

Scilab Textbook Companion for  
Electronics Devices And Circuit Theory  
by R. L. Boylestad And L. Nashelsky<sup>1</sup>

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# Book Description

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Scilab numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

**AP** Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

# Contents

List of Scilab Codes	4
1 Semiconductor Diodes	6
2 Diode Applications	10
3 Bipolar Junction Transistor	40
4 DC Biasing BJT	42
5 BJT AC Analysis	61
6 Field Effect Transistor	88
7 FET Biasing	94
8 FET Amplifiers	126
9 BJT and JFET frequency response	143
10 Operational Amplifiers	163
11 Op Amp Applications	174
12 Power Amplifiers	182

<b>13 Linear Digital ICs</b>	<b>193</b>
<b>14 Feedback and oscillator circuits</b>	<b>196</b>
<b>15 Power Supplies</b>	<b>202</b>

# List of Scilab Codes

Exa 1.1	Thermal Voltage calculation . . . . .	6
Exa 1.2	Dc level resistance calculation . . . . .	6
Exa 1.3	Ac resistance calculation . . . . .	7
Exa 1.4	Zener voltage determination . . . . .	8
Exa 1.5	Wavelength determination . . . . .	8
Exa 2.1	Q point using diode characteristics . . . . .	10
Exa 2.2	Vdq Vr and Idq by approx equivalent model . . . . .	11
Exa 2.3	Vdq Vr and Idq by ideal diode model . . . . .	11
Exa 2.4	Vd Vr and Id . . . . .	11
Exa 2.5	Vd Vr and Id with diode reversed . . . . .	12
Exa 2.6	Vd Vr and Id for series diode config . . . . .	12
Exa 2.7	Vo and Id calculation . . . . .	13
Exa 2.8	Id Vd2 and Vo calculation . . . . .	13
Exa 2.9	I V1 V2 and Vo calculation . . . . .	14
Exa 2.10	Vo I1 Id1 and Id2 for parallel diode config . . . . .	15
Exa 2.11	Resistor values . . . . .	15
Exa 2.12	Output voltage . . . . .	16
Exa 2.13	Determine network currents . . . . .	16
Exa 2.14	Output voltage . . . . .	17
Exa 2.15	Output voltage for positive logic AND . . . . .	17
Exa 2.16.a	Sketch output and determine dc level . . . . .	18
Exa 2.16.b	Sketch output and determine dc level for Si diode case . . . . .	19
Exa 2.16.c	Determine dc level if Vm is 200V . . . . .	20
Exa 2.17	Sketch output waveform . . . . .	20
Exa 2.18	Sketch output waveform . . . . .	22
Exa 2.19	Sketch output waveform . . . . .	23
Exa 2.20	Sketch output waveform . . . . .	25

Exa 2.21	Sketch output waveform using Ge diode . . .	27
Exa 2.22	Sketch output waveform . . . . .	29
Exa 2.23	Sketch output waveform using Si diode . . .	32
Exa 2.24	Voltages and Power calculation . . . . .	34
Exa 2.25	Sketch output waveform . . . . .	35
Exa 2.26.a	$V_I$ $V_r$ $I_z$ $P_z$ . . . . .	36
Exa 2.26.b	$V_I$ $V_r$ $I_z$ $P_z$ with different $R_l$ . . . . .	37
Exa 2.27	$R_l$ $I_l$ Range max power and zener increase .	37
Exa 2.28	Range of $V_i$ . . . . .	38
Exa 3.1	Determining Collector current and $V_{be}$ . . .	40
Exa 3.2	Determining Collector current . . . . .	41
Exa 4.1	Fixed Bias Network characteristics . . . . .	42
Exa 4.2	Saturation level . . . . .	43
Exa 4.3	$V_{cc}$ $R_c$ and $R_b$ for fixed bias config . . . . .	43
Exa 4.4	Emitter bias Network characteristics . . . . .	44
Exa 4.6	Saturation current . . . . .	44
Exa 4.7	$V_{ce}$ and $I_c$ for voltage divider config . . . . .	45
Exa 4.8	$I_{cq}$ and $V_{cq}$ calculation . . . . .	45
Exa 4.9	$I_{cq}$ and $V_{ceq}$ calculation . . . . .	46
Exa 4.10	$I_{cq}$ and $V_{ceq}$ calculation for voltage divider	47
Exa 4.11	$I_{cq}$ and $V_{ceq}$ calculation . . . . .	48
Exa 4.12	$I_{cq}$ and $V_{ceq}$ calculation for a different $\beta$	48
Exa 4.13	$I_b$ and $V_c$ calculation . . . . .	49
Exa 4.14	Network characteristics determination . . . . .	49
Exa 4.15	$V_c$ and $V_b$ calculcation . . . . .	50
Exa 4.16	$V_{ceq}$ and $I_e$ . . . . .	50
Exa 4.17	$V_{cb}$ and $I_b$ for common base config . . . . .	51
Exa 4.18	$V_c$ and $V_b$ calculcation . . . . .	52
Exa 4.19	$V_{cc}$ $R_c$ and $R_b$ for fixed bias config . . . . .	52
Exa 4.20	$R_1$ and $R_c$ . . . . .	53
Exa 4.21	$R_c$ $R_e$ and $R_b$ . . . . .	53
Exa 4.22	Resistor values for the netowrk . . . . .	54
Exa 4.23	$R_c$ $R_e$ $R_1$ and $R_2$ . . . . .	55
Exa 4.24	$R_b$ and $R_c$ . . . . .	55
Exa 4.25	Determine proper operation of network . . . . .	56
Exa 4.26	Determine proper operation of network . . . . .	56
Exa 4.27	$V_{ce}$ for voltage divider config . . . . .	57
Exa 4.28	Stabiliity factor and change in $I_c$ . . . . .	58

Exa 4.29	Stability factor and change in $I_c$ . . . . .	58
Exa 4.30	Determine $I_{cq}$ . . . . .	59
Exa 5.1	Common base config characteristics . . . . .	61
Exa 5.2	$Z_i$ $A_v$ and $A_i$ for common emitter . . . . .	62
Exa 5.3	Common emitter hybrid and common base model . . . . .	62
Exa 5.4	Network characteristics determination . . . . .	63
Exa 5.5	Network characteristics determination . . . . .	64
Exa 5.6	Network characteristics without $C_e$ . . . . .	65
Exa 5.7	Network characteristics with $C_e$ . . . . .	66
Exa 5.8	Network characteristics determination . . . . .	67
Exa 5.9	Network characteristics determination with $C_e$ . . . . .	68
Exa 5.10	Emitter follower Network characteristics determination . . . . .	69
Exa 5.11	Network characteristics determination . . . . .	70
Exa 5.12	Network characteristics determination . . . . .	71
Exa 5.13	Network characteristics determination . . . . .	72
Exa 5.14	Fixed Bias Network characteristics . . . . .	73
Exa 5.15	$A_v$ and $A_{vs}$ . . . . .	74
Exa 5.16	Network characteristics determination . . . . .	74
Exa 5.17	Network characteristics determination . . . . .	75
Exa 5.18	Network characteristics determination . . . . .	76
Exa 5.19	No load voltage gain . . . . .	77
Exa 5.20	Dc bias voltage and current . . . . .	78
Exa 5.21	Input impedance . . . . .	79
Exa 5.22	Ac current gain . . . . .	79
Exa 5.23	Output impedance . . . . .	80
Exa 5.24	Ac voltage gain . . . . .	80
Exa 5.25	Dc bias voltage and current . . . . .	80
Exa 5.26	Ac circuit values of $Z_i$ $Z_o$ $A_i$ $A_v$ . . . . .	81
Exa 5.27	Mirrored Current . . . . .	82
Exa 5.28	Current through transistors . . . . .	82
Exa 5.29	Constant current . . . . .	82
Exa 5.30	Constant current . . . . .	83
Exa 5.31	Network characteristics determination . . . . .	83
Exa 5.32	Network characteristics determination . . . . .	84
Exa 5.33	Determining parameters using hybrid equivalent model . . . . .	84



Exa 5.34	Determining parameters using hybrid equivalent model . . . . .	86
Exa 6.1	Sketching the transfer curve . . . . .	88
Exa 6.2	Sketching the transfer curve . . . . .	90
Exa 6.3	Sketching the transfer curve . . . . .	91
Exa 6.4	Sketching the transfer curve and finding value of k . . . . .	92
Exa 7.1	Network characteristics determination . . .	94
Exa 7.2	Network characteristics determination . . .	95
Exa 7.3	Q point for network . . . . .	97
Exa 7.4	Network characteristics determination . . .	101
Exa 7.5	Network characteristics determination . . .	102
Exa 7.6	Network characteristics determination . . .	106
Exa 7.7	$I_{DQ}$ $V_{GSQ}$ and $V_{DS}$ calculation . . . . .	107
Exa 7.8	$I_{DQ}$ $V_{GSQ}$ and $V_{DS}$ calculation . . . . .	110
Exa 7.9	$I_{DQ}$ $V_{GSQ}$ and $V_D$ calculation . . . . .	113
Exa 7.10	$V_{DS}$ determination . . . . .	115
Exa 7.11	$I_{DQ}$ $V_{DSQ}$ Calculation . . . . .	117
Exa 7.12	$I_{DQ}$ $V_{GSQ}$ and $V_{DS}$ calculation . . . . .	118
Exa 7.13	$V_D$ and $V_C$ level determination . . . . .	120
Exa 7.14	$V_D$ level determination . . . . .	120
Exa 7.15	$V_{DQ}$ and $I_{DQ}$ level . . . . .	121
Exa 7.16	$R_S$ determination . . . . .	121
Exa 7.17	$V_{DD}$ and $R_D$ determination . . . . .	122
Exa 7.18	$I_{DQ}$ $V_{GSQ}$ and $V_{DS}$ calculation . . . . .	122
Exa 7.19	Q point value of $I_D$ and $V_{GS}$ . . . . .	124
Exa 7.20	Q point value of $I_D$ and $V_{GS}$ . . . . .	124
Exa 8.1	Calculation of $g_m$ for different $V_{GS}$ . . . . .	126
Exa 8.2	Calculation of $g_m$ for different $V_{GS}$ and max $g_m$ . . . . .	128
Exa 8.3	$g_m$ vs $V_{GS}$ . . . . .	129
Exa 8.4	$g_m$ vs $I_D$ . . . . .	130
Exa 8.5	Output impedance . . . . .	132
Exa 8.6	FET equivalent model . . . . .	133
Exa 8.7	JFET fix bias configuration calculation . . .	133
Exa 8.8	JFET self bias configuration calculation . .	134
Exa 8.9	JFET source follower configuration calculation	135
Exa 8.10	JFET common gate configuration calculation	136

Exa 8.11	Network components determination . . . . .	137
Exa 8.12	E MOSFET components determination . . . . .	137
Exa 8.13	Rd value determination . . . . .	138
Exa 8.14	Rd and Rs determination . . . . .	139
Exa 8.15	Rd and Rs determination . . . . .	140
Exa 8.16	Network characteristics determination . . . . .	141
Exa 8.17	Input output impedance and output voltage . . . . .	142
Exa 9.1	Log calculation . . . . .	143
Exa 9.2	Log calculation . . . . .	143
Exa 9.3	Anti Log calculation . . . . .	144
Exa 9.4	Log calculation . . . . .	144
Exa 9.5	Magnitude gain calculation . . . . .	144
Exa 9.6	Power and voltage gain . . . . .	144
Exa 9.7	Input power and input voltage . . . . .	145
Exa 9.8	Break frequency and bode plot . . . . .	147
Exa 9.9	Frequency aand bode plot . . . . .	148
Exa 9.10	Frequency and bode plot . . . . .	150
Exa 9.11	Frequency and bode plot . . . . .	152
Exa 9.12	Frequency . . . . .	155
Exa 9.13	Frequency and bode plot . . . . .	157
Exa 9.14	Frequency . . . . .	161
Exa 9.15	Fourier transform and time . . . . .	162
Exa 10.1	Dc voltages and currents calculation . . . . .	163
Exa 10.2	Single ended output voltage . . . . .	163
Exa 10.3	Common mode gain . . . . .	164
Exa 10.4	Common mode gain . . . . .	164
Exa 10.5	Output voltage . . . . .	165
Exa 10.6	Output voltage . . . . .	165
Exa 10.7	Output voltage . . . . .	166
Exa 10.8	Output offset voltage . . . . .	167
Exa 10.9	Output offset voltage . . . . .	167
Exa 10.10	Total offset voltage . . . . .	167
Exa 10.11	Input bias current . . . . .	168
Exa 10.12	Cut off frequency . . . . .	168
Exa 10.13	Maximum closed loop voltage gain . . . . .	169
Exa 10.14	Maximum frequency . . . . .	169
Exa 10.15	Current drawn calculation . . . . .	170
Exa 10.16	Output offset voltage . . . . .	170

Exa 10.17	Gain and input output impedance calculation	170
Exa 10.18	Cut off frequency . . . . .	171
Exa 10.19	Maximum frequency . . . . .	171
Exa 10.20	Open loop voltage gain . . . . .	172
Exa 10.21	CMRR calculation . . . . .	172
Exa 10.22	Output voltage . . . . .	173
Exa 11.1	Output voltage . . . . .	174
Exa 11.2	Output voltage . . . . .	174
Exa 11.3	Output voltage . . . . .	175
Exa 11.4	Output voltage . . . . .	175
Exa 11.5	Connection of op amp stages . . . . .	176
Exa 11.6	Output voltage . . . . .	177
Exa 11.7	Output voltage . . . . .	178
Exa 11.8	Output voltage . . . . .	178
Exa 11.10	Il and Vo calculation . . . . .	179
Exa 11.11	Output voltage . . . . .	179
Exa 11.12	Cut off frequency . . . . .	180
Exa 11.13	Cut off frequency of high pass filter . . . . .	180
Exa 11.14	Cut off frequency of band pass filter . . . . .	181
Exa 12.1	input output power and efficiency . . . . .	182
Exa 12.2	Effective Resistance . . . . .	183
Exa 12.3	Turns ratio . . . . .	183
Exa 12.4	Ac power delivered . . . . .	183
Exa 12.5	input and dissipated power and efficiency . . . . .	184
Exa 12.6	Efficiency calculation . . . . .	185
Exa 12.7	Input output power and efficiency . . . . .	186
Exa 12.8	Power and transmission dissipation . . . . .	186
Exa 12.9	Efficiency calculation . . . . .	187
Exa 12.10	Input output dissipated power and efficiency . . . . .	187
Exa 12.11	Dissipated power and efficiency . . . . .	188
Exa 12.12	Max dissipated power and input voltage . . . . .	189
Exa 12.13	Harmonic distortion components . . . . .	189
Exa 12.14	Total Harmonic distortion components . . . . .	190
Exa 12.15	Second Harmonic distortion . . . . .	190
Exa 12.16	Total Harmonic distortion and fundamental and total power . . . . .	191
Exa 12.17	Maximum dissipation . . . . .	191
Exa 12.18	Max dissipated power . . . . .	192

Exa 13.1	frequency and output waveform . . . . .	193
Exa 13.2	Period of output waveform . . . . .	195
Exa 14.1	input output impedance and voltage gain . .	196
Exa 14.2	change in gain of feedback amplifier . . . . .	197
Exa 14.3	gain with and without feedback . . . . .	197
Exa 14.4	amplifier gain . . . . .	198
Exa 14.5	voltage gain . . . . .	198
Exa 14.6	voltage gain . . . . .	199
Exa 14.7	value of C . . . . .	199
Exa 14.8	resonant frequency and RC elements . . . . .	200
Exa 14.9	RC elements for wien bridge . . . . .	200
Exa 15.1	Measure output and filter voltage . . . . .	202
Exa 15.2	Voltage regulation value . . . . .	202
Exa 15.3	Ripple voltage and output voltage value . .	203
Exa 15.4	Filter dc voltage value . . . . .	203
Exa 15.5	Ripple of capacitor . . . . .	204
Exa 15.6	dc voltage across 1k load . . . . .	204
Exa 15.7	dc ac and ripple values of output signal . . .	204
Exa 15.8	output voltage and zener current . . . . .	205
Exa 15.9	regulated output voltage . . . . .	206
Exa 15.10	regulated output voltage . . . . .	206
Exa 15.11	regulated voltage and circuit current . . . . .	206
Exa 15.13	minimum input voltage . . . . .	207
Exa 15.14	max value of load current . . . . .	207
Exa 15.15	regulated output voltage . . . . .	208
Exa 15.16	regulated output voltage . . . . .	208

# List of Figures

2.1	Sketch output and determine dc level . . . . .	18
2.2	Sketch output and determine dc level for Si diode case . . . . .	19
2.3	Sketch output waveform . . . . .	21
2.4	Sketch output waveform . . . . .	23
2.5	Sketch output waveform . . . . .	24
2.6	Sketch output waveform . . . . .	26
2.7	Sketch output waveform using Ge diode . . . . .	28
2.8	Sketch output waveform . . . . .	30
2.9	Sketch output waveform using Si diode . . . . .	32
2.10	Sketch output waveform . . . . .	35
6.1	Sketching the transfer curve . . . . .	89
6.2	Sketching the transfer curve . . . . .	90
7.1	Network characteristics determination . . . . .	95
7.2	Q point for network . . . . .	97
7.3	Network characteristics determination . . . . .	100
7.4	Network characteristics determination . . . . .	103
7.5	Network characteristics determination . . . . .	105
7.6	$I_{dq}$ $V_{gsq}$ and $V_{ds}$ calculation . . . . .	108
7.7	$I_{dq}$ $V_{gsq}$ and $V_{ds}$ calculation . . . . .	111
7.8	$I_{dq}$ $V_{gsq}$ and $V_d$ calculation . . . . .	113
7.9	$I_{dq}$ $V_{dsq}$ Calculation . . . . .	116
7.10	$I_{dq}$ $V_{gsq}$ and $V_{ds}$ calculation . . . . .	118

8.1	Calculation of gm for different Vgs . . . . .	127
8.2	gm vs Vgs . . . . .	129
8.3	gm vs Id . . . . .	131
9.1	Break frequency and bode plot . . . . .	146
9.2	Frequency aand bode plot . . . . .	148
9.3	Frequency and bode plot . . . . .	150
9.4	Frequency and bode plot . . . . .	152
9.5	Frequency and bode plot . . . . .	156
11.1	Output voltage . . . . .	176
11.2	Connection of op amp stages . . . . .	177
11.3	Connection of unity gain ckt . . . . .	179
13.1	frequency and output waveform . . . . .	194

# Chapter 1

## Semiconductor Diodes

Scilab code Exa 1.1 Thermal Voltage calculation

```
1 clear; clc; close;
2
3 t = 273 + 27; //in kelvin
4 t_new = 273 +100;
5 k = 1.38*10^(-23); //in J/K
6 q = 1.6*10^(-19); //C
7
8 Vt = k*t/q;
9 format(10);
10 disp(Vt, 'Thermal voltage for 27 ''C(in V): ');
11
12 Vt = k*t_new/q;
13 disp(Vt, 'Thermal voltage for 100 ''C(in V): ');
```

---

Scilab code Exa 1.2 Dc level resistance calculation

```
1 clear; clc; close;
2
```

```

3 Id_low = 2; //mA
4 Id_high = 25; //mA
5 Vd_reverse_bias = -10; //V
6
7 Vd_low = 0.5; //V
8 Vd_high = 0.85; //V
9 Id_reverse_bias = -10*10(-6); //A
10
11 Rd_low = Vd_low/Id_low;
12 Rd_high = Vd_high/Id_high;
13 Rd_reverse_bias = Vd_reverse_bias/Id_reverse_bias;
14
15 disp(Rd_low, 'Low level dc resistance(in ohm):');
16 disp(Rd_high, 'High level dc resistance(in ohm):');
17 disp(Rd_reverse_bias, 'Reverse bias dc resistance(in
    ohm):');

```

---

### Scilab code Exa 1.3 Ac resistance calculation

```

1 clear; clc; close;
2
3 Id1 = 2*10(-3); //A
4 Id2 = 25*10(-3); //A
5
6 Delta_Id1 = (4-0)*10(-3); //A
7 Delta_Vd1 = 0.76-0.65; //V
8 rd1 = Delta_Vd1/Delta_Id1;
9
10 Delta_Id2 = (30-20)*10(-3); //A
11 Delta_Vd2 = 0.80-0.78; //V
12 rd2 = Delta_Vd2/Delta_Id2;
13
14 //From graph
15 Vd1 = 0.7; //V
16 Vd2 = 0.79; //V

```



```

17
18 Rd1 = Vd1/Id1;
19 Rd2 = Vd2/Id2;
20
21 disp(rd1,'ac resistance in part a(in ohm) is : ');
22 disp(rd2,'ac resistance in part b(in ohm) is : ');
23 disp(Rd1,'dc resistance in part a(in ohm) is : ');
24 disp(Rd2,'dc resistance in part b(in ohm) is : ');

```

---

#### Scilab code Exa 1.4 Zener voltage determination

```

1 clear; clc; close;
2
3 Tc = 0.072; // %/'C
4 Vz = 10; //V
5 T1 = 100; // 'C
6 T0 = 25; // 'C
7
8 Delta_Vz = Tc*Vz*(T1-T0)/100;
9
10 Vz_new = Vz + Delta_Vz;
11
12 disp(Delta_Vz,'Change in zener potential(in V):');
13 disp(Vz_new,'Resulting zener potntial(in V):');

```

---

#### Scilab code Exa 1.5 Wavelength determination

```

1 clear; clc; close;
2
3
4 c = 3*10^(17); // nm/s
5 f = 750*10^(12); // Hz
6

```

```
7 Lambda = c/f;  
8  
9 disp(Lambda, 'Wavelength provided for visible light(  
    in nm): ');
```

---

# Chapter 2

## Diode Applications

Scilab code Exa 2.1 Q point using diode characteristics

```
1 clear; clc; close;
2
3 E = 10;      // volts
4 R = 500;    // ohms
5
6 Id = E/R;
7 Vd = E;
8
9 Vdq = 0.78; // volts
10 Idq = 18.5*10(-3); // Amperes
11
12 Vr = Idq*R;
13
14 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_1.
      txt');
15 disp(Vdq, 'Voltage at Q-point is :');
16 disp(Idq, 'Current at Q-point is :');
17 disp(Vr, 'Vr = ');
```

---

### Scilab code Exa 2.2 Vdq Vr and Idq by approx equivalent model

```
1 clear; clc; close;
2
3 E = 10;      //volts
4 R = 500;    //ohms
5
6 Vdq = 0.7; //volts
7 Idq = 18.5*10(-3); //amperes
8
9 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_2.
      txt');
10 disp(Vdq, 'Voltage at Q-point is :');
11 disp(Idq, 'Current at Q-point is :');
```

---

### Scilab code Exa 2.3 Vdq Vr and Idq by ideal diode model

```
1 clear; clc; close;
2
3 E = 10;      //volts
4 R = 500;    //ohms
5
6 Vdq = 0;    //volts
7 Idq = 20*10(-3); //amperes
8
9 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_3.
      txt');
10 disp(Vdq, 'Voltage at Q-point is :');
11 disp(Idq, 'Current at Q-point is :');
```

---

### Scilab code Exa 2.4 Vd Vr and Id

```
1 clear; clc; close;
```

```

2
3 E = 8;      //volts
4 R = 2.2*10^(3);    //ohms
5
6 Vd = 0.7;    //Diode is on
7 Vr = E-Vd;
8 Id = Vr/R;
9
10 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_4.
      txt');
11 disp(Vd,'Diode Volatge is : ');
12 disp(Vr,'Voltage across R is : ');
13 disp(Id,'Current through diode is : ');

```

---

**Scilab code Exa 2.5** Vd Vr and Id with diode reversed

```

1 clear; clc; close;
2
3 E = 8;      //volts
4 R = 2.2*10^(3);    //ohms
5
6 Id = 0;    //diode reversed
7 Vr = Id*R;
8 Vd = E-Vr;
9
10 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_5.
      txt');
11 disp(Vd,'Diode Volatge is : ');
12 disp(Vr,'Voltage across R is : ');
13 disp(Id,'Current through diode is : ');

```

---

**Scilab code Exa 2.6** Vd Vr and Id for series diode config

```

1 clear; clc; close;
2
3 E = 0.5;      //volts
4 R = 1.2*10^(3); //ohms
5
6 Id = 0;      //diode off
7 Vr = Id*R;
8 Vd = E;
9
10 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_6.
      txt');
11 disp(Vd, 'Diode Volatge is : ');
12 disp(Vr, 'Voltage across R is : ');
13 disp(Id, 'Current through diode is : ');

```

---

#### Scilab code Exa 2.7 $V_o$ and $I_d$ calculation

```

1 clear; clc; close;
2
3 E = 12;      //volts
4 Vk1 = 0.7;   //volts
5 Vk2 = 1.8;   //volts
6 R = 0.680*10^(3); //ohms
7
8  $V_o = E - V_{k1} - V_{k2}$ ;
9  $I_d = V_o / R$ ;
10
11 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_7.
      txt');
12 disp( $V_o$ , 'Output Volatge is : ');
13 disp( $I_d$ , 'Output Currp is : ');

```

---

#### Scilab code Exa 2.8 $I_d$ $V_{d2}$ and $V_o$ calculation

```

1 clear; clc; close;
2
3 E = 20;      //volts
4 R = 5.6*10^(3); //ohms
5
6 Id = 0;     //amperes
7 Vd1 = 0;
8 Vo = Id*R;
9 Vd2 = E;
10
11
12 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_8.
      txt');
13 disp(Vo,'Output Volatge is : ');
14 disp(Id,'Output Current is : ');
15 disp(Vd2,'Voltage across diode 2 is :')

```

---

#### Scilab code Exa 2.9 I V1 V2 and Vo calculation

```

1 clear; clc; close;
2
3 E1 = 10;     //volts
4 E2 = 5;     //volts
5 R1 = 4.7*10^(3); //ohms
6 R2 = 2.2*10^(3); //ohms
7
8 Vd = 0.7;   //volts
9 I = (E1+E2-Vd)/(R1+R2);
10 V1 = I*R1;
11 V2 = I*R2;
12 Vo = V2 - E2;
13
14 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_9.
      txt');
15 disp(Vo,'Output Volatge is : ');

```

```
16 disp(I, 'Output Current is : ');
17 disp(V1, 'Voltage across resistance 1 is : ');
18 disp(V2, 'Voltage across resistance 2 is : ');
```

---

**Scilab code Exa 2.10** Vo I1 Id1 and Id2 for parallel diode config

```
1 clear; clc; close;
2
3 E = 10; //volts
4 R = 0.33*10^(3); //ohms
5
6 Vo = 0.7; //volts
7 I = (E - Vo)/R;
8 Id1 = I/2;
9 Id2 = I/2;
10
11 diary('C:\Users\DELL\Desktop\intern\chapter_2\2_10.
    txt');
12 disp(Vo, 'Output Volatge is : ');
13 disp(Id1, 'Current through diode 1 is : ');
14 disp(Id2, 'Current through diode 2 is : ');
```

---

**Scilab code Exa 2.11** Resistor values

```
1 clear; clc; close;
2
3 E = 8; //volts
4 Vled = 2; //volts
5 I = 20*10^(-3); //amperes
6
7 R = (E-Vled)/I;
8
9 disp(R, 'resistance value is : ');
```



---

Scilab code Exa 2.12 Output voltage

```
1
2 clear; clc; close;
3
4 E = 12;      //volts
5 Vd = 0.7;    //volts
6
7 Vo = E - Vd;
8
9 disp(Vo, 'output voltage is : ');
```

---

Scilab code Exa 2.13 Determine network currents

```
1
2 clear; clc; close;
3
4 E = 20;      //volts
5 Vk1 = 0.7;   //volts
6 Vk2 = 0.7;   //volts
7 R1 = 3.3*10^(3); //ohms
8 R2 = 5.6*10^(3); //ohms
9
10 I1 = Vk1/R1;
11 V2 = E-Vk1-Vk2;
12 I2 = V2/R2;
13
14 Id2 = I2 - I1;
15
16 disp(I1, 'I1 current is : ');
17 disp(I2, 'I2 current is : ');
18 disp(Id2, 'Id2 current is : ');
```

---

**Scilab code Exa 2.14 Output voltage**

```
1 clear; clc; close;
2
3 E = 10;      //volts
4 R = 1*10^(3); //ohms
5 Vd1 = 0.7;   //volts
6 Vd2 = 0;     //volts
7
8 Vo = E-Vd1;
9 I = (E-Vd1)/R;
10
11 disp(Vo, 'output voltage is : ');
```

---

**Scilab code Exa 2.15 Output voltage for positive logic AND**

```
1 clear; clc; close;
2
3 E = 10;      //volts
4 E1 = 10;     //volts
5 E2 = 0;      //volts
6 R = 1*10^(3); //ohms
7
8 Vd1 = 0;     //volts
9 Vd2 = 0.7;   //volts
10
11 Vo = Vd2;
12
13 disp(Vo, 'output voltage is : ');
```

---

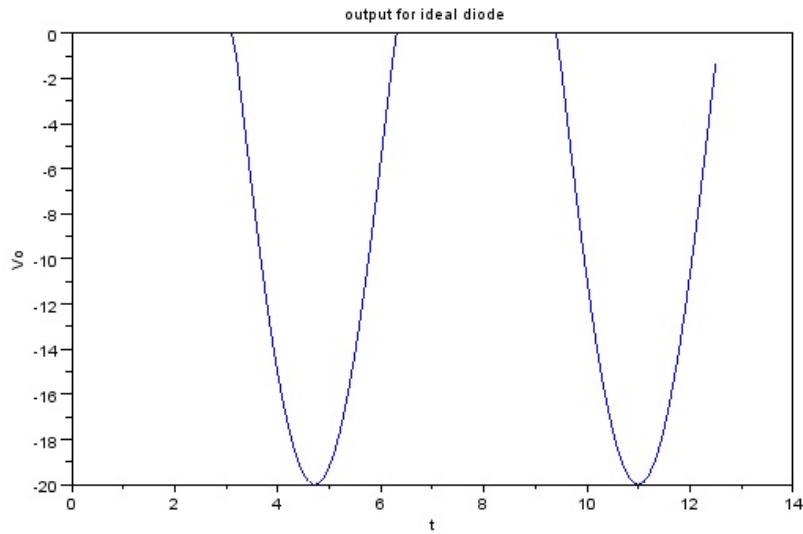


Figure 2.1: Sketch output and determine dc level

Scilab code Exa 2.16.a Sketch output and determine dc level

```

1 clear; clc; close;
2
3 Vm = 20;
4 Vdc = -0.318*Vm;
5
6 disp(Vdc, 'Dc volatge for ideal diode :');
7
8
9 t = 0:0.1:4*%pi;
10 x = 20*sin(t);
11
12 for i=1:length(t)
13     if(x(i)<=0)
14         y(i) = x(i);

```

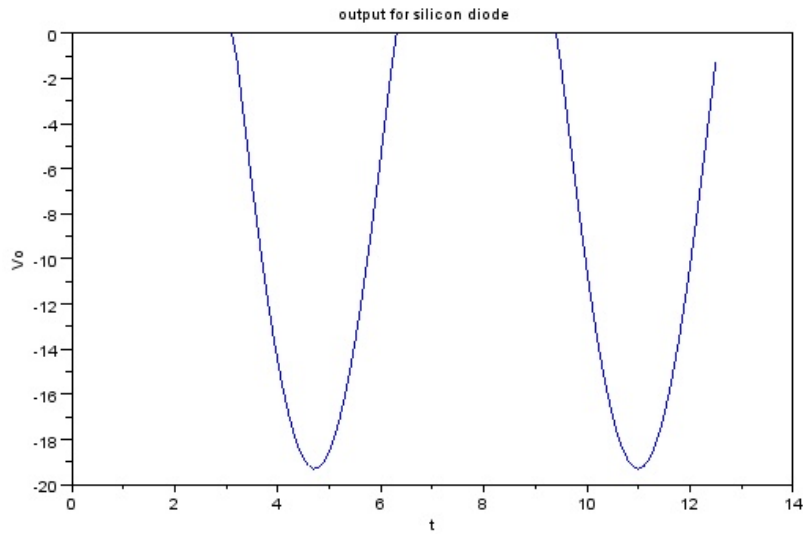


Figure 2.2: Sketch output and determine dc level for Si diode case

```

15     else y(i)=0
16     end
17 end
18
19 plot(t,y)
20 xtitle('output for ideal diode','t','Vo');

