

Scilab Textbook Companion for
Integrated Electronics: Analog And Digital
Circuits and Systems
by J. Millman And C. C. Halkias¹

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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 Energy Band in Solid	7
2 Transport Phenomena in Semiconductor	9
5 Transistor Characteristic	13
6 Digital Circuits	21
7 Integrated Circuit Fabrication and Characteristic	34
8 The Transistor at Low Frequency	38
9 Transistor Biasing and Thermal Stabilization	45
10 Field Effect Transistor	56
12 MultiStage Amplifiers	64
13 Feedback Amplifier	66
14 Stability and Oscillators	81
15 Operational Amplifier	84
16 Integrated Circuits as Analog System Building blocks	88
18 Power Circuits and Systems	100

List of Scilab Codes

Exa 1.1	Plane Parallel plate Capacitor	7
Exa 2.1.a	Using Avogadro no find the numerical value of concentration of atom in Germanium	9
Exa 2.1.b	Resistivity of intrinsic Germanium	10
Exa 2.1.c	Resistivity with given condition in germanium atoms	11
Exa 2.1.d	Ratio of Conductivities	11
Exa 5.1.a	To find transistor currents for npn transistor	13
Exa 5.1.b	To find transistor currents for npn transistor after adding resistor to circuit	14
Exa 5.2.a	Check whether transistor is in saturation region or not	16
Exa 5.2.b	Check whether transistor is in saturation region or not after adding a Emitter Transistor	17
Exa 6.1	Output Levels for a given input in a silicon transistor	21
Exa 6.2	To verify given equation	22
Exa 6.3.a	To find wether a given circuit is positive NAND	23
Exa 6.3.b	To find wether with given conditions NAND gate is satisfied	24
Exa 6.3.c	Silicon Transistors and diodes are used in positive NAND	25
Exa 6.4	To verify that AND OR topology is equivalent to NAND NAND system	26
Exa 6.5.a	To find hFEmin	27
Exa 6.5.b	When atleast one input is at V0 in NAND gate	29
Exa 6.5.c	If input is high in NAND gate	30
Exa 6.5.d	If input is low in NAND gate	31
Exa 6.6	Calculation of FAN OUT of NAND gate	31
Exa 7.1	Diffusion of a pn junction	34
Exa 7.2.a	Fabrication and Characteristics	35
Exa 7.2.b	Fabrication and Characteristics	36

Exa 8.2	transistor as a Common Emitter Amplifier	38
Exa 8.3	To derive output impedance of given figure in open circuit voltage short circuit current theorem	39
Exa 8.4	Parameters of a Common Emitter Amplifier	40
Exa 8.5	CE CC configuration	41
Exa 8.6	Parameters of CE CC configuration	43
Exa 9.1	To find Q point	45
Exa 9.2	To find resistances in 2N335 transistor	46
Exa 9.3.a	Variation of I_c in given Transistor	47
Exa 9.3.b	Variation of I_c in given Transistor	49
Exa 9.4	To design a self bias circuit	51
Exa 9.5	Value of theta for Ge Transistor	53
Exa 9.6.a	To find parameters of power amplifier using pnp germanium transistor	53
Exa 9.6.b	To find parameters of power amplifier using pnp germanium transistor	54
Exa 10.1.a	Pinch off V and channel half width of silicon FET	56
Exa 10.1.b	Pinch off V and channel half width of silicon FET	57
Exa 10.2.a	Amplifier using n channel FET	57
Exa 10.2.b	Amplifier using n channel FET	58
Exa 10.2.c	Amplifier using n channel FET	59
Exa 10.2.d	Amplifier using n channel FET	59
Exa 10.3.a	To find the parameters of a FET 2N3684	60
Exa 10.3.b	To find the range of possible values of I_d in FET 2N3684 from the graph	61
Exa 10.4	Voltage Gain of MOSFET as a single stage and then as first transistor	62
Exa 12.1.a	Minimum value of coupling capacitance for a given FET	64
Exa 12.1.b	Minimum value of coupling capacitance for a given FET	65
Exa 13.1	parameters of a Second collector to first emitter feedback amplifier	66
Exa 13.2.a	To find parameters of Current series Feedback Amplifier	68
Exa 13.2.b	To find parameters of Current series Feedback Amplifier	69
Exa 13.2.c	To find parameters of Current series Feedback Amplifier	70
Exa 13.2.d	To find parameters of Current series Feedback Amplifier	71
Exa 13.3.a	Gain of second emitter to first basefeedback pair	72
Exa 13.3.b	Gain of second emitter to first basefeedback pair	73
Exa 13.3.c	Gain of second emitter to first basefeedback pair	74

Exa 13.3.d Gain of second emitter to first basefeedback pair . . .	76
Exa 13.4.a To find gain and resistance of Voltage Shunt Feedback	77
Exa 13.4.b To find gain and resistance of Voltage Shunt Feedback	78
Exa 13.4.c To find gain and resistance of Voltage Shunt Feedback	79
Exa 14.1.a Lowest poles of an Amplifier	81
Exa 14.1.b Frequency Response Peak	82
Exa 15.1.a difference in output voltage for two set of output signals	84
Exa 15.1.b difference in output voltage for two set of output signals	85
Exa 15.2 Design an amplifier using yA702A	87
Exa 16.1 Fourth Order Butterworth Filter	88
Exa 16.2 Design a second order bandpass filter	89
Exa 16.3 Design a video amplifier using MC1550	90
Exa 16.4.a Logic Level Output of an ECL gate	91
Exa 16.4.b Calculation of noise margin	93
Exa 16.4.c Verify that conducting transistor is in active region . .	94
Exa 16.4.d Calculation of R	96
Exa 16.4.e Average power dissipated by the gate	97
Exa 18.1.a Design a series regulated power supply	100
Exa 18.1.b Calculation of Sv	102
Exa 18.1.c Find output resistance Ro	103
Exa 18.1.d Calculation of change in output voltage due to change in input voltage and load current	105
Exa 18.2.a SCR half wave power control circuit	107
Exa 18.2.b SCR half wave power control circuit	108
Exa 18.2.c SCR half wave power control circuit	109
Exa 18.3 SCR Relaxation Oscillator Phase control Circuit . . .	110

