Scilab Manual for Electronic Devices and Circuits by Prof Mrugendra Vasmatkar Others VESIT[1]

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Experiment: 1

To find the transfer characteristics of FET

Scilab code Solution 1.1 transfer characteristics of FET

```
clc;
close;
//Scilab 5.5.0;64 bit(windows 7)

IDSS=12;      // in mili-amperes
VP=-5;        // in volts

// Plotting transfer curve
VGS=[0:-0.01:VP];   // Gate source voltage in volts
// Using Shockley's equation
ID=IDSS*(1-VGS/VP).^2;     // Drain current in mili-
   amperes
plot(VGS,ID);
xtitle("Transfer Curve","VGS (V)","ID (mA)");
```

Scilab code Solution 1.2 transfer characteristics of FET

```
clc;
close;
//Scilab 5.5.0;64 bit(windows 7)

IDSS=15;      // in mili-amperes
VP=-4;        // in volts

// Plotting transfer curve
VGS=[0:-0.01:VP];    // Gate source voltage in volts
// Using Shockley's equation
ID=IDSS*(1-VGS/VP).^2;     // Drain current in mili-
   amperes
plot(VGS,ID);
xtitle("Transfer Curve","VGS (V)","ID (mA)");
```

Experiment: 2

To find the transfer characteristics of FET for self bias configuration

Scilab code Solution 2.1 transfer characteristics of FET for self bias

```
clc;
close;
//Scilab 5.5.0;64 bit(windows 7)

IDSS=5e-3; // in amperes
VP=-5; // in volts

// input circuit parameters
VDD=15; // in volts
RD=2.2e3; // in ohms
RS=1.6e3; // in ohms

// Plotting transfer characteristics
VGS=[0:-0.01:VP]; // Gate source voltage in volts
// Using Shockley's equation
ID=IDSS*(1-VGS/VP).^2; // Drain current in amperes
ID=ID*1e3; // Drain current in mili-amperes
```

```
18 plot(VGS,ID);
19 xtitle("Transfer Characteristics","VGS (V)","ID (mA)
   ");
20
21 // Plotting bias line
22 // From gate source circuit
23 ID=-VGS/RS; // Source current in amperes
24 ID=ID*1e3; // Source current in mili-amperes
25 plot(VGS,ID,"RED");
26
27 // Intersection of transfer characteristics with the
    bias curve
28 // Putting VGS = -ID*RS in Shockley's equation and
   solving, we get ID^2*RS^2 + (2*RS*VP - VP^2/IDSS)
   *ID + VP^2
29 // Solving the equation
30 p_eq = poly([VP^2 (2*RS*VP-VP^2/IDSS) RS^2],"x","
   coeff");
31 p_roots= roots(p_eq);
32 IDQ=p_roots(1); // in amperes
33 // Writing the KVL for the output loop
34 VDSQ=VDD-IDQ*(RD+RS); // in volts
35 VS=IDQ*RS; // in volts
36 VD=VDSQ+VS; // in volts
37 IDQ=IDQ*1e3; // in mili-amperes
38 disp(VDSQ,"VDSQ (V) =");
39 disp(IDQ,"IDQ (mA) =");
40 disp(VD,"VD (V) =");
41 disp(VS,"VS (V) =");
```

Experiment: 3

To find operating point of FET

Scilab code Solution 3.1 operating point of FET

```
1  clc;
2  close;
3  //Scilab 5.5.0;64 bit(windows 7)
4
5  VP=-5;       // in volts
6  IDSS=18e-3; // in amperes
7
8  // input circuit parameters
9  VDD=18; // in volts
10 R1=400; // in kilo-ohms
11 R2=90;  // in kilo-ohms
12 RD=2e3; // in ohms
13 RS=2e3; // in ohms
14 // Applying Thevnin's theorem
15 VGG=VDD*R2/(R1+R2);   // in volts
16
17 // Plotting transfer characteristics
18 VGS=[VGG:-0.01:VP];   // Gate source voltage in
      volts
19 // Using Shockley's equation
20 ID=IDSS*(1-VGS/VP).^2; // Drain current in amperes
```

```
21 ID=ID*1e3; // Drain current in mili-amperes
22 plot2d(VGS,ID,rect=[-5,0,3,12]);
23 xtitle("Transfer Characteristics","VGS (V)","ID (mA)
   ");
24
25 // Plotting bias line
26 // From the KVL for the gate-loop
27 ID=(-VGS+VGG)/RS; // Source current in amperes
28 ID=ID*1e3; // Source current in mili-amperes
29 plot(VGS,ID,"RED");
30
31 // Intersection of transfer curve with the bias
   curve
32 // Putting VGS = VGG-ID*RS in Shockley's equation
   and solving, we get
33 // ID^2*RS^2 + (2*RS*VP - 2*VGG*RS - VP^2/IDSS)*ID +
    (VGG-VP)^2
34 // Solving the equation
35 p_eq = poly([(VGG-VP)^2 (2*RS*VP-2*VGG*RS-VP^2/IDSS)
    RS^2],"x","coeff");
36 p_roots= roots(p_eq);
37 IDQ=p_roots(1); // in amperes
38 // Writing the KVL for the drain source loop
39 VDSQ=VDD-IDQ*(RD+RS); // in volts
40 IDQ=IDQ*1e3; // in mili-amperes
41 disp(VDSQ,"VDSQ (V) =");
42 disp(IDQ,"IDQ (mA) =");
```