```

---

Scilab code Exa 2.16.b Sketch output and determine dc level for Si diode case

```

1 clear; clc; close;
2
3 Vm = 20; //volts
4 Vdc = -0.318*(Vm-0.7); //volts
5

```

```

6 disp(Vdc, 'Dc voltage for silicon diode :');
7
8
9 t = 0:0.1:4*%pi;
10 x = (20-0.7)*sin(t);
11
12 for i=1:length(t)
13     if(x(i)<=0)
14         y(i) = x(i);
15     else y(i)=0
16     end
17 end
18
19 plot(t,y);
20 xtitle('output for silicon diode','t','Vo');

```

---

**Scilab code Exa 2.16.c** Determine dc level if Vm is 200V

```

1 clear; clc; close;
2
3 Vm = 200; // volts
4 Vk = 0.7; // volts
5 Vdc = -0.318*Vm;
6 Vdc_si = -0.318*(Vm - Vk);
7
8 disp(Vdc, 'Dc volatge for ideal diode :');
9 disp(Vdc_si, 'Dc voltage for silicon diode :');

```

---

**Scilab code Exa 2.17** Sketch output waveform

```

1 clear; clc; close;

```

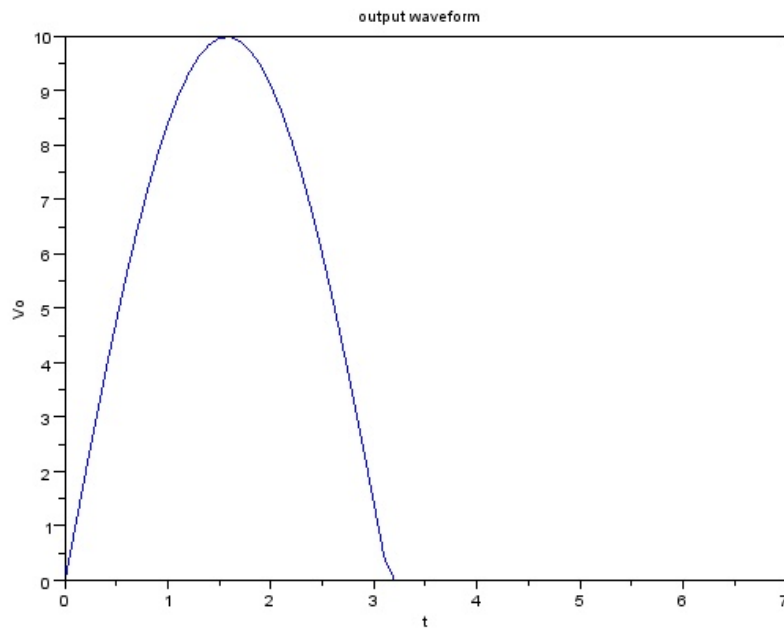


Figure 2.3: Sketch output waveform

```

2
3 Vi_max = 10;
4 Vo_max = 0.5*Vi_max;
5
6 Vdc = 0.636*Vo_max;
7
8 disp(Vdc, 'Required Dc voltage :');
9
10 t = 0:0.1:2*%pi;
11 x = 10*sin(t);
12
13 for i=1:length(t)
14     if(x(i)>=0)
15         y(i) = x(i);
16     else y(i)=0;
17     end
18 end
19
20 plot(t,y)
21 xtitle('output waveform', 't', 'Vo');

```

---

#### Scilab code Exa 2.18 Sketch output waveform

```

1 clear; clc; close;
2
3 amp = 20;
4 vi_t = -5; //transition voltage
5
6 t = 0:0.1:2*%pi;
7 vi = amp*sin(t);
8 vo = vi+5; //output voltage
9
10 disp(vi_t, 'transition voltage : ');

```

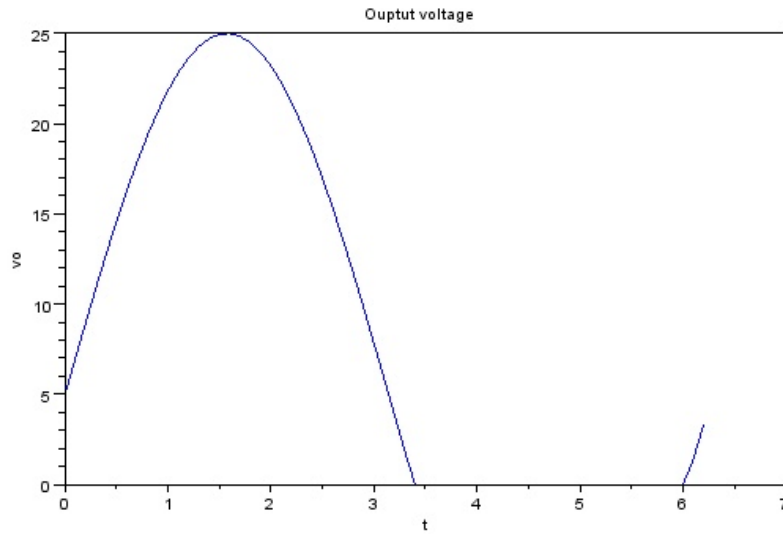


Figure 2.4: Sketch output waveform

```

11
12 for i = 1:length(t)
13     if(vo(i)<=0)
14         vo(i)=0;
15     end
16
17
18 end
19
20 plot(t,vo);
21 xtitle('Ouptut voltage','t','vo');

```

---

Scilab code Exa 2.19 Sketch output waveform



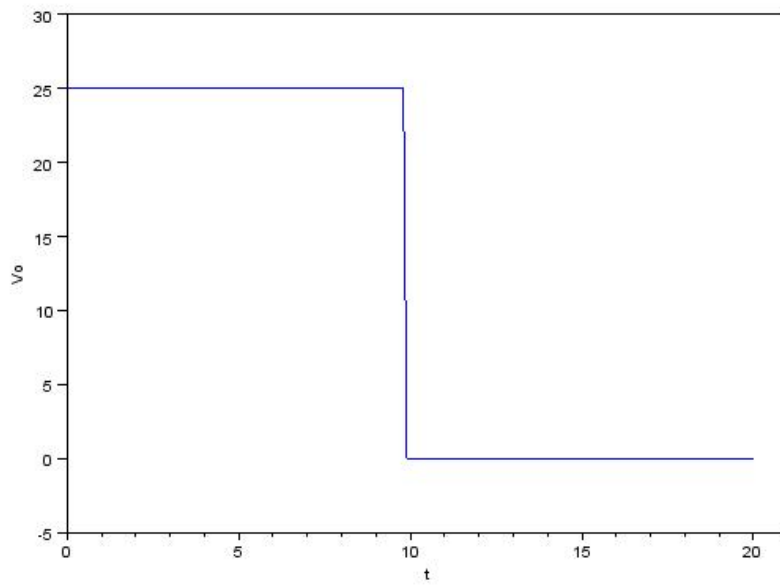


Figure 2.5: Sketch output waveform

```

1 clear; clc; close;
2
3 t = 0:0.1:20;
4 for i=1:int(length(t)/2)
5     vi(i) = 20;
6 end
7 for i = int(length(t)/2):length(t)
8     vi(i) = 0;
9 end
10 for i=1:int(length(t)/2)
11     vo(i) = 20+5;
12 end
13 for i = int(length(t)/2):length(t)
14     vo(i) = 0;
15 end
16 plot2d(t,vo,2,'011','',[0,-5,21,30]);
17 a = gca();
18 a.x_label.text = 't';
19 a.y_label.text = 'Vo';

```

---

### Scilab code Exa 2.20 Sketch output waveform

```

1 clear; clc; close;
2
3 t = 0:0.1:20;
4 for i = 1:length(t);
5     if(t(i)<=5)
6         x(i) = (16/5)*t(i);
7     elseif(t(i)>=5 & t(i)<=16)
8         x(i) = -3.2*t(i) + 32;
9     elseif(t(i)>=16 & t(i)<=20)
10        x(i) = (16/5)*t(i)-64;
11    end

```

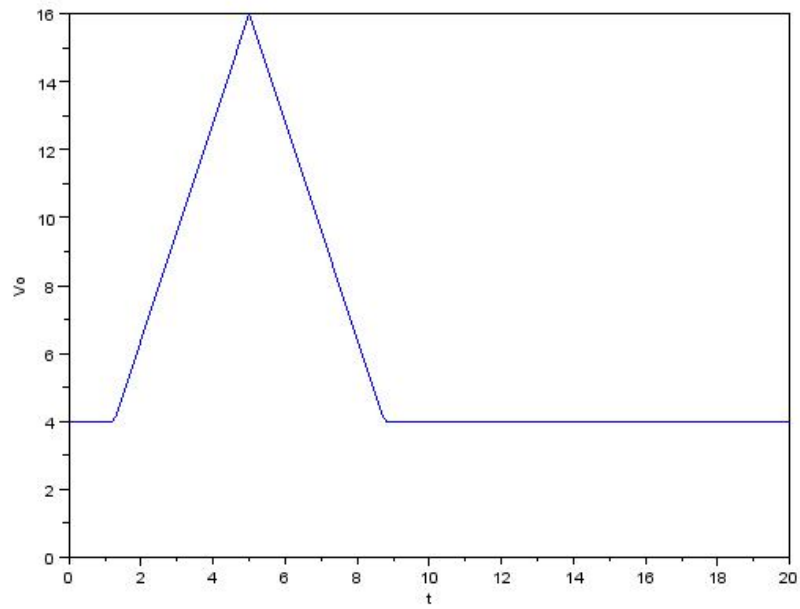


Figure 2.6: Sketch output waveform

```

12 end
13
14 for i = 1:length(t)
15     if(x(i)>4)
16         y(i)=x(i);
17     elseif(x(i)<=4)
18         y(i)=4;
19     end
20 end
21
22 plot2d(t,y,2,'011','',[0,0,20,16]);
23
24 a = gca();
25 a.x_label.text = 't';
26 a.y_label.text = 'Vo';

```

---

Scilab code Exa 2.21 Sketch output waveform using Ge diode

```

1 clear; clc; close;
2
3 V = 4;
4 Vk = 0.3;
5 id = 0;
6 vd = 0.3;
7
8 vi = V-Vk;
9 disp(vi,'new transition level : ');
10
11 t = 0:0.1:20;
12 for i = 1:length(t);
13     if(t(i)<=5)
14         x(i) = (16/5)*t(i);
15     elseif(t(i)>=5 & t(i)<=16)

```

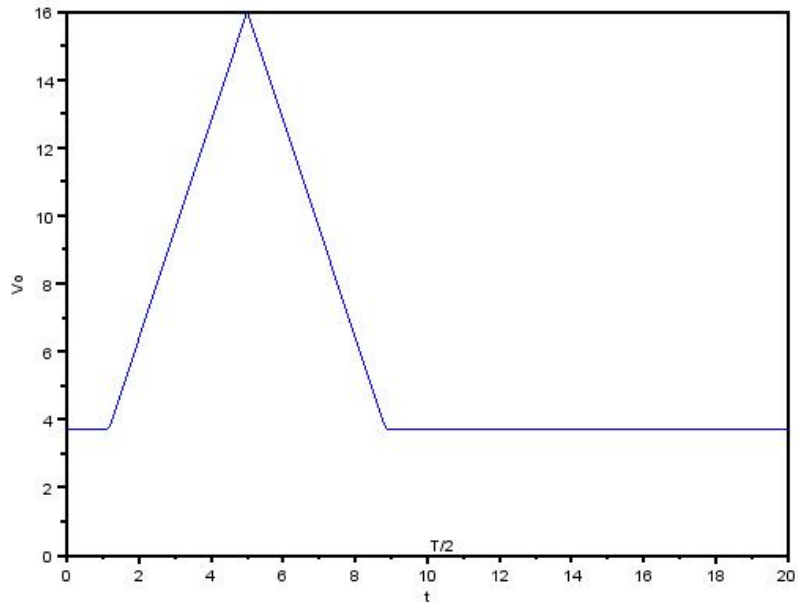


Figure 2.7: Sketch output waveform using Ge diode

```

16         x(i) = -3.2*t(i) + 32;
17     elseif(t(i)>=16 & t(i)<=20)
18         x(i) = (16/5)*t(i)-64;
19     end
20 end
21
22 for i = 1:length(t)
23     if(x(i)>vi)
24         y(i)=x(i);
25     elseif(x(i)<=3.7)
26         y(i)=3.7;
27     end
28 end
29
30 plot2d(t,y,2,'011','',[0,0,20,16]);
31
32 a = gca();
33 a.x_label.text = 't';
34 a.y_label.text = 'Vo';
35
36 xset('thickness',2);
37 xstring(10,0,'T/2');

```

---

### Scilab code Exa 2.22 Sketch output waveform

```

1 clear; clc; close;
2
3 f = 1000;
4 T = 1/f;
5 C = 0.1*10(-6);
6 R = 100*10(3);
7 //between t1—>t2
8 vo_1 = 5;

```

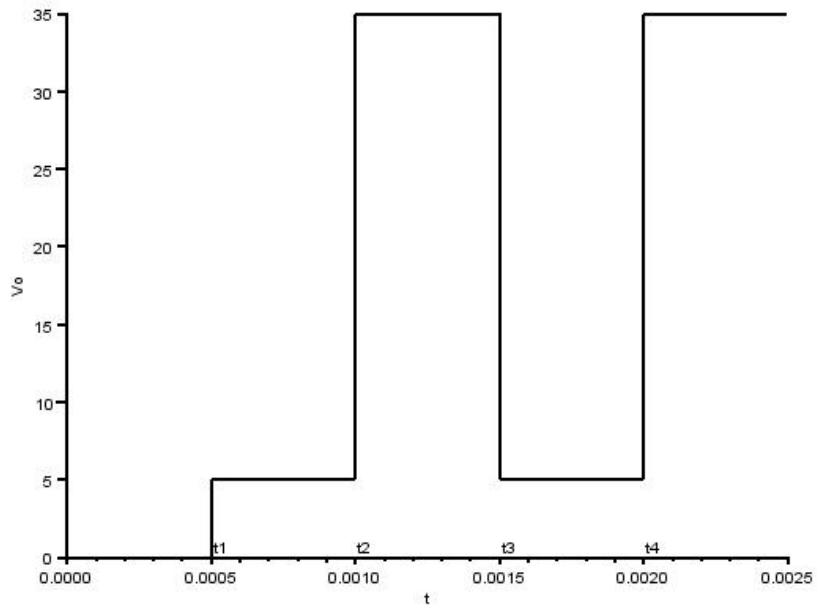


Figure 2.8: Sketch output waveform

```

9 Vc = 25;
10 //between t2—>t3
11 Rth = 0;
12 Eth = 5;
13 vo_2 =35;
14 tau = R*C;
15 discharge_time = 5*tau;
16 //between t3—>t4
17 vo_3 = 5;
18
19 disp(vo_1,'output voltage during t1—>t2 : ');
20 disp(vo_2,'output voltage during t2—>t3 : ');
21 disp(vo_3,'output voltage during t3—>t4 : ');
22
23
24 t = 0:10(-6):2.5*10(-3);
25
26 for i= 1:length(t)
27     if(t(i)>=0 & t(i)<=0.5*10(-3))
28         y(i) = 0;
29     elseif(t(i)>=0.5*10(-3) & t(i)<=10(-3))
30         y(i) = 5;
31     elseif(t(i)>=10(-3) & t(i)<=1.5*10(-3))
32         y(i)=35;
33     elseif(t(i)>=1.5*10(-3) & t(i)<=2.0*10(-3))
34         y(i)=5;
35     elseif(t(i)>=2.0*10(-3) & t(i)<=2.5*10(-3))
36         y(i)=35;
37     end
38 end
39 a = gca();
40 a.thickness = 2;
41 plot2d(t,y);
42 a.x_label.text = 't';
43 a.y_label.text = 'Vo';
44 xset('thickness',2);
45 xstring(0.5*10(-3),0,'t1');
46 xstring(10(-3),0,'t2');

```



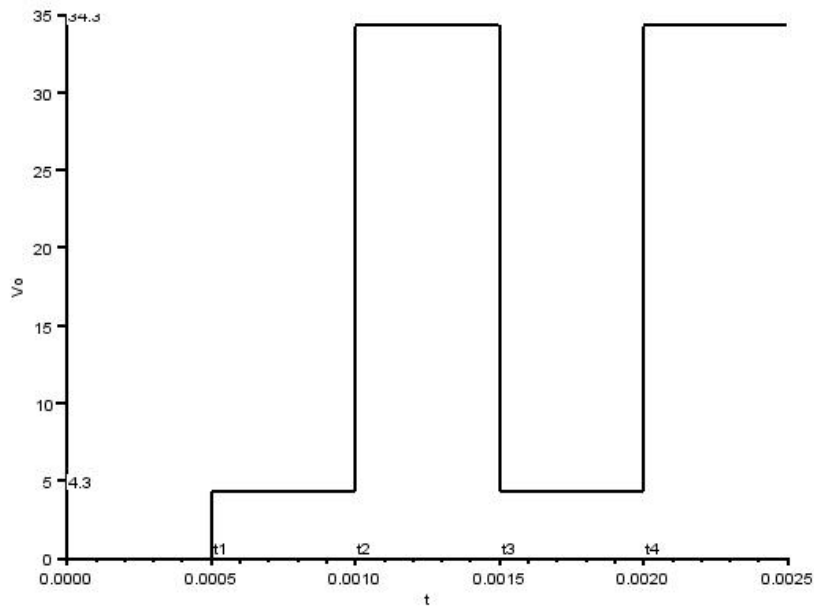


Figure 2.9: Sketch output waveform using Si diode

```
47 xstring(1.5*10(-3),0,'t3 ');
48 xstring(2*10(-3),0,'t4 ');
```

---

Scilab code Exa 2.23 Sketch output waveform using Si diode

```
1 clear; clc; close;
2
3 f = 1000;
4 T = 1/f;
5 C = 0.1*10(-6);
6 R = 100*10(3);
```

```

7 Vk = 0.7;
8 //between t1→t2
9 vo_1 = 4.3;
10 Vc = 25-0.7;
11 //between t2→t3
12 Rth = 0;
13 Eth = 4.3;
14 vo_2 =34.3;
15 tau = R*C;
16 discharge_time = 5*tau;
17 //between t3→t4
18 vo_3 = 5;
19
20 disp(vo_1, 'output voltage during t1→t2 : ');
21 disp(vo_2, 'output voltage during t2→t3 : ');
22 disp(vo_3, 'output voltage during t3→t4 : ');
23
24
25 t = 0:10(-6):2.5*10(-3);
26
27 for i= 1:length(t)
28     if(t(i)>=0 & t(i)<=0.5*10(-3))
29         y(i) = 0;
30     elseif(t(i)>=0.5*10(-3) & t(i)<=10(-3))
31         y(i) = 4.3;
32     elseif(t(i)>=10(-3) & t(i)<=1.5*10(-3))
33         y(i)=34.3;
34     elseif(t(i)>=1.5*10(-3) & t(i)<=2.0*10(-3))
35         y(i)=4.3;
36     elseif(t(i)>=2.0*10(-3) & t(i)<=2.5*10(-3))
37         y(i)=34.3;
38     end
39 end
40 a = gca();
41 a.thickness = 2;
42 plot2d(t,y);
43 a.x_label.text = 't';
44 a.y_label.text = 'Vo';

```

```

45 xset('thickness',2);
46 xstring(0.5*10(-3),0,'t1');
47 xstring(10(-3),0,'t2');
48 xstring(1.5*10(-3),0,'t3');
49 xstring(2*10(-3),0,'t4');
50 xstring(0,4.3,'4.3');
51 xstring(0,34.3,'34.3');

```

---

### Scilab code Exa 2.24 Voltages and Power calculation

```

1 clear; clc; close;
2
3 E = 40;
4 Vk = 0.7;
5 Vz1 = 6;
6 Vz2 = 3.3;
7 R = 1.3*10(3);
8
9 Vo1 = Vz2 + Vk;
10 Vled =Vo1;
11 Vo2 = Vo1 + Vz1;
12 Vr = E-Vo2-Vled;
13 Ir = Vr/R;
14 Iled = Ir;
15 Iz = Ir;
16 Ps = E*Ir;
17 Pled = Vled*Iled;
18 Pz = Vz1*Iz;
19
20 disp(Vo1,'Reference voltage 1 : ');
21 disp(Vo2,'Reference voltage 2 : ');
22 disp(Iled,'Level of current through led :');
23 disp(Ps,'Power supplied by circuit : ');
24 disp(Pled,'Power absorbed by led :');
25 disp(Pz,'Power absorbed by zener diode :');

```

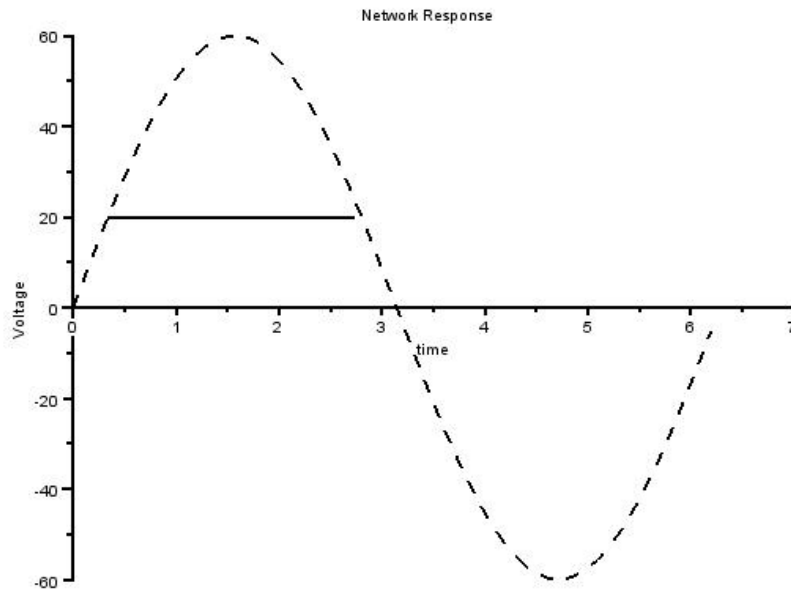


Figure 2.10: Sketch output waveform

---

#### Scilab code Exa 2.25 Sketch output waveform

```
1 clear; clc; close;
2
3
4 t = 0:0.1:2*%pi;
5 y = 60*sin(t);
6
7 a = gca();
8 a.line_style = 3;
```

```

 9 a.thickness = 2;
10 a.y_location = 'left';
11 a.x_location = 'middle';
12 a.x_label.text = 'time';
13 a.y_label.text = 'Voltage';
14 a.title.text = 'Network Response';
15 plot2d(t,y);
16
17
18 //a.grid = [1 1];
19
20 t1 = (asin(1/3)):0.1:(%pi-asin(1/3));
21
22 y1 = 20*(t1>=(asin(1/3)))
23
24 b = gca();
25 b.line_style = 1;
26 plot2d(t1,y1);

```

---

#### Scilab code Exa 2.26.a V1 Vr Iz Pz

```

1 //Implementation of example 2.26_a in chapter 2
2
3 clear; clc; close;
4
5 R1 = 1.2*10^(3);
6 R = 10^(3);
7 Vi = 16;
8 Vz = 10;
9
10 V = (R1*Vi)/(R+R1);
11 V1 = V;
12 Vr = Vi-V1;
13 Iz = 0;
14

```

```
15 Pz = Iz*Vz;
16
17 disp(Vl, 'Vl is : ');
18 disp(Vr, 'Vr is : ');
19 disp(Iz, 'IZ is : ');
20 disp(Pz, 'Pz is : ');
```

---

Scilab code Exa 2.26.b V1 Vr Iz Pz with different R1

```
1 clear; clc; close;
2
3 R1 = 3*10^(3);
4 R = 10^(3);
5 Vi = 16;
6 Vz = 10;
7
8 V = Vz;
9 Vl = V;
10 Vr = Vi-Vl;
11 I1 = Vl/R1;
12 Ir = Vr/R;
13 Iz = Ir - I1;
14
15
16 Pz = Iz*Vz;
17
18 disp(Vl, 'Vl is : ');
19 disp(Vr, 'Vr is : ');
20 disp(Iz, 'IZ is : ');
21 disp(Pz, 'Pz is : ');
```

---

Scilab code Exa 2.27 R1 I1 Range max power and zener increase

```

1
2 clear; clc; close;
3
4 R = 10^(3);
5 Vz = 10;
6 Vi = 50;
7 Izm = 32*10^(-3);
8 Pz = 380*10^(-3);
9
10 Rlmin = (R*Vz)/(Vi-Vz);
11 Vr = Vi-Vz;
12 Ir = Vr/R;
13 Ilmin = Ir - Izm;
14 Rlmax = Vz/Ilmin;
15 Pmax = Vz*Izm;
16 Izm_2 = Pz/Vz;
17 Ilmin_2 = Ir - Izm_2;
18
19 disp(Rlmin, 'Lowest value of R : ');
20 disp(Rlmax, 'Max value of R : ');
21 disp(Ilmin, 'Min value of I : ');
22 disp(Pmax, 'Maximum wattage rating of diode : ');
23 disp(Ilmin_2, 'New min value of I : ');

```

---

### Scilab code Exa 2.28 Range of Vi

```

1 clear; clc; close;
2
3 R1 = 1200;
4 R = 320;
5 Vz = 20;
6 Izm = 60*10^(-3);
7
8 Vimin = ((R1+R)*Vz)/(R1);
9 Il = Vz/R1;

```

```
10 Imax = Im+Il;  
11 Vmax = Imax*R + Vz;  
12 disp(Vmin, 'Min value of V :');  
13 disp(Vmax, 'Max value of V: ');
```

---



# Chapter 3

## Bipolar Junction Transistor

Scilab code Exa 3.1 Determining Collector current and Vbe

```
1 clear; clc; close;
2
3 //part a
4 Ie = 3*10^(-3);
5 Vcb = 10;
6 Ic = Ie;
7 disp(Ic, 'Ic (A): ');
8
9 //part b
10 Vcb = 2;
11 Ie = 3*10^(-3);
12 Ic = Ie;
13 disp(Ic, 'No effect of changing Vcb & Ic remains same
    , Ic(A) is : ');
14 //part c
15 Ic = 4*10^(-3);
16 Vcb = 20;
17 Ie = Ic;
18 Vbe = 0.74;
19 disp(Vbe, 'Vbe(volts) is : ');
20 //part d
```

```
21 Ic = 4*10(-3);
22 Ie = Ic;
23 Vbe = 0.7;
24 disp(Vbe, 'Vbe(volts) in this case is : ');
```

---

### Scilab code Exa 3.2 Determining Collector current

```
1 clear; clc; close;
2
3
4 //part a
5 Ib = 30*10(-6);
6 Vce = 7.5;
7 Ic = 3.3*10(-3);
8 disp(Ic, 'Ic(A) is : ');
9 //part b
10 Vce = 15;
11 Vbe = 0.7;
12 Ib = 20*10(-6);
13 Ic = 2.5*10(-3);
14 disp(Ic, 'Ic(A) ate the intersection of Ib & Vceis : '
    );
15 //part c
16 Ib = 4*10(-6);
17 Vce = 15;
18 Ic = 800*10(-6);
19 disp(Ic, 'Ic(A) in this case is : ');
```

---

# Chapter 4

## DC Biasing BJT

Scilab code Exa 4.1 Fixed Bias Network characteristics

```
1 clear; clc; close;
2
3 Vcc = 12;
4 Vbe = 0.7;
5 Vce = 4.23;
6 Rb = 240*10^(3);
7 Rc = 2.2*10^(3);
8 Beta = 75;
9 Ic = 3.53*10^(-3);
10
11 Ibq = (Vcc-Vbe)/Rb;
12 Icq = Beta*Ibq;
13 Vceq = Vcc-Ic*Rc;
14 Vb = Vbe;
15 Vc = Vce;
16 Vbc = Vb-Vc;
17
18 disp(Ibq, 'Ibq (Amperes) is :');
19 disp(Icq, 'Icq (Amperes) is :');
20 disp(Vceq, 'Vceq (volts) is :');
21 disp(Vb, 'Vb (volts) is :');
```

```
22 disp(Vc, 'Vc(volts) is :');
23 disp(Vbc, 'Vbc(volts) is :');
```

---

#### Scilab code Exa 4.2 Saturation level

```
1 clear; clc; close;
2
3 Vcc = 12;
4 Rc = 2.2*10^(3);
5
6 Icsat = Vcc/Rc;
7 disp(Icsat, 'saturation current(Amperes) for network
   is :');
```

---

#### Scilab code Exa 4.3 Vcc Rc and Rb for fixed bias config

```
1 clear; clc; close;
2
3 Vce = 16;
4 Ic = 10*10^(-3);
5 Vbe = 0.7;
6 Ib = 25*10^(-6);
7
8 Vcc = Vce;
9 Rc = Vcc/Ic;
10 Rb = (Vcc-Vbe)/Ib;
11
12 disp('At Q-point ')
13 disp(Vcc, 'Value of Vcc(Volts) is :');
14 disp(Rc, 'Value of Rc(ohms) is :');
15 disp(Rb, 'Value of Rb(ohms) is :');
```

---

#### Scilab code Exa 4.4 Emitter bias Network characteristics

```
1 clear; clc; close;
2
3 Vcc = 16;
4 Vbe = 0.7;
5 Rb = 430*10^(3);
6 Rc = 2*10^(3);
7 Re = 1*10^(3);
8 Beta = 75;
9
10
11 Ib = (Vcc-Vbe)/(Rb+(1+Beta)*Re);
12 Ic = Beta*Ib;
13 Vce = Vcc - Ic*(Rc+Re);
14 Vc = Vcc-Ic*Rc;
15 Ve = Vc - Vce;
16 Vb = Vbe + Ve;
17 Vbc = Vb - Vc;
18
19 disp(Ib, 'Ib (Amperes) is : ');
20 disp(Ic, 'Ic (Amperes) is : ');
21 disp(Vce, 'Vce (volts) is : ');
22 disp(Vc, 'Vc (Volts) is : ');
23 disp(Ve, 'Ve (volts) is : ');
24 disp(Vb, 'Vb (Volts) is : ');
25 disp(Vbc, 'Vbc (Volts) is : ');
```

---

#### Scilab code Exa 4.6 Saturation current

```
1 clear; clc; close;
2
```

```

3 Vcc = 16;
4 Rc = 2*10^(3);
5 Re = 1*10^(3);
6
7 Icsat = Vcc/(Rc+Re);
8
9 disp(Icsat, 'Saturation current (amperes) for the
   given network : ');

```

---

#### Scilab code Exa 4.7 Vce and Ic for voltage divider config

```

1 clear; clc; close;
2
3 R1 = 39*10^(3);
4 R2 = 3.9*10^(3);
5 Re = 1.5*10^(3);
6 Rc = 4*10^(3);
7 Vcc = 18;
8 Vbe = 0.7;
9 Beta = 140;
10
11 Rth = R1*R2/(R1+R2);
12 Eth = R2*Vcc/(R1+R2);
13 Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
14 Ic = Beta*Ib;
15 Vce = Vcc - Ic*(Rc+Re);
16
17 disp(Ic, 'Collector current (Amperes) in :');
18 disp(Vce, 'Vce (Volts) is : ');
19 disp('Value of Vce differs because wrong value of
   Vcc is used in the book');

```

---

#### Scilab code Exa 4.8 Icq and Vcq calculation

```

1 clear; clc; close;
2
3 R1 = 39*10^(3);
4 R2 = 3.9*10^(3);
5 Re = 1.5*10^(3);
6 Rc = 4*10^(3);
7 Vcc = 18;
8 Vbe = 0.7;
9 Beta = 140;
10 Ic = 0.63*10^(-3);
11
12 disp('Since the approximate technique can be applied
      ,hence ');
13 Eth = R2*Vcc/(R1+R2);
14 Vb = Eth;
15 Ve = Vb - Vbe;
16 Icq = Ve/Re;
17 Vceq = Vcc - Ic*(Rc+Re);
18
19 disp(Icq, 'Value of Icq (Amperes) is : ');
20 disp(Vceq, 'Value of Vceq (Volts) : ');

