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TRANZISTORUL MOS_SOFT-HARD

MODULUL MCM4/EV

"Tranzistorul cu efect de câmp metal-oxid-semiconductor" (**MOSFET**, **MOS-FET** sau **MOS FET**), cunoscut și sub numele de **tranzistor metal-oxid-siliciu** (**tranzistor MOS** sau **MOS**) este un tip de tranzistor cu efect de câmp (FET) cu poartă izolată care este fabricat prin oxidarea controlată a unui semiconductor, de obicei siliciu.

Tensiunea aplicată pe poarta acoperită determină conductivitatea electrica a dispozitivului; această capacitate de a schimba conductibilitatea cu cantitatea de tensiune aplicată poate fi utilizată pentru amplificare sau comutare semnale electrice.

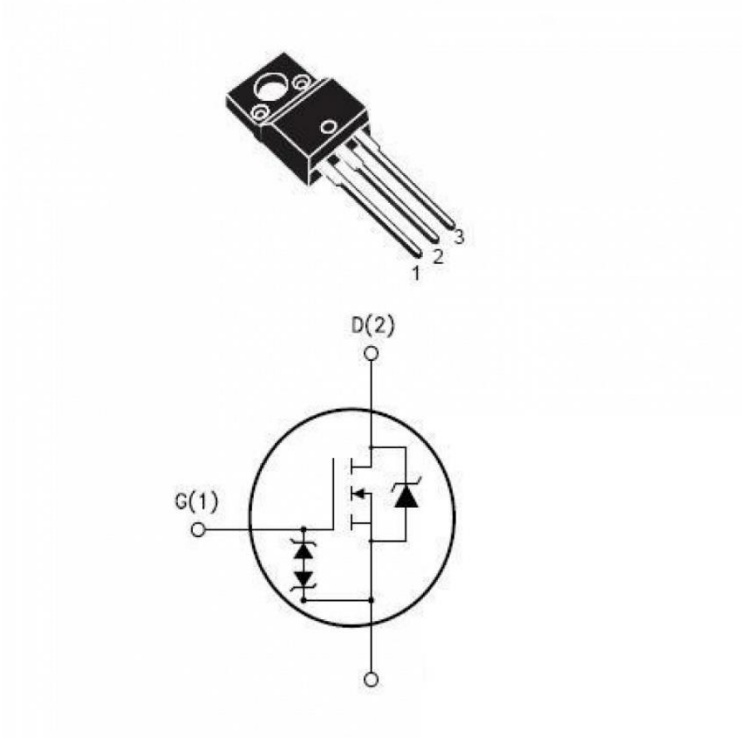

Fig. 1: Aspect si reprezentare in scheme electronice

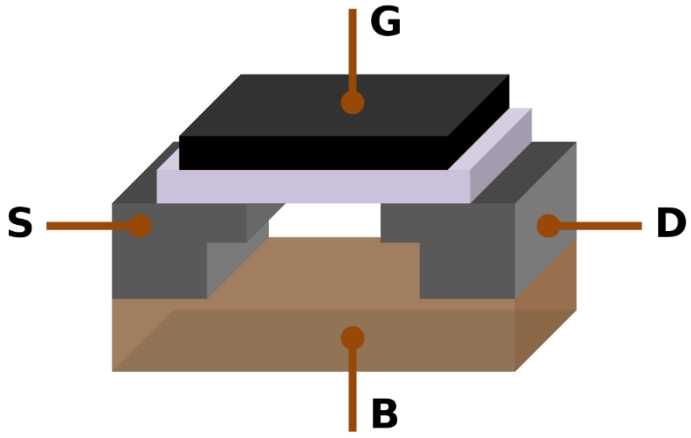

Fig. 2: Sectiune transversala MOS-FET

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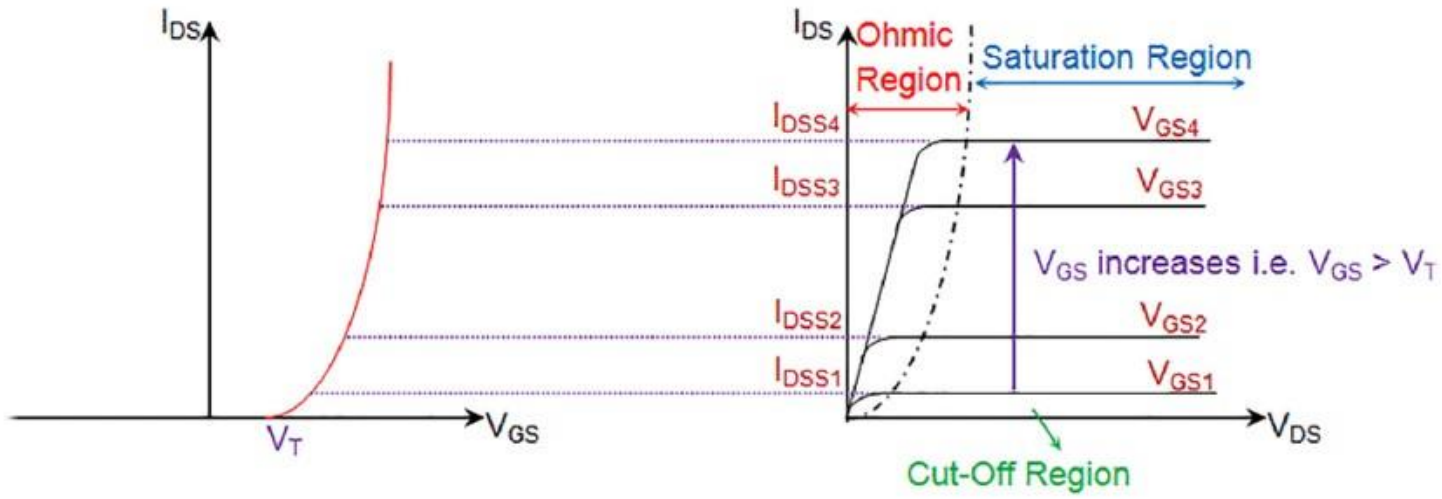


(a) Caracteristica de transfer a unui tranzistor MOS-FET

(b) Caracteristica de iesire a unui tranzistor MOS-FET

Placa de lucru MCM4/EV

Placa de lucru MCM4/EV este o placa preasamblata pentru experimente produsa de compania italiana ELETTRONICA VENETA divizata in 5 blocuri functionale ce pot fi modificate, interconectate si legate la diverse aparate de masurare prin intermediul cablurilor de legatura si jumper-ilor disponibili.