Chapter 1

Energy Band in Solid

Scilab code Exa 1.1 Plane Parallel plate Capacitor

```
1 clear all;
2 clc;
3
4 //Caption: Plane Parallel plate Capacitor
5 //Given Data
6 d=0.001;//distance between parallel plate in m
7 V=1000;//applied voltage
8 q=1.6*(10^-19);//charge on an electron
9 m = 9.1*(10^-31);//mass of electron in kg
10 //Time taken by electron to reach other side of
    parallel plate capacitor
11 E=V/d;//Electric Field in V/m
12 //Formulae : s = u*t + (a*t^2)/2
13 a = (q*E)/m;//acceleration on electron in m/s^2
14 t = (2*d/a)^0.5;//time taken to reach the other side
    of plate
15 disp('sec',t,'Time taken to reach other side = ');
16
17 //Magnitude of force exerted on electron
18 disp('Since the potential is constant the force will
    be constant between the plates of capacitor');
```



```
19 F=q*E;//force
20 disp('N',F,'Force on electron = ');
21
22 //Velocity of electron at the other plate
23 //Formulae: v = u + a*t
24 v = a*t;//velocity at the end of other plate
25 disp('m/sec ',v,'v=');
26
27
28 //end
```

Chapter 2

Transport Phenomena in Semiconductor

Scilab code Exa 2.1.a Using Avogadro no find the numerical value of concentration of atom in Germanium

```
1 clear all;
2 clc
3
4 //Example 2a
5 //Using Avogadro no. find the numerical value of
   concentration of atom in Germanium
6
7 //Given Values
8
9 Av=6.02*(10^23) //Avogadro No.
10 m=72.6 //Molar mass of germanium in gm/moles
11 d=5.32//density in gm/cm^3
12
13 conc = (Av/m)*d //Concentration of atom in germanium
14
15 disp('atom/cm^3',conc,'The concentration of
   germanium atom is=');
16
```

17 //End

Scilab code Exa 2.1.b Resistivity of intrinsic Germanium

```
1 clear all;
2 clc
3
4 //Example 2b
5 //To find the resistivity of intrinsic germanium at
   300K
6
7 //Given Values
8
9 Av=6.02*(10^23) //Avogadro No.
10 m=72.6 //Molar mass of germanium in gm/moles
11 d=5.32//density in gm/cm^3
12 ni=2.5*(10^13);//in cm^-3
13 n=ni;
14 p=ni;//n=magnitude of free electrons , p=magnitude of
   holes , ni=magnitude of intrinsic concentration
15 q=1.6*(10^-19);//Charge of an Electron
16 yn=3800;//in cm^2/V-s
17 yp=1800;//in cm^2/V-s
18
19 //Required Formula
20 A=ni*q*(yn+yp); // Conductivity
21 disp('ohm-cm^-1',A,'Conductivity is =');
22
23 R =1/A // Resistivity
24 disp('ohm-cm',R,'Resistivity is =');
25
26 //End
```

Scilab code Exa 2.1.c Resistivity with given condition in germanium atoms

```
1 clear all;
2 clc;
3
4 disp('We know that n=p=ni where n is conc of free
      electron p is conc of holes and ni is conc of
      intrinsic carriers');
5 //Given data
6 //Resistivity if 1 donor atom per 10^8 germanium
  atoms
7 Nd=4.41*(10^14); //in atoms/cm^3
8 ni=2.5*(10^13); //in cm^3
9 yn=3800; //in cm^2/V-s
10 q=1.6*(10^-19);
11
12 n=Nd;
13 p=(ni^2)/Nd;
14
15 disp('holes/cm^3',p,'the concentration of holes is=');
    );
16 if(n>p)
17     A=n*q*yn; // Conductivity
18     disp('ohm-cm^-1',A,'The conductivity is =');
19 end
20
21 R=1/A; // Resistivity
22 disp('ohm-cm',R,'The resistivity is=');
23
24
25 //End
```

Scilab code Exa 2.1.d Ratio of Conductivities

```
1 clear all;
```

```

2  clc;
3
4  disp('We know that n=p=ni where n is conc of free
        electron p is conc of holes and ni is conc of
        intrinsic carriers');
5  //Given data
6  //Ratio of Conductivities
7  Nd=4.41*(10^14); //in atoms/cm^3
8  ni=2.5*(10^13); //in cm^3
9  yn=3800; //in cm^2/V-s
10 q=1.6*(10^-19);
11
12 n=Nd;
13 A=n*q*yn; //Conductivity
14
15 //If germanium atom were monovalent metal , ratio of
        conductivity to that of n-type semiconductor
16
17 n=4.41*(10^22); //in electrons/cm^3
18
19 disp('If germanium atom were monovalent metal');
20 A1=n*q*yn;
21 disp('ohm=cm^-1',A1,'the conductivity of metal is=');
22
23 F=A1/A;
24 disp(F,'The factor by which the conductivity of metal
        is higher than that of n type semiconductor is')
        ;
25
26 //End

```

Chapter 5

Transistor Characteristic

Scilab code Exa 5.1.a To find transistor currents for npn transistor

```
1 clear all;
2 clc;
3
4 //Example 1.1
5 //Caption : Program to find transistor currents for
   npn transistor.
6
7 //Given Values
8
9 //Silicon Transistor
10 B=100; //Beta
11 Ico=20; //in nA
12 Rc=3;
13 Rb=200;
14 Vbb=5; //in V
15 Vcc=10; //in V
16 Vbe=0.7; //in Active region
17
18 //Applying KVL to base circuit
19
20 //Vbb+Rb*Ib+Vbe=0
```

```

21
22 Ib=(Vbb-Vbe)/Rb; //in mA
23
24 //Ico<<Ib
25
26 Ic=B*Ib; //in mA
27
28 //To verify the Active region Assumption
29
30 //Vcc+Rc*Ic+Vcb+Vbe=0
31
32 Vcb=(-Rc*Ic)+Vcc-Vbe; //in V
33
34 disp('V',Vcb,'Vcb = ');
35
36 if(Vcb>0)
37     disp('Positive value of Vcb represents reversed
          biased collector junction and Transistor in
          active region');
38 end
39
40 disp('mA',Ic,'Current in transistor(Ic) is ');
41
42 disp('mA',Ib,'Current in transistor(Ib) is ');
43
44 //End