```

---

#### Scilab code Exa 4.9 Icq and Vceq calculation

```

1 clear; clc; close;
2
3 R1 = 39*10^(3);
4 R2 = 3.9*10^(3);
5 Re = 1.5*10^(3);
6 Rc = 4*10^(3);
7 Vcc = 18;
8 Vbe = 0.7;
9 Beta = 70;
10
11 Rth = R1*R2/(R1+R2);

```

```

12 Eth = R2*Vcc/(R1+R2);
13 Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
14 Icq = Beta*Ib;
15 Vceq = Vcc - Icq*(Rc+Re);
16 disp(Icq, 'Collector current (Amperes) in : ');
17 disp(Vceq, 'Vce (Volts) is : ');

```

---

Scilab code Exa 4.10 Icq and Vceq calculation for voltage divider

```

1 clear; clc; close;
2
3 R1 = 82*10^(3);
4 R2 = 22*10^(3);
5 Re = 1.2*10^(3);
6 Rc = 5.6*10^(3);
7 Vcc = 18;
8 Vbe = 0.7;
9 Beta = 50;
10
11 Rth = R1*R2/(R1+R2);
12 Eth = R2*Vcc/(R1+R2);
13 Ib = (Eth - Vbe)/(Rth + (Beta+1)*Re);
14 Icq = Beta*Ib;
15 Vceq = Vcc - Icq*(Rc+Re);
16 disp(Icq, 'Collector current (Amperes) in : ');
17 disp(Vceq, 'Vce (Volts) is : ');
18
19 //approximate analysis
20 Eth = R2*Vcc/(R1+R2);
21 Vb = Eth;
22 Ve = Vb - Vbe;
23 Icq = Ve/Re;
24 Vceq = Vcc - Icq*(Rc+Re);
25 disp('For approximate analysis : ');
26 disp(Icq, 'Value of Icq (Amperes) is : ');

```



```
27 disp(Vceq, 'Value of Vceq(Volts) : ');
```

---

#### Scilab code Exa 4.11 Ic<sub>q</sub> and Vce<sub>q</sub> calculation

```
1 clear; clc; close;
2
3 Re = 1.2*10^(3);
4 Rc = 4.7*10^(3);
5 Rb = 250*10^(3);
6 Vcc = 10;
7 Vbe = 0.7;
8 Beta = 90;
9
10 Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
11 Icq = Beta*Ib;
12 Vceq = Vcc - Icq*(Rc+Re);
13 disp(Icq, 'Value of Icq(Amperes) is : ');
14 disp(Vceq, 'Value of Vceq(Volts) : ');
```

---

#### Scilab code Exa 4.12 Ic<sub>q</sub> and Vce<sub>q</sub> calculation for a different beta

```
1 clear; clc; close;
2
3 Re = 1.2*10^(3);
4 Rc = 4.7*10^(3);
5 Rb = 250*10^(3);
6 Vcc = 10;
7 Vbe = 0.7;
8 Beta = 135;
9
10 Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
11 Icq = Beta*Ib;
12 Vceq = Vcc - Icq*(Rc+Re);
```

```
13 disp(Icq, 'Value of Icq(Amperes) is : ');
14 disp(Vceq, 'Value of Vceq(Volts) : ');
```

---

#### Scilab code Exa 4.13 Ib and Vc calculation

```
1 clear; clc; close;
2
3 Re = 0.51*10^(3);
4 Rc = 3.3*10^(3);
5 Rb = (91+110)*10^(3);
6 Vcc = 18;
7 Vbe = 0.7;
8 Beta = 75;
9
10 Ib = (Vcc - Vbe)/(Rb + (Beta)*(Re+Rc));
11 Ic = Beta*Ib;
12 Vc = Vcc - Ic*(Rc);
13 disp(Ic, 'Value of Icq(Amperes) is : ');
14 disp(Vc, 'Value of Vceq(Volts) : ');
```

---

#### Scilab code Exa 4.14 Network characteristics determination

```
1 clear; clc; close;
2
3 Re = 0;
4 Rc = 4.7*10^(3);
5 Rb = 680*10^(3);
6 Vcc = 20;
7 Vbe = 0.7;
8 Beta = 120;
9
10 Ib = (Vcc - Vbe)/(Rb + (Beta)*(Rc));
11 Icq = Beta*Ib;
```

```

12 Vceq = Vcc - Icq*(Rc);
13 Vb = Vbe;
14 Vc = Vceq;
15 Ve = 0;
16 Vbc = Vb-Vc;
17 disp(Icq, 'Value of Icq(Amperes) is : ');
18 disp(Vceq, 'Value of Vceq(Volts) : ');
19 disp(Vc, 'Vc(volts) is : ');
20 disp(Vb, 'Vb(volts) is : ');
21 disp(Ve, 'Ve(volts) is : ');
22 disp(Vbc, 'Vbc(volts) is : ');

```

---

#### Scilab code Exa 4.15 Vc and Vb calculcation

```

1 clear; clc; close;
2
3 Re = 0;
4 Rc = 1.2*10^(3);
5 Rb = 100*10^(3);
6 Vee = 9;
7 Vbe = 0.7;
8 Beta = 45;
9
10 Ib = (Vee-Vbe)/Rb;
11 Ic = Beta*Ib;
12 Vc = -Ic*Rc;
13 Vb = -Ib*Rb;
14 disp(Vc, 'Vc(Volts) is : ');
15 disp(Vb, 'Vb(Volts) is : ');

```

---

#### Scilab code Exa 4.16 Vceq and Ie

```

1 clear; clc; close;

```

```

2
3 Re = 2*10^(3);
4 Rb = 240*10^(3);
5 Vee = 20;
6 Vbe = 0.7;
7 Beta = 90;
8
9 Ib = (Vee-Vbe)/(Rb+(Beta+1)*Re);
10 Ic = Beta*Ib;
11 Ie = (Beta+1)*Ib;
12 Vceq = Vee - (Beta+1)*Ib*Re;
13 disp(Vceq, 'Vceq(Volts) is :');
14 disp(Ie, 'Ie(amperes) is :');

```

---

Scilab code Exa 4.17 Vcb and Ib for common base config

```

1 clear; clc; close;
2
3 Re = 1.2*10^(3);
4 Rc = 2.4*10^(3);
5 Rb = 240*10^(3);
6 Vee = 4;
7 Vcc = 10;
8 Vbe = 0.7;
9 Beta = 60;
10
11 Ie = (Vee-Vbe)/Re;
12 Ic = Ie;
13 Vcb = Vcc-Ic*Rc;
14 Ib = Ic/Beta;
15 disp(Vcb, 'Vcb(Volts) is : ');
16 disp(Ib, 'Ib(amperes) is : ');

```

---

### Scilab code Exa 4.18 Vc and Vb calculation

```
1 clear; clc; close;
2
3 Re = 1.8*10^(3);
4 Rc = 2.7*10^(3);
5 R1 = 8.2*10^(3);
6 R2 = 2.2*10^(3);
7 Vee = 20;
8 Vcc = 20;
9 Vbe = 0.7;
10 Beta = 120;
11
12 Rth = R1*R2/(R1+R2);
13 I = (Vcc+Vee)/(R1+R2);
14 Eth = I*R2 - Vee;
15 Ib = (Vee-Eth-Vbe)/(Rth+(Beta+1)*Re);
16 Ib = 35.39*10^(-6);
17 Ic = Beta*Ib;
18 Vc = Vcc - Ic*Rc;
19 Vb = Eth+Ib*Rth;
20 disp(Vc, 'Vc(volts) is :');
21 disp(Vb, 'Vb(Volts) is :');
```

---

### Scilab code Exa 4.19 Vcc Rc and Rb for fixed bias config

```
1 clear; clc; close;
2
3 Vcc = 20;
4 Ic = 8*10^(-3);
5 Vbe = 0.7;
6 Ib = 40*10^(-6);
7
8 Rc = Vcc/Ic;
9 Rb = (Vcc-Vbe)/Ib;
```

```
10
11 disp(Rc, 'Rc(ohms) is : ');
12 disp(Rb, 'Rb(ohms) is : ');
```

---

#### Scilab code Exa 4.20 R1 and Rc

```
1 clear; clc; close;
2
3 Re = 1.2*10^(3);
4 R2 = 18*10^(3);
5 Vcc = 18;
6 Vce = 10;
7 Vbe = 0.7;
8 Ve = 2.4
9 Ic = 2*10^(-3);
10
11 Ve = Ic*Re;
12 Vb = Vbe+Ve;
13 R1 = (R2*Vcc/Vb) - R2;
14 Vc = Vce+Ve;
15 Rc = (Vcc-Vc)/Ic;
16 disp(R1, 'R1(ohms) is : ');
17 disp(Rc, 'Rc(ohms) is : ');
```

---

#### Scilab code Exa 4.21 Rc Re and Rb

```
1 clear; clc; close;
2
3 Icq = 4*10^(-3);
4 Vcc = 28;
5 Vc = 18;
6 Vbe = 0.7;
7 Ve = 2.4;
```

```

8 Beta = 110;
9 Icsat = 8*10(-3);
10
11 Rc = (Vcc-Vc)/Icq;
12 Re = (Vcc/Icsat)-Rc;
13 Ibq = Icq/Beta;
14 Rb = ((Vcc-Vbe)/Ibq) - (Beta+1)*Re;
15
16 disp(Rc, 'Rc(ohms) is : ');
17 disp(Re, 'Re(ohms) is : ');
18 disp(Rb, 'Rb(ohms) is : ');

```

---

**Scilab code Exa 4.22** Resistor values for the netowrk

```

1 clear; clc; close;
2
3 Vcc = 20;
4 Vc = 18;
5 Vce = 10;
6 Vbe = 0.7;
7 Beta = 150;
8 Ic = 2*10(-3);
9 Ie = Ic;
10
11 Ve = 0.1*Vcc;
12 Re = Ve/Ie;
13 Rc = (Vcc-Vce-Ve)/Ic;
14 Ib = Ic/Beta;
15 Rb = (Vcc-Vbe-Ve)/Ib;
16
17 disp(Re, 'Value of Re(ohms) is : ');
18 disp(Rc, 'Value of Rc(ohms) is : ');
19 disp(Rb, 'Value of Rb(ohms) is : ');

```

---

### Scilab code Exa 4.23 Rc Re R1 and R2

```
1 clear; clc; close;
2
3 Vcc = 20;
4 Vc = 18;
5 Vce = 8;
6 Vbe = 0.7;
7 Beta = 150;
8 Ic = 10*10(-3);
9 Ie = Ic;
10 R2 = 1.6*10(3);
11 Ve = 0.1*Vcc;
12 Re = Ve/Ie;
13 Rc = (Vcc-Vce-Ve)/Ic;
14
15 Vb = Vbe + Ve;
16 R1 = R2*Vcc/Vb - R2;
17
18 disp(Re, 'Value of Re(ohms) is : ');
19 disp(Rc, 'Value of Rc(ohms) is : ');
20 disp(R1, 'Value of R1(ohms) is : ');
```

---

### Scilab code Exa 4.24 Rb and Rc

```
1 clear; clc; close;
2
3 Vcc = 10;
4 Vbe = 0.7;
5 Beta_dc = 250;
6 Icsat = 10*10(-3);
7
```



```

8 Rc = Vcc/Icsat;
9 Ib_min = Icsat/Beta_dc;
10 Rb = (Vcc-Vbe)/Ib_min;
11 //if we take standard Rb value then
12 Rb = 150*10^(3);
13 Ib = (Vcc-Vbe)/Rb;
14
15 disp(Rc, 'value of Rc(ohms) is : ');
16 disp(Rb, 'value of Rb(ohms) is : ');

```

---

**Scilab code Exa 4.25** Determine proper operation of network

```

1 clear; clc; close;
2
3 Vcc = 20;
4 Vbe = 0.7;
5 Beta = 100;
6 Rb = 250*10^(3);
7 Re = 2*10^(3);
8 Vrb = 19.85;
9 Ic = 0;
10
11 Irb = Vcc/(Rb+Re);
12 Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
13
14 disp(Irb, 'The base current(amperes) obtained is : ')
15 ;
16 disp(Ib, 'Ideally Ib(Ampere) should be : ');
17 disp('Hence the transistor is in a damaged state, ');
18 disp('with short-circuit between base and emitter. ');
19 ;

```

---

**Scilab code Exa 4.26** Determine proper operation of network

```

1 clear; clc; close;
2
3 Vcc = 20;
4 Vb = 4;
5 Ve = 3.3;
6 Ic = 0;
7 disp('Drop across transistor is : ');
8 disp('This suggests that transistor is in on state.'
      ,Vb-Ve);
9 disp('Ic is : ')
10 disp('This suggest 2 things.',Ic)
11 disp('Either there is poor connection between Rc &
      terminal');
12 disp('or the transistor has an open base-to-
      collector junction.');
```

---

#### Scilab code Exa 4.27 Vce for voltage divider config

```

1 clear; clc; close;
2
3 Vcc = -18;
4 Vbe = -0.7;
5 Beta = 100;
6 R1 = 47*10^(3);
7 R2 = 10*10^(3);
8 Re = 1.1*10^(3);
9 Rc = 2.4*10^(3);
10
11 Vb = R2*Vcc/(R1+R2);
12 Ve = Vb-Vbe;
13 Ie = abs(Ve)/Re;
14 Ic = Ie;
15 Vce = Vcc+Ic*(Rc+Re);
16 disp(Vce, 'Vce(volts) is : ');
```

---

Scilab code Exa 4.28 Stability factor and change in  $I_c$

```
1 clear; clc; close;
2
3 Beta = 50;
4 //denoting Rb/Re by x, we have
5 //for part a
6 x = 250;
7 ico = 19.9*10(-9);
8 s = (1+Beta)*((1+x)/(Beta+1+x));
9 delta_ic = s*ico;
10 disp(s,'stability factor for part a is :');
11 disp(delta_ic,'change in Ic(amperes) is : ');
12
13 //for part b
14 x = 10;
15 s = (1+Beta)*((1+x)/(Beta+1+x));
16 delta_ic = s*ico;
17 disp(s,'stability factor for part b is :');
18 disp(delta_ic,'change in Ic(amperes) is : ');
19
20 //for part c
21 x = 0.01;
22 s = (1+Beta)*((1+x)/(Beta+1+x));
23 delta_ic = s*ico;
24 disp(s,'stability factor for part c is :');
25 disp(delta_ic,'change in Ic(amperes) is : ');
```

---

Scilab code Exa 4.29 Stability factor and change in  $I_c$

```
1 clear; clc; close;
2
```

```

3 //for part a
4 beta = 100;
5 delta_vbe = -0.17;
6 Rb = 240*10^(3);
7
8 s = -beta/Rb;
9 delta_ic = delta_vbe*s;
10 disp(s,'Stability factor for part a is : ');
11 disp(delta_ic,'change in Ic(amperes) for part a is :
    ');
12
13 //for part b
14 Rb = 240*10^(3);
15 Re = 1*10^(3);
16 s = -beta/(Rb+(beta+1)*Re);
17 delta_ic = delta_vbe*s;
18 disp(s,'Stability factor for part b is : ');
19 disp(delta_ic,'change in Ic(amperes) for part b is :
    ');
20
21 //for part c
22 Rb = 47*10^(3);
23 Re = 4.7*10^(3);
24 s = -1/Re;
25 delta_ic = delta_vbe*s;
26 disp(s,'Stability factor for part c is : ');
27 disp(delta_ic,'change in Ic(amperes) for part c is :
    ');

```

---

#### Scilab code Exa 4.30 Determine $I_{cQ}$

```

1 clear; clc; close;
2
3 //lets say Rb/Re = x, then we have
4 x = 20;

```

```
5 Ic1 = 2*10^(-3);
6 beta1=50;
7 beta2=80;
8
9 s = (Ic1*(1+x))/(beta1*(1+beta2+x));
10 delta_ic = s*(beta2-beta1);
11
12 disp(delta_ic,'change in the level of Ic(amperes) is
    : ')
```

---

# Chapter 5

## BJT AC Analysis

Scilab code Exa 5.1 Common base config characteristics

```
1 clear; clc; close;
2
3 Vt=26*(10^(-3)); //thermal voltage=26mV
4 Vi=3*(10^(-3));
5 Ie=4*(10^(-3));; //emitter current=4mV
6 alpha=0.991; //common base amplification factor
7 Rl=610; //Load Resistance(in ohms)
8
9 //Part-1 -> Determining input impedance
10 re = Vt/Ie;
11 disp(re, 'Input impedance(ohms) :');
12
13 //Part-2 -> Calculating the voltage gain
14 Ii = (Vi/re);
15 Ie = Ii;
16 Ic=alpha*Ie;
17 Vo=Ic*Rl;
18 Av = Vo/Vi;
19 disp(Av, "Voltage gain :");
20
21 //Part-3 -> Calculating the output impedance and
```

```

    current gain
22 disp(%inf,"The output impedance(ohms) is :");
23 Ai = -Ic/Ie;
24 disp(Ai,"Current gain is :");

```

---

#### Scilab code Exa 5.2 Zi Av and Ai for common emitter

```

1 clear; clc; close;
2
3 Vt=26*(10^(-3)); //thermal voltage
4 Ie=3.2*(10^(-3)); //emitter current
5 Beta=150; //Common Emitter amplification
   factor
6 Rl = 2*(10^(3)); //Load Resistance
7
8 re = Vt/Ie;
9 Zi = Beta*re;
10 disp(Zi,"Input Impedance(ohms) is : ");
11
12 Av = -(Rl/re);
13 disp(Av,"Voltage gain is :");
14
15 Ai = Beta;
16 disp(Ai,"Current gain is :");

```

---

#### Scilab code Exa 5.3 Common emitter hybrid and common base model

```

1 clear; clc; close;
2
3 Vt=26*(10^(-3)); //thermal voltage
4 Ie=3.2*(10^(-3)); //emitter current
5 Beta = 150; //Common Emitter amplification factor
6 h_oe = 25*(10^(-6));

```

```

7 h_ob =0.5*(10^(-6));
8
9 re = Vt/Ie;
10 h_ie = Beta*re;
11 r_o = 1/h_oe;
12 disp("For the common emitter hybrid equivalent
      circuit :-")
13 disp(re, 're(ohms) =');
14 disp(h_ie,"hie(ohms) = ");
15 disp(r_o,"hoe(ohms) = ");
16
17 r_o = 1/h_ob;
18 alpha = 1; //approximation
19 disp("For the common base re model :-")
20 disp(re, 're(ohms) =');
21 disp(alpha,"alpha = ");
22 disp(r_o,"ro(ohms) = ");

```

---

#### Scilab code Exa 5.4 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 15;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Rb = 470*(10^(3));
7 Rc = 4.7*(10^(3));
8 ro = 50*(10^(3));
9 Beta = 100;
10
11
12 Ib = (Vcc-Vbe)/Rb;
13 Ie = (Beta+1)*Ib;
14 re = Vt/Ie;
15 disp(re,"Value of diode resistive element is :")

```



```

16
17 Zb = Beta*re;    //resistance seen from base into
    the diode
18 Zi = (Rb*Zb)/(Rb+Zb);
19 disp(Zi,"Input impedance(ohms) :");
20
21 disp("At ro = infinity values are :-");
22 Zo = Rc;
23 disp(Zo,"Output impedance(ohms) :");
24
25 Av = -Rc/re;
26 disp(Av,"Voltage gain :");
27
28 disp("At ro = 50kohm, values are :-");
29 Zo_2 = (ro*Rc)/(ro+Rc);
30 disp(Zo_2,"Input impedance(ohms) :");
31
32 Av_2 = -((ro*Rc)/(ro+Rc))/re;
33 disp(Av_2,"Voltage gain :");

```

---

### Scilab code Exa 5.5 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 22;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 R1 = 56*(10^(3));
7 R2 = 8.2*(10^(3));
8 Re = 1.5*(10^(3));
9 Rc = 6.8*(10^(3));
10 ro = 50*(10^(3));
11 Beta = 90;
12
13

```

```

14 Vb = (R2/(R1+R2))*Vcc;
15 Ve = Vb - Vbe;
16 Ie = Ve/Re;
17 re = Vt/Ie;
18 disp(re,"Value of diode resistive element is :");
19
20 disp("At ro=infinity ,the values are :-");
21 Rx = (R1*R2)/(R1+R2);
22 Zb = Beta*re;
23 Zi = (Rx*Zb)/(Rx+Zb);
24 disp(Zi,"Input Impedance(ohms) :");
25
26 Zo = Rc;
27 disp(Zo,"Output Impedance(ohms) :");
28
29 Av = -Rc/re;
30 disp(Av,"Voltage gain :");
31
32 disp("At ro=1/hoe,the values are :-")
33 disp(Zi,"Input Impedance(ohms) :");
34 Zo_2 = (Rc*ro)/(Rc+ro);
35 disp(Zo_2,"Output Impedance(ohms) :");
36 Av_2 = -((ro*Rc)/(ro+Rc))/re;
37 disp(Av_2,"Voltage gain :");

```

---

#### Scilab code Exa 5.6 Network characteristics without Ce

```

1 clear; clc; close;
2
3 Vcc = 20;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Re = 0.56*(10^(3));
7 Rc = 2.2*(10^(3));
8 Rb = 470*(10^(3));

```

```

9 ro = 40*(10^(3));
10 Beta = 120;
11
12 Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
13 Ie = (Beta+1)*Ib;
14 re = Vt/Ie;
15 disp(re,"Value of diode resistive element is :");
16
17 Zb = Beta*(re+Re);
18 Zi = (Rb*Zb)/(Rb+Zb);
19 disp(Zi,"Input Impedance(ohms) :");
20
21 Zo = Rc;
22 disp(Zo,"Output Impedance(ohms) :");
23
24 Av = -Beta*Rc/Zb;
25 disp(Av,"Voltage gain :");

```

---

#### Scilab code Exa 5.7 Network characteristics with Ce

```

1 clear; clc; close;
2
3 Vcc = 20;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Re = 0.56*(10^(3));
7 Rc = 2.2*(10^(3));
8 Rb = 470*(10^(3));
9 ro = 40*(10^(3));
10 Beta = 120;
11
12 Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
13 Ie = (Beta+1)*Ib;
14 re = Vt/Ie;
15 disp(re,"Value of diode resistive element is (in

```

```

        ohms) :");
16
17 Zb = Beta*re;
18 Zi = (Rb*Zb)/(Rb+Zb);
19 disp(Zi,"Input Impedance(ohms) :");
20
21 Zo = Rc;
22 disp(Zo,"Output Impedance(ohms) :");
23
24 Av = -Rc/re;
25 disp(Av,"Voltage gain :");

```

---

#### Scilab code Exa 5.8 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 16;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 R1 = 90*(10^(3));
7 R2 = 10*(10^(3));
8 Re = 0.68*(10^(3));
9 Rc = 2.2*(10^(3));
10 ro = 50*(10^(3));
11 Beta = 210;
12
13 Vb = (R2/(R1+R2))*Vcc;
14 Ve = Vb - Vbe;
15 Ie = Ve/Re;
16 re = Vt/Ie;
17 disp(re,"Value of diode resistive element is(in ohms
    ) :");
18
19 Rb = (R1*R2)/(R1+R2);
20 Zb = Beta*Re;

```

```

21 Zi = (Rb*Zb)/(Rb+Zb);
22 disp(Zi,"Input Impedance(ohms) :");
23
24 Zo = Rc;
25 disp(Zo,"Output Impedance(ohms) :");
26
27 Av = -Rc/Re;
28 disp(Av,"Voltage gain :");

```

---

### Scilab code Exa 5.9 Network characteristics determination with Ce

```

1 clear; clc; close;
2
3 Vcc = 16;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 R1 = 90*(10^(3));
7 R2 = 10*(10^(3));
8 Re = 0.68*(10^(3));
9 Rc = 2.2*(10^(3));
10 ro = 50*(10^(3));
11 Beta = 210;
12
13 Vb = (R2/(R1+R2))*Vcc;
14 Ve = Vb - Vbe;
15 Ie = Ve/Re;
16 re = Vt/Ie;
17 disp(re,"Value of diode resistive element is(in ohms
   ) :");
18
19 Rb = (R1*R2)/(R1+R2);
20 Zb = Beta*re;
21 Zi = (Rb*Zb)/(Rb+Zb);
22 disp(Zi,"Input Impedance(ohms) :");
23

```

```

24 Zo = Rc;
25 disp(Zo," Output Impedance(ohms) :");
26
27 Av = -Rc/re;
28 disp(Av," Voltage gain :");

```

---

### Scilab code Exa 5.10 Emitter follower Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 12;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Re = 3.3*(10^(3));
7 Rb = 220*(10^(3));
8 ro = %inf;
9 Beta = 100;
10
11 disp("For ro=infinity the values are:-");
12 Ib = (Vcc-Vbe)/(Rb+(Beta+1)*Re);
13 Ie = (Beta+1)*Ib;
14 re = Vt/Ie;
15 disp(re," Value of diode resistive element is(in ohms
    ) :");
16
17 Zb = (Beta*re) + ((Beta+1)*Re);
18 Zi = (Rb*Zb)/(Rb+Zb);
19 disp(Zi," Input Impedance(ohms) :");
20
21 Zo = (Re*re)/(Re+re);
22 disp(Zo," Output Impedance(ohms) :");
23
24 Av = Re/(Re+re);
25 disp(Av," Voltage gain :");
26

```

```

27 disp("For ro=25kohm the values are :-")
28 ro_2 = 25*(10^(3));
29
30 Zb_2 = (Beta*re) + ((Beta+1)*Re)/(1+(Re/ro_2));
31 Zi_2 = (Rb*Zb_2)/(Rb+Zb_2);
32 disp(Zi_2,"Input Impedance(ohms) :");
33
34 Zo_2 = (Re*re)/(Re+re);
35 disp(Zo_2,"Output Impedance(ohms) :");
36
37 Av_2 = (((Beta+1)*Re)/Zb_2)/(1+(Re/ro_2));
38 disp(Av_2,"Voltage gain :");

```

---

#### Scilab code Exa 5.11 Network characteristics determination

```

1 clear; clc; close;
2
3 Vee = 2;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Re = 1*(10^(3));
7 Rc = 5*(10^(3));
8 ro = 1*(10^(6));
9 alpha = 0.98;
10
11 Ie = (Vee-Vbe)/Re;
12 re = Vt/Ie;
13 disp(re,"Value of diode resistive element(re) :");
14
15 Zi = (Re*re)/(Re+re);
16 disp(Zi,"Input Impedance(Zi) :");
17
18 Zo = Rc;
19 disp(Zo,"Output Impedance(Zo) :");
20

```

```

21 Av = Rc/re;
22 disp(Av," Voltage gain (Av) :");
23
24 Ai = -alpha;
25 disp(Ai," Current gain (Ai) :");

```

---

### Scilab code Exa 5.12 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 9;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Rf = 180*(10^(3));
7 Rc = 2.7*(10^(3));
8 Beta = 200;
9 ro = %inf;
10
11 disp(" Values at ro=infinity are :-");
12 Ib = (Vcc-Vbe)/(Rf+(Beta*Rc));
13 Ie = (Beta+1)*Ib;
14 re = Vt/Ie;
15 disp(re," Value of diode resistive element (re) :");
16
17 Zi = re/((1/Beta)+(Rc/Rf));
18 disp(Zi," Input Impedance (Zi) :");
19
20 Zo = (Rc*Rf)/(Rc+Rf);
21 disp(Zo," Output Impedance (Zo) :");
22
23 Av = -Rc/re;
24 disp(Av," Voltage gain (Av) :");
25 disp(" Values at ro=25kohm are :- ");
26 ro_2 = 20*(10^(3));
27

```



```

28 Zi_2 = (1+((Rc*ro_2)/(Rc+ro_2))/Rf)/((1/(Beta*re))
          +(1/Rf)+((Rc*ro_2)/(Rc+ro_2))/(Rf*re));
29 disp(Zi_2,"Input Impedance(Zi) :");
30
31 Zo_2 = (ro_2*Rc*Rf)/(ro_2*Rc+Rc*Rf+Rf*ro_2);
32 disp(Zo_2,"Output Impedance(Zo) :");
33
34 Av_2 = -[1/Rf + 1/re]*[ro_2*Rc/(ro_2+Rc)]/[1+[(ro_2*
          Rc)/(ro_2+Rc)]/Rf];
35 disp(Av_2,"Voltage gain(Av) :");

```

---

#### Scilab code Exa 5.13 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 12;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Rc = 3*(10^(3));
7 Rf1 = 120*(10^(3));
8 Rf2 = 68*(10^(3));
9 Rf = Rf1 + Rf2;
10 ro = 30*(10^(3));
11 Beta = 140;
12
13 Ib = (Vcc-Vbe)/(Rf+Beta*Rc);
14 Ie = (1+Beta)*Ib;
15 re = Vt/Ie;
16 disp(re,"Value of diode resistive element(re) :");
17
18 Zb = Beta*re;
19 Zi = (Rf1*Zb)/(Rf1+Zb);
20 disp(Zi,"Input Impedance(Zi) :");
21
22 Zo = (Rc*Rf2)/(Rc+Rf2);

```

```

23 disp(Zo," Output Impedance(Zo) :");
24
25 Av = -[(Rf2*Rc)/(Rf2+Rc)]/re;
26 disp(Av," Voltage gain(Av) :");

```

---

#### Scilab code Exa 5.14 Fixed Bias Network characteristics

```

1 clear; clc; close;
2
3 Vcc = 15;
4 Vbe = 0.7;
5 Vt = 26*(10^(-3));
6 Rb = 470*(10^(3));
7 Rc = 4.7*(10^(3));
8 Rl = 4.7*(10^(3));
9 Rs = 0.3*(10^(3));
10 ro = 50*(10^(3));
11 Beta = 100;
12
13
14 Ib = (Vcc-Vbe)/Rb;
15 Ie = (Beta+1)*Ib;
16 re = Vt/Ie;
17 disp(re," Value of diode resistive element(re) :")
18
19 Zb = Beta*re;
20 Zi_prev = (Rb*Zb)/(Rb+Zb);
21 disp(Zi_prev," Input Impedance(Zi) :");
22
23 Zo_prev = Rc;
24 disp(Zo_prev," Output Impedance(Zo) :");
25
26 Av_prev = -Rc/re;
27 disp(Av_prev," Voltage gain(Av) with no-load :");
28

```

```

29
30
31 Av = -[(Rc*Rl)/(Rc+Rl)]/re;
32 disp(Av," Voltage gain(Av) with 4.7kohm load :");
33
34 Avs = (Zi_prev/(Zi_prev+Rs))*Av;
35 disp(Avs," Voltage gain(Avs) from source to output
    with 4.7kohm load :");
36 disp(Av_prev," Voltage gain(Av) with no-load :");

```

---

#### Scilab code Exa 5.15 Av and Avs

```

1 clear; clc; close;
2
3 Rl = 4.7*(10^(3));
4 Rs = 0.3*(10^(3));
5 Ro = 4.7*(10^(3));
6 Zi = 846.1;
7 Zo = 4.7*(10^(3));
8 AvNL = -555.55; //gain under no-load condition
9
10 Av = {Rl/(Rl+Ro)}*AvNL;
11 disp(Av," Voltage gain(Av) with 4.7kohm load :");
12
13 Avs = (Zi/(Zi+Rs))*(Rl/(Rl+Ro))*AvNL;
14 disp(Avs," Voltage gain(Avs) from source to output
    with 4.7kohm load :");