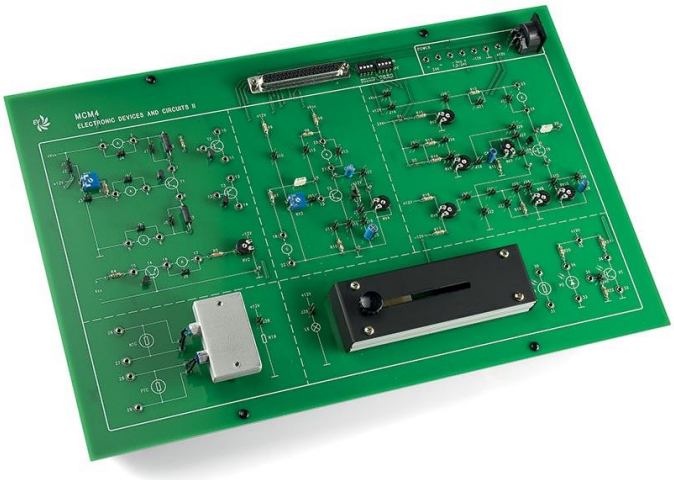
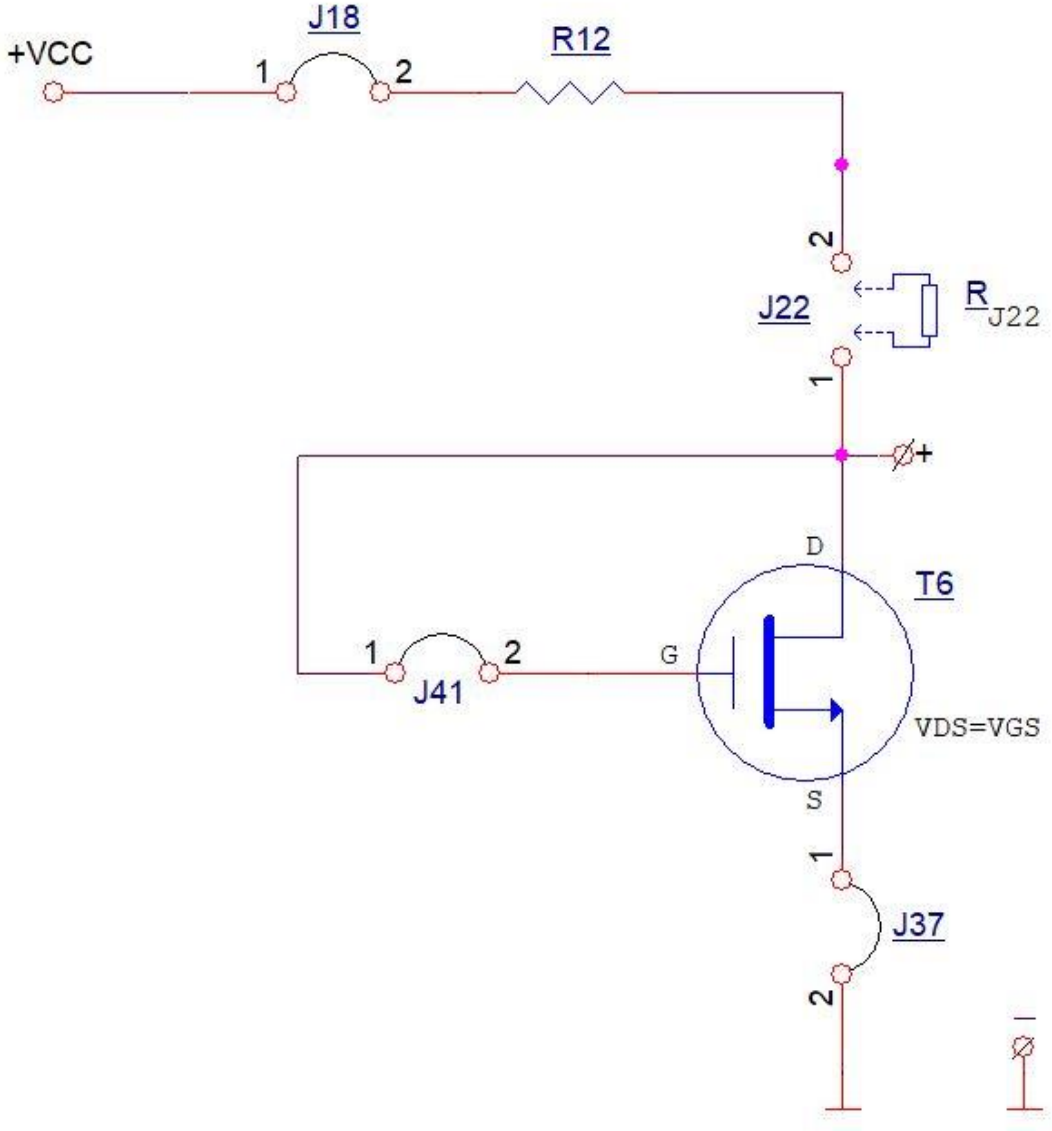