```

Scilab code Exa 5.1.b To find transistor currents for npn transistor after adding resistor to circuit

```

1 clear all;
2 clc;
3
4 //Example 1.2
5 //Caption : Program to find transistor currents for

```

```

        npn transistor after adding resistor to circuit.
6
7 //Given Values
8
9 //Silicon Transistor
10 B=100; //Beta
11 Ico=20; //in nA
12 Rc=3;
13 Ico=20; //in nA
14 Rb=200;
15 Re=2;
16 Vbb=5; //in V
17 Vcc=10; //in V
18 Vbe=0.7; //in Active region
19
20 //Ico<<Ib Assuming
21
22 //Itot=Ib+Ic=Ib+B*Ib=(B+1)*Ib
23
24 //Applying KVL to base circuit
25
26 //Vbb+Rb*Ib+Vbe+Re*Itot=0
27
28 Ib=(Vbb-Vbe)/(Rb+(Re*(B+1))); //in mA
29
30 Ic=B*Ib; //in mA
31
32 //Hence Ico<<Ib
33
34 //To verify the Active region Assumption
35
36 //Vcc+Rc*Ic+Vcb+Vbe=0
37
38 Vcb=(-Rc*Ic)+Vcc-Vbe-(Re*(B+1)*Ib); //in V
39
40 disp('V',Vcb,'Vcb = ');
41
42 if(Vcb>0)

```



```

43     disp('Positive value of Vcb represents reversed
         biased collector junction and Transistor in
         active region');
44 end
45
46 disp('mA',Ic,'Current in transistor(Ic) is ');
47
48 disp('mA',Ib,'Current in transistor(Ib) is ');
49
50
51 //End

```

Scilab code Exa 5.2.a Check whether transistor is in saturation region or not

```

1  clear all;
2  clc;
3
4  //Caption : Program to find transistor currents for
         npn transistor and check whether transistor is in
         saturation region or not.
5
6  //Given Values
7
8  //Silicon Transistor
9
10 Rc=3;
11 Rb=50;
12 Vbb=5; //in V
13 Vcc=10; //in V
14 Vce=0.2; //in V
15 Vbe=0.8; //in Active region
16 hFE=100;
17
18 //Assuming transistor in saturated region

```

```

19
20 //Applying KVL to base circuit
21
22 //Vbb+Rb*Ib+Vbe=0
23
24 Ib=(Vbb-Vbe)/Rb; //in mA
25
26 //Applying KVL to Collector circuit
27
28 //Vcc+Rc*Ic+Vce=0
29
30 Ic=(Vcc-Vce)/Rc; //in mA
31
32 Ib_min=Ic/hFE;
33
34 disp('mA',Ib_min,'Minimum Ib = ');
35
36 if(Ib>Ib_min)
37     disp('Transistor in saturated Region');
38 end
39
40 disp('mA',Ic,'Current in transistor(Ic) is');
41
42 disp('mA',Ib,'Current in transistor(Ib) is');
43
44
45 //End

```

Scilab code Exa 5.2.b Check whether transistor is in saturation region or not after adding a Emitter Transistor

```

1 clear all;
2 clc;
3
4 //Caption : Program to find transistor currents for

```

```

    npn transistor and check whether transistor is in
    saturation region or not after adding a Emitter
    Transistor.
5
6 //Given Values
7
8 //Silicon Transistor
9
10 Beta=100; //Beta
11 Rc=3;
12 Rb=50;
13 Re=2;
14 Vbb=5; //in V
15 Vcc=10; //in V
16 Vce=0.2; //in V
17 Vbe=0.8; //in Active region
18 hFE=100;
19
20 //Assuming transistor in saturated region
21
22 //Applying KVL to base circuit
23
24 
$$-V_{bb} + R_b I_b + V_{be} + R_e (I_c + I_b) = 0$$

25
26 //Simplifying  $(R_b + R_e) I_b + R_e I_c = V_{bb} - V_{be}$ 
27
28 //Applying KVL to Collector circuit
29
30 
$$-V_{cc} + R_c I_c + V_{ce} + R_e (I_c + I_b) = 0$$

31
32 //Simplifying  $R_e I_b + (R_c + R_e) I_c = V_{cc} - V_{ce}$ 
33
34
35  $A = [(R_b + R_e) \quad R_e; R_e, (R_c + R_e)];$ 
36  $B = [(V_{bb} - V_{be}); (V_{cc} - V_{ce})];$ 
37  $X = A \setminus B;$ 
38  $I_b = X(1);$ 
39  $I_c = X(2);$ 

```

```

40
41 Ib_min=Ic/hFE;
42
43 disp('mA',Ib_min,'Minimum Ib = ');
44
45
46 disp('mA',Ic,'Current in transistor(Ic)');
47
48 disp('mA',Ib,'Current in transistor(Ib)');
49
50 if(Ib>Ib_min)
51     disp('Transistor in Saturated Region');
52 else
53     disp('Transistor not in Saturated Region.Hence
        must be operating in Active region');
54 end
55
56 //Ico<<Ib Assuming
57
58 //Itot=Ib+Ic=Ib+B*Ib=(B+1)*Ib
59
60 //Applying KVL to base circuit
61
62 //Vbb+Rb*Ib+Vbe+Re*Itot=0
63
64 Ib=(Vbb-Vbe)/(Rb+(Re*(Beta+1))); //in mA
65
66 Ic=Beta*Ib; //in mA
67
68 //Hence Ico<<Ib
69
70 //To verify the Active region Assumption
71
72 //Vcc+Rc*Ic+Vcb+Vbe=0
73
74 Vcb=(-Rc*Ic)+Vcc-Vbe-(Re*(Beta+1)*Ib); //in V
75
76 disp('V',Vcb,'Vcb = ');

```

```
77
78 if(Vcb>0)
79     disp('Positive value of Vcb represents reversed
          biased collector junction and Transistor in
          active region');
80 end
81
82 disp('mA',Ic,'Current in transistor(Ic) is ');
83
84 disp('mA',Ib,'Current in transistor(Ib) is ');
85
86
87
88 //End
```