```

---

#### Scilab code Exa 5.16 Network characteristics determination

```

1 clear; clc; close;
2
3 Zi = 4*(10^(3));

```

```

4 Zo = 2*(10^(3));
5 Rs = 0.2*(10^(3));
6 AvNL = -480;
7 disp(AvNL,"Voltage gain(Av) with no-load :")
8
9 Rl = 1.2*(10^(3));
10 Av = {Rl/(Rl+Zo)}*AvNL;
11 disp(Av,"Voltage gain(Av) with 1.2kohm load :");
12
13 Rl = 5.6*(10^(3));
14 Av = {Rl/(Rl+Zo)}*AvNL;
15 disp(Av,"Voltage gain(Av) with 5.6kohm load :");
16
17 Rl = 1.2*(10^(3));
18 Avs = {Zi/(Zi+Rs)}*{Rl/(Rl+Zo)}*AvNL;
19 disp(Avs,"Voltage gain(Avs) from source to output
    with 1.2kohm load :");
20
21 Rl = 5.6*(10^(3));
22 Ai = -Av*(Zi/Rl);
23 disp(Ai,"Current gain with 5.6kohm load :");

```

---

#### Scilab code Exa 5.17 Network characteristics determination

```

1 clear; clc; close;
2
3 Rs = 1*(10^(3));
4 Rl = 8.2*(10^(3));
5
6 Zi1 = 10*(10^(3));
7 Zo1 = 12;
8 AvNL1 = 1;
9 Vi1 = rand();
10
11 Zi2 = 26;

```

```

12 Zo2 = 5.1*(10^(3));
13 AvNL2 = 240;
14 Vi2 = rand();
15
16 Vo1 = (Zi2/(Zi2+Zo1))*AvNL1*Vi1;
17 Av1 = Vo1/Vi1;
18 disp(Av1," Voltage gain(Av1) for first stage :");
19
20 Vo2 = (R1/(R1+Zo2))*AvNL2*Vi2;
21 Av2 = Vo2/Vi2;
22 disp(Av2," Voltage gain(Av2) for second stage :");
23
24 Avt = Av1*Av2;
25 disp(Avt," Total Voltage gain(Avt) :");
26
27 Avs = {Zi1/(Zi1+Rs)}*Avt;
28 disp(Avs," Total Voltage gain(Avs) from source:");
29
30 Ait = -Avt*(Zi1/R1);
31 disp(Ait," Total current gain(Ai) :");
32
33 Vs = rand();
34 Vi = {Zi2/(Zi2+Rs)}*Vs;
35 Avs = (Vi/Vs)*Av2;
36 disp(Avs," Total gain if emitter-follower
configuration removed :");

```

---

#### Scilab code Exa 5.18 Network characteristics determination

```

1 clear; clc; close;
2
3 Vi = 25*(10^(-6));
4 Beta = 200;
5 R1 = 15*(10^(3));
6 R2 = 4.7*(10^(3));

```

```

7 Rc = 2.2*(10^(3));
8 Zo = Rc;
9 Re = 1*(10^(3));
10
11 Vb = 4.7;
12 Ve = 4;
13 Vc = 11;
14 Vt = 26*(10^(-3));
15 Ie = 4*(10^(-3));
16
17 re = Vt/Ie;
18 Zb = Beta*re;
19 Zi2 = (R1*R2*Zb)/(R1*R2 + R2*Zb + Zb*R1);
20 Av1 = -(Rc*Zi2)/(Rc+Zi2)/re;
21 AvNL2 = -Rc/re;
22 AvT_NL = Av1*AvNL2;
23 disp(AvT_NL,"No-load voltage gain(Avt(NL)) :");
24
25 Vo = AvT_NL*Vi;
26 disp(Vo,"Voltage gain(Vo) :");
27
28 Rl = 10*(10^(3));
29 Avt = {Rl/(Rl+Zo)}*AvT_NL;
30 disp(Avt,"Voltage gain(Avt) when 10kohm load applied
to stage 2:");
31
32 Zi1 = Zi2;
33 disp(Zi1,"input impedance of first stage(Zi1) :");
34
35 Zo2 = Rc;
36 disp(Zo2,"Output impedance of second stage(Vo2) :");

```

---

Scilab code Exa 5.19 No load voltage gain

```
1 clear; clc; close;
```

```

2
3 Vcc = 18;
4 Vt = 26*(10^(-3));
5 Beta = 200;
6
7 Vb1 = 4.9;
8 Vb2 = 10.8;
9 Ic1 = 3.8*(10^(-3));
10 Ic2 = 3.8*(10^(-3));
11 Ie = Ic1;
12 Re1 = 1.1*(10^(3));
13 Rc2 = 1.8*(10^(3));
14
15
16 re = Vt/Ie;
17 Rc1 = re;
18 Av1 = -Rc1/re;
19
20 Av2 = Rc2/re;
21 Avt = Av1*Av2;
22 disp(Avt,"no-load voltage gain(Avt) :");

```

---

### Scilab code Exa 5.20 Dc bias voltage and current

```

1 clear; clc; close;
2
3 Vcc = 18;
4 Vbe = 1.6;
5 Rb = 3.3*(10^(6));
6 Re = 390;
7 Beta = 8000;
8
9 Ib = (Vcc-Vbe)/(Rb+(Beta*Re));
10 disp(Ib,"Ib :");
11 Ie = (Beta+1)*Ib;

```

```
12 disp(Ie,"Ie :");
13 Ve = Ie*Re;
14 disp(Ve,"Ve :");
15 Vb = Ve+Vbe;
16 disp(Vb,"Vb :");
17 disp(Vcc,"Vc :");
```

---

#### Scilab code Exa 5.21 Input impedance

```
1 clear; clc; close;
2
3 ri = 5*(10^(3));
4 Rb = 3.3*(10^(6));
5 Beta = 8000;
6 Re = 390;
7
8 Zb = ri + (Beta*Re);
9 Zi = (Rb*Zb)/(Rb+Zb);
10 disp(Zi,"input impedance(Zi) :");
```

---

#### Scilab code Exa 5.22 Ac current gain

```
1 clear; clc; close;
2
3 Rb = 3.3*(10^(6));
4 Beta = 8000;
5 Re = 390;
6
7 Ai = (Beta*Rb)/(Rb+Beta*Re);
8 disp(Ai,"ac current gain(Ai) :");
```

---



### Scilab code Exa 5.23 Output impedance

```
1 clear; clc; close;
2
3 Beta = 8000;
4 Re = 390;
5 ri = 5*(10^(3));
6
7 x = ri/Beta;
8 Zo = (Re*ri*x)/(Re*ri+ri*x+x*Re);
9 disp(Zo,"output impedance(Zo) :");
```

---

### Scilab code Exa 5.24 Ac voltage gain

```
1 clear; clc; close;
2
3 Beta = 8000;
4 Re = 390;
5 ri = 5*(10^(3));
6
7 Av = (Re+(Beta*Re))/(ri+(Re+Beta*Re));
8 disp(Av,"ac voltage gain(Av) :");
```

---

### Scilab code Exa 5.25 Dc bias voltage and current

```
1 clear; clc; close;
2
3 Vcc = 18;
4 Veb1 = 0.7;
5 Rb = 2*(10^(6));
6 Rc = 75;
7 Beta1 = 140;
8 Beta2 = 180;
```

```

9
10 Ib1 = (Vcc-Veb1)/(Rb+(Beta1*Beta2*Rc));
11 Ic1 = Beta1*Ib1;
12 Ib2 = Ic1;
13 disp(Ib2," Ib :");
14 Ic2 = Beta2*Ib2;
15 disp(Ic2," Ic :");
16 Ie1 = Ic1-Ib1;
17 Ic = Ie1+Ic2;
18 disp(Ic," Ic (Total) :");
19 Vo_dc = Vcc-Ic*Rc;
20 disp(Vo_dc,"Dc voltage (Ouput) :");
21 Vi_dc = Vo_dc-Veb1;
22 disp(Vi_dc,"Dc voltage (Input) :");

```

---

#### Scilab code Exa 5.26 Ac circuit values of Zi Zo Ai Av

```

1 clear; clc; close;
2
3 Vcc = 18;
4 Veb1 = 0.7;
5 Rb = 2*(10^(6));
6 Rc = 75;
7 Beta1 = 140;
8 Beta2 = 180;
9 ri1 = 3*(10^(3));
10
11 Zb = ri1+(Beta1*Beta2*Rc);
12 Zi = (Rb*Zb)/(Rb+Zb);
13 disp(Zi,"Input impedance (Zi) :");
14
15 Ai = (Beta1*Beta2)*(Rb/(Rb+Zi));
16 disp(Ai,"Current gain (Ai) :");
17
18 Zo = ri1/(Beta1*Beta2);

```

```
19 disp(Zo," Output impedance(Zo) :");
20 Av = (Beta1*Beta2*Rc)/((Beta1*Beta2*Rc)+ri1);
21 disp(Av," volatge gain(Av) :");
```

---

#### Scilab code Exa 5.27 Mirrored Current

```
1 clear; clc; close;
2
3 Vcc = 12;
4 Vbe = 0.7;
5 Rx = 1.1*(10^(3));
6
7 Ix = (Vcc-Vbe)/Rx;
8 disp(Ix," Mirrored current :");
```

---

#### Scilab code Exa 5.28 Current through transistors

```
1 clear; clc; close;
2
3 Vcc = 6;
4 Vbe = 0.7;
5 Rx = 1.3*(10^(3));
6
7 Ix = (Vcc-Vbe)/Rx;
8 disp(Ix," Current through each transistor :");
```

---

#### Scilab code Exa 5.29 Constant current

```
1 clear; clc; close;
2
```

```

3 Vee = 20;
4 Vbe = 0.7;
5 R1 = 5.1*(10^(3));
6 R2 = R1;
7 Re = 2.2*(10^(3));
8
9 Vb = (R1/(R1+R2))*(-Vee);
10 Ve = Vb - Vbe;
11 Ie = (Ve-(-Vee))/Re;
12 disp(Ie,"Constant current :");

```

---

#### Scilab code Exa 5.30 Constant current

```

1 clear; clc; close;
2
3 Vee = 18;
4 Vz = 6.2;
5 Vbe = 0.7;
6 Re = 1.8*(10^(3));
7
8 I = (Vz-Vbe)/Re;
9 disp(I,"Constant current :");

```

---

#### Scilab code Exa 5.31 Network characteristics determination

```

1 clear; clc; close;
2
3 Vcc = 10;
4 Vbe = 0.7;
5 hfe = 120;
6 hie = 1.175*(10^(3));
7 hoe = 20*(10^(-6));
8 Rb = 470*(10^(3));

```

```

9 Rc = 2.7*(10^(3));
10
11 Zi = (Rb*hie)/(Rb+hie);
12 disp(Zi,"Input impedance(Zi) :");
13 ro = 1/hoe;
14 Zo = (ro*Rc)/(ro+Rc);
15 disp(Zo,"Output impedance(Zo) :");
16 Av = -hfe*Zo/hie;
17 disp(Av,"Voltage gain(Av) :");
18 Ai = hfe;
19 disp(Ai,"Current gain(Ai) :");

```

---

**Scilab code Exa 5.32** Network characteristics determination

```

1 clear; clc; close;
2
3 hfb = -0.99;
4 hib = 14.3;
5 hob = 0.5*(10^(-6));
6 Re = 2.2*(10^(3));
7 Rc = 3.3*(10^(3));
8
9 Zi = (Re*hib)/(Re+hib);
10 disp(Zi,"Input impedance(Zi) :");
11 ro=1/hob;
12 Zo = (ro*Rc)/(ro+Rc);
13 disp(Zo,"Output impedance(Zo) :");
14 Av = -hfb*Rc/hib;
15 disp(Av,"Voltage gain(Av) :");
16 Ai = hfb;
17 disp(Ai,"Current gain(Ai) :");

```

---

**Scilab code Exa 5.33** Determing parameters using hybrid equivalent model

```

1  clear; clc; close;
2
3  Vcc = 8;
4  hfe = 110;
5  hie = 1.6*(10^(3));
6  hoe = 20*(10^(-6));
7  hre = 2*(10^(-4));
8  Rl = 4.7*(10^(3));
9  Rc = 4.7*(10^(3));
10 Rb = 470*(10^(3));
11 Rs = 1*(10^(3));
12
13 Zi = hie - (hfe*hre*Rl)/(1+hoe*Rl);
14 disp(Zi,"Input impedance using hybrid equivalent :")
    ;
15 disp(hie,"Input impedance using approximate model :")
    )
16 Zi_b = (Rb*hie)/(Rb+hie);
17 disp(Zi_b,"Input impedance including Rb :");
18
19 Av = -hfe*Rl/(hie+(hie*hoe-hfe*hre)*Rl);
20 disp(Av,"Voltage gain using hybrid equivalent :");
21 Av_approx = -hfe*Rl/hie;
22 disp(Av_approx,"Voltage gain using approximate model
    :");
23
24 Ai = hfe/(1+hoe*Rl);
25 disp(Ai,"Current gain using hybrid equivalent :");
26 Ai_approx = hfe;
27 disp(Ai_approx,"Current gain using approximate model
    :");
28
29 Zo = 1/[hoe-(hfe*hre)/(hie+Rs)];
30 disp(Zo,"Output impedance using hybrid equivalent :")
    );
31 Zo_approx = 1/hoe;
32 disp(Zo_approx,"Output impedance using approximate
    model :");

```

```

33 Zo_rc = (Rc*Zo)/(Rc+Zo);
34 disp(Zo_rc,"Output impedance including Rc & using
    hybrid equivalent :");
35 Zo_rc_approx = Rc;
36 disp(Zo_rc_approx,"Output impedance including Rc &
    using approximate model :");

```

---

**Scilab code Exa 5.34** Determining parameters using hybrid equivalent model

```

1 clear; clc; close;
2
3 hfe = 110;
4 hie = 1.6*(10^(3));
5 hoe = 20*(10^(-6));
6 hre = 2*(10^(-4));
7 Rl = 2.2*(10^(3));
8 Rc = 2.2*(10^(3));
9 R1 = 3*(10^(3));
10 Rs = 1*(10^(3));
11 disp("Common base hybrid parameters are as follows :
    ")
12 hib = hie/(1+hfe);
13 disp(hib,"hib :");
14 hrb = (hie*hoe)/(1+hfe)-hre;
15 disp(hrb,"hrb :");
16 hfb = -hfe/(1+hfe);
17 disp(hfb,"hfb :");
18 hob = hoe/(1+hfe);
19 disp(hob,"hob :");
20
21 Zi = hib - (hfb*hrb*Rl)/(1+hob*Rl);
22 disp(Zi,"Input impedance using hybrid equivalent :")
    ;
23 disp(hib,"Input impedance using approximate model :")
    );

```

```

24 Zi_b = (R1*hib)/(R1+hib);
25 disp(Zi_b,"Input impedance including Rb :");
26
27 Ai = hfb/(1+hob*R1);
28 disp(Ai,"Current gain using hybrid equivalent :");
29 Ai_approx = hfb;
30 disp(Ai_approx,"Current gain using approximate model
      :");
31
32 Av = -hfb*R1/(hib+(hib*hob-hfb*hrb)*R1);
33 disp(Av,"Voltage gain using hybrid equivalent :");
34 Av_approx = -hfb*R1/hib;
35 disp(Av_approx,"Voltage gain using approximate model
      :");
36
37 Zo = 1/[hob-(hfb*hrb)/(hib+Rs)];
38 disp(Zo,"Output impedance using hybrid equivalent :");
39 Zo_approx = 1/hob;
40 disp(Zo_approx,"Output impedance using approximate
      model :");
41 Zo_rc = (Rc*Zo)/(Rc+Zo);
42 disp(Zo_rc,"Output impedance including Rc & using
      hybrid equivalent :");
43 Zo_rc_approx = Rc;
44 disp(Zo_rc_approx,"Output impedance including Rc &
      using approximate model :");

```

---



# Chapter 6

## Field Effect Transistor

Scilab code Exa 6.1 Sketching the transfer curve

```
1 clear; clc; close;
2
3 Idss = 12;
4 Vp = -4;
5 //point 1
6 Vgs1 = Vp/2;
7 Id1 = Idss/4;
8 //point 2
9 Id2 = Idss/2;
10 Vgs2 = 0.3*Vp;
11
12
13 x = [-4 -2 -1.2 0];
14 y = [0 3 6 12];
15 //plot2d(x,y);
16 yi=smooth([x;y],0.1);
17 a = gca();
18 a.thickness = 2;
19 a.y_location = 'right';
```

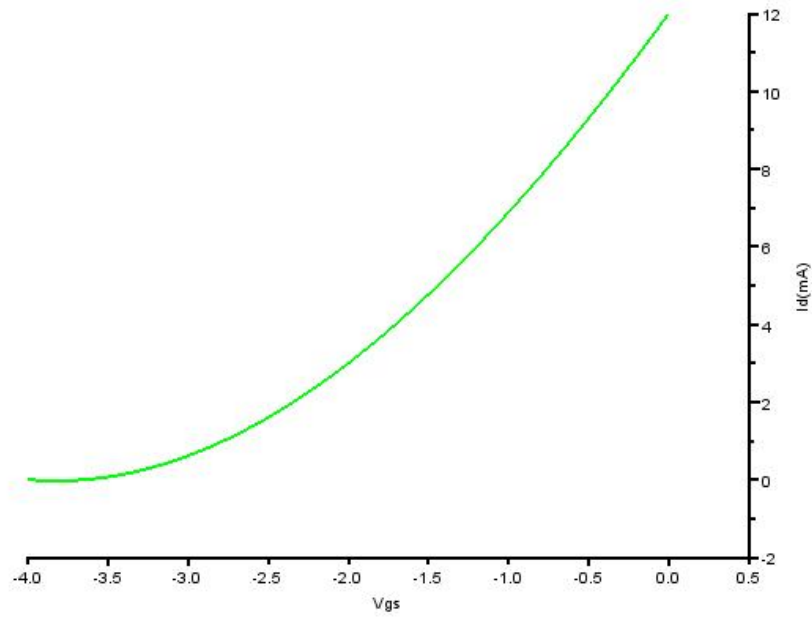


Figure 6.1: Sketching the transfer curve

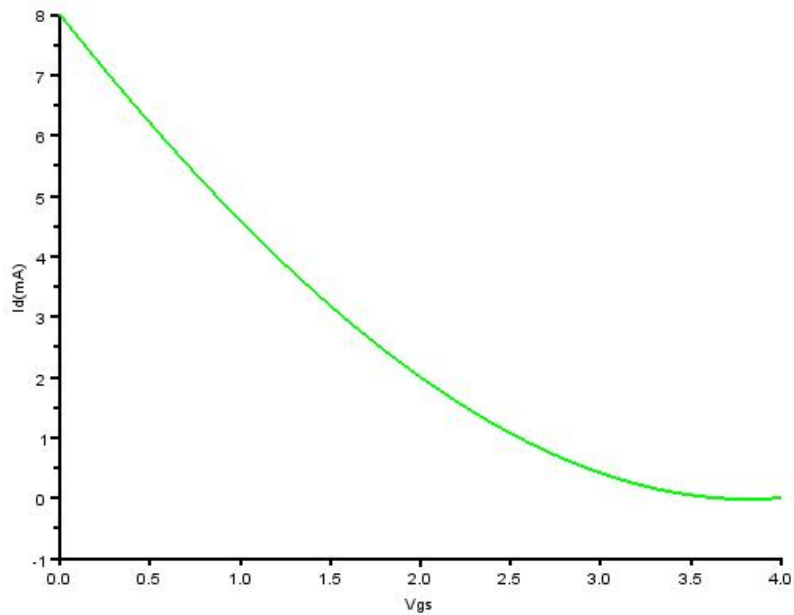


Figure 6.2: Sketching the transfer curve

```

20 a.x_label.text = 'Vgs';
21 a.y_label.text = 'Id (mA)';
22 plot2d(yi(1,:),yi(2,:),[3]);

```

---

#### Scilab code Exa 6.2 Sketching the transfer curve

```

1 clear; clc; close;
2
3 Idss = 8;
4 Vp = 4;
5 //point 1

```

```

6 Vgs1 = Vp/2;
7 Id1 = Idss/4;
8 //point 2
9 Id2 = Idss/2;
10 Vgs2 = 0.3*Vp;
11
12
13 x = [0 1.2 2 4];
14 y = [8 4 2 0];
15 yi=smooth([x;y],0.1);
16 a = gca();
17 a.thickness = 2;
18 a.y_location = 'left';
19 a.x_label.text = 'Vgs';
20 a.y_label.text = 'Id(mA)';
21 plot2d(yi(1,:),yi(2,:),[3]);

```

---

### Scilab code Exa 6.3 Sketching the transfer curve

```

1 clear; clc; close;
2
3 Idss = 10;
4 Vp = -4;
5 //point 1
6 Vgs1 = Vp/2;
7 Id1 = Idss/4;
8 //point 2
9 Id2 = Idss/2;
10 Vgs2 = 0.3*Vp;
11 Vgs3 = 1;
12 Id = Idss(1-Vgs3/Vp)^2;
13 x = [-4 -2 -1.2 1];
14 y = [0 2.5 5 15.63];
15
16 yi=smooth([x;y],0.1);

```

```

17 a = gca();
18 a.thickness = 2;
19 a.y_location = 'middle';
20 a.x_label.text = 'Vgs';
21 a.y_label.text = 'Id (mA)';
22 plot2d(yi(1,:),yi(2,:),[3]);

```

---

Scilab code Exa 6.4 Sketching the transfer curve and finding value of k

```

1 clear; clc; close;
2
3 Id_on = 3*10^(-3);
4 Vgs_on = 10;
5 Vgs_th = 3;
6 Vt = 3;
7
8 k = Id_on/(Vgs_on-Vgs_th)^2;
9 disp(k,'resulting value of k(A/V^2) is : ');
10
11 Vgs1 = 5;
12 Id1 = k*(Vgs1-Vt)^2;
13 Vgs2 = 8;
14 Id2 = k*(Vgs2-Vt)^2;
15 Vgs3 = 10;
16 Id3 = k*(Vgs3-Vt)^2;
17 Vgs4 = 12;
18 Id4 = k*(Vgs4-Vt)^2;
19 Vgs5 = 14;
20 Id5 = k*(Vgs5-Vt)^2;
21
22 x = [Vt Vgs1 Vgs2 Vgs3 Vgs4 Vgs5];
23 y = [0 Id1 Id2 Id3 Id4 Id5];
24 yi=smooth([x;y],0.1);
25 a = gca();
26 a.thickness = 2;

```

```
27 a.y_location = 'left';
28 a.x_label.text = 'Vgs';
29 a.y_label.text = 'Id(A)';
30 plot2d(yi(1,:),yi(2,:),[3]);
```

---

# Chapter 7

## FET Biasing

Scilab code Exa 7.1 Network characteristics determination

```
1 clear; clc; close;
2
3 Vgg = 2;
4 Idss = 10*10(-3);
5 Vp = -4;
6 Vdd = 16;
7 Rd = 2*10(3);
8
9 Vgs = -Vgg;
10 Id = Idss*(1-(Vgs/Vp))2;
11 Vds = Vdd - Id*Rd;
12 Vd = Vds;
13 Vg = Vgs;
14 Vs = 0;
15
16 disp(Vgs, 'Vgsq(Volts) = ');
17 disp(Id, 'Idq(Amperes) = ');
18 disp(Vds, 'Vds(Volts) = ');
19 disp(Vd, 'Vd(Volts) = ');
20 disp(Vg, 'Vg(Volts) = ');
21 disp(Vs, 'Vs(Volts) = ');
```

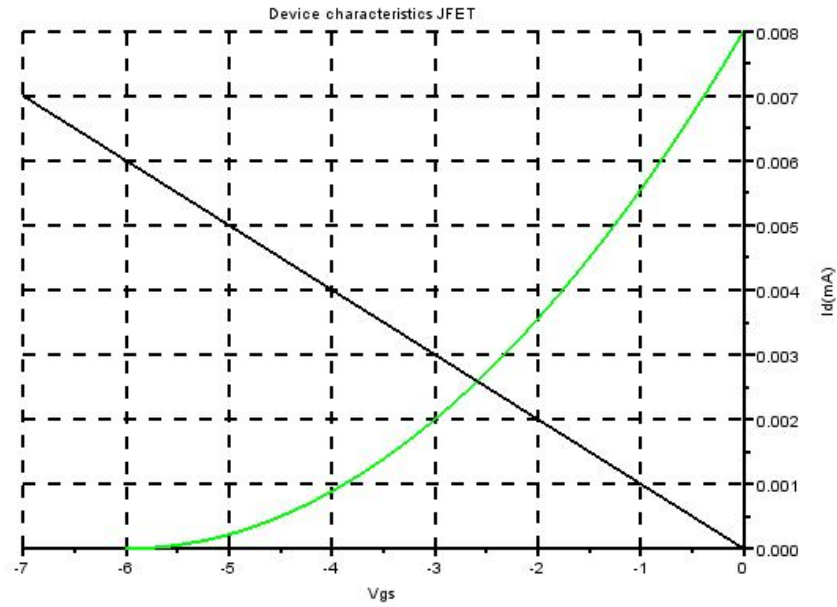


Figure 7.1: Network characteristics determination

---

**Scilab code Exa 7.2 Network characteristics determination**

```

1 clear; clc; close;
2
3 Idss = 8*10^(-3);
4 Vp = -6;
5 Vdd = 20;
6 Rd = 3.3*10^(3);
7 Rs = 1*10^(3);
8
9 Vgs1 = Vp;

```



```

10 Id1 = 0;
11 Vgs2 = Vp/2;
12 Id2 = Idss/4;
13 Vgs3 = 0;
14 Id3 = Idss;
15 x = [Vgs1 Vgs2 Vgs3];
16 y = [Id1 Id2 Id3];
17
18 yi=smooth([x;y],0.1);
19 a = gca();
20 a.thickness = 2;
21 a.y_location = 'right';
22 a.x_label.text = 'Vgs';
23 a.y_label.text = 'Id(mA)';
24 a.title.text = 'Device characteristics JFET';
25 a.grid = [1 1];
26 plot2d(yi(1,:),yi(2,:),[3]);
27
28
29 Vgs1 = 0;
30 Id1 = 0;
31 Id2 = 4*10(-3);
32 Vgs2 = -Id2*Rs;
33 Id3 = 8*10(-3);
34 Vgs3 = -Id3*Rs;
35 x = [Vgs1 Vgs2 Vgs3];
36 y = [Id1 Id2 Id3];
37 plot2d(x,y);
38
39 Vgsq = -2.6;
40 disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');
41
42 Idq = 2.6*10(-3);
43 Vds = Vdd - Idq*(Rs+Rd);
44 Vs = Idq*Rs;
45 Vg = 0;
46 Vd = Vds + Vs;

```

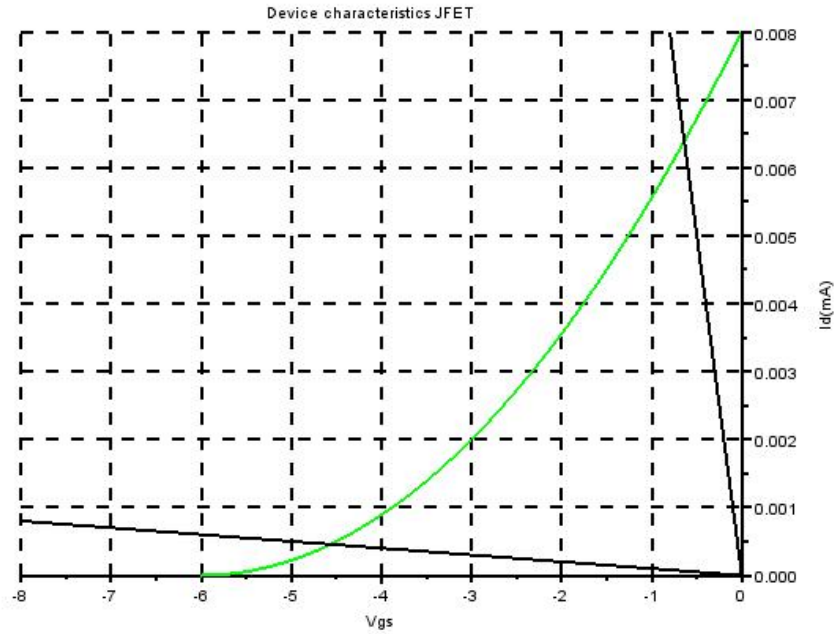


Figure 7.2: Q point for network

```

47
48 disp(Idq, 'Idq (Amperes) = ');
49 disp(Vds, 'Vds (Volts) = ');
50 disp(Vd, 'Vd (Volts) = ');
51 disp(Vg, 'Vg (Volts) = ');
52 disp(Vs, 'Vs (Volts) = ');

```

---

Scilab code Exa 7.3 Q point for network

```

1 clear; clc; close;
2

```

```

3 Rs = 100;
4 Idss = 8*10(-3);
5 Vp = -6;
6 Vdd = 20;
7
8 Vgs1 = Vp;
9 Id1 = 0;
10 Vgs2 = Vp/2;
11 Id2 = Idss/4;
12 Vgs3 = 0;
13 Id3 = Idss;
14 x = [Vgs1 Vgs2 Vgs3];
15 y = [Id1 Id2 Id3];
16
17 yi=smooth([x;y],0.1);
18 a = gca();
19 a.thickness = 2;
20 a.y_location = 'right';
21 a.x_label.text = 'Vgs';
22 a.y_label.text = 'Id(mA)';
23 a.title.text = 'Device characteristics JFET';
24 a.grid = [1 1];
25
26 plot2d(yi(1,:),yi(2,:),[3]);
27
28
29 Vgs1 = 0;
30 Id1 = 0;
31 Id2 = 4*10(-3);
32 Vgs2 = -Id2*Rs;
33 Id3 = 8*10(-3);
34 Vgs3 = -Id3*Rs;
35 x = [Vgs1 Vgs2 Vgs3];
36 y = [Id1 Id2 Id3];
37 plot2d(x,y);
38
39
40

```

```

41
42 Idq = 6.4*10(-3);
43 Vgsq = -0.64;
44 disp('From the figure ,for part a i.e Rs=100Kohm,we
      get ');
45 disp(Idq, 'Idq(Amperes) = ');
46 disp(Vgsq, 'Vgsq(Volts) = ');
47
48 //part b
49
50 Rs = 10*10(3);
51 Idss = 8*10(-3);
52 Vp = -6;
53 Vdd = 20;
54
55
56
57 Vgs1 = 0;
58 Id1 = 0;
59 Id2 = 4*10(-3);
60 Vgs2 = -Id2*Rs;
61 Id3 = 8*10(-3);
62 Vgs3 = -Id3*Rs;
63 x = [Vgs1 Vgs2 Vgs3];
64 y = [Id1 Id2 Id3];
65 plot2d(x,y);
66 a.data_bounds = [-8 0;0 8*10(-3)];
67 Idq = 0.46*10(-3);
68 Vgsq = -4.6;
69 disp('From the figure ,for part b i.e Rs=10Kohm,we
      get ')
70 disp(Idq, 'Idq(Amperes) = ');
71 disp(Vgsq, 'Vgsq(Volts) = ');

