

Scilab Manual for
Electronic Devices and Circuits
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Experiment: 1

To find the transfer characteristics of FET

Scilab code Solution 1.1 transfer characteristics of FET

```
1  clc;
2  close;
3  //Scilab 5.5.0;64 bit(windows 7)
4
5  IDSS=12;      // in mili-amperes
6  VP=-5;       // in volts
7
8  // Plotting transfer curve
9  VGS=[0:-0.01:VP]; // Gate source voltage in volts
10 // Using Shockley's equation
11 ID=IDSS*(1-VGS/VP).^2; // Drain current in mili-
    amperes
12 plot(VGS, ID);
13 xtitle("Transfer Curve", "VGS (V)", "ID (mA)");
```

Scilab code Solution 1.2 transfer characteristics of FET

```
1 clc;
2 close;
3 //Scilab 5.5.0;64 bit(windows 7)
4
5 IDSS=15;      // in mili-amperes
6 VP=-4;       // in volts
7
8 // Plotting transfer curve
9 VGS=[0:-0.01:VP]; // Gate source voltage in volts
10 // Using Shockley's equation
11 ID=IDSS*(1-VGS/VP).^2; // Drain current in mili-
    amperes
12 plot(VGS, ID);
13 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

```
1  clc;
2  close;
3  //Scilab 5.5.0;64 bit(windows 7)
4
5  IDSS=5e-3; // in amperes
6  VP=-5; // in volts
7
8  // input circuit parameters
9  VDD=15; // in volts
10 RD=2.2e3; // in ohms
11 RS=1.6e3; // in ohms
12
13 // Plotting transfer characteristics
14 VGS=[0:-0.01:VP]; // Gate source voltage in volts
15 // Using Shockley's equation
16 ID=IDSS*(1-VGS/VP).^2; // Drain current in amperes
17 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 Thevni'n'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

```
1  clc;
2  close;
3  //Scilab 5.5.0;64 bit(windows 7)
4
5  ID=6e-3; // in amperes
6  VGS=8; // in volts
7  VT=3; // in volts
8  // input circuit parameters
9  VDD=12; // in volts
10 RD=2e3; // in ohms
11
12 // Plotting transfer curve
13 k=ID/(VGS-VT).^2; // in amperes per volt square
14 VGS=[3:0.01:VDD]; // Gate source voltage in volts
15 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) =");

```