Chapter 6

Digital Circuits

Scilab code Exa 6.1 Output Levels for a given input in a silicon transistor

```
1 clear all;
2 clc;
3
4 //Caption:Output Levels for a given input in a
   silicon transistor
5 //Given Data
6 R1=15;//in K
7 R2=100;//in K
8 //R1 and R2 are voltages at base which acts as
   potential divider
9 Rc=2.2;//voltage at collector in K
10 hfe=30;
11
12 //For vi=0
13 Vb = (R1/(R1+R2))*(-12);//Voltage at base in V
14 disp('V',Vb,'Vb=');
15 //A bias of 0V is required to cut off a silicon
   emitter junction transistor given in table
16 Vo = 0;//in V
17 disp('Vo',Vo,'Vo = ');
18
```

```

19 //For vi=12
20 vi=12;//in V
21 //Few standard values for silicon transistor
22 Vbesat=0.8;//in V
23 Vcesat=0.2;//in V
24 //Assumption: Q is in saturation region
25 Ic = (vi-Vcesat)/Rc;//Collector Current
26 disp('mA',Ic,'Ic=');
27 Ibmin=(Ic/hfe);//Minimum current at the base
28 disp('mA',Ibmin,'Ibmin=');
29 I1=(vi-Vbesat)/R1;//Current in R1
30 I2=(Vbesat-(-12))/100;//Current in R2
31 Ib = I1-I2;//Base current
32 disp('mA',Ib,'Ib=');
33
34 if(Ib>Ibmin)
35     disp('Since Ib>Ibmin , The transistor is in
          saturation region and drop is Vcesat');
36     vo=Vcesat;
37     disp('V',vo,'vo=');
38 end
39
40 //end

```

Scilab code Exa 6.2 To verify given equation

```

1 clear all;
2 clc;
3
4 //Caption: To verify given equation
5
6 disp('NOTE: We will write A with a bar on its top as
      a ');
7 disp('To verify ');
8 disp(' A + aB = A + B');

```

```

9
10 disp('We know that  $B + 1 = 1$  and  $A1 = A$ ');
11 disp('A + aB = A(B+1) + aB = AB + A + aB =');
12 disp('(A + a)B + A = B + A');
13 disp('which is equal to RHS')
14 //end

```

Scilab code Exa 6.3.a To find whether a given circuit is positive NAND

```

1 clear all;
2 clc;
3
4 //Caption:To find whether a given circuit is positive
  NAND
5 //Given Data
6 R=15; //in K
7 R1=15; //in K
8 R2=100; //in K
9 R3=2.2; //in K
10 V0=0; //in V
11 V1=12; //in V
12 Vcc=12; //in V
13
14 //If input is at V0=0V
15 Vb = -Vcc*(R1/(R1+R2)); //The base voltage of the
  transistor
16 disp('V',Vb,'The base voltage of transistor Vb=');
17 if(Vb<0)
18     disp('Q is cutoff and Y is at 12V');
19     disp('The result confirms the first three rows
  of truth table');
20 end
21
22 //If input is at V1 = 12V
23 //Assumption:All the diodes are reversed biased and

```



```

    transistor is in saturation
24 //If Q is in saturation
25 Vbe=0; //in V
26 Vp = V1*(R/(R+R1)); //voltage at point P in front of
    all diodes
27 disp(Vp, 'All diodes are reversed biased by');
28 Iq = (V1/(R+R1)-(V1/R2)); //The base current of Q
29 Ic=V1/R3; //Current in the collector junction
30 disp('mA', Ic, 'Ic=');
31 hFEmin = Ic/Iq;
32 disp(hFEmin, 'hFEmin=');
33 disp(hFEmin, 'When hFE >');
34 disp('Under these condition the output is at ground
    and this satisfies the first three rows of truth
    table');
35
36
37 //end

```

Scilab code Exa 6.3.b To find whether with given conditions NAND gate is satisfied

```

1 clear all;
2 clc;
3
4 //Caption://To find whether with given conditions
    NAND gate is satisfied
5 //Given Data
6 R=15; //in K
7 R1=15; //in K
8 R2=100; //in K
9 R3=2.2; //in K
10 V0=0; //in V
11 V1=12; //in V
12 Vcc=12; //in V

```

```

13
14 //If input is at V0=0V
15 Vb = -Vcc*(R1/(R1+R2)); //Base Current in V
16
17 //Finding thevenin equivalent fom P to ground
18 Rd = 1; //in K
19 Vd=0.7; //in v
20 Vr=1; //in K
21 //Thevenin Equivalent Voltage and resistance from P
    to ground
22 v = (Vcc*(Rd/(Rd+R)))+(Vd*(R/(R+Rd)));
23 rs = Rd*(R/(R+Rd));
24 //Open Circuit Voltage at base of the transistor
25 Vb1 = (-Vcc*((R1+rs)/(R1+R2+rs)) + (v*(R2/(R1+R2+rs
    ))));
26 disp('V',Vb1,'Vb1=');
27 if(Vb1>Vb)
28     disp('The voltage is adequate to reverse bias Q'
    );
29 end
30
31
32 //end

```

Scilab code Exa 6.3.c Silicon Transistors and diodes are used in positive NAND

```

1 clear all;
2 clc;
3
4 //Caption: Silicon Transistors and diodes are used in
    positive NAND
5 //Given Data
6 R=15; //in K
7 R1=15; //in K

```

```

8 R2=100; //in K
9 R3=2.2; //in K
10 V0=0; //in V
11 V1=12; //in V
12 Vcc=12; //in V
13
14 //To find wether with given conditions NANAD gate is
    satisfied
15 //Finding thevenin equivalent from P to ground
16 Rd = 1; //in K
17 Vd=0.7; //in v
18 Vr=1; //in K
19 v = (Vcc*(Rd/(Rd+R)))+(Vd*(R/(R+Rd)));
20 rs = Rd*(R/(R+Rd));
21
22 //If the inputs are high
23
24 Vcesat = 0.2; //in V
25 Vb2 = (-Vcc*(R1/(R1+R2)) + ((Vd+Vcesat)*R2/(R1+R2)))
    ;
26 disp('V',Vb2,'Vb2=');
27 disp('It cuts off Q Y=1 ');
28
29 //end