```

---

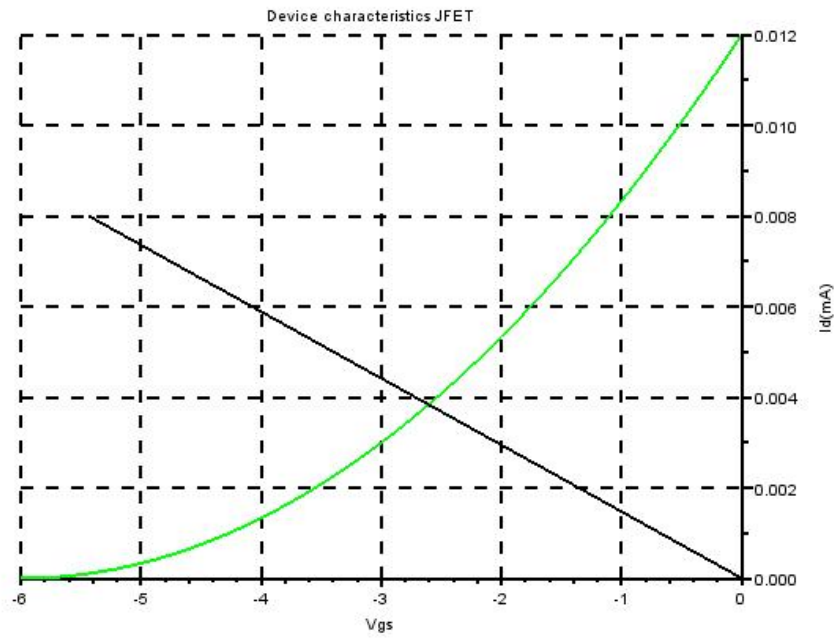


Figure 7.3: Network characteristics determination

#### Scilab code Exa 7.4 Network characteristics determination

```
1 clear; clc; close;
2
3 Idss = 12*10(-3);
4 Vp = -6;
5 Vdd = 12;
6 Rd = 1.5*10(3);
7 Rs = 680;
8
9 Vgs1 = Vp;
10 Id1 = 0;
11 Vgs2 = Vp/2;
12 Id2 = Idss/4;
13 Vgs3 = 0;
14 Id3 = Idss;
15 x = [Vgs1 Vgs2 Vgs3];
16 y = [Id1 Id2 Id3];
17
18 yi=smooth([x;y],0.1);
19 a = gca();
20 a.thickness = 2;
21 a.y_location = 'right';
22 a.x_label.text = 'Vgs';
23 a.y_label.text = 'Id(mA)';
24 a.title.text = 'Device characteristics JFET';
25 a.grid = [1 1];
26 plot2d(yi(1,:),yi(2,:),[3]);
27
28
29 Vgs1 = 0;
30 Id1 = 0;
31 Id2 = 4*10(-3);
32 Vgs2 = -Id2*Rs;
33 Id3 = 8*10(-3);
34 Vgs3 = -Id3*Rs;
35 x = [Vgs1 Vgs2 Vgs3];
36 y = [Id1 Id2 Id3];
```

```

37 plot2d(x,y);
38
39
40 Vgsq = -2.6;
41 disp(Vgsq, 'Q-point value of Vgs(found after
    interpolation) is :');
42
43 Idq = 3.8*10(-3);
44 Vd = Vdd - Idq*Rd;
45 Vg = 0;
46 Vs = Idq*Rs;
47 Vds = Vd-Vs;
48
49 disp(Idq, 'Idq(Amperes) = ');
50 disp(Vds, 'Vds(Volts) = ');
51 disp(Vd, 'Vd(Volts) = ');
52 disp(Vg, 'Vg(Volts) = ');
53 disp(Vs, 'Vs(Volts) = ');
54 disp(Vds, 'Vds(Volts) = ');

```

---

#### Scilab code Exa 7.5 Network characteristics determination

```

1 clear; clc; close;
2
3 Idss = 8*10(-3);
4 Vp = -4;
5 Vdd = 16;
6 Rd = 2.4*10(3);
7 Rs = 1.5*10(3);
8 R1 = 2.1*10(6);
9 R2 = 0.27*10(6);
10 //finding Vg
11 Vg = R2*Vdd/(R1+R2);

```

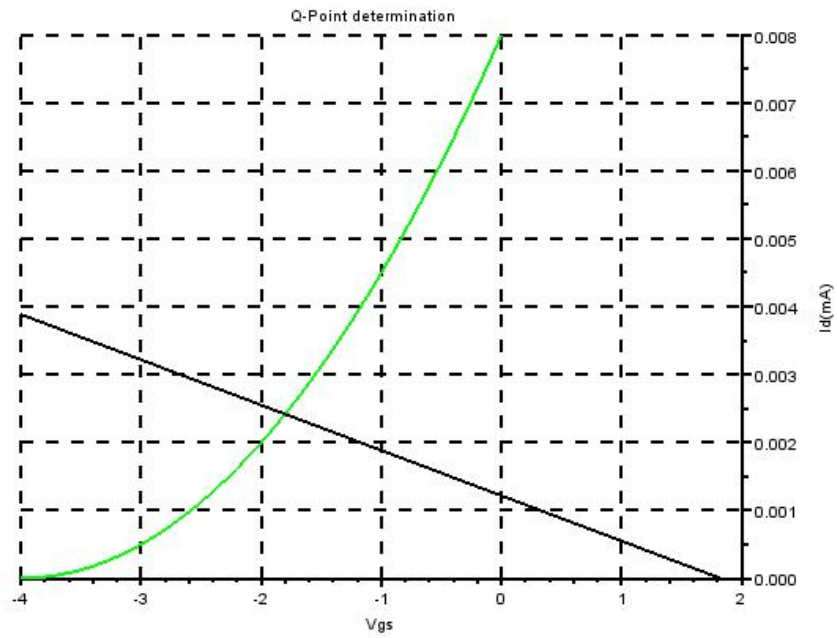


Figure 7.4: Network characteristics determination



```

12
13 //plotting transfer curve
14
15 Vgs1 = Vp;
16 Id1 = 0;
17 Vgs2 = Vp/2;
18 Id2 = Idss/4;
19 Vgs3 = 0;
20 Id3 = Idss;
21 x = [Vgs1 Vgs2 Vgs3];
22 y = [Id1 Id2 Id3];
23
24 yi=smooth([x;y],0.1);
25 a = gca();
26 a.thickness = 2;
27 a.y_location = 'right';
28 a.x_label.text = 'Vgs';
29 a.y_label.text = 'Id(mA)';
30 a.title.text = 'Q-Point determination';
31 a.grid = [1 1];
32 plot2d(yi(1,:),yi(2,:),[3]);
33
34
35 Id1 = 0;
36 Vgs1 = Vg-Id1*Rs;
37 Id2 = 4*10(-3);
38 Vgs2 = Vg-Id2*Rs;
39 Id3 = 8*10(-3);
40 Vgs3 = Vg-Id3*Rs;
41 x = [Vgs1 Vgs2 Vgs3];
42 y = [Id1 Id2 Id3];
43 plot2d(x,y);
44 a.data_bounds = [-4 0;2 8*10(-3)];
45
46
47 Vgsq = -1.8;
48 disp(Vgsq,'Q-point value of Vgs(found after
interpolation) is :');

```

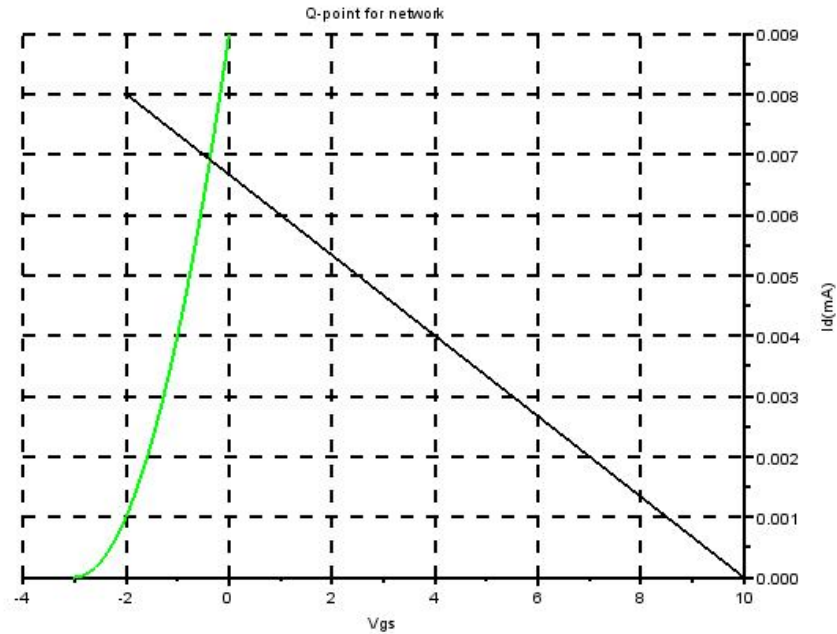


Figure 7.5: Network characteristics determination

```

49
50 Idq = 2.4*10(-3);
51
52 Vd = Vdd-Idq*Rd;
53 Vs = Idq*Rs;
54 Vds = Vdd - Idq*(Rd+Rs);
55
56 disp(Idq, 'Idq (Amperes) = ');
57 disp(Vds, 'Vds (Volts) = ');
58 disp(Vd, 'Vd (Volts) = ');
59 disp(Vs, 'Vs (Volts) = ');
60 disp(Vds, 'Vds (Volts) = ');

```

---

## Scilab code Exa 7.6 Network characteristics determination

```
1 clear; clc; close;
2
3 Idss = 9*10(-3);
4 Vp = -3;
5 Vdd = 20;
6 Vss = 10;
7 Rd = 1.8*10(3);
8 Rs = 1.5*10(3);
9
10
11 Vgs1 = Vp;
12 Id1 = 0;
13 Vgs2 = Vp/2;
14 Id2 = Idss/4;
15 Vgs3 = 0;
16 Id3 = Idss;
17 x = [Vgs1 Vgs2 Vgs3];
18 y = [Id1 Id2 Id3];
19
20 yi=smooth([x;y],0.1);
21 a = gca();
22 a.thickness = 2;
23 a.y_location = 'right';
24 a.x_label.text = 'Vgs';
25 a.y_label.text = 'Id(mA)';
26 a.title.text = 'Q-point for network';
27 a.grid = [1 1];
28 plot2d(yi(1,:) ',yi(2,:) ', [3]);
29
30
31
32 Id1 = 0;
```

```

33 Vgs1 = Vss-Id1*Rs;
34 Id2 = 4*10(-3);
35 Vgs2 = Vss-Id2*Rs;
36 Id3 = 8*10(-3);
37 Vgs3 = Vss-Id3*Rs;
38 x = [Vgs1 Vgs2 Vgs3];
39 y = [Id1 Id2 Id3];
40 plot2d(x,y);
41 a.data_bounds = [-3 0;10 9*10(-3)];
42
43
44
45 Vgsq = -0.35;
46 disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');
47
48 Idq = 6.9*10(-3);
49
50 Vds = Vdd+Vss-Idq*(Rd+Rs);
51 Vd = Vdd-Idq*Rd;
52 Vs = Vd-Vds;
53
54 disp(Idq,'Idq (Amperes) = ');
55 disp(Vds,'Vds (Volts) = ');
56 disp(Vd,'Vd (Volts) = ');
57 disp(Vs,'Vs (Volts) = ');
58 disp(Vds,'Vds (Volts) = ');

```

---

### Scilab code Exa 7.7 Idq Vgsq and Vds calculation

```

1 clear; clc; close;
2
3 Idss = 6*10(-3);

```

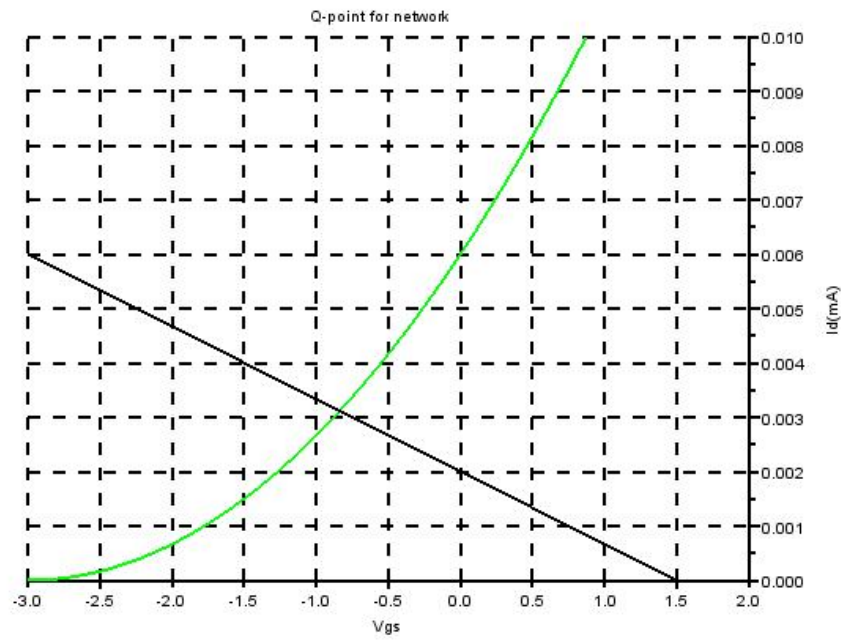


Figure 7.6:  $I_d$   $V_{gs}$  and  $V_{ds}$  calculation

```

4 Vp = -3;
5 Vdd = 18;
6 Rd = 1.8*10^(3);
7 Rs = 750;
8
9 Vg = 10*10^(6)*18/((10+110)*10^(6));
10
11 Vgs1 = Vp;
12 Id1 = 0;
13 Vgs2 = Vp/2;
14 Id2 = Idss/4;
15 Vgs3 = 0;
16 Id3 = Idss;
17 Vgs4 = 1;
18 Id4 = Idss*(1-(Vgs4/Vp))^2;
19 disp(Id4);
20 x = [Vgs1 Vgs2 Vgs3 Vgs4];
21 y = [Id1 Id2 Id3 Id4];
22
23 yi=smooth([x;y],0.1);
24 a = gca();
25 a.thickness = 2;
26 a.y_location = 'right';
27 a.x_label.text = 'Vgs';
28 a.y_label.text = 'Id(mA)';
29 a.title.text = 'Q-point for network';
30 a.grid = [1 1];
31 plot2d(yi(1,:),yi(2,:),[3]);
32
33
34 Id1 = 0;
35 Vgs1 = Vg-Id1*Rs;
36 Id2 = 3*10^(-3);
37 Vgs2 = Vg-Id2*Rs;
38 Id3 = 6*10^(-3);
39 Vgs3 = Vg-Id3*Rs;
40 x = [Vgs1 Vgs2 Vgs3];
41 y = [Id1 Id2 Id3];

```

```

42 plot2d(x,y);
43 a.data_bounds = [-3 0;2 10*10^(-3)];
44
45
46 Vgsq = -0.8;
47 disp(Vgsq, 'Q-point value of Vgs(found after
      interpolation) is :');
48
49 Idq = 3.1*10^(-3);
50
51 Vds = Vdd - Idq*(Rd+Rs);
52
53 disp(Idq, 'Idq(Amperes) = ');
54 disp(Vds, 'Vds(Volts) = ');

```

---

#### Scilab code Exa 7.8 Idq Vgsq and Vds calculation

```

1 clear; clc; close;
2
3 Idss = 6*10^(-3);
4 Vp = -3;
5 Vdd = 18;
6 Rd = 1.8*10^3;
7 Rs = 150;
8
9
10 Vg = 10*10^6*18/((10+110)*10^6);
11
12 Vgs1 = Vp;
13 Id1 = 0;
14 Vgs2 = Vp/2;
15 Id2 = Idss/4;
16 Vgs3 = 0;

```

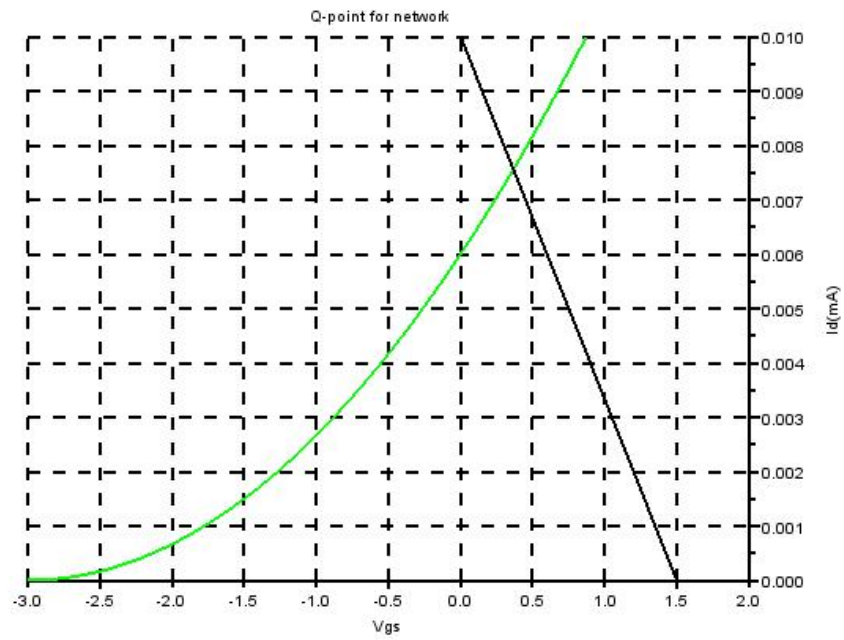


Figure 7.7:  $I_d$   $V_{gs}$  and  $V_{ds}$  calculation



```

17 Id3 = Idss;
18 Vgs4 = 1;
19 Id4 = Idss*(1-(Vgs4/Vp))^2;
20 disp(Id4);
21 x = [Vgs1 Vgs2 Vgs3 Vgs4];
22 y = [Id1 Id2 Id3 Id4];
23
24 yi=smooth([x;y],0.1);
25 a = gca();
26 a.thickness = 2;
27 a.y_location = 'right';
28 a.x_label.text = 'Vgs';
29 a.y_label.text = 'Id(mA)';
30 a.title.text = 'Q-point for network';
31 a.grid = [1 1];
32 plot2d(yi(1,:),yi(2,:),[3]);
33
34
35 Id1 = 0;
36 Vgs1 = Vg-Id1*Rs;
37 Id2 = 3*10^(-3);
38 Vgs2 = Vg-Id2*Rs;
39 Id3 = 6*10^(-3);
40 Vgs3 = Vg-Id3*Rs;
41 Vgs4 = 0;
42 Id4 = (Vg - Vgs4)/Rs;
43 x = [Vgs1 Vgs2 Vgs3 Vgs4];
44 y = [Id1 Id2 Id3 Id4];
45 plot2d(x,y);
46 a.data_bounds = [-3 0;2 10*10^(-3)];
47
48
49
50
51 Vgsq = 0.35;
52 disp(Vgsq,'Q-point value of Vgs(found after
    interpolation) is :');
53

```

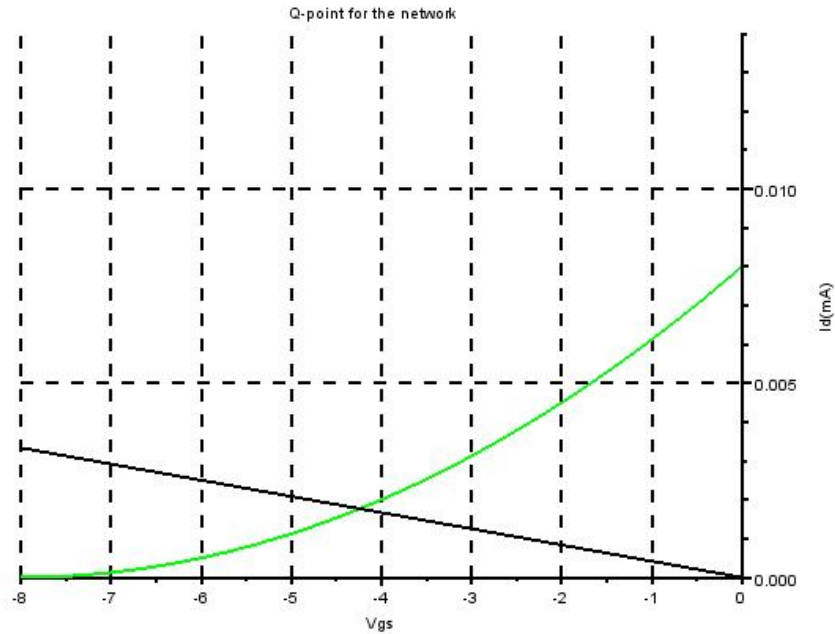


Figure 7.8: Idq Vgsq and Vd calculation

```

54 Idq = 7.6*10^(-3);
55
56 Vds = Vdd - Idq*(Rd+Rs);
57
58 disp(Idq, 'Idq (Amperes) = ');
59 disp(Vds, 'Vds (Volts) = ');

```

---

Scilab code Exa 7.9 Idq Vgsq and Vd calculation

```

1 clear; clc; close;
2

```

```

3 Idss = 8*10(-3);
4 Vp = -8;
5 Vdd = 20;
6 Rd = 6.2*10(3);
7 Rs = 2.4*10(3);
8
9 Vgs1 = Vp;
10 Id1 = 0;
11 Vgs2 = Vp/2;
12 Id2 = Idss/4;
13 Vgs3 = 0;
14 Id3 = Idss;
15 Vgs4 = 2;
16 Id4 = Idss*(1-(Vgs4/Vp))2;
17 x = [Vgs1 Vgs2 Vgs3 Vgs4];
18 y = [Id1 Id2 Id3 Id4];
19
20 yi=smooth([x;y],0.1);
21 a = gca();
22 a.thickness = 2;
23 a.y_location = 'right';
24 a.x_label.text = 'Vgs';
25 a.y_label.text = 'Id(mA)';
26 a.title.text = 'Q-point for the network';
27 a.grid = [1 1];
28 plot2d(yi(1,:),yi(2,:),[3]);
29
30
31 Vgs1 = 0;
32 Id1 = 0;
33 Id2 = 4*10(-3);
34 Vgs2 = -Id2*Rs;
35 Id3 = 8*10(-3);
36 Vgs3 = -Id3*Rs;
37 x = [Vgs1 Vgs2 Vgs3];
38 y = [Id1 Id2 Id3];
39 plot2d(x,y);
40 a.data_bounds = [-8 0;0 13*10(-3)];

```

```

41
42
43 Vgsq = -4.3;
44 disp(Vgsq, 'Q-point value of Vgs(found after
    interpolation) is :');
45
46 Idq = 1.7*10(-3);
47
48 Vd = Vdd - Idq*(Rd);
49
50 disp(Idq, 'Idq(Amperes) = ');
51 disp(Vd, 'Vd(Volts) = ');

```

---

#### Scilab code Exa 7.10 Vds determination

```

1 clear; clc; close;
2
3 Idss = 10*10(-3);
4 Vp = -4;
5 Vdd = 20;
6 Rd = 1.5*10(3);
7
8 Vgsq = 0;
9 disp(Vgsq, 'Q-point value of Vgs(found after
    interpolation) is :');
10
11 Idq = 10*10(-3);
12
13 Vd = Vdd - Idq*(Rd);
14
15 disp(Idq, 'Idq(Amperes) = ');
16 disp(Vd, 'Vds(Volts) = ');

```

---

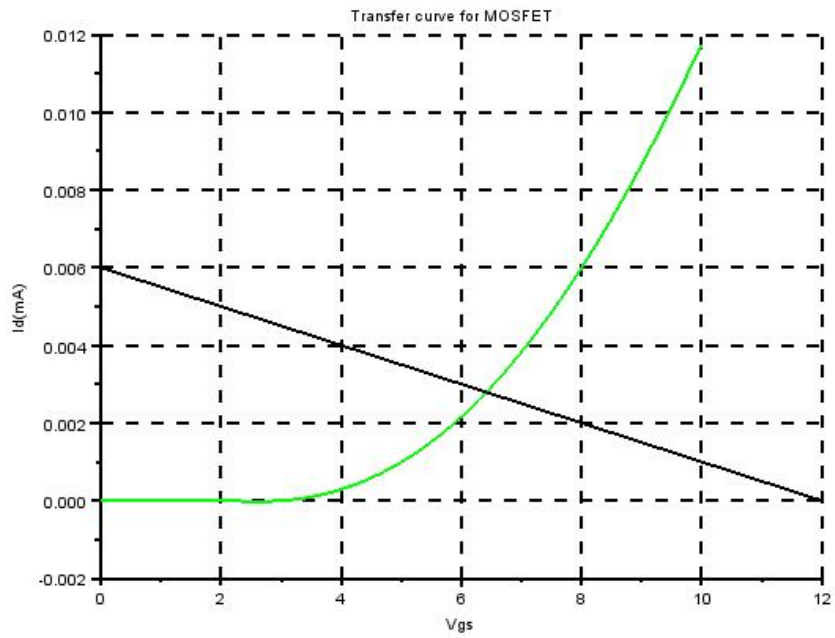


Figure 7.9: Idq Vdsq Calculation

### Scilab code Exa 7.11 Idq Vdsq Calculation

```
1 clear; clc; close;
2
3 Id_on = 6*10^(-3);
4 Vgs_on = 8;
5 Vgs_th = 3;
6 Rd = 2*10^(3);
7 Vdd = 12;
8
9 k = Id_on/(Vgs_on-Vgs_th);
10
11 Vgs1 = Vgs_th;
12 Id1 = 0;
13 Vgs2 = 6;
14 Id2 = 0.24*10^(-3)*(6-3)^2;
15 Vgs3 = Vgs_on;
16 Id3 = Id_on;
17 Vgs4 = 10;
18 Id4 = 0.24*10^(-3)*(10-3)^2;
19
20 x = [0 1 2 Vgs1 Vgs2 Vgs3 Vgs4];
21 y = [0 0 0 Id1 Id2 Id3 Id4];
22
23 yi=smooth([x;y],0.1);
24 a = gca();
25 a.thickness = 2;
26 a.y_location = 'left';
27 a.x_label.text = 'Vgs';
28 a.y_label.text = 'Id(mA)';
29 a.title.text = 'Transfer curve for MOSFET';
30 a.grid = [1 1];
31 plot2d(yi(1,:),yi(2,:),[3]);
32
```

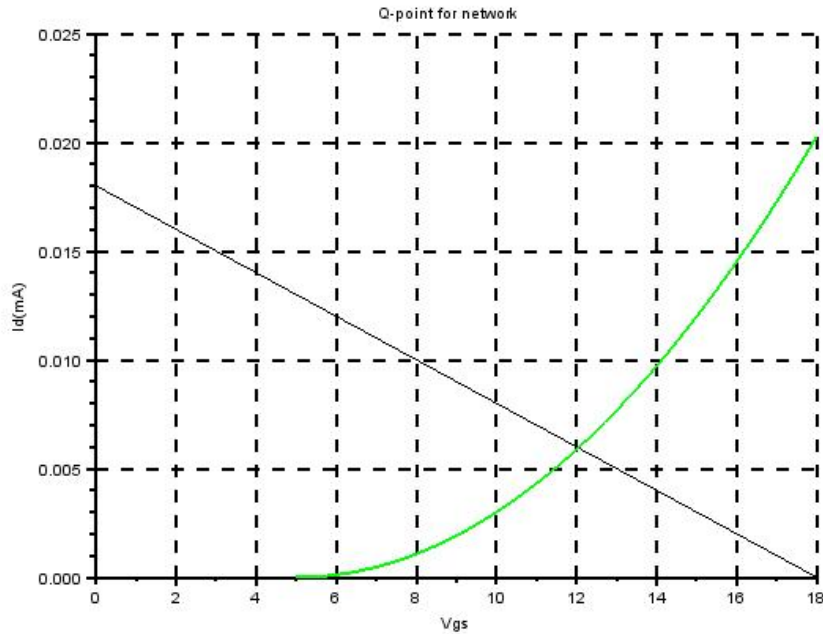


Figure 7.10: Idq Vgsq and Vds calculation

```

33 Vgs = Vdd; //at Id = 0
34 Id = Vdd/Rd; //at Vgs = 0
35 x = 0:1:12;
36 y = (-0.5*10(-3))*x + 6*10(-3);
37 plot2d(x,y);
38 Idq = 2.75*10(-3);
39 Vgsq = 6.4;
40 Vdsq = Vgsq;
41 disp(Idq, 'Idq (Amperes) = ');
42 disp(Vdsq, 'Vdsq (Volts) = ');

```

---

### Scilab code Exa 7.12 Idq Vgsq and Vds calculation

```
1 clear; clc; close;
2
3 Id_on = 3*10^(-3);
4 Vgs_on = 10;
5 Vgs_th = 5;
6 Vdd = 40;
7 R1 = 22*10^(6);
8 R2 = 18*10^(6);
9 Rs = 1*10^(3);
10 Rd = 3*10^(3);
11
12 Vg = (R2*Vdd)/(R1+R2)
13 Vgs = 0:1:18;
14 Id = (Vg-Vgs)/Rs;
15 plot2d(Vgs,Id);
16 a = gca();
17 a.thickness = 2;
18 a.y_location = 'left';
19 a.x_label.text = 'Vgs';
20 a.y_label.text = 'Id(mA)';
21 a.title.text = 'Q-point for network';
22 a.grid = [1 1];
23
24 k = Id_on/(Vgs_on-Vgs_th)^2;
25 Vgs = 5:1:18;
26 Id = k*(Vgs-Vgs_th)^2;
27 yi=smooth([Vgs;Id],0.1);
28 plot2d(yi(1,:) ',yi(2,:) ',[3]);
29
30 Idq = 5.2*10^(-3);
31 Vgsq = 12.5;
32 Vds = Vdd-Idq*(Rs+Rd);
33
34 disp(Idq, 'Idq (Amperes) = ');
35 disp(Vgsq, 'Vgsq (Volts) = ');
36 disp(Vds, 'Vds (Volts) = ');
```



---

**Scilab code Exa 7.13 Vd and Vc level determination**

```
1 clear; clc; close;
2
3 Idss = 12*10(-3);
4 Vp = -3;
5 Vbe = 0.7;
6 Beta = 180;
7 Re = 1.6*10(3);
8
9 Vb = (24*10(3)*16)/((82+24)*10(3));
10 Ve = Vb-Vbe;
11 Vre = Ve;
12 Ie = Vre/Re;
13 Ic = Ie;
14 Id = Ic;
15 Vd = 16-Id*(2.7*10(3));
16 Vgsq = -1.8;
17 Vc = Vb - Vgsq;
18
19 disp(Vd, 'Vd(Volts) = ');
20 disp(Vc, 'Vc(Volts) = ');
```

---

**Scilab code Exa 7.14 Vd level determination**

```
1 clear; clc; close;
2
3 Idss = 12*10(-3);
4 Vp = -3;
5 Vbe = 0.7;
6 Beta = 80;
```

```

7 Re = 1.6*10^(3);
8 Rs = 2.4*10^(3);
9
10 Vgsq = -2.6;
11 Idq = 1*10^(-3);
12 Ic = Idq;
13 Ie = Ic;
14 Ib = Ic/Beta;
15 Vb = 16-Ib*(470*10^(3));
16 Vd = Vb-Vbe;
17 disp(Vd, 'Vd(Volts) = ');

```

---

#### Scilab code Exa 7.15 Vdq and Idq level

```

1 clear; clc; close;
2
3 Vdd = 20;
4 Vdq = 12;
5 Idq = 2.5*10^(-3);
6 Vgsq = -1;
7 Rd = (Vdd-Vdq)/Idq;
8 Rs = -Vgsq/Idq;
9
10 disp(Rd, 'Rd(Ohms) = ');
11 disp(Rs, 'Rs(Ohms) = ');
12 disp(3.3*10^(3), 'Closest commercial value of Rd(Ohms) = ');
13 disp(0.39*10^(3), 'Closest commercial value of Rs(Ohms) = ');

```

---

#### Scilab code Exa 7.16 Rs determination

```

1 clear; clc; close;

```

```

2
3 Vd =12;
4 Vdd = 16;
5 Vgsq = -2;
6 Rd = 1.8*10^(3);
7
8 Vg = (47*10^(3)*16)/((47+91)*10^(3));
9 Id = (Vdd-Vd)/Rd;
10
11 Rs = (Vg-Vgsq)/Id;
12
13 disp(Rs, 'Rs(Ohms) = ');

```

---

#### Scilab code Exa 7.17 Vdd and Rd determination

```

1 clear; clc; close;
2
3 Id_on = 4*10^(-3);
4 Vgs_on = 6;
5 Vgs_th = 3;
6
7 Vgs = Vgs_on;
8 Vdd = 2*Vgs;
9 Vds = Vgs;
10 Id = Id_on;
11
12 Rd = (Vdd-Vds)/Id;
13
14 disp(Rd, 'Rd(Ohms) = ');