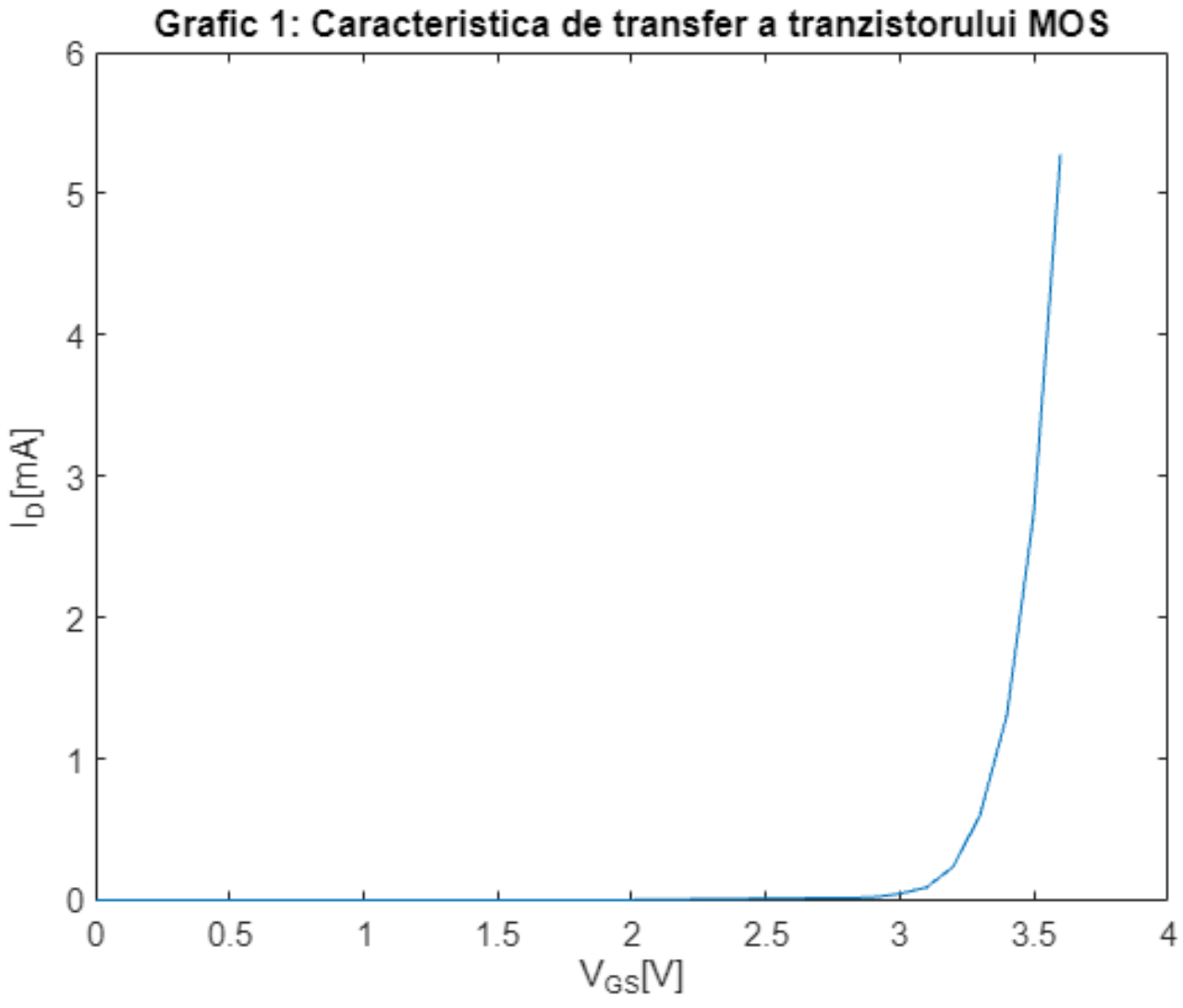
Fig. 3: Placa de lucru MCM4/EV



Schema 1: Masurarea caracteristicii de transfer a tranzistorului MOS

V_{GS} [V]	0	2	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6
$V_{GS\ măsurat}$ [V]	0	2.01	2.91	3	3.105	3.2	3.303	3.4	3.5	3.6
V_{CC} [V]	0	2.02	4.62	7.4	3.16	3.36	3.71	4.29	5.36	7.19
$R_D=R_{12}+R_{j22}$ [$k\Omega$]	100.68	100.68	100.68	100.68	0.68	0.68	0.68	0.68	0.68	0.68
$I_D=(V_{CC}-V_{DS})/R_D$ [mA]	0	0.0002	0.0171	0.0437	0.0882	0.2353	0.6029	1.3088	2.7353	5.2794
$\frac{1}{2}(V_{GS}-V_T)^2$ [V^2]	2	0	0.405	0.5	0.605	0.72	0.845	0.98	1.125	1.28