Experiment: 4

To find the transfer characteristics of n channel enhancement type MOSFET

Scilab code Solution 4.1 transfer characteristics of n channel enhancement type MOSFET

```
clc;
close;
//Scilab 5.5.0;64 bit(windows 7)

ID=6e-3; // in amperes
VGS=8;   // in volts
VT=3;    // in volts
// input circuit parameters
VDD=12; // in volts
RD=2e3; // in ohms

// Plotting transfer curve
k=ID/(VGS-VT).^2;  // in amperes per volt square
VGS=[3:0.01:VDD]; // Gate source voltage in volts
ID=k*(VGS-VT).^2;  // Drain current in amperes
   ..........(1)
```

```
16 ID=ID*1e3; // Drain current in mili-amperes
17 plot(VGS,ID);
18 xtitle("Transfer Curve","VGS (V)","ID (mA)");
19
20 // Plotting bias line
21 // From the simplified dc equivalent circuit
22 VGS=[0:0.01:VDD]; // Gate source voltage in volts
23 ID=(VDD-VGS)/RD;  // Source current in amperes
24 ID=ID*1e3; // Source current in mili-amperes
25 plot(VGS,ID,"RED");
26
27 // Intersection of transfer curve with the bias
   curve
28 // Putting VGS = VDD-ID*RD in equation (1) and
   solving, we get ID^2*RD^2 + (2*RD*VT - 2*VDD*RD -
    1/k)*ID + (VDD-VT)^2
29 // Solving the equation
30 p_eq = poly([(VDD-VT)^2 (2*RD*VT-2*VDD*RD-1/k) RD
   ^2],"x","coeff");
31 p_roots= roots(p_eq);
32 IDQ=p_roots(1);  // in amperes
33 VGSQ=VDD-IDQ*RD; // in volts
34 IDQ=IDQ*1e3;     // in mili-amperes
35 disp(VGSQ,"VDSQ (V) =");
36 disp(IDQ,"IDQ (mA) =");
```

Experiment: 5

To find operating point of MOSFET

Scilab code Solution 5.1 operating point of MOSFET

```
1  clc;
2  close;
3  //Scilab 5.5.0;64 bit(windows 7)
4
5  ID=5e-3; // in amperes
6  VGS=6;   // in volts
7  VT=3;    // in volts
8
9  // input circuit parameters
10 VDD=24;   // in volts
11 R1=10;    // in mega-ohms
12 R2=6.8;   // in mega-ohms
13 RD=2.2e3; // in ohms
14 RS=0.75e3;// in ohms
15 // Applying Thevnin's theorem
16 VGG=VDD*R2/(R1+R2); // in volts
17
18 // Plotting transfer characteristics
19 k=ID/(VGS-VT).^2;    // in amperes per volt square
```

```
20 VGS=[3:0.01:VGG];    // Gate source voltage in volts
21 ID=k*(VGS-VT).^2;     // Drain current in amperes
      ..... (i)
22 ID=ID*1e3; // Drain current in mili-amperes
23 plot(VGS,ID);
24 xtitle("Transfer Characteristics","VGS (V)","ID (mA)
      ");
25
26 // Plotting bias line
27 VGS=[0:0.01:VGG]; // Gate source voltage in volts
28 // Writing KVL for the gate-source loop
29 ID=(VGG-VGS)/RS; // Source current in amperes
30 ID=ID*1e3;       // Source current in mili-amperes
31 plot(VGS,ID,"RED");
32
33 // Intersection of transfer curve with the bias
      curve
34 // Putting VGS = VGG-ID*RD in equation (i) and
      solving, we get ID^2*RS^2 + (2*RS*VT - 2*VGG*RS -
       1/k)*ID + (VGG-VT)^2
35 // Solving the equation
36 p_eq = poly([(VGG-VT)^2 (2*RS*VT-2*VGG*RS-1/k) RS
      ^2],"x","coeff");
37 p_roots= roots(p_eq);
38 IDQ=p_roots(1); // in amperes
39 VGSQ=VGG-IDQ*RS; // in volts
40 // From the output circuit
41 VDSQ=VDD-IDQ*(RD+RS); // in volts
42 IDQ=IDQ*1e3; // in mili-amperes
43 disp(IDQ,"IDQ (mA) =");
44 disp(VDSQ,"VDSQ (V) =");
45 disp(VGSQ,"VGSQ (V) =");
```