```

Scilab code Exa 6.4 To verify that AND OR topology is equivalent to NAND NAND system

```

1 clear all;
2 clc;
3
4 //Caption: To verify that AND-OR topology is
    equivalent to NAND-NAND system
5 disp('In digital electronics we have to come across
    situations where we need to use an input with a

```

```

    bar but here we will denote as');
6  disp('X with a bar = Xb and X with two bars = Xbb');
7
8  //Solution
9  disp('We know that X =Xbb');
10 disp('For AND OR logic the output of AND and
    simultaneously neglecting the input to following
    OR does not change the logic');
11 disp('We have also neglected the output of the OR
    gate and at the same time have added an INVERTER
    so that logic is once again unaffected');
12 disp('AN OR gate neglected at each terminal is an an
    AND circuit');
13 disp('Since AND followed by an inverter is NAND ');
14 disp('Hencee the NAND NAND is equvallent to AND OR'
    );
15
16 //end

```

Scilab code Exa 6.5.a To find hFEmin

```

1  clear all;
2  clc;
3
4  //Caption:To find hFEmin
5  //Given Data
6  //For transistor
7  Vbesat=0.8; //Vgamma of diode in V
8  Vy=0.5; //in V
9  Vcesat=0.2; //in V
10 R = 5; //in K
11 Rc = 2.2; //in K
12
13 //For diode
14 Vyd=0.6; //in V

```

```

15 Vdrop=0.7; //in V
16
17 //The logic levels are Vcesato=0.2V for 0 state
18 Vcesato=0.2; //in V
19 //The logic levels are Vcc=5V for 1 state
20 Vcc=5; //in V
21 disp('If atleast one input is in 0 state');
22 Vp = Vcesato + Vy; //Potential at point P
23 disp('V',Vp, 'Vp=');
24 //For diodes D1 and D2 to be conducting
25 v = 2*Vdrop;
26 disp('For diodes D1 and D2 to be conducting');
27 disp(v, 'required voltage = ');
28 //These diodes cutoff
29 Vbe = 0;
30 if(Vbe<Vy)
31     disp('Q is OFF');
32     disp('Output rises to 5V and Y = 1');
33     disp('This confirms first 3 rows of NAND truth
           table');
34 end
35
36 //if all inputs are at V(1)=5V , we shall assume all
           input diodes OFF and D1 and D2 conduct and Q is
           in saturation
37 disp('When inputs are at 5V');
38 Vp = Vdrop + Vdrop + Vbesat;
39 disp('V',Vp, 'Vp=');
40 disp(Vcc-Vp, 'The voltage across all input diode');
41
42 //For finding hFEmin
43 I1 = (Vcc-Vp)/R;
44 I2 = Vbesat/R;
45 Ib = I1-I2;
46 Ic = (Vcc-Vcesat)/Rc;
47 hFEmin = Ic/Ib;
48 disp(hFEmin, 'hFEmin=');
49

```

50 //end

Scilab code Exa 6.5.b When atleast one input is at V0 in NAND gate

```
1 clear all;
2 clc;
3
4 //Caption:When atleast one input is at V(0) in NAND
   gate
5 //Given Data
6 //For transistor
7 Vbesat=0.8; //in V
8 Vy=0.5; //in V
9 Vcesat=0.2; //in V
10 R = 5; //in K
11 Rc = 2.2; //in K
12
13 //For diode
14 Vyd=0.6; //Vgamma in V
15 Vdrop=0.7; //in V
16
17 //The logic levels are Vcesato=0.2V for 0 state
18 Vcesato=0.2; //in V
19
20 disp('If atleast one input is in 0 state');
21 Vp = Vcesato + Vdrop; //Voltage at point P
22 disp('V',Vp, 'Vp=');
23 Vbe = Vp-Vyd; //Voltage at base emitter
24 disp('V',Vbe, 'Vbe=');
25 if(Vbe<Vy)
26     disp('Q is cutoff');
27 end
28 if(Vbe>Vy)
29     disp('Q is ON');
30 end
```

31 //end

Scilab code Exa 6.5.c If input is high in NAND gate

```
1 clear all;
2 clc;
3
4 //Caption:If input is high in NAND gate
5 //Given Data
6 //For transistor
7 Vbesat=0.8;//in V
8 Vy=0.5;//in V
9 R = 5;//in K
10 Rc = 2.2;//in K
11
12 //For diode
13 Vyd=0.6;//in V
14 Vdrop=0.7;//in V
15
16 //The logic levels are Vcesato=0.2V for 0 state
17 Vcesato=0.2;//in V
18
19 Vp = Vdrop + Vdrop + Vbesat;//Voltage at point P
20 disp('V',Vp,'Vp=');
21 disp('V',Vcc-Vp,'Each diode is reversed biased by ')
22 ;
23 disp('V',Vyd,'A diode starts to conduct when it is
24 forward bias by');
25 vn = (Vcc-Vp) + Vyd;//Noise Spike which will cause
26 the malfunction
27 disp('V',vn,'A noise spike which will cause
28 malfunction is ');
29
30 //end
```

Scilab code Exa 6.5.d If input is low in NAND gate

```
1 clear all;
2 clc;
3
4 //Caption: If input is low in NAND gate
5 //Given Data
6 //For transistor
7 Vbesat=0.8; //in V
8 Vy=0.5; //in V
9 R = 5; //in K
10 Rc = 2.2; //in K
11
12 //The logic levels are Vcesato=0.2V for 0 state
13 Vcesato=0.2; //in V
14 //For diode
15
16 Vyd=0.6; //in V
17 Vdrop=0.7; //in V
18
19 Vp = Vcesato + Vdrop; //Voltage at point P
20 disp('V',Vp,'Vp=');
21 Vbe = Vy; //Voltage at base emitter will be same as
    Vgamma
22 vp = Vbe + Vyd +Vyd; //The level to which vp should
    increase
23 Vn = vp - Vp; //Noise Margin
24 disp('V',Vn,'Noise Margin = ');
25
26 //end
```

