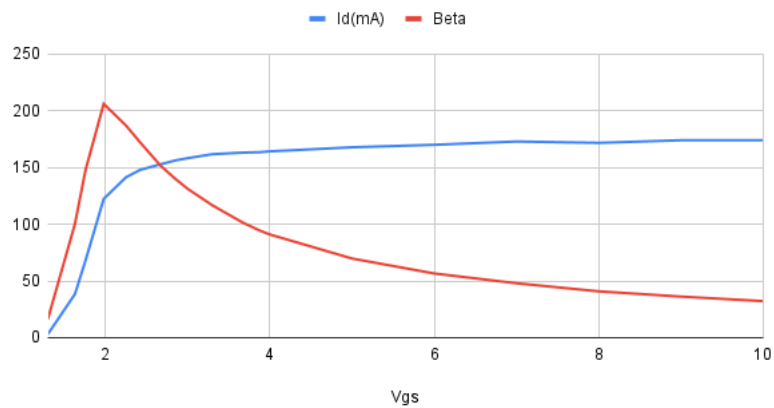
1.2.2 Readings Obtained

Readings Obtained for 30 ° C

Vgs	Id(mA)	Beta
1.3	3	16.18122977
1.63	38.4	100.1564945
1.76	68.3	148.0277417
1.98	122.3	206.1004382
2.25	141.3	187.0532168
2.42	147.8	172.3816188
2.67	152.8	151.6775859
2.85	156.2	140.0394477
3	158.2	131.242741
3.3	161.7	116.7171936
3.67	163.1	101.4682095
3.88	163.5	94.32329526
4	164.2	90.9493741
5	167.8	69.75970733
6	170	56.56484994
7	172.9	47.95584401
8	171.7	40.82845865
9	174	36.20926458
10	174.1	32.20853221

1.2.3 Plot Obtained

Id(mA) and Beta at 30 deg C



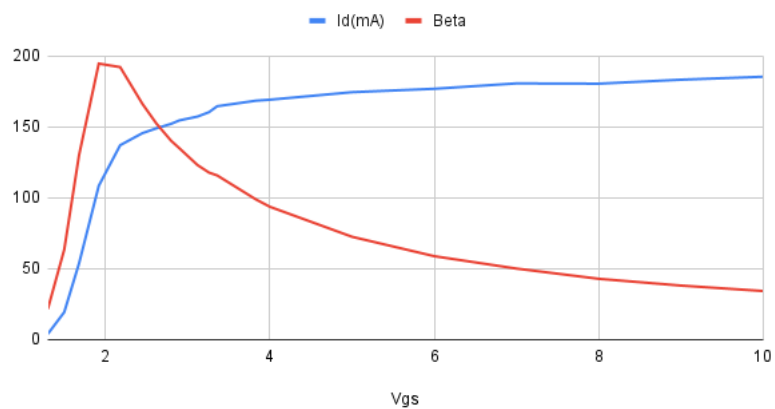
1.2.4 Readings Obtained

Readings Obtained for 50 ° C

Vgs	Id(mA)	Beta
1.3	4	21.57497303
1.5	19.4	63.5232482
1.68	53.8	130.1403
1.92	108.5	194.6537496
2.18	137.1	192.1783011
2.45	145.6	166.3239662
2.62	149	152.4452629
2.8	152.2	140.2248019
2.9	154.6	134.9746813
3.12	157.3	123.1407547
3.26	160.4	117.8198913
3.36	164.6	115.8013226
3.83	168.5	98.91980744
4	169.2	93.71884347
5	174.5	72.54510684
6	176.9	58.86071738
7	180.7	50.11926555
8	180.5	42.92100633
9	183.3	38.14458734
10	185.4	34.2990343