```

---

#### Scilab code Exa 7.18 Idq Vgsq and Vds calculation

```

1 clear; clc; close;

```

```

2
3 Idss = 8*10(-3);
4 Vp = 4;
5 Vdd = 20;
6 Rd = 4*10(3);
7 Rs = 1.8*10(3);
8
9 Vg = 20*10(3)*(-20)/((20+68)*10(3));
10
11 Vgs1 = 0;
12 Id1 = Idss;
13 Vgs2 = Vp/2;
14 Id2 = Idss/4;
15 Vgs3 = Vp;
16 Id3 = 0;
17 x = [Vgs1 Vgs2 Vgs3];
18 y = [Id1 Id2 Id3];
19
20 yi=smooth([x;y],0.1);
21 a = gca();
22 a.thickness = 2;
23 a.data_bounds = [-5 0;5 8*10(-3)];
24 a.y_location = 'middle';
25 a.x_label.text = 'Vgs';
26 a.y_label.text = 'Id(mA)';
27 a.title.text = 'Q-point for network';
28 a.grid = [1 1];
29 plot2d(yi(1,:),yi(2,:),[3]);
30
31
32 Id1 = 0;
33 Vgs1 = Vg+Id1*Rs;
34 Vgs2 = 0;
35 Id2 = (Vgs2-Vg)/Rs;
36 Id3 = 4*10(-3);
37 Vgs3 = Vg+Id3*Rs;
38 x = [Vgs1 Vgs2 Vgs3];
39 y = [Id1 Id2 Id3];

```

```

40 plot2d(x,y);
41
42
43 Vgsq = 1.6;
44 Idq = 3.1*10(-3);
45 Vds = -Vdd+Idq*(Rd+Rs);
46
47 disp(Vgsq, 'Q-point value of Vgs(found after
    interpolation) is :');
48 disp(Idq, 'Q-point value of Id(found after
    interpolation) is :');
49 disp(Vds, 'Vds(Volts) = ');

```

---

Scilab code Exa 7.19 Q point value of Id and Vgs

```

1 clear; clc; close;
2
3 Idss = 6*10(-3);
4 Vp = -3;
5 Vdd = 16;
6 Rd = 3.9*10(3);
7 Rs = 1.6*10(3);
8
9 m = abs(Vp)/(Idss*Rs);
10 Idq = 0.18*Idss;
11 Vgsq = -0.575*abs(Vp);
12
13 disp(Vgsq, 'Vgsq(Volts) = ');
14 disp(Idq, 'Idq(Amperes) = ');

```

---

Scilab code Exa 7.20 Q point value of Id and Vgs

```

1 clear; clc; close;

```

```
2
3 Idss = 8*10(-3);
4 Vp = -6;
5 Vdd = 18;
6 Rs = 1.2*10(3);
7 R1 = 2*10(6);
8 R2 = 470*10(3);
9
10 m = abs(Vp)/(Idss*Rs);
11 Vg = R2*Vdd/(R1+R2);
12 M = m*(Vg/abs(Vp));
13
14 Idq = 0.52*Idss;
15 Vgsq = -0.27*abs(Vp);
16
17 disp(Vgsq, 'Vgsq (Volts) = ');
18 disp(Idq, 'Idq (Amperes) = ');
```

---

# Chapter 8

## FET Amplifiers

Scilab code Exa 8.1 Calculation of gm for different Vgs

```
1 clear; clc; close;
2
3 Idss = 8*10^(-3);
4 Vp = -4;
5
6
7 Vgs1 = Vp;
8 Id1 = 0;
9 Vgs2 = Vp/2;
10 Id2 = Idss/4;
11 Vgs3 = 0;
12 Id3 = Idss;
13 x = [Vgs1 Vgs2 Vgs3];
14 y = [Id1 Id2 Id3];
15
16 yi=smooth([x;y],0.1);
17 a = gca();
18 a.thickness = 2;
19 a.y_location = 'right';
```

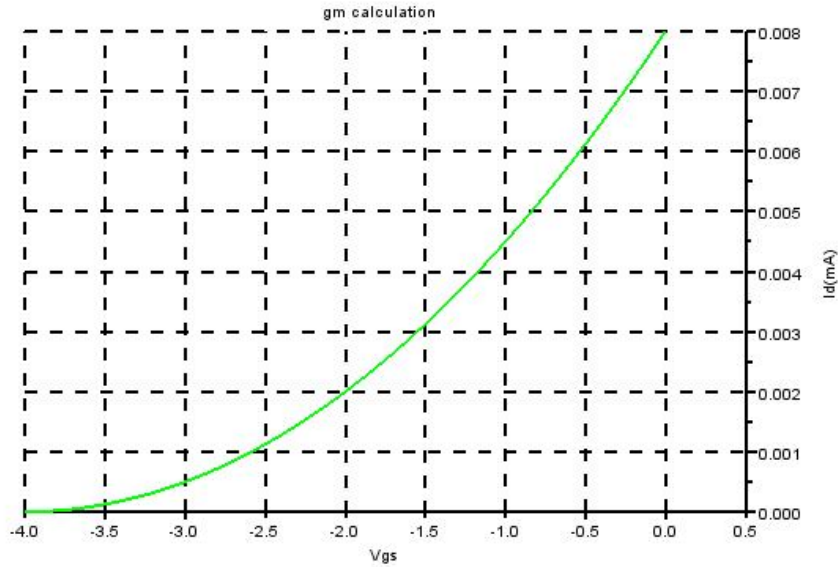


Figure 8.1: Calculation of gm for different Vgs

```

20 a.x_label.text = 'Vgs';
21 a.y_label.text = 'Id(mA)';
22 a.title.text = 'gm calculation';
23 a.grid = [1 1];
24 plot2d(yi(1,:),yi(2,:),[3]);
25
26
27 //part-a
28 Vgs = -0.5;
29 Id_delta = 2.1*10^(-3);
30 Vgs_delta = 0.6;
31
32 gm = Id_delta/Vgs_delta;
33 disp(gm,'gm(in S) for part a = ');
34
35 //part-b
36 Vgs = -1.5;
37 Id_delta = 1.8*10^(-3);

```



```

38 Vgs_delta = 0.7;
39
40 gm = Id_delta/Vgs_delta;
41 disp(gm, 'gm(in S) for part b = ');
42
43 //part-c
44 Vgs = -2.5;
45 Id_delta = 1.5*10^(-3);
46 Vgs_delta = 1;
47
48 gm = Id_delta/Vgs_delta;
49 disp(gm, 'gm(in S) for part c = ');

```

---

Scilab code Exa 8.2 Calculation of gm for different Vgs and max gm

```

1 clear; clc; close;
2
3 Idss = 8*10^(-3);
4 Vp = -4;
5
6 gmo = 2*Idss/abs(Vp);
7
8 //part-a
9 Vgs = -0.5;
10
11 gm = gmo*(1-(Vgs/Vp));
12 disp(gm, 'gm(in S) for part a = ');
13
14 //part-b
15 Vgs = -1.5;
16 gm = gmo*(1-(Vgs/Vp));
17 disp(gm, 'gm(in S) for part b = ');
18
19 //part-c
20 Vgs = -2.5;

```

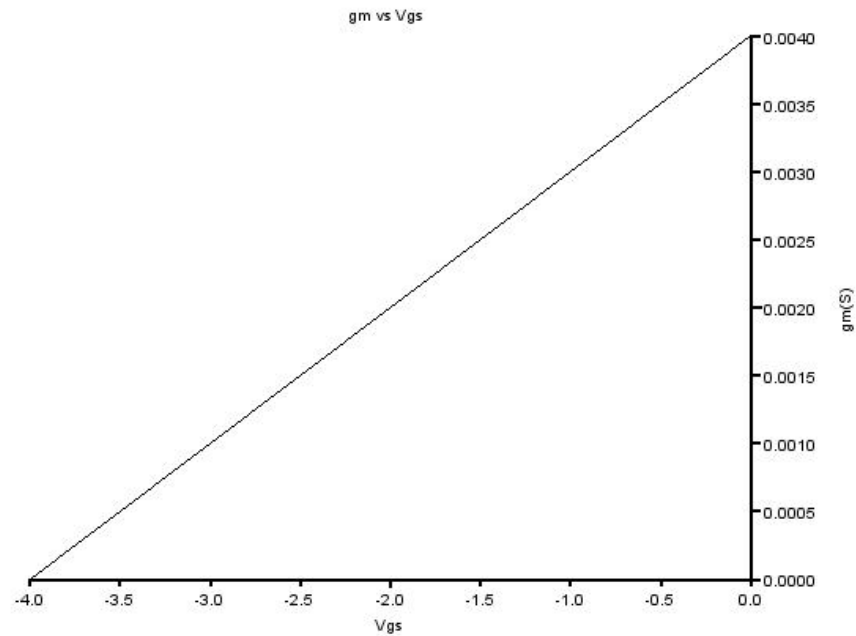


Figure 8.2: gm vs Vgs

```

21 Id_delta = 1.5*10^(-3);
22 Vgs_delta = 1;
23
24 gm = gmo*(1-(Vgs/Vp));
25 disp(gm, 'gm(in S) for part c = ');
26
27 disp(gmo, 'Max gm(in S) is = ')

```

---

Scilab code Exa 8.3 gm vs Vgs

```

1 clear; clc; close;

```

```

2
3 Vp = -4;
4 gmo = 4*10(-3);
5
6 vgs1 = -4;
7 gm1 = gmo*(1-(vgs1/Vp));
8 vgs2 = -2.5;
9 gm2 = gmo*(1-(vgs2/Vp));
10 vgs3 = -1.5;
11 gm3 = gmo*(1-(vgs3/Vp));
12 vgs4 = -1.5;
13 gm4 = gmo*(1-(vgs4/Vp));
14 vgs5 = 0;
15 gm5 = gmo*(1-(vgs5/Vp));
16
17 x = [vgs1 vgs2 vgs3 vgs4 vgs5];
18 y = [gm1 gm2 gm3 gm4 gm5];
19 plot2d(x,y);
20 a = gca();
21 a.thickness = 2;
22 a.y_location = 'right';
23 a.x_label.text = 'Vgs';
24 a.y_label.text = 'gm(S)';
25 a.title.text = 'gm vs Vgs';

```

---

#### Scilab code Exa 8.4 gm vs Id

```

1 clear; clc; close;
2
3 Idss = 8*10(-3);
4 Vp = -4;
5
6 gmo = 2*Idss/abs(Vp);

```

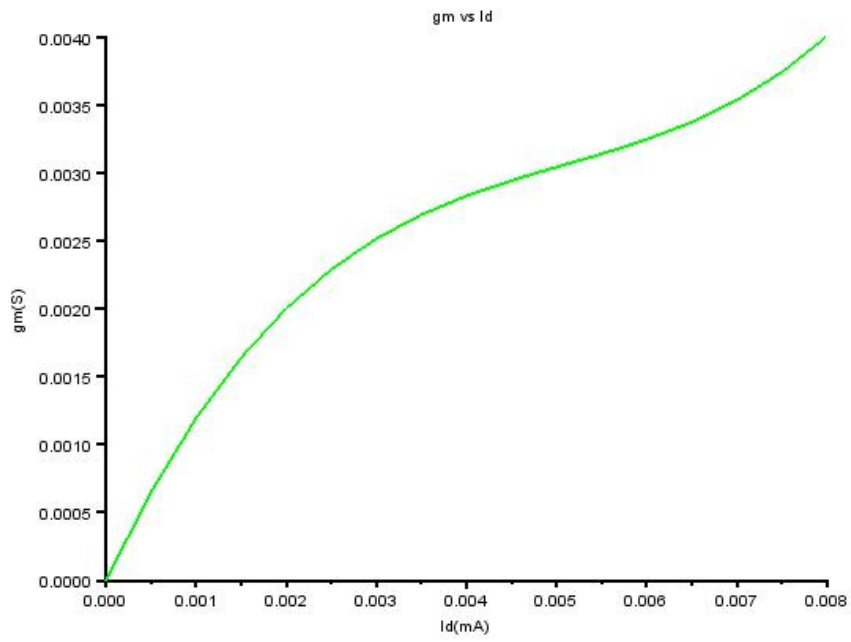


Figure 8.3:  $g_m$  vs  $I_d$

```

7
8 Id1 = 0;
9 gm1 = gmo*(sqrt(Id1/Idss));
10 Id2 = Idss/4;
11 gm2 = gmo*(sqrt(Id2/Idss));
12 Id3 = Idss/2;
13 gm3 = gmo*(sqrt(Id3/Idss));
14 Id4 = Idss;
15 gm4 = gmo*(sqrt(Id4/Idss));
16
17 x = [Id1 Id2 Id3 Id4];
18 y = [gm1 gm2 gm3 gm4];
19 yi=smooth([x;y],0.0005);
20 a = gca();
21 a.thickness = 2;
22 a.y_location = 'left';
23 a.x_label.text = 'Id(mA)';
24 a.y_label.text = 'gm(S)';
25 a.title.text = 'gm vs Id';
26 plot2d(yi(1,:),yi(2,:),[3]);

```

---

### Scilab code Exa 8.5 Output impedance

```

1 clear; clc; close;
2
3 Vds = 8;
4
5 Vgs = 0;
6 Vds_delta = 5;
7 Id_delta = 0.2*10^(-3);
8 rd = Vds_delta/Id_delta;
9 disp(rd,'For Vgs = 0V,rd(ohms) = ');
10
11 Vgs = -2;
12 Vds_delta = 8;

```

```
13 Id_delta = 0.1*10(-3);
14 rd = Vds_delta/Id_delta;
15 disp(rd, 'For Vgs = -2V, rd(ohms) = ');
```

---

#### Scilab code Exa 8.6 FET equivalent model

```
1 clear; clc; close;
2
3 yfs = 3.8*10(-3);
4 yos = 20*10(-6);
5
6 gm = yfs;
7 rd = 1/yos;
8
9 disp(gm, 'gm(in S) = ');
10 disp(rd, 'rd(ohms) = ');
```

---

#### Scilab code Exa 8.7 JFET fix bias configuration calculation

```
1 clear; clc; close;
2
3 yos = 20*10(-6);
4 Idss = 10*10(-3);
5 Vp = -8;
6 Vgsq = -2;
7 Idq = 5.625*10(-3);
8 Rg = 1*10(6);
9 Rd = 2*10(3);
10
11 gmo = 2*Idss/abs(Vp);
12 gm = gmo*(1-(Vgsq/Vp));
13 rd = 1/yos;
14 Zi = Rg;
```

```

15 Zo = Rd*rd/(Rd+rd);
16 Av = -gm*(Rd*rd/(Rd+rd));
17 Av2 = -gm*Rd;
18
19 disp(gm, 'gm(S) = ');
20 disp(rd, 'rd(ohms) = ');
21 disp(Zi, 'Zi(ohms) = ');
22 disp(Zo, 'Zo(ohms) = ');
23 disp(Av, 'Voltage gain Av = ');
24 disp(Av2, 'Volatge gain Av(ignoring rd) = ');

```

---

#### Scilab code Exa 8.8 JFET self bias configuration calculation

```

1 clear; clc; close;
2
3 yos = 25*10^(-6);
4 Idss = 8*10^(-3);
5 Vp = -6;
6 Vgsq = -2.6;
7 Idq = 2.6*10^(-3);
8 Rg = 1*10^(6);
9 Rd = 3.3*10^(3);
10 Rs = 1*10^(3);
11
12 gmo = 2*Idss/abs(Vp);
13 gm = gmo*(1-(Vgsq/Vp));
14 rd = 1/yos;
15 Zi = Rg;
16 Zo = Rd;
17 Av = -gm*Rd/(1+gm*Rs+((Rd+Rs)/rd));
18 Av2 = -gm*Rd/(1+gm*Rs);
19
20 disp(gm, 'gm(S) = ');
21 disp(rd, 'rd(ohms) = ');
22 disp(Zi, 'Zi(ohms) = ');

```

```

23 disp(Zo, 'Zo(ohms) = ');
24 disp(Av, 'Voltage gain Av = ');
25 disp(Av2, 'Volatge gain Av(ignoring rd) = ');

```

---

### Scilab code Exa 8.9 JFET source follower configuration calculation

```

1 clear; clc; close;
2
3 yos = 30*10(-6);
4 Idss = 16*10(-3);
5 Vp = -4;
6 Vgsq = -2.86;
7 Idq = 4.56*10(-3);
8 Rg = 1*10(6);
9 Rs = 2.2*10(3);
10
11
12 gmo = 2*Idss/abs(Vp);
13 gm = gmo*(1-(Vgsq/Vp));
14 rd = 1/yos;
15 Zi = Rg;
16 Zo = rd*Rs*gm(-1)/((rd*Rs)+(Rs*gm(-1))+(rd*gm(-1)
    ));
17 Zo2 = Rs*gm(-1)/(Rs+gm(-1));
18 Av = gm*(rd*Rs/(rd+Rs))/(1+(gm*(rd*Rs/(rd+Rs))));
19 Av2 = gm*Rs/(1+gm*Rs);
20
21 disp(gm, 'gm(S) = ');
22 disp(rd, 'rd(ohms) = ');
23 disp(Zi, 'Zi(ohms) = ');
24 disp(Zo, 'Zo(ohms) = ');
25 disp(Zo2, 'Zo without rd = ');
26 disp(Av, 'Voltage gain Av = ');
27 disp(Av2, 'Volatge gain Av(ignoring rd) = ');

```

---



### Scilab code Exa 8.10 JFET common gate configuration calculation

```
1 clear; clc; close;
2
3 yos = 50*10^(-6);
4 Idss = 10*10^(-3);
5 Vp = -4;
6 Vgsq = -2.2;
7 Idq = 2.03*10^(-3);
8 Rd = 3.6*10^3;
9 Rs = 1.1*10^3;
10 Vi = 40*10^(-3);
11
12 gmo = 2*Idss/abs(Vp);
13 gm = gmo*(1-(Vgsq/Vp));
14 rd = 1/yos;
15 Zi = Rs*((rd+Rd)/(1+gm*rd))/(Rs+((rd+Rd)/(1+gm*rd)))
    ;
16 Zi2 = Rs*gm^(-1)/(Rs+gm^(-1));
17 Zo = Rd*rd/(Rd+rd);
18 Zo2 = Rd;
19 Av = (gm*Rd+(Rd/rd))/(1+Rd/rd);
20 Vo = Av*Vi;
21 Av2 = gm*Rd;
22 Vo2 = Av2*Vi;
23
24 disp(gm, 'gm(S) = ');
25 disp(rd, 'rd(ohms) = ');
26 disp(Zi, 'Zi(ohms) = ');
27 disp(Zi2, 'Zi(ohms) without rd = ');
28 disp(Zo, 'Zo(ohms) = ');
29 disp(Zo2, 'Zo(ohms) without rd = ');
30 disp(Av, 'Voltage gain Av = ');
31 disp(Vo, 'Vo = ');
```

```
32 disp(Av2, 'Volatge gain Av(ignoring rd) = ');
33 disp(Vo2, 'Vo2 witout rd = ');
```

---

#### Scilab code Exa 8.11 Network components determination

```
1 clear; clc; close;
2
3 yos = 10*10^(-6);
4 Idss = 6*10^(-3);
5 Vp = -3;
6 Vgsq = 0.35;
7 Idq = 7.6*10^(-3);
8 Rd = 1.8*10^3;
9 R1 = 10*10^6;
10 R2 = 110*10^6;
11
12
13 gmo = 2*Idss/abs(Vp);
14 gm = gmo*(1-(Vgsq/Vp));
15 rd = 1/yos;
16 Zi = R1*R2/(R1+R2);
17 Zo = rd*Rd/(Rd+rd);
18 Av = -gm*Rd;
19
20 disp(gmo, 'gmo(S) = ');
21 disp(gm, 'gm(S) = ');
22 disp(rd, 'rd(ohms) = ');
23 disp(Zi, 'Zi(ohms) = ');
24 disp(Zo, 'Zo(ohms) = ');
25 disp(Av, 'Av = ');
```

---

#### Scilab code Exa 8.12 E MOSFET components determination

```

1 clear; clc; close;
2
3 yos = 20*10(-6);
4 Vgs_on = 8;
5 Vgs_th = 3;
6 Vgsq = 6.4;
7 Idq = 2.75*10(-3);
8 Id_on = 6*10(-3);
9 k = 0.24*10(-3);
10 Rf = 10*10(6);
11 Rd = 2*10(3);
12
13 gm = 2*k*(Vgsq-Vgs_th);
14 rd = 1/yos;
15 Zi = (Rf+(rd*Rd/(rd+Rd)))/(1+gm*(rd*Rd/(rd+Rd)));
16 Zi2 = Rf/(1+gm*Rd);
17 Zo = Rf*Rd*rd/(Rf*rd+rd*Rd+Rd*Rf);
18 Zo2 = Rd;
19 Av = -gm*Rf*Rd*rd/(Rf*rd+rd*Rd+Rd*Rf);
20 Av2 = -gm*Rd;
21
22 disp(gm, 'gm(S) = ');
23 disp(rd, 'rd(ohms) = ');
24 disp(Zi, 'Zi(ohms) = ');
25 disp(Zi2, 'Zi without rd(ohms) = ');
26 disp(Zo, 'Zo(ohms) = ');
27 disp(Zo2, 'Zo without rd(ohms) = ');
28 disp(Av, 'Voltage gain Av = ');
29 disp(Av2, 'Volatge gain Av(ignoring rd) = ');

```

---

### Scilab code Exa 8.13 Rd value determination

```

1 clear; clc; close;
2
3 yos = 30*10(-6);

```

```

4 Idss = 10*10(-3);
5 Idq = 10*10(-3);
6 Vp = -4;
7 Vgsq = 0;
8 Rg = 10*10(6);
9 Av = -15;
10 Vdd = 30;
11
12 gmo = 2*Idss/abs(Vp);
13 gm = gmo;
14 rd = 1/yos;
15
16 //let x = Rd||rd
17 x = -Av/gm;
18 Rd = 100*10(3)/30.33; //found by solving for x
19 Vdsq = Vdd-Idq*Rd;
20 Zi = Rg;
21 Zo = Rd*rd/(Rd+rd);
22
23
24 disp(Rd, 'Rd(ohms) = ');
25 disp(Zi, 'Zi(ohms) = ');
26 disp(Zo, 'Zo(ohms) = ');

```

---

#### Scilab code Exa 8.14 Rd and Rs determination

```

1 clear; clc; close;
2
3 yos = 20*10(-6);
4 Idss = 10*10(-3);
5 Idq = 10*10(-3);
6 Vp = -4;
7 Vdsq = Vp/4;
8 Rg = 10*10(6);
9 Av = -8;

```

```

10 Vdd = 20;
11
12
13 Vgsq = Vp/4;
14 Id = Idss*(1-(Vgsq/Vp))^2;
15 gmo = 2*Idss/abs(Vp);
16 gm = gmo*(1-(Vgsq/Vp));
17 //let Rd||rd = x
18 x = abs(Av)/gm;
19 rd = 1/yos;
20 Rd = 106.5*10^(3)/47.87;
21 Rs = -Vgsq/Id;
22
23 disp(Rd, 'Rd(ohms) = ');
24 disp(Rs, 'Rs(ohms) = ');

```

---

#### Scilab code Exa 8.15 Rd and Rs determination

```

1 clear; clc; close;
2
3 yos = 20*10^(-6);
4 Idss = 10*10^(-3);
5 Idq = 10*10^(-3);
6 Vp = -4;
7 Vdsq = Vp/4;
8 Rg = 10*10^(6);
9 Av = -8;
10 Vdd = 20;
11
12 Vgsq = Vp/4;
13 Id = Idss*(1-(Vgsq/Vp))^2;
14
15 Rs = -Vgsq/Id;
16
17 gmo = 2*Idss/abs(Vp);

```

```

18 gm = gmo*(1-(Vgsq/Vp));
19 Rd = -Av*(1+gm*Rs)/gm;
20
21 disp(Rs, 'Rs(ohms) = ');
22 disp(Rd, 'Rd(ohms) = ');

```

---

### Scilab code Exa 8.16 Network characteristics determination

```

1 clear; clc; close;
2
3 yos = 20*10^(-6);
4 Idss = 10*10^(-3);
5 Idq = 2.8*10^(-3);
6 Vp = -4;
7 Vgsq = -1.9;
8 Vi = 20*10^(-3);
9 Rd = 2.4*10^3;
10 Rg = 3.3*10^6;
11 Rl = 10*10^3;
12
13 gmo = 2*Idss/abs(Vp);
14 gm = gmo*(1-(Vgsq/Vp));
15 Av2 = -gm*Rd;
16 Av1 = -gm*(Rd*Rg/(Rd+Rg));
17 Av = Av1*Av2;
18 Vo = Av*Vi;
19 Zi = Rg;
20 Zo = Rd;
21 Vl = (Rl/(Zo+Rl))*Vo;
22
23
24 disp(gm, 'gm(S) = ');
25 disp(Av2, 'voltage gain = ');
26 disp(Vo, 'output voltage(Volts) = ');
27 disp(Zi, 'input impedance(ohms) = ');

```

```
28 disp(Zo, 'output impedance(ohms) = ');
29 disp(Vl, 'output voltage across the load(Volts) = ');
```

---

### Scilab code Exa 8.17 Input output impedance and output voltage

```
1 clear; clc; close;
2
3 Ri_stage2 = 15*(10^(3))*4.7*(10^(3))
      *1300/(15*(10^(3))*4.7*(10^(3))+4.7*(10^(3))
      *1300+15*(10^(3))*1300);
4 Rd1 = 2.4*10^(3);
5 Rd2 = 2.2*10^(3);
6 gm = 2.6*10^(-3);
7 Vi1 = 20*10^(-3);
8 Vi2 = 1*10^(-3);
9
10 Av1 = -gm*(Rd1*Ri_stage2/(Rd1+Ri_stage2));
11 Av2 = -338.46;
12 Av = Av1*Av2;
13 Vo1 = Av*Vi1;
14 Vo2 = Av*Vi2;
15 Zi = 3.3*10^(6);
16 Zo = Rd2;
17
18
19 disp(Vo2, 'Output voltage is ');
20 disp(Zi, 'Input impedance is ');
21 disp(Zo, 'Output impedance is ');
```

---

# Chapter 9

## BJT and JFET frequency response

Scilab code Exa 9.1 Log calculation

```
1 clear; clc; close;
2
3 disp(log10(10^6), 'ans for part a :- ');
4 disp(log(%e^3), 'ans for part b :- ');
5 disp(log10(10^(-2)), 'ans for part c :- ');
6 disp(log(%e^-1), 'ans for part d :- ');
```

---

Scilab code Exa 9.2 Log calculation

```
1 clear; clc; close;
2
3 disp(log10(64), 'ans for part a :- ');
4 disp(log(64), 'ans for part b :- ');
5 disp(log10(1600), 'ans for part c :- ');
6 disp(log10(8000), 'ans for part d :- ');
```

---



### Scilab code Exa 9.3 Anti Log calculation

```
1 clear; clc; close;
2
3 disp(10^1.6, 'ans for part a :- ');
4 disp(%e^0.04, 'ans for part b :- ');
```

---

### Scilab code Exa 9.4 Log calculation

```
1 clear; clc; close;
2
3 disp(log10(0.5), 'ans for part a :- ');
4 disp(log10(4000/250), 'ans for part b :- ');
5 disp(log10(0.6*30), 'ans for part c :- ');
```

---

### Scilab code Exa 9.5 Magnitude gain calculation

```
1 clear; clc; close;
2
3 Gdb = 100;
4 Ratio_V2_by_V1 = 10^(Gdb/20);
5
6 disp(Ratio_V2_by_V1, 'Magnitude gain = ');
```

---

### Scilab code Exa 9.6 Power and voltage gain

```

1 clear; clc; close;
2
3 Pi = 10*10^(3);
4 Po = 500;
5 Vi = 1000;
6 Ro = 20;
7
8 Gdb = 10*log10(Po/Pi);
9 Gv = 20*log10(sqrt(Po*Ro)/Vi);
10 Ri = Vi^2/Pi;
11
12 disp(Gdb, 'Power gain in decibels = ');
13 disp(Gv, 'Voltage gain in decibels = ');
14 disp(Ri, 'Ri(ohms) is ');
15 disp('which is not equal to Ro');

```

---

#### Scilab code Exa 9.7 Input power and input voltage

```

1 clear; clc; close;
2
3 Po = 40;
4 Ro = 10;
5 Gv = 40;
6 Gdb = 25;
7
8 Pi = Po/(10^(25/10));
9 disp(Pi, 'Input power in Watt = ');
10
11 Vo = sqrt(Po*Ro);
12 Vi = Vo/10^(Gv/20);
13 disp(Vi, 'Input voltage in volts = ');

```

---

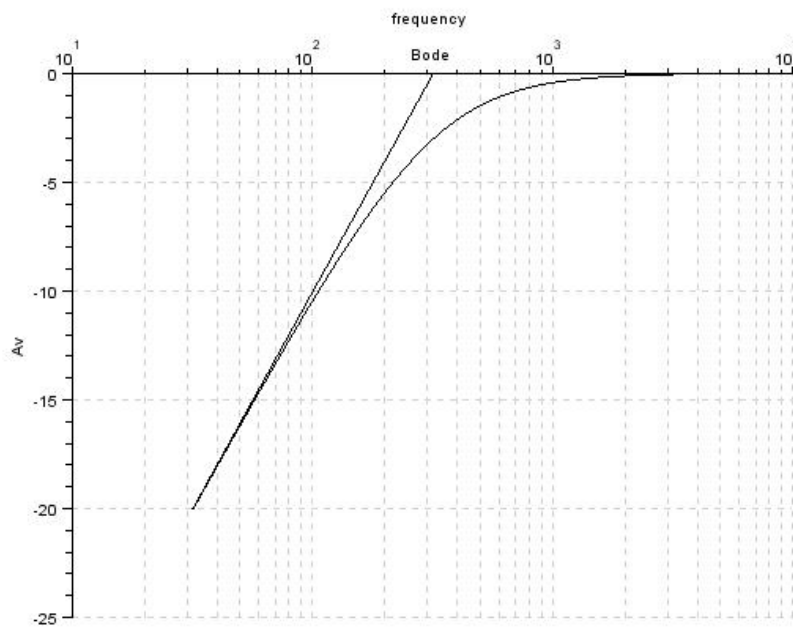


Figure 9.1: Break frequency and bode plot

### Scilab code Exa 9.8 Break frequency and bode plot

```
1 clear; clc; close;
2
3 R = 5*10^(3);
4 C = 0.1*10^(-6);
5
6 f1 = 1/(2*%pi*R*C);
7 disp(f1, 'Break frequency = ');
8
9 f = 31.85:10:10*f1;
10 av = (1+(f1./f)^2)^(-1/2); // -10*log10
11 av1 = -20*log10(f1/f1);
12 f2 = f1/10;
13 av2 = -20*log10(f1/f2);
14 f3 = f1/4;
15 av3 = -20*log10(f1/f3);
16 f4 = f1/2;
17 av4 = -20*log10(f1/f4);
18
19
20 x = [f2 f3 f4 f1];
21 y = [av2 av3 av4 av1];
22
23 gainplot(f, av);
24 a = gca();
25 a.y_location = 'left';
26 a.x_location = 'top';
27 a.x_label.text = 'frequency';
28 a.y_label.text = 'Av';
29 a.title.text = 'Bode';
30 plot2d(x, y);
```

---

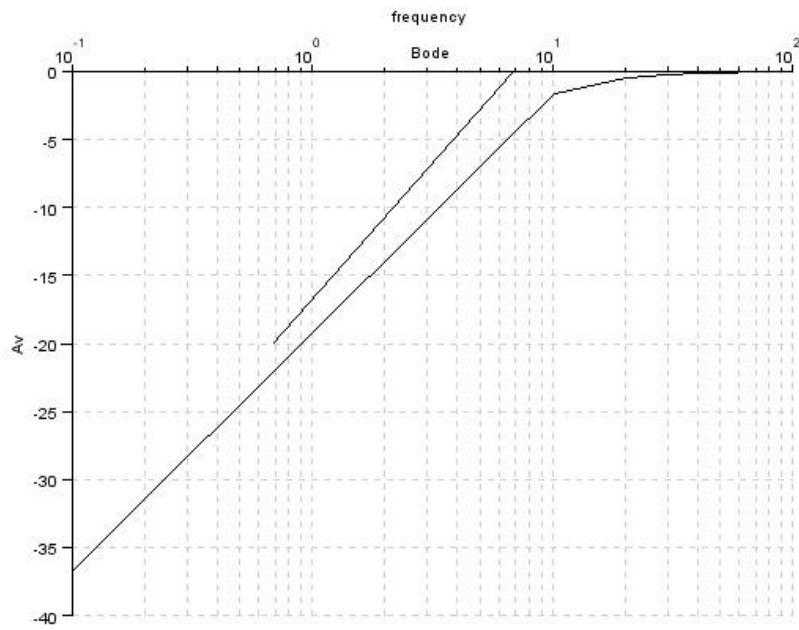


Figure 9.2: Frequency aand bode plot

### Scilab code Exa 9.9 Frequency aand bode plot

```

1 clear; clc; close;
2
3 Cs = 10*10^(-6);
4 Ce = 20*10^(-6);
5 Cc = 1*10^(-6);
6 Rs = 1*10^(3);
7 R1 = 40*10^(3);
8 R2 = 10*10^(3);