Scilab code Exa 6.6 Calculation of FAN OUT of NAND gate


```

1 clear all;
2 clc;
3
4 //Caption: Calculation of FAN OUT of NAND gate
5 //Given Values
6 hFE=30;
7 Vbe1active=0.7;//in V
8 Vd2=0.7;//in V
9 Vbe2sat=0.8;//in V
10 Vcc=5;//in V
11 R1=1.75;//in K
12 R2=2;//in K
13 R3=2.2;//in K
14 R4=5;//in K
15
16 Vp = Vbe1active + Vd2 + Vbe2sat;//Voltage at point P
17 //The current in 2K resistor is Ib1
18 //In active region
19 //Ic1=hFE*Ib1
20 //I1 = Ib1+Ic1=(1+hFE)*Ib1.... Now applying KVL
    between Vcc and Vp
21 //Vcc-Vp = R1*(1+hFE)*Ib1 + 2*Ib1
22 Ib1 = (Vcc-Vp)/(R1*(1+hFE)+2);//Base current in
    transistor 1
23 disp('mA',Ib1,'Ib1=');
24 Ic1=hFE*Ib1;//Collector Current in transistor 1
25 disp('mA',Ic1,'Ic1=');
26 I1 = Ib1 + Ic1;//in mA
27 I2=Vbe2sat/R4;//in mA
28 Ib2 = I1-I2;//Base Current in Transistor 2
29 //The unloaded current of Q2
30 Iq2=(Vcc-0.2)/R3;
31 //For each gate which it drive ,Q2 must sink a
    standard load of
32 I=(Vcc-Vd2-0.2)/(R1+R2);
33 //To Calculate the FAN OUT
34 //The maximum current is hFE*Ib2
35 //hFE*Ib2 = (I*N) + Iq2

```

```
36 N=((hFE*Ib2)-Iq2)/I; //FAN OUT
37 disp(N, 'N=');
38
39 //end
```

Chapter 7

Integrated Circuit Fabrication and Characteristic

Scilab code Exa 7.1 Diffusion of a pn junction

```
1 clear all;
2 clc;
3
4 //caption:Diffusion of a pn junction
5
6 disp('At distance equal to x=xi at which N =
      concentration n of doped silicon wafers , the net
      impurity density is zero. Thus xi is the
      distance at which junction is formed');
7
8 //Given Data
9 q = 1.6*(10^-19); //Charge of electron
10 yn=1300; //mobility of silicon
11 p = 0.5; //resistivity in ohm=cm
12 y=2.2;
13 t=2*3600; //in sec.
14 xi = 2.7*(10^-4); // Junction Depth in cm.
15
16 n = 1/(p*yn*q); //Concentration of doped silicon
```

```

    wafer
17 disp('cm-3',n,'The concentration n =');
18 disp('The junction is formed when N = n');
19
20 //y = xi/(2*(D*t)^0.5)
21 D=((xi)^2/((2*y)^2*t)); // Diffusion Constant
22
23 disp('cm2/sec',D,'The value of Diffusion Constant
    for Boron = ');
24
25 //end

```

Scilab code Exa 7.2.a Fabrication and Characteristics

```

1 clear all;
2 clc;
3
4 //Caption:Fabrication and Characteristics
5 //Given Data
6 y = 2.2; //from the figure y=2.2
7 Nob = 5*1018 //Uniform Concentration of Boron
    Profile
8
9 //y = 2.7/(2*(D*t)^0.5)
10 //2*(D*t)^0.5 = a
11 a = 2.7/y;
12 x = 2; //distance at which emitter junction is formed
    in micrometer
13 Nb = Nob*erfc(x/a); //boron Profile
14 disp('cm-3',Nb,'Nb=');
15 disp('The boron diffusion equation is ');
16 disp(a,'5*1018*erfc x / ');
17 //At x=2 Np = Nb
18 //erfc(2/(2*(D*t)^0.5))=k
19 Nop=1021;

```

```

20 k = Nb/Nop;
21 a = 2/2.7;
22 disp('The phosphorous diffusion equation is ');
23 disp(a, '10^21*erfc x / ');
24
25
26 //end

```

Scilab code Exa 7.2.b Fabrication and Characteristics

```

1 clear all;
2 clc;
3
4 //Caption: Fabrication and Characteristics
5 //Given Data
6 y = 2.2; //from the figure y=2.2
7 Nob = 5*10^18 //Uniform Concentration of Boron
   Profile
8
9 //y = 2.7/(2*(D*t)^0.5)
10 //2*(D*t)^0.5 = a(let)
11 a = 2.7/y;
12 x = 2; //distance at which emitter junction is formed
   in micrometer
13 Nb = Nob*erfc(x/a); //boron Profile
14
15 //At x=2 Np = Nb
16 //erfc(2/(2*(D*t)^0.5))=k
17 Nop=10^21;
18 k = Nb/Nop;
19 a = 2/2.7;
20 //Time allowed for diffusion if diffusion of
   Phosphorous is conducted at 1100 degreeC
21 //From the figure D=3.8*10^-13 cm^2/sec
22 D=3.8*10^-13 //in cm^2/sec

```

```
23 t = ((a*10^-4)/2)^2*(1/D);  
24 disp('sec ',t,'t=');  
25  
26 //end
```

Chapter 8

The Transistor at Low Frequency

Scilab code Exa 8.2 transistor as a Common Emitter Amplifier

```
1 clear all;
2 clc;
3
4 //Caption:transistor as a Common Emitter Amplifier
5 //Given Data
6
7 Rl=10;//in K
8 Rs=1;//in K
9 hie=1.1;//in K
10 hre=2.5*(10^-4);
11 hfe=50;
12 hoe=25*(10^-3);//in K^-1
13
14 Ai= -hfe/(1+(hoe*Rl));//Current Gain or Current
    Amplification
15 disp(Ai, 'Ai=');
16
17 Ri = hie + (hre*Rl*Ai);
18 disp('K',Ri, 'Ri=');
```

```

19
20 Av=(Ai*Rl)/Ri;//Voltage Gain
21 disp(Av,'Av=');
22
23 Avs=(Av*Ri)/(Ri+Rs);//Overall Voltage Gain taking
    source resistance into account
24 disp(Avs,'Avs=');
25
26 Ais=(Ai*Rs)/(Ri+Rs);//Overall current gain taking
    source resistance into account
27 disp(Ais,'Ais=');
28
29 Yo=hoe-((hfe*hre)/(hie+Rs));//Admittance
30 disp('K-1',Yo,'Yo=');
31
32 Zo = 1/Yo;//Impedence
33 disp('K',Zo,'Zo=');
34
35 //end