Tabelul 1: Caracteristica de transfer a tranzistorului MOS

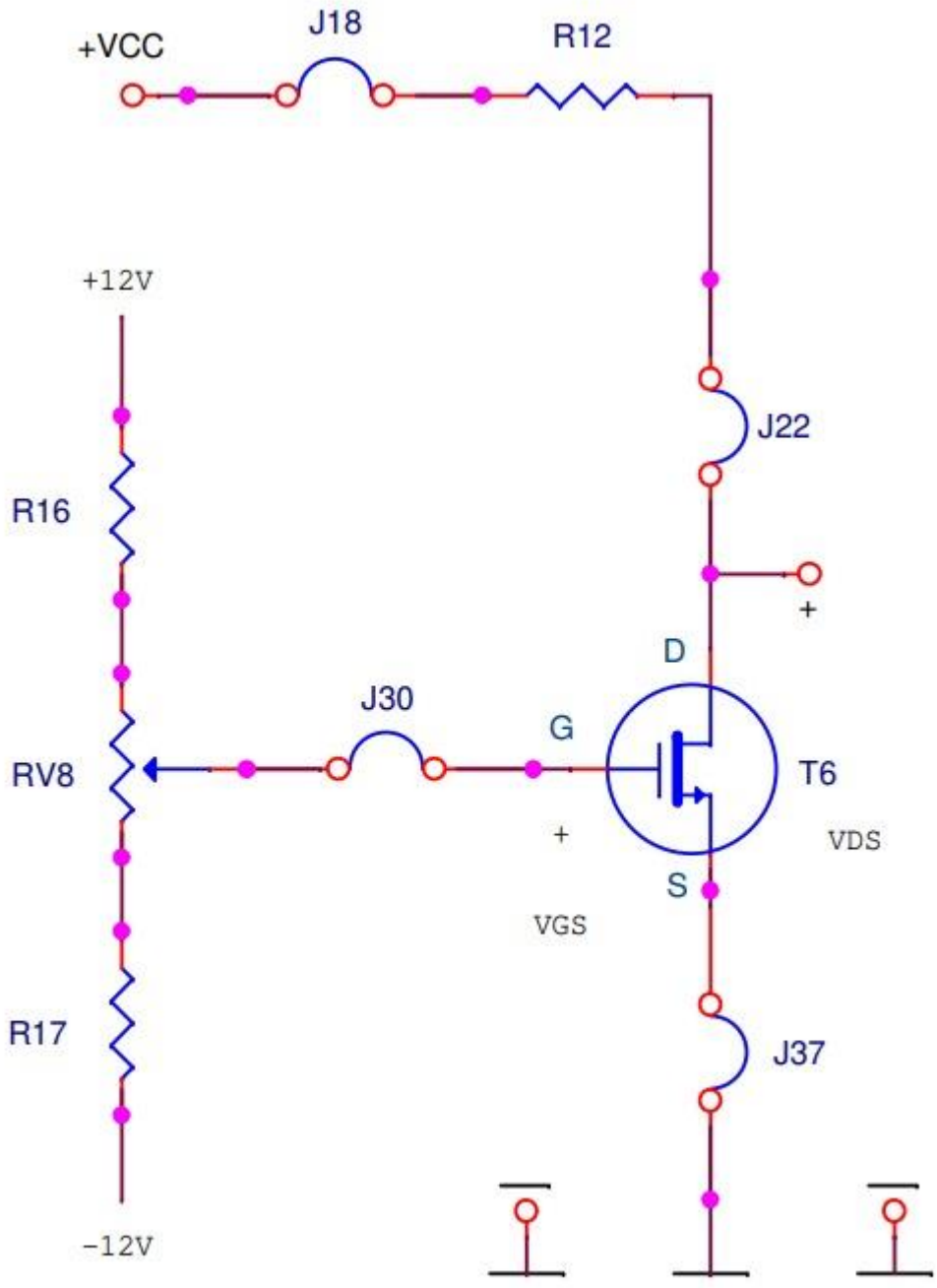

Grafic 1: Caracteristica de transfer a tranzistorului MOS
6
5
4
3
2
1
0
I_D[mA]
0
0.5
1
1.5
2
2.5
3
3.5
4
V_{GS}[V]

```
Vgs = [0 2 2.9 3 3.1 3.2 3.3 3.4 3.5 3.6];
Vcc = [0 2.02 4.62 7.4 3.16 3.36 3.71 4.29 5.36 7.19];
R =  [100.68 100.68 100.68 100.68 0.68 0.68 0.68 0.68 0.68 0.68];

Id = (Vcc-Vgs)./R;

figure(1);
plot(Vgs,Id);
xlabel("V_{GS}[V]");
ylabel("I_{D}[mA]");
title("Grafic 1: Caracteristica de transfer a tranzistorului MOS");
```