```

```

 9 Re = 2*10^(3);
10 Rc = 4*10^(3);
11 Rl = 2.2*10^(3);
12 Beta = 100;
13 ro = %inf;
14 Vcc = 20;
15 Ve = 4-0.7;
16
17 Vb = R2*Vcc/(R2+R1);
18 Ie = Ve/Re;
19 re = 26*10^(-3)/(1.65*10^(-3));
20 x = Beta*re;
21 Av = -Rc*Rl/((Rc+Rl)*re);
22 Zi = R1*R2*x/(R1*R2+R2*x+x*R1);
23 Ri = Zi;
24 Vi_by_Vs = Ri/(Ri+Rs);
25 Avs = Av*Vi_by_Vs;
26 fls = 1/(2*%pi*(Rs+Ri)*Cs);
27 disp(fl,'Low cutoff frequency is ');
28
29 f1 = fls;
30 f = .1:10:10*f1;
31 av = (1+(f1./f)^2)^(-1/2);
32 av1 = -20*log10(f1/f1);
33 f2 = f1/10;
34 av2 = -20*log10(f1/f2);
35 f3 = f1/4;
36 av3 = -20*log10(f1/f3);
37 f4 = f1/2;
38 av4 = -20*log10(f1/f4);
39
40
41 x = [f2 f3 f4 f1];
42 y = [av2 av3 av4 av1];
43
44 gainplot(f,av);
45 a = gca();
46 a.y_location = 'left';

```

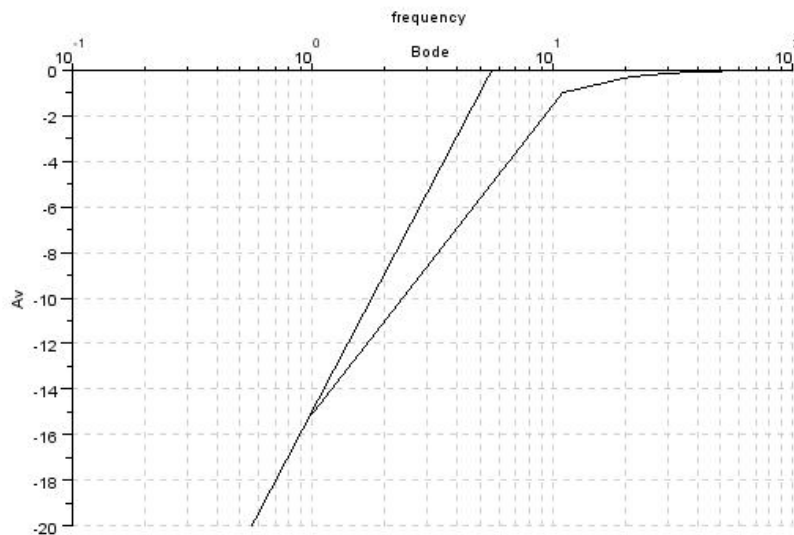


Figure 9.3: Frequency and bode plot

```

47 a.x_location = 'top';
48 a.x_label.text = 'frequency';
49 a.y_label.text = 'Av';
50 a.title.text = 'Bode';
51 plot2d(x,y);

```

---

#### Scilab code Exa 9.10 Frequency and bode plot

```

1 clear; clc; close;
2
3 Cs = 10*10^(-6);
4 Ce = 20*10^(-6);
5 Cc = 1*10^(-6);
6 Rs = 1*10^(3);

```

```

7 R1 = 40*10^(3);
8 R2 = 10*10^(3);
9 Re = 1.2*10^(3);
10 Rc = 4*10^(3);
11 Rl = 10*10^(3);
12 Beta = 100;
13 ro = %inf;
14 Vcc = 10;
15 Ve = 2-0.7;
16
17 Vb = R2*Vcc/(R2+R1);
18 Ie = Ve/Re;
19 re = 26*10^(-3)/(1.083*10^(-3));
20 x = Beta*re;
21 Av = -Rc*Rl/((Rc+Rl)*re);
22 Zi = R1*R2*x/(R1*R2+R2*x+x*R1);
23 Ri = Zi;
24 Vi_by_Vs = Ri/(Ri+Rs);
25 Avs = Av*Vi_by_Vs;
26 fls = 1/(2*pi*(Rs+Ri)*Cs);
27 disp(fl,'Low cutoff frequency is ');
28
29 f1 = fls;
30 f = 1:10:10*f1;
31 av = (1+(f1./f)^2)^(-1/2);
32 av1 = -20*log10(f1/f1);
33 f2 = f1/10;
34 av2 = -20*log10(f1/f2);
35 f3 = f1/4;
36 av3 = -20*log10(f1/f3);
37 f4 = f1/2;
38 av4 = -20*log10(f1/f4);
39
40
41 x = [f2 f3 f4 f1];
42 y = [av2 av3 av4 av1];
43
44 gainplot(f,av);

```



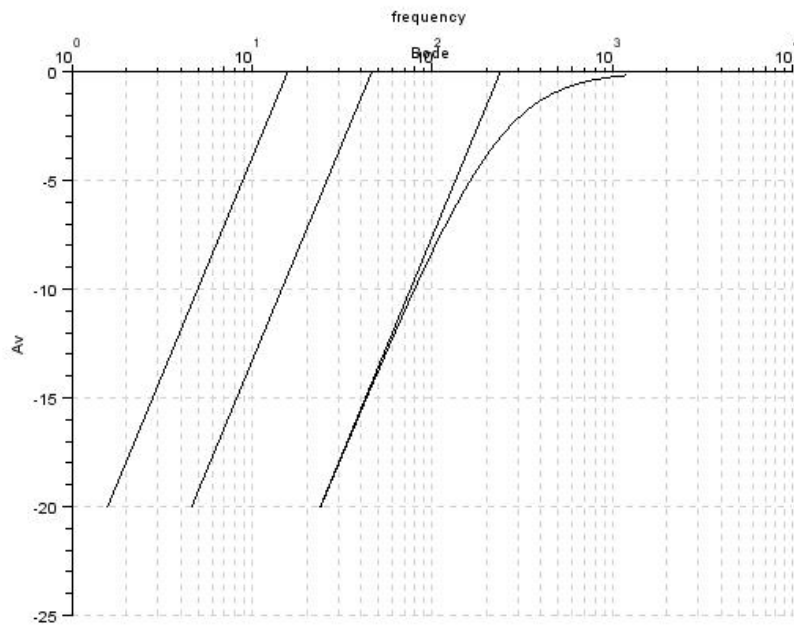


Figure 9.4: Frequency and bode plot

```

45 a = gca();
46 a.y_location = 'left';
47 a.x_location = 'top';
48 a.x_label.text = 'frequency';
49 a.y_label.text = 'Av';
50 a.title.text = 'Bode';
51 plot2d(x,y);

```

---

Scilab code Exa 9.11 Frequency and bode plot

```

1 clear; clc; close;

```

```

2
3 Cs = 2*10(-6);
4 Cg = 0.01*10(-6);
5 Cc = 0.5*10(-6);
6 Rs = 1*10(3);
7 Rg = 1*10(6);
8 Rsig = 10*10(3);
9 Rd = 4.7*10(3);
10 Rl = 2.2*10(3);
11
12 Idss = 8*10(-3);
13 Vp = -4;
14 rd = %inf;
15 Vdd = 20;
16
17 Vgsq = -2;
18 Idq = 2*10(-3);
19 gmo = 2*Idss/abs(Vp);
20 gm = gmo*(1-(Vgsq/Vp));
21 flg = 1/(2*%pi*(Rsig+Rg)*Cg);
22 flc = 1/(2*%pi*(Rd+Rl)*Cc);
23 Req = Rs*(1/gm)/(Rs+(1/gm));
24 fls = 1/(2*%pi*Req*Cs);
25 Avmid = -gm*(Rd*Rl/(Rd+Rl));
26
27 disp(fl_s, 'Lowest frequency cutoff = ');
28 disp(Avmid, 'midband gain = ');
29
30 f1 = fl_s;
31 f = .1*f1:10:5*f1;
32 av = (1+(f1./f)^2)(-1/2);
33 av1 = -20*log10(f1/f1);
34 f2 = f1/10;
35 av2 = -20*log10(f1/f2);
36 f3 = f1/4;
37 av3 = -20*log10(f1/f3);
38 f4 = f1/2;
39 av4 = -20*log10(f1/f4);

```

```

40
41 x = [f2 f3 f4 f1];
42 y = [av2 av3 av4 av1];
43
44 gainplot(f,av);
45 a = gca();
46 a.y_location = 'left';
47 a.x_location = 'top';
48 a.x_label.text = 'frequency';
49 a.y_label.text = 'Av';
50 a.title.text = 'Bode';
51 plot2d(x,y);
52
53
54 f1 = flg;
55 //f = .1*f1:10:10*f1;
56 av = -10*log10(1+(f1./f)^2);
57 av1 = -20*log10(f1/f1);
58 f2 = f1/10;
59 av2 = -20*log10(f1/f2);
60 f3 = f1/4;
61 av3 = -20*log10(f1/f3);
62 f4 = f1/2;
63 av4 = -20*log10(f1/f4);
64
65 x = [f2 f3 f4 f1];
66 y = [av2 av3 av4 av1];
67
68 plot2d(x,y);
69
70 f1 = flc;
71 //f = .1*f1:10:10*f1;
72 av = -10*log10(1+(f1./f)^2);
73 av1 = -20*log10(f1/f1);
74 f2 = f1/10;
75 av2 = -20*log10(f1/f2);
76 f3 = f1/4;
77 av3 = -20*log10(f1/f3);

```

```

78 f4 = f1/2;
79 av4 = -20*log10(f1/f4);
80
81 x = [f2 f3 f4 f1];
82 y = [av2 av3 av4 av1];
83 plot2d(x,y);

```

---

### Scilab code Exa 9.12 Frequency

```

1 clear; clc; close;
2
3 Cs = 10*10^(-6);
4 Ce = 20*10^(-6);
5 Cc = 1*10^(-6);
6 Rs = 1*10^3;
7 R1 = 40*10^3;
8 R2 = 10*10^3;
9 Re = 2*10^3;
10 Rc = 4*10^3;
11 Rl = 2.2*10^3;
12 Beta = 100;
13 ro = %inf;
14 re = 15.76;
15 Vcc = 20;
16 Ve = 4-0.7;
17 Cwo = 8*10^(-12);
18 Cwi = 6*10^(-12);
19 Cce = 1*10^(-12);
20 Cbc = 4*10^(-12);
21 Cbe = 36*10^(-12);
22 fls = 6.86;
23
24 Ri = 1.32*10^3;
25 Avmid = -90;
26 Rthi = Rs*R1*R2*Ri/(Rs*R1*R2+R1*R2*Ri+R2*Ri*Rs+Ri*Rs

```

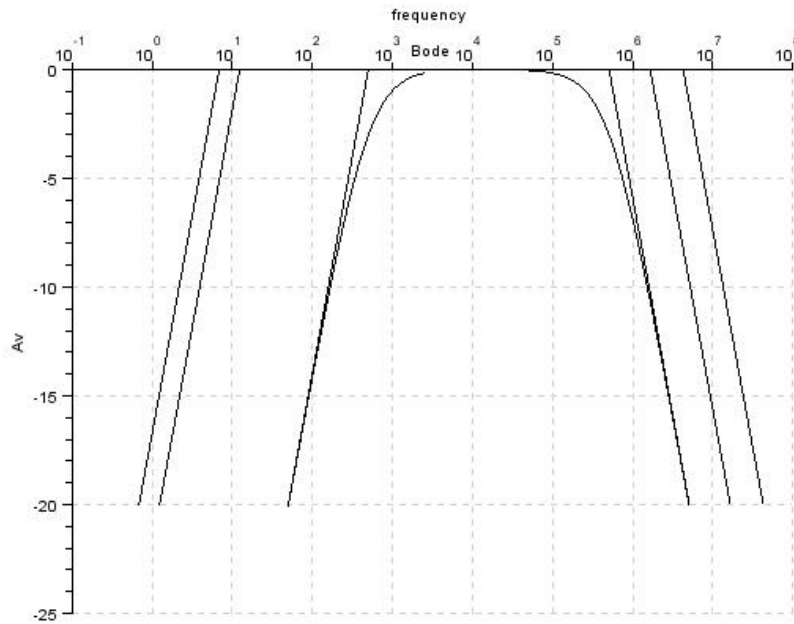


Figure 9.5: Frequency and bode plot

```

    *R1);
27 Ci = Cwi+Cbe+(1-Avmid)*Cbc;
28 fhi = 1/(2*pi*Rthi*Ci);
29 Rtho = Rc*Rl/(Rc+Rl);
30 Co = Cwo+Cce+(1-(1/Avmid))*Cbc;
31 fho = 1/(2*pi*Rtho*Co);
32 fbeta = 1/(2*pi*Beta*re*(Cbe+Cbc));
33 ft = Beta*fbeta;
34 disp(fhi, 'fhi = ');
35 disp(fho, 'fho = ');
36 disp(fbeta, 'fbeta = ');
37 disp(ft, 'ft = ');

```

---

### Scilab code Exa 9.13 Frequency and bode plot

```
1 clear; clc; close;
2
3 Cs = 10*10^(-6);
4 Ce = 20*10^(-6);
5 Cc = 1*10^(-6);
6 Rs = 1*10^3;
7 R1 = 40*10^3;
8 R2 = 10*10^3;
9 Re = 1.2*10^3;
10 Rc = 4*10^3;
11 Rl = 10*10^3;
12 Beta = 100;
13 ro = %inf;
14 re = 24.01;
15 Vcc = 10;
16 Ve = 2-0.7;
17 Cwo = 8*10^(-12);
18 Cwi = 6*10^(-12);
19 Cce = 1*10^(-12);
20 Cbc = 4*10^(-12);
21 Cbe = 36*10^(-12);
22 fls = 6.86;
23
24 Ri = 1.85*10^3;
25 Avmid = -119;
26 Rthi = Rs*R1*R2*Ri/(Rs*R1*R2+R1*R2*Ri+R2*Ri*Rs+Ri*Rs
    *R1);
27 Ci = Cwi+Cbe+(1-Avmid)*Cbc;
28 fhi = 1/(2*pi*Rthi*Ci);
29 Rtho = Rc*Rl/(Rc+Rl);
30 Co = Cwo+Cce+(1-(1/Avmid))*Cbc;
31 fho = 1/(2*pi*Rtho*Co);
```

```

32 fpie = 1/(2*%pi*Beta*re*(Cbe+Cbc));
33 ft = Beta*fpie;
34
35 disp(fhi, 'fhi = ');
36 disp(fho, 'fho = ');
37 disp(fpie, 'fbeta = ');
38 disp(ft, 'ft = ');
39 fle = 500;
40 flc = 1/(2*%pi*(Rl+Rtho)*Cc);
41
42 f1 = fle;
43 f = 0.1*f1:100:10*f1;
44 av = (1+(f1./f)^2)^(-1/2);
45 av1 = -20*log10(f1/f1);
46 f2 = f1/10;
47 av2 = -20*log10(f1/f2);
48 f3 = f1/4;
49 av3 = -20*log10(f1/f3);
50 f4 = f1/2;
51 av4 = -20*log10(f1/f4);
52
53 x = [f2 f3 f4 f1];
54 y = [av2 av3 av4 av1];
55
56 gainplot(f, av);
57 a = gca();
58 a.y_location = 'left';
59 a.x_location = 'top';
60 a.x_label.text = 'frequency';
61 a.y_label.text = 'Av';
62 a.title.text = 'Bode';
63 plot2d(x, y);
64
65
66 f1 = fls;
67 //f = .1*f1:10:10*f1;
68 av = -10*log10(1+(f1./f)^2);
69 av1 = -20*log10(f1/f1);

```

```

70 f2 = f1/10;
71 av2 = -20*log10(f1/f2);
72 f3 = f1/4;
73 av3 = -20*log10(f1/f3);
74 f4 = f1/2;
75 av4 = -20*log10(f1/f4);
76
77 x = [f2 f3 f4 f1];
78 y = [av2 av3 av4 av1];
79 plot2d(x,y);
80
81
82 f1 = flc;
83 //f = .1*f1:10:10*f1;
84 av = -10*log10(1+(f1./f)^2);
85 av1 = -20*log10(f1/f1);
86 f2 = f1/10;
87 av2 = -20*log10(f1/f2);
88 f3 = f1/4;
89 av3 = -20*log10(f1/f3);
90 f4 = f1/2;
91 av4 = -20*log10(f1/f4);
92
93 x = [f2 f3 f4 f1];
94 y = [av2 av3 av4 av1];
95 plot2d(x,y);
96
97 f1 = fhi;
98 f = 0.1*f1:100:10*f1;
99 av = (1+(f/f1)^2)^(-1/2);
100 av1 = -20*log10(f1/f1);
101 f2 = f1*10;
102 av2 = -20*log10(f2/f1);
103 f3 = f1*4;
104 av3 = -20*log10(f3/f1);
105 f4 = f1*2;
106 av4 = -20*log10(f4/f1);
107

```



```
108 x = [f1 f4 f3 f2];
109 y = [av1 av4 av3 av2];
110
111 gainplot(f,av);
112 plot2d(x,y);
113
114
115 f1 = fpie;
116 av1 = -20*log10(f1/f1);
117 f2 = f1*10;
118 av2 = -20*log10(f2/f1);
119 f3 = f1*4;
120 av3 = -20*log10(f3/f1);
121 f4 = f1*2;
122 av4 = -20*log10(f4/f1);
123
124 x = [f1 f4 f3 f2];
125 y = [av1 av4 av3 av2];
126
127 plot2d(x,y);
128
129
130 f1 = fho;
131 av1 = -20*log10(f1/f1);
132 f2 = f1*10;
133 av2 = -20*log10(f2/f1);
134 f3 = f1*4;
135 av3 = -20*log10(f3/f1);
136 f4 = f1*2;
137 av4 = -20*log10(f4/f1);
138
139 x = [f1 f4 f3 f2];
140 y = [av1 av4 av3 av2];
141
142 plot2d(x,y);
```

---

### Scilab code Exa 9.14 Frequency

```
1 clear; clc; close;
2
3 Cs = 2*10^(-6);
4 Cg = 0.01*10^(-6);
5 Cc = 0.5*10^(-6);
6 Rs = 1*10^(3);
7 Rg = 1*10^(6);
8 Rsig = 10*10^(3);
9 Rd = 4.7*10^(3);
10 Rl = 2.2*10^(3);
11 Idss = 8*10^(-3);
12 Vp = -4;
13 rd = %inf;
14 Vdd = 20;
15 Cgd = 2*10^(-12);
16 Cgs = 4*10^(-12);
17 Cds = 0.5*10^(-12);
18 Cwi = 5*10^(-12);
19 Cwo = 6*10^(-12);
20
21
22 Rthi = Rsig*Rg/(Rsig+Rg);
23 Av = -3;
24 Ci = Cwi+Cgs+(1-Av)*Cgd;
25 fhi = 1/(2*%pi*Rthi*Ci);
26 Rtho = Rd*Rl/(Rd+Rl);
27 Co = Cwo+Cds+(1-(1/Av))*Cgd;
28 fho = 1/(2*%pi*Rtho*Co);
29
30 disp(fhi, 'fhi = ');
31 disp(fho, 'fho = ');
```

---

### Scilab code Exa 9.15 Fourier transform and time

```
1 clear; clc; close;
2
3 V = 50*10(-3);
4 V_bar = 40*10(-3);
5 fs = 5*10(3);
6
7 vi = (4*10(-3)/%pi)*(sin(2*%pi*5*10(3)*%t)+(1/3)*
      sin(2*%pi*15*10(3)*%t)+(1/5)*sin(2*%pi*25*10(3)
      *%t)+(1/7)*sin(2*%pi*35*10(3)*%t)+(1/9)*sin(2*
      %pi*45*10(3)*%t));
8
9 tr = (18-2)*10(-6);
10 BW = 0.35/tr;
11 P = (V-V_bar)/V;
12 flo = (P/%pi)*fs;
13
14 disp(BW, 'Bandwidth is ');
15 disp(flo, 'Low cutoff frequency = ');
```

---

# Chapter 10

## Operational Amplifiers

Scilab code Exa 10.1 Dc voltages and currents calculation

```
1 clear; clc; close;
2
3 Vcc = 9;
4 Vee = Vcc;
5 Rc = 3.9*10^(3);
6 Re = 3.3*10^(3);
7
8
9 Ie = (Vee-0.7)/Re;
10 Ic = Ie/2;
11 Vc = Vcc-Ic*Rc;
12
13 disp(Ie, 'Emitter current (Amperes) = ');
14 disp(Ic, 'Collector current (Amperes) = ');
15 disp(Vc, 'Collector voltage (Volts) = ');
```

---

Scilab code Exa 10.2 Single ended output voltage

```

1 clear; clc; close;
2
3 Vcc = 9;
4 Vee = Vcc;
5 Vi = 2*10(-3);
6 Rc = 47*10(3);
7 Re = 43*10(3);
8
9
10 Ie = (Vee-0.7)/Re;
11 Ic = Ie/2;
12 Vc = Vcc-Ic*Rc;
13 re = 26/0.0965;
14 Av = Rc/(2*re);
15 Vo = Av*Vi;
16
17 disp(Vo, 'Single ended output voltage (Volts) = ');

```

---

### Scilab code Exa 10.3 Common mode gain

```

1 clear; clc; close;
2
3 Beta = 75;
4 Rc = 47*10(3);
5 ri = 20*10(3);
6 Re = 43*10(3);
7
8 Ac = Beta*Rc/(ri+2*(Beta+1)*Re);
9
10 disp(Ac, 'Common mode gain = ');

```

---

### Scilab code Exa 10.4 Common mode gain

```
1 clear; clc; close;
2
3 Beta = 75;
4 Rc = 10*10^(3);
5 ri = 11*10^(3);
6 Re = 200*10^(3);
7 ro = 200*10^(3);
8
9 Re = ro;
10 Ac = Beta*Rc/(ri+2*(Beta+1)*Re);
11
12 disp(Ac, 'Common mode gain = ');
```

---

#### Scilab code Exa 10.5 Output voltage

```
1 clear; clc; close;
2
3 Rf = 500*10^(3);
4 R1 = 100*10^(3);
5 V1 = 2;
6
7 Vo = -(Rf/R1)*V1;
8
9 disp(Vo, 'Output voltage (Volts) = ');
```

---

#### Scilab code Exa 10.6 Output voltage

```
1 clear; clc; close;
2
3 Rf = 500*10^(3);
4 R1 = 100*10^(3);
5 V1 = 2;
6
```

```
7 Vo = (1+(Rf/R1))*V1;
8
9 disp(Vo, 'Output voltage (Volts) = ');
```

---

#### Scilab code Exa 10.7 Output voltage

```
1 clear; clc; close;
2
3 //part a
4
5 V1 = 1;
6 V2 = 2;
7 V3 = 3;
8 R1 = 500*10^(3);
9 R2 = 1*10^(6);
10 R3 = 1*10^(6);
11 Rf = 1000*10^(3);
12
13 Vo = -((Rf/R1)*V1+(Rf/R2)*V2+(Rf/R3)*V3);
14 disp(Vo, 'Output voltage (Volts) = ');
15
16 //part b
17
18
19 V1 = -2;
20 V2 = 3;
21 V3 = 1;
22 R1 = 200*10^(3);
23 R2 = 500*10^(3);
24 R3 = 1*10^(6);
25 Rf = 1000*10^(3);
26
27 Vo = -((Rf/R1)*V1+(Rf/R2)*V2+(Rf/R3)*V3);
28 disp(Vo, 'Output voltage (Volts) = ');
```

---

### Scilab code Exa 10.8 Output offset voltage

```
1 clear; clc; close;
2
3 Vio = 1.2*10^(-3);
4 R1 = 2*10^3;
5 Rf = 150*10^3;
6
7 Vo = Vio*((R1+Rf)/R1);
8 disp(Vo, 'Output offset voltage (Volts) = ');
```

---

### Scilab code Exa 10.9 Output offset voltage

```
1 clear; clc; close;
2
3 Iio = 100*10^(-9);
4 Rf = 150*10^3;
5
6 Vo = Iio*Rf;
7 disp(Vo, 'Output offset voltage (Volts) = ');
```

---

### Scilab code Exa 10.10 Total offset voltage

```
1 clear; clc; close;
2
3 Iio = 150*10^(-9);
4 Rf = 500*10^3;
5 R1 = 5*10^3;
6 Vio = 4*10^(-3);
```



```

7
8 Vo_vio = Vio*(R1+Rf)/R1;
9 Vo_io = Iio*Rf;
10 Vo = Vo_vio+Vo_io;
11
12 disp(Vo, 'Total voltage offset (Volts) = ');

```

---

#### Scilab code Exa 10.11 Input bias current

```

1 clear; clc; close;
2
3 Iio = 5*10^(-9);
4 Iib = 30*10^(-9);
5
6 Iib_positive = Iib + Iio/2;
7 Iib_negative = Iib -Iio/2;
8
9 disp(Iib_positive, 'Positive input bias current(
    Amperes) = ');
10 disp(Iib_negative, 'Negative input bias current(
    Amperes) = ');

```

---

#### Scilab code Exa 10.12 Cut off frequency

```

1 clear; clc; close;
2
3 B1 = 1*10^(6);
4 Avd = 200*10^(3); //converting from V/mV
5
6 f1 = B1;
7 fc = f1/Avd;
8
9 disp(fc, 'Cutoff frequency (Hertz) = ')

```

---

**Scilab code Exa 10.13** Maximum closed loop voltage gain

```
1 clear; clc; close;
2
3 SR = 2;
4 Vi_delta = 0.5;
5 t_delta = 10;
6
7 Acl = SR/(Vi_delta/t_delta);
8
9 disp(Acl, 'Maximum Closed loop voltage gain = ');
```

---

**Scilab code Exa 10.14** Maximum frequency

```
1 clear; clc; close;
2
3 Rf = 240*10^(3);
4 R1 = 10*10^(3);
5 Vi = 0.02;
6 w = 300*10^(3);
7 SR = 0.5;
8
9 Acl = abs(Rf/R1);
10 K = Acl*Vi;
11 w1 = SR/K;
12
13 disp(w, 'Since this frequency is much less than
    maximum obtained, hence no distortion will be
    observed');
```

---

### Scilab code Exa 10.15 Current drawn calculation

```
1 clear; clc; close;
2
3 V = 12;
4 P = 250*10(-3);
5
6 I = P/V;
7
8 disp(I, 'Current drawn(Amperes) = ');
```

---

### Scilab code Exa 10.16 Output offset voltage

```
1 clear; clc; close;
2
3 Rf = 360*10(3);
4 R1 = 12*10(3);
5 Iio = 20*10(-9);
6 Vio = 1*10(-3);
7
8 Vo_vio = Vio*(R1+Rf)/R1;
9 Vo_iio = Iio*Rf;
10 Vo = Vo_vio + Vo_iio;
11
12 disp(Vo, 'Output offset voltage(Volts) = ');
```

---

### Scilab code Exa 10.17 Gain and input output impedance calculation

```
1 clear; clc; close;
2
3 Rf = 360*10(3);
4 R1 = 12*10(3);
5 ro = 75;
```

```

6 A = 200*10^(3);
7 Beta = 1/30;
8
9 Acl = -Rf/R1;
10 Zi = R1;
11 Zo = ro/(1+Beta*A)
12
13 disp(Acl, 'Acl = ');
14 disp(Zi, 'Zi(Ohms) = ');
15 disp(Zo, 'Zo(Ohms) = ');

```

---

#### Scilab code Exa 10.18 Cut off frequency

```

1 clear; clc; close;
2
3 B1 = 1*10^(6);
4 Avd = 20*10^3;
5
6 f1 = B1;
7 fc = f1/Avd;
8
9
10 disp(fc, 'Cutoff frequency(Hertz) = ');

```

---

#### Scilab code Exa 10.19 Maximum frequency

```

1 clear; clc; close;
2
3 Vi = 25*10^(-3);
4 Acl = 30;
5 SR = 0.5*10^6; //convertin from us to s
6
7 K = Acl*Vi;

```

```
8 fmax = SR/(2*%pi*K);
9
10 disp(fmax, 'Maximum frequency (Hertz) = ');
```

---

Scilab code Exa 10.20 Open loop voltage gain

```
1 clear; clc; close;
2
3 Avd_db = 104;
4 Avd = 10^(104/20);
5
6 disp(Avd, 'Open loop voltage gain (Volts) = ');
```

---

Scilab code Exa 10.21 CMRR calculation

```
1 clear; clc; close;
2
3 Vo = 8;
4 Vo_1 = 12*10^(-3);
5 Vd = 1*10^(-3);
6 Vc = 1*10^(-3);
7
8
9 Ad = Vo/Vd;
10 Ac = Vo_1/Vc;
11 CMRR = Ad/Ac;
12 CMRR = 20*log10(Ad/Ac);
13
14 disp(CMRR, 'CMRR(dB) = ');
```

---

### Scilab code Exa 10.22 Output voltage

```
1 clear; clc; close;
2
3 Vi1 = 150*10^(-6);
4 Vi2 = 140*10^(-6);
5 Ad = 4000;
6
7 //part a
8 CMRR = 100;
9
10 Vd = Vi1 - Vi2;
11 Vc = 1/2*(Vi1+Vi2);
12 Vo = Ad*Vd*(1+(1/CMRR)*(Vc/Vd));
13 disp(Vo, 'Output voltage (Volts) = ');
14
15
16 //part b
17
18 CMRR = 100000;
19
20 Vd = Vi1 - Vi2;
21 Vc = 1/2*(Vi1+Vi2);
22 Vo = Ad*Vd*(1+(1/CMRR)*(Vc/Vd));
23 disp(Vo, 'Output voltage (Volts) = ');
```

---

# Chapter 11

## Op Amp Applications

Scilab code Exa 11.1 Output voltage

```
1 clear; clc; close;
2
3 Rf = 200*10^(3);
4 R1 = 2*10^(3);
5 Vi = 2.5*10^(-3);
6
7 A = -Rf/R1;
8 Vo = A*Vi;
9
10 disp(Vo, 'Output voltage (Volts) = ');
```

---

Scilab code Exa 11.2 Output voltage

```
1 clear; clc; close;
2
3 Rf = 240*10^(3);
4 R1 = 2.4*10^(3);
5 Vi = 120*10^(-6);
```

```
6
7 A = 1+(Rf/R1);
8 Vo = A*Vi;
9
10 disp(Vo, 'Output voltage (Volts) = ');
```

---

### Scilab code Exa 11.3 Output voltage

```
1 clear; clc; close;
2
3 Rf = 470*10^(3);
4 R1 = 4.3*10^(3);
5 R2 = 33*10^(3);
6 R3 = 33*10^(3);
7
8 Vi = 80*10^(-6);
9
10 A = ((1+(Rf/R1))*(-Rf/R2))*(-Rf/R3));
11 Vo = A*Vi;
12
13 disp(Vo, 'Output voltage (Volts) = ');
```

---

### Scilab code Exa 11.4 Output voltage

```
1 clear; clc; close;
2
3 Rf = 270*10^(3);
4 A1 = 10;
5 A2 = -18;
6 A3 = -27;
7 Vi = 150*10^(-6);
```