```

Scilab code Exa 8.3 To derive output impedance of given figure in open circuit voltage short circuit current theorem

```

1 clear all;
2 clc;
3
4 //Caption:To derive output impedance of given figure
    in open circuit-voltage short-circuit-current
    theorem
5 //Solution
6
7 //Yo = I/Vo
8 //When current in a short circuit placed across the
    output terminals and V is the open circuit
    voltage

```



```

9 disp('When current in a short circuit placed across
      the output terminals and V is the open circuit
      voltage ');
10 disp('I = -hf*I1=-(hf*Vs)/(Rs+hi)');
11 //Applying KVL
12 disp('Vs = I1*(Rs+hi)+hr*V = -ho*V*(Rs+hi)/hf+hr*V')
      ;
13 disp('or ');
14 disp('V = -(hf*Vs/(Rs+hi))/(ho-hf*hr(Rs+hi))');
15
16 //end

```

Scilab code Exa 8.4 Parameters of a Common Emitter Amplifier

```

1 clear all;
2 clc;
3
4 //Caption : Parameters of a Common Emitter Amplifier
5 //Given Data
6 hie=1.1;//in K
7 hre=2.5*(10^-4);
8 hfe=50;
9 hoe=25*(10^-3);//in K^-1
10 r=200;//in K
11 Rs=10;//in K
12 Ri=1;//in K
13 Rl=10;//in K
14
15 rl=(r*Rs)/(r+Rs);//in K
16
17 Ai = -hfe/(1+(hoe*rl));//Current Gain
18 disp(Ai, 'Ai = ');
19
20 Ri = hie + (hre*Ai*rl);
21 disp('K', Ri, 'Ri=');

```

```

22
23 Av=(Ai*rl)/Ri;//Voltage Gain
24 disp(Av,'Av = ');
25
26 k = r/(1-Av);
27 ri = (Ri*k)/(Ri+k);
28 disp('K',ri,'ri = ');
29
30 Avs = Av*(ri/(ri+Rs));//Overall voltage Gain taking
    Source resistance into account
31 disp(Avs,'Avs = ');
32
33 ai = Avs*((ri+Rs)/Rl);
34 disp(ai,'ai = -I2/I1 ');
35
36 //End

```

Scilab code Exa 8.5 CE CC configuration

```

1 clear all;
2 clc;
3
4 //Caption : CE-CC configuration
5 //Given Data
6 hie = 2;//in K
7 hfe = 50;
8 hre = 6*(10^-4);
9 hoe = 25*(10^-3);//in K^-1
10 hic=2;//in K
11 hfc=-51;
12 hrc=1;
13 hoc=25*(10^-3);///in K^-1
14 Re2=5;//in K
15 Rs=1;//in K
16 Rc1=5;//in K

```

```

17
18 //The Second Stage
19
20 Rl = Re2;
21 Ai2 = -hfc/(1+(hoc*Re2)); //Current Gain in @nd
    Transistor
22 disp(Ai2, 'Ai2=');
23
24 Ri2 = hic + (hrc*Ai2*Re2);
25 disp('K', Ri2, 'Ri2=');
26
27 Av2 = (Ai2*Re2)/Ri2; //Voltage Gain in 2nd Transistor
28 disp(Av2, 'Av2=');
29
30 //The First Stage
31
32 Rl1 = (Rc1*Ri2)/(Rc1+Ri2);
33 disp('K', Rl1, 'Rl1=');
34
35 Ai1 = -hfe/(1+(hoe*Rl1)); //Current Gain in 1st
    Transistor
36 disp(Ai1, 'Ai1=');
37
38 Ri1 = hie + (hre*Ai1*Rl1);
39 disp('K', Ri1, 'Ri1=');
40
41 Av1 = (Ai1*Rl1)/Ri1; //Voltage Gain in 1st Transistor
42 disp(Av1, 'Av1=');
43
44 disp('The output Admittance of Transistor ');
45 Yo1 = hoe - ((hfe*hre)/(hie+Rs));
46 disp('K^-1', Yo1, 'Yo1=');
47
48 Ro1 = 1/Yo1;
49
50 //Output Impedance of First Stage
51 disp('Output Impedance of First Stage');
52 ro1 = (Ro1*Rc1)/(Ro1+Rc1);

```

```

53 disp('K',ro1,'ro1=');
54
55 rs2 = ro1;
56
57 Yo2 = hoc - ((hfc*hrc)/(hic+rs2));
58 disp('K-1',Yo2,'Yo2=');
59
60 A1 = (Ai2*Ai2*Rc1)/(Ri2+Rc1); //Overall Current gain
61 disp(A1,'A1=');
62
63 Av = Av2*Av1; //Overall Voltage Gain
64 disp(Av,'Voltage Gain = Av=');
65
66 Avs = (Av*Ri1)/(Ri1+Rs); //Overall Voltage gain with
    Source Impedence
67 disp(Avs,'Overall Voltage gain taking Source
    Impedence into account = Avs = ');
68
69
70 //End

```

Scilab code Exa 8.6 Parameters of CE CC configuration

```

1 clear all;
2 clc;
3
4 //Caption:Parameters of CE-CC configuration
5 //Given Data
6
7 hie = 2; //in K
8 hfe = 50;
9 hre = 6*(10-4);
10 hoe = 25*(10-3); //in K-1
11 hic=2; //in K
12 hfc=-51;

```

```

13 hrc=1;
14 hoc=25*(10^-3);///in K-1
15 Re2=5;///in K
16 Rs=5;///in K
17 Rc1=5;///in K
18
19 //For the CC output Stage
20 disp('For the CC output Stage');
21 Rl = Re2;
22 Ai2 = 1+ hfe;///Current gain in 2nd Transistor
23 disp(Ai2, 'Ai2=');
24 Ri2 = hie+((1+hfe)*Rl);
25 disp('K',Ri2, 'Ri2=');
26 Av2=1-(hie/Ri2);///voltage gain in 2nd transistor
27 disp(Av2, 'Av2=');
28
29 //For the CE input Stage
30 disp('For the CE input Stage');
31
32 Ai1=-hfe;///Current gain in 1st transistor
33 Ri1 = hie;
34 disp(Ai1, 'Ai1=');
35 Rl1=(Rc1*Ri2)/(Rc1+Ri2);
36 disp('K',Rl1, 'Rl1=');
37 Av1=(Ai1*Rl1)/Ri1;///Voltage gain in 1st transistor
38 disp(Av1, 'Av1=');
39 ro1=Rc1;
40 Ro2 = (hie+Rs)/(1+hfe);
41 ro2=(Ro2*Rl)/(Ro2+Rl);
42 disp('K',ro2, 'Effective Source Impedence');
43
44 Av = Av1*Av2;///Overall voltage gain
45 disp(Av, 'Overall Voltage Gain=');
46 Ai = Ai1*Ai2*(Rc1/(Rc1+Ri2));///Overall current Gain
47 disp(Ai, 'Overall Current Gain=');
48
49 //End