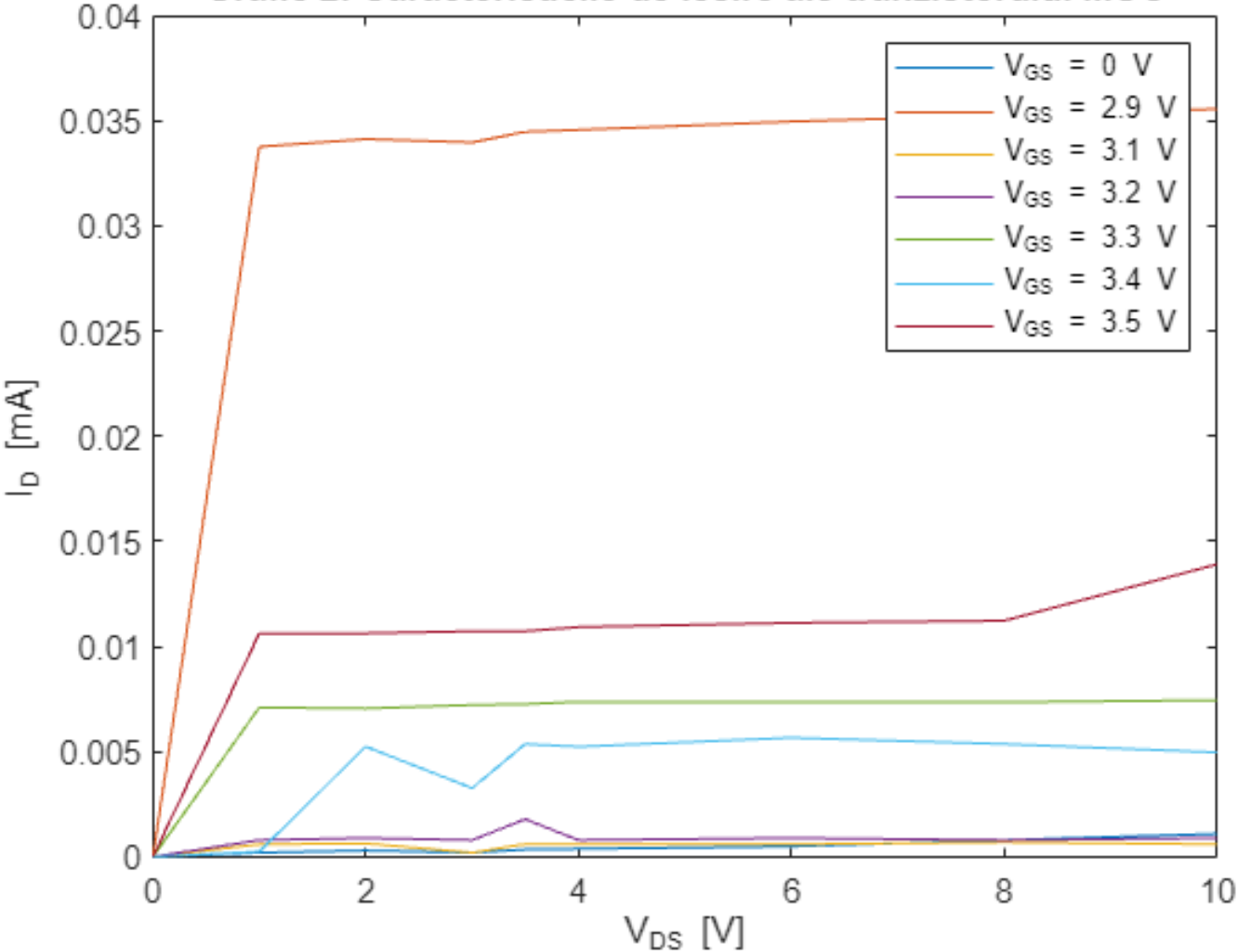
Cod 1 in Matlab: Realizarea Graficului 1