1.2.5 Plot Obtained

Id(mA) and Beta at 50 deg C



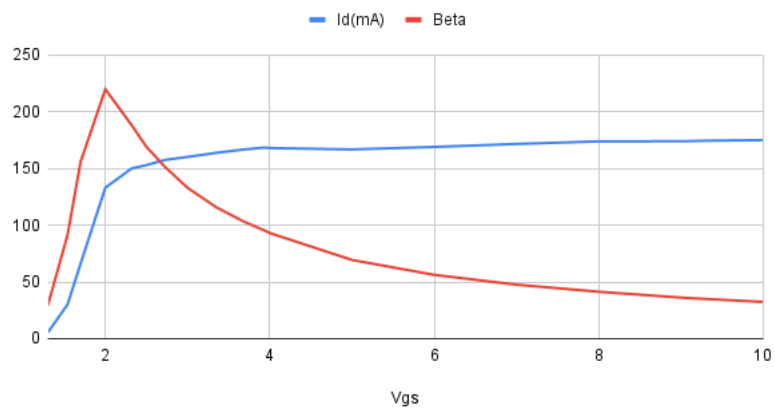
1.2.6 Readings Obtained

Readings Obtained for 70 ° C

Vgs	Id(mA)	Beta
1.3	5.4	29.12621359
1.54	30.1	91.37826351
1.7	66.4	156.0883874
2	133.1	219.8546416
2.32	150	188.1113619
2.5	153	168.9860835
2.73	157.6	151.0446617
3	160.2	132.9019413
3.35	163.8	115.727003
3.68	166.7	103.3221768
3.93	168.4	95.49733469
4	168	93.05417082
5	166.8	69.34397605
6	169	56.23211553
7	171.6	47.59527376
8	173.9	41.35159557
9	174	36.20926458
9.32	174.5	34.91815744
10	175	32.37503238
10	185.4	34.2990343

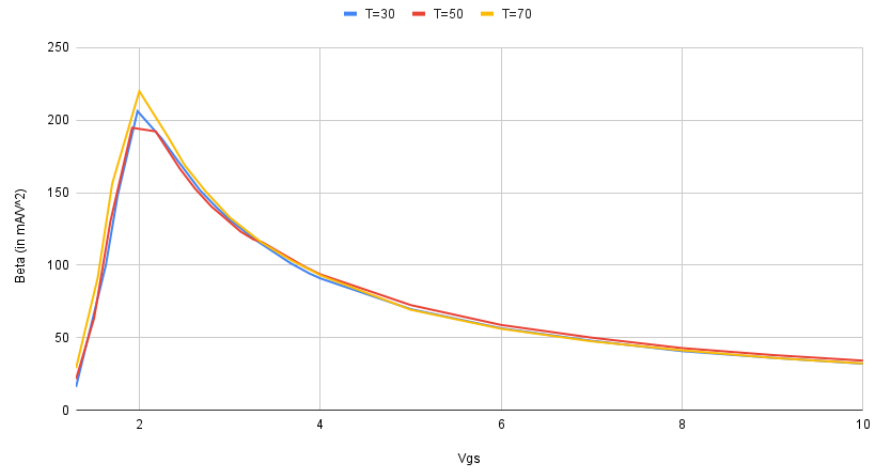
1.2.7 Plot Obtained

Id(mA) and Beta at 70 deg C



1.3 Quantification of Temperature Dependence

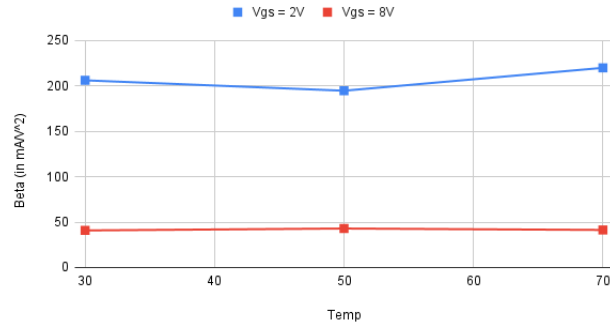
Variation of Beta with Temperature and Vgs



We see that at low V_{GS} , β increases with increase in V_{GS} , and decreases for larger values of V_{GS} with increase in V_{GS} .

T	Vgs = 2V	Vgs = 8V
30	206.1004382	40.82845865
50	194.6537496	42.92100633
70	219.8546416	41.35159557

Variation of Beta with Temperature



From the above plots and table, we see that β is nearly constant with temperature.