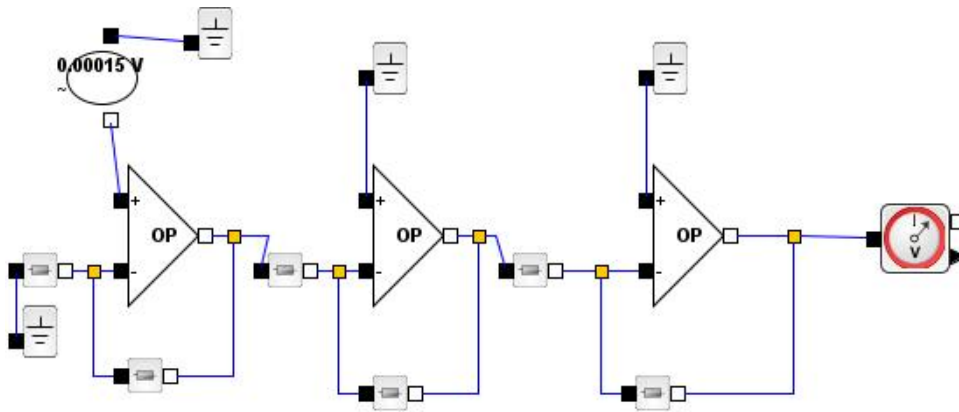


Figure 11.1: Output voltage

```

8
9
10 R1 = Rf / (A1 - 1);
11 R2 = Rf / -A2;
12 R3 = Rf / -A3;
13
14 Vo = A1 * A2 * A3 * Vi;
15
16 disp(Vo, 'Output voltage (Volts) = ');

```

---

### Scilab code Exa 11.5 Connection of op amp stages

```

1 clear; clc; close;
2
3 Rf = 500 * 10^3;
4 A1 = -10;
5 A2 = -20;
6 A3 = -50;
7

```

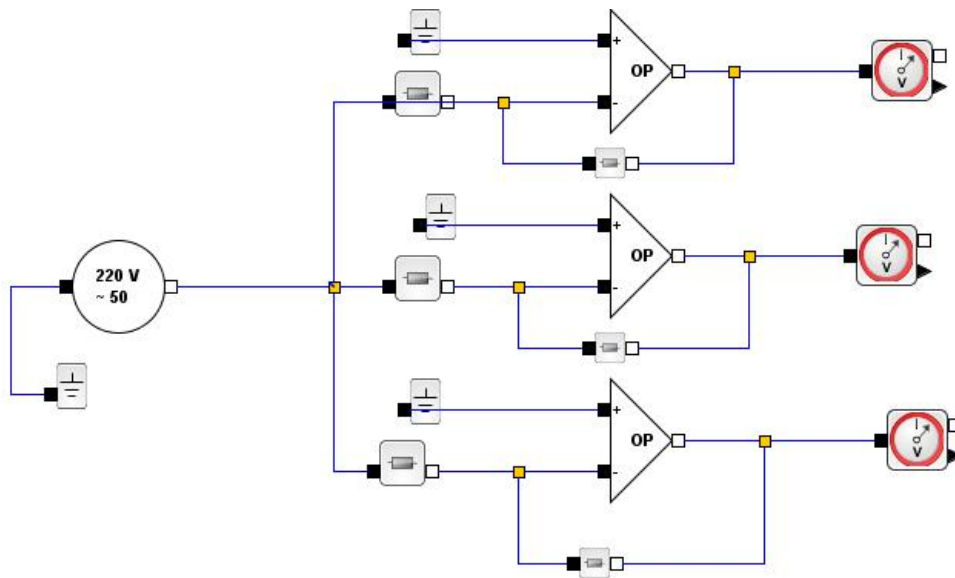


Figure 11.2: Connection of op amp stages

```

8 R1 = -Rf/A1;
9 R2 = -Rf/A2;
10 R3 = -Rf/A3;
11
12
13 disp(R1, 'R1(ohms) = ');
14 disp(R2, 'R2(ohms) = ');
15 disp(R3, 'R3(ohms) = ');

```

---

#### Scilab code Exa 11.6 Output voltage

```

1 clear; clc; close;
2
3 v1 = ["*sin(1000t)"];
4 v2 = ["*sin(3000t)"];
5

```

```

6 Vo = strcat([string(-(330*10^3)/(33*10^3)*50*10^(-3)
    ),v1,string(-(330*10^3)/(10*10^3)*10^(-3)),v2]);
7
8 disp(Vo,'Output voltage (Volts) = ');

```

---

#### Scilab code Exa 11.7 Output voltage

```

1 clear; clc; close;
2
3 Rf = 1*10^(6);
4 R1 = 100*10^(3);
5 R2 = 50*10^(3);
6 R3 = 500*10^(3);
7
8 v2 = ["*V2"];
9 v1 = ["*V1"];
10 Vo = strcat([string((-Rf/R2)),v2,"+",string((Rf/R3)
    *(Rf/R1)),v1]);
11
12 disp(Vo,'Output voltage = ');

```

---

#### Scilab code Exa 11.8 Output voltage

```

1 clear; clc; close;
2
3 Vo = strcat([ string((20/(20+20)) * ((100+100)/100))
    ,"*V1",string(-(100*10^3)/(100*10^3)),"*V2"]);
4
5 disp(Vo,'Output voltage = ');

```

---

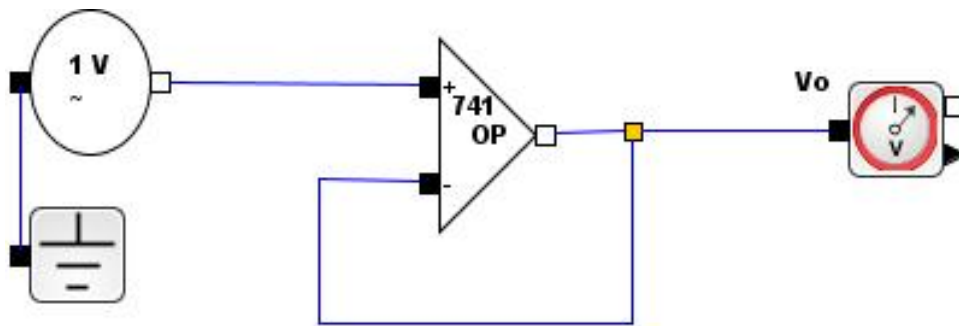


Figure 11.3: Connection of unity gain ckt

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in)

#### Scilab code Exa 11.10 I1 and Vo calculation

```

1  clear; clc; close;
2
3  V1 = 8;
4  R1 = 2*10^3;
5  I1 = 10*10^(-3);
6
7
8  I1 = V1/R1;
9  Vo = -I1*R1;
10
11 disp(I1, 'I1(Ampere) = ');
12 disp(Vo, 'Vo(Volts) = ');

```

---

#### Scilab code Exa 11.11 Output voltage

```

1 clear; clc; close;
2
3 R = 5000;
4 Rp = 500;
5
6
7 a = ['*(V1-V2)'];
8 Vo = strcat([string((1+(2*R/Rp))),a]);
9
10 disp(Vo, 'Output voltage ');

```

---

#### Scilab code Exa 11.12 Cut off frequency

```

1 clear; clc; close;
2
3 R1 = 1.2*10^(3);
4 C1 = 0.02*10^(-6);
5
6 foh = 1/(2*pi*R1*C1);
7
8 disp(foh, 'Cutoff frequency of low pass filter (Hertz)
= ');

```

---

#### Scilab code Exa 11.13 Cut off frequency of high pass filter

```

1 clear; clc; close;
2
3 Rf = 50*10^(3);
4 Rg = 10*10^(3);
5 R1 = 2.1*10^(3);
6 C1 = 0.05*10^(-6);
7
8 Av = 1+(Rf/Rg);

```

```
9 fol = 1/(2*%pi*R1*C1);
10
11 disp(fol, 'Cutoff frequency of second order high pass
    filter (Hertz) = ');
```

---

Scilab code Exa 11.14 Cut off frequency of band pass filter

```
1 clear; clc; close;
2
3 R1 = 10*10^(3);
4 R2 = 10*10^(3);
5 C1 = 0.1*10^(-6);
6 C2 = 0.002*10^(-6);
7
8
9 fol = 1/(2*%pi*R1*C1);
10 foh = 1/(2*%pi*R2*C2);
11
12 disp(fol, 'Low Cutoff frequency of band pass filter (
    hertz) = ');
13 disp(foh, 'High Cutoff frequency of band pass filter (
    hertz) = ');
```

---

# Chapter 12

## Power Amplifiers

Scilab code Exa 12.1 input output power and efficiency

```
1 clear; clc; close;
2
3 Vcc = 20;
4 Rb = 1*10^(3);
5 Rc = 20;
6 Beta = 25;
7 Ib_p = 10*10^(-3);
8
9
10 Ibq = (Vcc-0.7)/Rb;
11 Ib = Ibq;
12 Icq = Beta*Ibq;
13 Ic = Icq;
14 Vceq = Vcc-Ic*Rc;
15 Ic_p = Beta*Ib_p;
16 Po_ac = (Ic_p^2)*Rc/2;
17 Pi_dc = Vcc*Icq;
18 n = (Po_ac/Pi_dc)*100;
19
20 disp(Po_ac, 'Output power = ');
21 disp(Pi_dc, 'Input power = ');
```

```
22 disp(n, 'Efficiency in percentage = ');
```

---

### Scilab code Exa 12.2 Effective Resistance

```
1 clear; clc; close;
2
3 a = 15;
4 R1 = 8;
5
6 R1_dash = (a^2)*R1;
7
8 disp(R1_dash, 'Effective resistance looking into
   primary transformer is ');
```

---

### Scilab code Exa 12.3 Turns ratio

```
1 clear; clc; close;
2
3 R1_dash = 10*10^(3);
4 R1 = 8;
5
6 N1_N2 = sqrt(R1_dash/R1);
7
8 disp(N1_N2, 'Turns ratio = ');
```

---

### Scilab code Exa 12.4 Ac power delivered

```
1 clear; clc; close;
2
3 Vcc = 10;
```



```

4 a = 3;
5 Rl = 8;
6
7
8 Vceq = Vcc;
9 Vce = Vceq;
10 Icq = 140*10(-3);
11
12 Rl_dash = (a2)*Rl;
13 Ic = Vce/Rl_dash;
14
15 Vce_min = 1.7;
16 Vce_max = 18.3;
17 Ic_min = 25*10(-3);
18 Ic_max = 255*10(-3);
19
20 Po_ac = (Vce_max-Vce_min)*(Ic_max-Ic_min)/8;
21
22 disp(Po_ac, 'Ac Power delivered (Watts) = ');

```

---

#### Scilab code Exa 12.5 input and dissipated power and efficiency

```

1 clear; clc; close;
2
3 Vcc = 10;
4 Icq = 140*10(-3);
5 Po_ac = 0.477;
6
7
8 Pi_dc = Vcc*Icq;
9 Pq = Pi_dc-Po_ac;
10 n = (Po_ac/Pi_dc)*100;
11
12 disp(Pi_dc, 'Dc input power (Watts) = ');
13 disp(Pq, 'Power dissipated by transistor (Watts) = ');

```

```
14 disp(n, 'Efficiency (Percentage) = ');
```

---

### Scilab code Exa 12.6 Efficiency calculation

```
1 clear; clc; close;
2
3 Vcc = 12;
4
5 //part a
6 V_p = 12;
7 Vceq = Vcc;
8 Vce_max = Vceq + V_p;
9 Vce_min = Vceq - V_p;
10
11 n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;
12
13 disp(n, 'Efficiency (Percentage) = ');
14
15 //part b
16 V_p = 6;
17 Vceq = Vcc;
18 Vce_max = Vceq + V_p;
19 Vce_min = Vceq - V_p;
20
21 n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;
22
23 disp(n, 'Efficiency (Percentage) = ');
24
25
26 //part c
27 V_p = 8;
28 Vceq = Vcc;
29 Vce_max = Vceq + V_p;
30 Vce_min = Vceq - V_p;
31
```

```
32 n = 50*((Vce_max-Vce_min)/(Vce_max+Vce_min))^2;
33
34 disp(n, 'Efficiency (Percentage) = ');
```

---

#### Scilab code Exa 12.7 Input output power and efficiency

```
1 clear; clc; close;
2
3 V1_p = 20;
4 Vcc = 30;
5 R1 = 16;
6
7
8 I1_p = V1_p/R1;
9 Idc = (2/%pi)*I1_p;
10 Pi_dc = Vcc*Idc;
11 Po_ac = ((V1_p)^2)/(2*R1);
12 n = (Po_ac/Pi_dc)*100;
13
14
15 disp(Pi_dc, 'Input power (Watts) = ');
16 disp(Po_ac, 'Output power (Watts) = ');
17 disp(n, 'Efficiency (Percentage) = ');
```

---

#### Scilab code Exa 12.8 Power and transmission dissipation

```
1 clear; clc; close;
2
3 Vcc = 30;
4 R1 = 16;
5
6
7 Po_max = (Vcc^2)/(2*R1);
```

```

8 Pi_max = (2*Vcc^2)/(%pi*Rl);
9 n_max = (Po_max/Pi_max)*100;
10 Pq_max = (1/2)*(2*Vcc^2/((%pi^2)*Rl));
11
12 disp(Po_max, 'Maximum output power(Watts) = ');
13 disp(Pi_max, 'Maximum input power(Watts) = ');
14 disp(Pq_max, 'Transmission dissipation(Watts) = ');

```

---

### Scilab code Exa 12.9 Efficiency calculation

```

1 clear; clc; close;
2
3 Vcc = 24;
4
5 //part a
6 Vl_p = 22;
7 n = 78.54*(Vl_p/Vcc);
8 disp(n, 'Efficiency(Percentage) = ');
9
10
11 //part b
12 Vl_p = 12;
13 n = 78.54*(Vl_p/Vcc);
14 disp(n, 'Efficiency(Percentage) = ');

```

---

### Scilab code Exa 12.10 Input output dissipated power and efficiency

```

1 clear; clc; close;
2
3 Vi_rms = 12;
4 Rl = 4;
5 Vcc = 25;
6

```

```

7
8
9 Vi_p = sqrt(2)*Vi_rms;
10 Vl_p = Vi_p;
11 Po_ac = (Vl_p^2)/(2*Rl);
12 Il_p = Vl_p/Rl;
13 Idc = (2/%pi)*(Il_p);
14 Pi_dc = Vcc*Idc;
15 Pq = (Pi_dc-Po_ac)/2;
16
17 n = (Po_ac/Pi_dc)*100;
18
19 disp(Po_ac, 'Output power(Watts) = ');
20 disp(Pi_dc, 'Input power(Watts) = ');
21 disp(Pq, 'Power dissipated(Watts) = ');
22 disp(n, 'Efficiency(Percentage) = ');

```

---

### Scilab code Exa 12.11 Dissipated power and efficiency

```

1 clear; clc; close;
2
3 Vcc =25;
4 Rl = 4;
5
6
7 Po_max = (Vcc^2)/(2*Rl);
8 Pi_max = (2*Vcc^2)/(%pi*Rl);
9 n_max = (Po_max/Pi_max)*100;
10 Vl_p = Vcc;
11 P2q = Pi_max-Po_max;
12
13
14 disp(Po_max, 'Output power(Watts) = ');
15 disp(Pi_max, 'Input power(Watts) = ');
16 disp(P2q, 'Power dissipated(Watts) = ');

```

```
17 disp(n_max, 'Efficiency (Percentage) = ');
```

---

#### Scilab code Exa 12.12 Max dissipated power and input voltage

```
1 clear; clc; close;
2
3 Vcc =25;
4 R1 = 4;
5 V1_p = Vcc;
6
7 P2q_max = (2*Vcc^2)/((%pi^2)*R1);
8 V1 = 0.636*V1_p;
9
10 disp(P2q_max, 'Maximum power dissipated (Watts) = ');
11 disp(V1, 'Input voltage at which this occurs (Volts) =
    ');
```

---

#### Scilab code Exa 12.13 Harmonic distortion components

```
1 clear; clc; close;
2
3 A1 = 2.5;
4 A2 = 0.25;
5 A3 = 0.1;
6 A4 = 0.05;
7
8 D2 = (abs(A2)/abs(A1))*100;
9 D3 = (abs(A3)/abs(A1))*100;
10 D4 = (abs(A4)/abs(A1))*100;
11
12
13 disp(D2, 'Second harmonic distortion (Percentage) = ');
    ;
```

```
14 disp(D3, 'Third harmonic distortion (Percentage) = ');
15 disp(D4, 'Fourth harmonic distortion (Percentage) = ');
    ;
```

---

#### Scilab code Exa 12.14 Total Harmonic distortion components

```
1 clear; clc; close;
2
3 D2 = 0.1;
4 D3 = 0.04;
5 D4 = 0.02;
6
7 THD = sqrt((D2^2)+(D3^2)+(D4^2))*100;
8
9 disp(THD, 'Total harmonic distortion (Percentage) = ');
    ;
```

---

#### Scilab code Exa 12.15 Second Harmonic distortion

```
1 clear; clc; close;
2
3 //part a
4 Vce_min = 1;
5 Vce_max = 22;
6 Vceq = 12;
7 D2 = abs(((1/2)*(Vce_max+Vce_min)-Vceq)/(Vce_max -
    Vce_min))*100;
8 disp(D2, 'Second harmonic distortion (Percentage) = ');
    ;
9
10 //part b
11 Vce_min = 4;
12 Vce_max = 20;
```

```

13 Vceq = 12;
14 D2 = abs(((1/2)*(Vce_max+Vce_min)-Vceq)/(Vce_max-
    Vce_min))*100;
15 disp(D2,'Second harmonic distortion(Percentage) = ')
    ;

```

---

**Scilab code Exa 12.16** Total Harmonic distortion and fundamental and total power

```

1 clear; clc; close;
2
3 D2 = 0.1;
4 D3 = 0.02;
5 D4 = 0.01;
6 I1 = 4;
7 Rc = 8;
8
9 THD = sqrt((D2^2)+(D3^2)+(D4^2));
10 P1 = (I1^2)*Rc/2;
11 P = (1+THD^2)*P1;
12
13 disp(THD,'Total harmonic distortion = ');
14 disp(P1,'Fundamental power component(Watts) = ');
15 disp(P,'Total power(Watts) = ');

```

---

**Scilab code Exa 12.17** Maximum dissipation

```

1 clear; clc; close;
2
3 Pd_temp0 = 80;
4 T1 = 100;
5 T0 = 25;
6 D = 0.5;
7

```



```
8
9 Pd_temp1 = Pd_temp0 - (T1 - T0) * (D);
10
11 disp(Pd_temp1, 'Maximum power dissipation (Watts) = ');
;
```

---

### Scilab code Exa 12.18 Max dissipated power

```
1 clear; clc; close;
2
3 Tj = 200;
4 Ta = 40;
5 Qjc = 0.5;
6 Qcs = 0.6;
7 Qsa = 1.5;
8
9
10 Pd = (Tj - Ta) / (Qjc + Qcs + Qsa);
11
12 disp(Pd, 'Maximum power dissipated (Watts) = ');
```

---

# Chapter 13

## Linear Digital ICs

Scilab code Exa 13.1 frequency and output waveform

```
1 clear; clc; close;
2
3 Ra = 7.5*10^(3);
4 Rb = 7.5*10^(3);
5 C = 0.1*10^(-6);
6
7 Thigh = 0.7*(Ra+Rb)*C;
8 Tlow = 0.7*(Rb*C);
9 T = Thigh +Tlow;
10
11 f = 1/T;
12
13 disp(f, 'Frequency = ');
14
15
16 x = 0:0.001:1.575;
17 y = 5*(x<=1.05) + 1*(x>1.05);
18 plot2d(x,y);
19 a = gca();
```

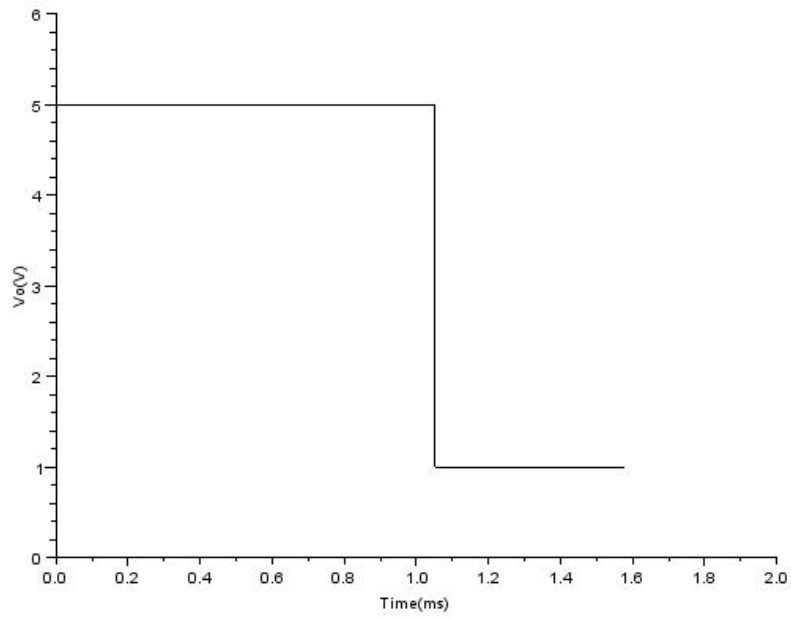


Figure 13.1: frequency and output waveform

```
20 a.data_bounds = [0 0;2 5.2];
21 a.x_label.text = 'Time(ms)';
22 a.y_label.text = 'Vo(V)';
```

---

### Scilab code Exa 13.2 Period of output waveform

```
1 clear; clc; close;
2
3 Ra = 10*10^(3);
4 C = 0.1*10^(-6);
5
6 Thigh = 1.1*Ra*C;
7
8 disp(Thigh, 'Period of output waveform = ')
```

---

# Chapter 14

## Feedback and oscillator circuits

Scilab code Exa 14.1 input output impedance and voltage gain

```
1 clear; clc; close;
2
3 A = -100;
4 Zi = 10*10^(3);
5 Zo = 20*10^(3);
6
7
8 //part a
9 Beta = -0.1;
10 Af = A/(1+Beta*A);
11 Zif = Zi*(1+Beta*A);
12 Zof = Zo/(1+Beta*A);
13
14 disp(Af, 'Voltage gain for part a= ');
15 disp(Zif, 'Input impedance for part a= ');
16 disp(Zof, 'Output Impedance for part a= ');
17
18 //part b
19 Beta = -0.5;
20 Af = A/(1+Beta*A);
21 Zif = Zi*(1+Beta*A);
```

```

22 Zof = Zo/(1+Beta*A);
23
24 disp(Af, 'Voltage gain for part b = ');
25 disp(Zif, 'Input impedance for part b = ');
26 disp(Zof, 'Output Impedance for part b = ');

```

---

#### Scilab code Exa 14.2 change in gain of feedback amplifier

```

1 clear; clc; close;
2
3 Beta = -0.1;
4 dA_A = 20;
5 A = -1000;
6
7 dAf_Af = abs(1/(Beta*A))*abs((dA_A));
8 disp(dAf_Af, 'Percentage Change in gain of feedback
   amplifier = ');

```

---

#### Scilab code Exa 14.3 gain with and without feedback

```

1 clear; clc; close;
2
3 R1 = 80*10^(3);
4 R2 = 20*10^(3);
5 Ro = 10*10^(3);
6 Rd = 10*10^(3);
7 gm = 4000*10^(-6);
8
9
10 R1 = Ro*Rd/(Ro+Rd);
11 A = -gm*R1;
12 Beta = -R2/(R1+R2);
13 Af = A/(1+Beta*A);

```

```
14
15 disp(A, 'Gain without feedback = ');
16 disp(Af, 'Gain with feedback = ');
```

---

#### Scilab code Exa 14.4 amplifier gain

```
1 clear; clc; close;
2
3 R1 = 1.8*10^(3);
4 R2 = 200;
5 A = 100000;
6
7
8 Beta = R2/(R1+R2);
9 Af = A/(1+Beta*A);
10 Af = 1/Beta;
11
12 disp(Af, 'Amplifier gain = ');
```

---

#### Scilab code Exa 14.5 voltage gain

```
1 clear; clc; close;
2
3 hfe = 120;
4 hie = 900;
5 Re = 510;
6 Rc = 2.2*10^(3);
7 re = 7.5;
8
9 A = -hfe/(hie+Re);
10 Beta = -Re;
11 Af = A/(1+Beta*A);
12 Avf = Af*Rc;
```

```
13 Av = -Rc/re;
14
15
16 disp(Avf, 'Voltage gain with feedback = ');
17 disp(Av, 'Voltage gain without feedback = ');
```

---

#### Scilab code Exa 14.6 voltage gain

```
1 clear; clc; close;
2
3 gm = 5*10^(-3);
4 Rd = 5.1*10^(3);
5 Rs = 1*10^(3);
6 Rf = 10*10^(3);
7
8
9 Av = -gm*Rd;
10 Avf = (-gm*Rd)*(Rf/(Rf+(gm*Rd*Rs)));
11
12 disp(Av, 'Voltage gain without feedback = ');
13 disp(Avf, 'Voltage gain with feedback = ');
```

---

#### Scilab code Exa 14.7 value of C

```
1 clear; clc; close;
2
3 R = 10*10^(3);
4 f = 5*10^(3);
5 A = 40;
6 gm = 5000*10^(-6);
7
8 C = 1/(2*%pi*R*f*sqrt(6));
9 Rl = abs(A)/gm;
```



```
10
11 disp(C, 'Value of C = ');
12 disp(Rl, 'Value of Rl = ');
```

---

#### Scilab code Exa 14.8 resonant frequency and RC elements

```
1 clear; clc; close;
2
3 R = 51*10^(3);
4 C = 0.001*10^(-6);
5
6
7 fo = 1/(2*%pi*R*C);
8
9 disp(fo, 'Resonant frequency = ');
10
11 fo2 = 2*fo;
12 RC = 1/(2*%pi*fo2);
13 R = 50*10^(3);
14 C = 510*10^(-12);
15
16 disp(R, 'Value of R can be = ');
17 disp(C, 'Value of C can be = ');
```

---

#### Scilab code Exa 14.9 RC elements for wien bridge

```
1 clear; clc; close;
2
3 fo = 5*10^(3);
4
5 R = 50*10^(3);
6 C = 1/(2*%pi*fo*R);
7
```

```
8 disp(R, 'Value of R can be = ');  
9 disp(C, 'Value of C is = ');
```

---

# Chapter 15

## Power Supplies

Scilab code Exa 15.1 Measure output and filter voltage

```
1 clear; clc; close;
2
3 Vdc = 25;
4 Vr = 1.5;
5
6
7 r_a = (Vr/Vdc)*100;
8 r_b = (Vr*0.35/Vdc)*100;
9
10 disp(r_a, 'Ripple value in part a = ');
11 disp(r_b, 'New Ripple value in part b = ');
```

---

Scilab code Exa 15.2 Voltage regulation value

```
1 clear; clc; close;
2
3 Vn1 = 60;
4 Vf1 = 56;
```

```
5
6 VR = ((Vn1-Vf1)/Vf1)*100;
7
8 disp(VR, 'Voltage regulation in percentage = ');
```

---

### Scilab code Exa 15.3 Ripple voltage and output voltage value

```
1 clear; clc; close;
2
3 //part a
4 Idc = 50*10(-3);
5 C = 100*10(-6);
6
7 Vr_rms = 2.4*(10(-3))*Idc/(C);
8
9 disp(Vr_rms, 'Ripple voltage = ');
10
11 //part b
12
13 Rl = 100;
14
15 Vdc = Vr_rms*Rl*C/2.4;
16
17 disp(Vdc, 'Output voltage = ');
```

---

### Scilab code Exa 15.4 Filter dc voltage value

```
1 clear; clc; close;
2
3 Vm = 30;
4 Idc = 50;
5 C = 100;
6
```

```
7 Vdc = Vm - 4.17*Idc/C;
8
9 disp(Vdc, 'Filter dc voltage = ');
```

---

#### Scilab code Exa 15.5 Ripple of capacitor

```
1 clear; clc; close;
2
3 Idc = 50;
4 C = 100;
5 Vdc = 27.9;
6
7 r = (2.4*Idc/(C*Vdc))*100;
8
9 disp(r, 'Ripple value of capacitor in percentage = ');
;
```

---

#### Scilab code Exa 15.6 dc voltage across 1k load

```
1 clear; clc; close;
2
3 R1 = 1000;
4 R = 120;
5 Vdc = 60;
6
7 Vdc_dash = (R1/(R+R1))*Vdc;
8
9 disp(Vdc_dash, 'Dc voltage across 1k-ohm load = ');
```

---

#### Scilab code Exa 15.7 dc ac and ripple values of output signal

```

1 clear; clc; close;
2
3 Rl = 5*10^(3);
4 R = 500;
5 Vdc = 150;
6 C = 10*10^(-3);
7 Vr_rms = 15;
8
9 Vdc_dash = (Rl/(R+Rl))*Vdc;
10 Xc = 1.3/C;
11 Vr_rms_dash = (Xc/R)*Vr_rms;
12 r = (Vr_rms_dash/Vdc_dash)*100;
13
14 disp(Vdc_dash, 'Dc component of output voltage = ');
15 disp(Vr_rms_dash, 'Ac component of output voltage = '
    );
16 disp(r, 'Ripple = ');

```

---

#### Scilab code Exa 15.8 output voltage and zener current

```

1 clear; clc; close;
2
3 Vz = 12;
4 Vbe = 0.7;
5 Vi = 20;
6 Rl = 5*10^(3);
7 Ic = 2.26*10^(-3);
8 Beta = 50;
9 R = 220;
10
11 Vo = Vz-Vbe;
12 Vce = Vi-Vo;
13 Ir = (Vi-Vz)/R;
14 Il = Vo/Rl;
15 Ib = Ic/Beta;

```

```
16 Iz = Ir-Ib;
17
18 disp(Vo, 'Output voltage = ');
19 disp(Iz, 'Zener current = ');
```

---

#### Scilab code Exa 15.9 regulated output voltage

```
1 clear; clc; close;
2
3 R1 = 20*10^(3);
4 R2 = 30*10^(3);
5 Vz = 8.3;
6 Vbe = 0.7;
7
8 Vo = ((R1+R2)/R2)*(Vz+Vbe);
9
10 disp(Vo, 'Regulated Output voltage = ');
```

---

#### Scilab code Exa 15.10 regulated output voltage

```
1 clear; clc; close;
2
3 Vo = (1+( 30*10^(3)/(15*10^(3)) ))*6.2;
4
5 disp(Vo, 'Regulated Output voltage = ');
```

---

#### Scilab code Exa 15.11 regulated voltage and circuit current

```
1 clear; clc; close;
2
```

```

3 R1 = 320;
4 Vi = 22;
5 Rs = 120;
6
7
8 V1 = 8.2+0.7;
9 I1 = V1/R1;
10 Is = (Vi-V1)/Rs;
11 Ic = Is-I1;
12
13 disp(V1, 'V1 = ');
14 disp(I1, 'I1 = ');
15 disp(Is, 'Is = ');
16 disp(Ic, 'Ic = ');

```

---

**Scilab code Exa 15.13** minimum input voltage

```

1 clear; clc; close;
2
3 Idc = 400*10^(-3);
4 C = 250*10^(-6);
5 Vm = 15;
6 Vdc = 15;
7
8 Vr_peak = sqrt(3)*2.4*(10^-3)*Idc/C;
9 Vi = Vdc - Vr_peak;
10
11 disp(Vi, 'Minimum input voltage = ');

```

---

**Scilab code Exa 15.14** max value of load current

```

1 clear; clc; close;
2

```



```

3 Vm = 15;
4 Vi_min = 7.3;
5 C = 250*10(-6);
6
7 Vr_peak = Vm - Vi_min;
8 Vr_rms = Vr_peak/sqrt(3);
9
10 Idc = Vr_rms*C/(2.4*(10-3));
11
12 disp(Idc, 'Max value of load current = ');

```

---

#### Scilab code Exa 15.15 regulated output voltage

```

1 clear; clc; close;
2
3 Vo = 1.25*(1+ (1.8*103/240)) + (100*10(-6))
   * (1.8*103);
4
5 disp(Vo, 'Regulated Output voltage = ');

```

---

#### Scilab code Exa 15.16 regulated output voltage

```

1 clear; clc; close;
2
3 Vo = 1.25*(1+ (1.8*103/240)) + (100*10(-6))
   * (1.8*103);
4
5 disp(Vo, 'Regulated Output voltage = ');

```

---