Schema 2: Masurarea caracteristicii de iesire a tranzistorului MOS

V_{DS} [V]		0	1	2	3	3.5	4	6	8	10
V_{GS} = 0 [V]	V_{DS} măs [V]	0	1	2	3	3.5	4	6	8	10
	V_{DD} [V]	0	1.02	2.03	3.02	3.535	4.038	6.05	8.08	10.11
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	$1.9*10^{-4}$	$2.9*10^{-4}$	$1.9*10^{-4}$	$3.4*10^{-4}$	$3.7*10^{-4}$	$4.9*10^{-4}$	$7.9*10^{-4}$	$11*10^{-4}$
V_{GS} = 2.9 [V]	V_{DS} măs [V]	0	1	1.996	3.04	3.499	4	6	8	10
	V_{DD} [V]	0	4.399	5.432	6.46	6.97	7.48	9.52	11.55	13.58
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.0338	0.0341	0.0344	0.0345	0.0346	0.0350	0.0353	0.0356
V_{GS} = 3.1 [V]	V_{DS} măs [V]	0	1	1.996	3.04	3.499	4	6	8	10
	V_{DD} [V]	0	1.06	2.06	3.06	3.56	4.06	6.06	8.07	10.06
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.5959	0.5959	0.5959	0.5959	0.5959	0.5959	0.6953	0.5959
V_{GS} = 3.2 [V]	V_{DS} măs [V]	0	1	2	3	3.5	4	6	8	10
	V_{DD} [V]	0	1.08	2.09	3.08	3.58	4.08	6.09	8.08	10.09
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.0008	0.0009	0.0008	0.0008	0.0008	0.0009	0.0008	0.0009
V_{GS} = 3.3 [V]	V_{DS} măs [V]	0	1.001	2.006	3.006	3.502	4	6	8	10
	V_{DD} [V]	0	1.716	2.716	3.733	4.233	4.742	6.74	8.74	10.75
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.0071	0.0071	0.0073	0.0073	0.0074	0.0074	0.0074	0.0074
V_{GS} = 3.4 [V]	V_{DS} măs [V]	0	1	2	3	3.5	4	6	8	10
	V_{DD} [V]	0	1.025	2.528	3.329	4.04	4.527	6.57	8.54	10.5
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.0002	0.0052	0.0033	0.0054	0.0052	0.0057	0.0054	0.0050
V_{GS} = 3.5 [V]	V_{DS} măs [V]	0	1	2	3	3.5	4	6	8	10
	V_{DD} [V]	0	2.07	3.07	4.08	4.58	5.10	7.12	9.13	11.4
	$R_{12}+R_{J22}$ [kΩ]	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68	100.68
	I_D [mA]	0	0.0106	0.0106	0.0107	0.0107	0.0109	0.0111	0.0112	0.0139

Tabelul 2: Caracteristicele de iesire ale tranzistorului MOS


Grafic 2: Caracteristicile de iesire ale tranzistorului MOS
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
I_D [mA]
0
2
4
6
8
10
V_{DS} [V]
V_{GS} = 0 V
V_{GS} = 2.9 V
V_{GS} = 3.1 V
V_{GS} = 3.2 V
V_{GS} = 3.3 V
V_{GS} = 3.4 V
V_{GS} = 3.5 V

```
VDS0 = [0 1 2 3 3.5 4 6 8 10];
VDS29 = [0 1 1.996 3.04 3.499 4 6 8 10];
VDS31 = [0 1 1.996 3.04 3.499 4 6 8 10];
VDS32 = [0 1 2 3 3.5 4 6 8 10];
VDS33 = [0 1.001 2.006 3.006 3.502 4 6 8 10];
VDS34 = [0 1 2 3 3.5 4 6 8 10];
VDS35 = [0 1 2 3 3.5 4 6 8 10];

VDD0 = [0 1.02 2.03 3.02 3.535 4.038 6.05 8.08 10.11];
VDD29 = [0 4.399 5.432 6.46 6.97 7.48 9.52 11.55 13.58];
VDD31 = [0 1.06 2.06 3.06 3.56 4.06 6.06 8.07 10.06];
VDD32 = [0 1.08 2.09 3.08 3.68 4.08 6.09 8.08 10.09];
VDD33 = [0 1.716 2.716 3.733 4.233 4.742 6.74 8.74 10.75];
VDD34 = [0 1.025 2.528 3.329 4.04 4.527 6.57 8.54 10.5];
VDD35 =[0 2.07 3.07 4.08 4.58 5.10 7.12 9.13 11.4];

ID0 = (VDD0 - VDS0)/ 100.68;
ID29 = (VDD29 - VDS29)/ 100.68;
ID31 = (VDD31 - VDS31)/ 100.68;
ID32 = (VDD32 - VDS32)/ 100.68;
ID33 = (VDD33 - VDS33)/ 100.68;
ID34 = (VDD34 - VDS34)/ 100.68;
ID35 = (VDD35 - VDS35)/ 100.68;

plot(VDS,ID0,VDS,ID29,VDS,ID31,VDS,ID32,VDS,ID33,VDS,ID34,VDS,ID35);
xlabel("V_{DS} [V]");
ylabel("I_D [mA]");
legend("V_{GS} = 0 V","V_{GS} = 2.9 V","V_{GS} = 3.1 V",...
    "V_{GS} = 3.2 V","V_{GS} = 3.3 V","V_{GS} = 3.4 V","V_{GS} = 3.5 V");
title("Grafic 2: Caracteristicile de iesire ale tranzistorului MOS");
```

Cod 2 in Matlab: Realizarea Graficului 2