```

Chapter 9

Transistor Biasing and Thermal Stabilization

Scilab code Exa 9.1 To find Q point

```
1 clear all;
2 clc;
3
4 //Caption:To find Q point
5 //Given Data
6 Vcc=22.5//in V
7 Rc=5.6;//in K
8 Re=1;//in K
9 R2=10;//in K
10 R1=90;//in K
11 B=55;//beta
12
13
14 V=(R2*Vcc)/(R2+R1);//Thevenin Equivalent Voltage
15 Rb=(R2*R1)/(R2+R1);//Thevenin Equivalent Resistance
16 disp('Volts',V,'The equivalent Vbb =');
17 disp('ohm',Rb,'The equivalent Rb is');
18
19 //For base current large compared to reverse
```

```

    saturation current ie  $I_b \gg I_{co}$  it follows that  $I_c = B \cdot I_b$ 
20
21 //Applying KVL to the base circuit
22 //0.65-2.25+Ic+10*Ib=0
23 disp('As B=55 we have Ic=55*Ib');
24
25 //We have  $-1.60 + I_c + (10/55) \cdot I_c = 0$ 
26 Ic=1.60/(65/55);
27 Ib=Ic/55;
28 disp('milli amp',Ic,'Ic=');
29 disp('micro amp',Ib,'Ib=');
30
31 //Applying KVL to the collector circuit yields
32 // -22.5+6.6*Ic+Ib+Vce
33
34 Vce = 22.5-(6.6*1.36)-0.025;
35 disp('Volts ',Vce,'Vce=');
36
37 //end

```

Scilab code Exa 9.2 To find resistances in 2N335 transistor

```

1 clear all;
2 clc;
3
4 //Caption:To find resistances in 2N335 transistor
5 //Given Data
6 Rc=4;//in K
7 Vcc=20;//in V
8 Vce=10;//in V
9 Ic=2;//in mA
10 //Ic varies from 1.75 to 2.25 and B(beta) varies
    from 36 to 90
11

```

```

12 Re = (Vcc-Vce)/Ic - Rc;
13
14 //S=delta Ic/delta B
15 Ic2=2.25; //in mA
16 Ic1=1.75; //in mA
17 B2=90;
18 B1=36;
19 S=(Ic2-Ic1)/(B2-B1);
20 S2=(S*36*(1+90))/1.75;
21 disp(S2, 'S2=', 'K', Re, 'Re=', 'B2=90 ');
22
23 //S2=(1+B)*(1+(Rb/Re))/(1+B+(Rb/Re))
24 Rb=(S2-1)*(1+B2)*Re/(1+B2-S2);
25 disp('K', Rb, 'Rb=');
26
27 Vbe=0.65; //in V
28 disp('V', Vbe, 'We know that Vbe = ');
29
30 V = Vbe + ((Rb+Re*(1+B1))*Ic1/B1);
31 disp('Volts', V, 'V = ');
32
33 R1=Rb*Vcc/V;
34 R2=R1*V/(Vcc-V);
35 disp('K', R1, 'R1=');
36 disp('K', R2, 'R2=');
37
38 //end

```

Scilab code Exa 9.3.a Variation of Ic in given Transistor

```

1 clear all;
2 clc;
3
4 //Caption: Variation of Ic in given Transistor
5 //Given Data at 25degree C

```



```

6 Re=4.7; //in K
7 Rb=7.75; //in K
8 B1=55; //beta at 25degree C
9 Ic1=1.5; //in mA
10 Ico1=1;
11 Vbe1=0.6; //in V
12
13 //Part a
14
15 Ico2=33000; //in nA
16 Vbe2=0.225; //in V
17 M1=1/(1+(Rb/(Re*B1))); //Stability Factor
18 disp(M1, 'Stability Factor at 25degree C=');
19 B2=100; //at 175degree C
20 M2=1/(1+(Rb/(Re*B2))); //Stability Factor
21 disp(M2, 'Stability Factor at 175degree C=');
22
23 if(M2>M1)
24     M1=1;
25     M2=1;
26 end
27
28 //Let k = (delta Ic)/(Ic1)
29 k=(1+(Rb/Re))*(M1*(Ico2-Ico1)*(10^-9)/Ic1*(10^-3))-
    (M1*(Vbe2-Vbe1)/(Ic1*Re))+(1+(Rb/Re))*(M2*(B2-B1)
    /(B2*B1));
30 deltaIc=k*Ic1;
31 disp('mA', deltaIc, 'Change in Collector Current at
    175degree C is =');
32
33 //Given Data at -65degree C
34 Ico2=1.95*(10^-3);
35 B2=25;
36 Vbe2=0.78;
37
38 M2=1/(1+(Rb/(Re*B2))); //Stability Factor
39 disp(M2, 'Stability Factor at -65degree C=');
40

```

```

41 //Let k = (delta Ic)/(Ic1)
42 k=(1+(Rb/Re))*(M1*(Ico2-Ico1)*(10^-9)/Ic1*(10^-3))-
      M1*(Vbe2-Vbe1)/(Ic1*Re))+1+(Rb/Re))*(M2*(B2-B1)
      /(B2*B1));
43 deltaIc=k*Ic1;
44 disp('mA',deltaIc,'Change in Collector Current at
      -65degree C is =')
45
46
47 //End

```

Scilab code Exa 9.3.b Variation of Ic in given Transistor

```

1 clear all;
2 clc;
3
4 //Caption:Variation of Ic in given Transistor
5 //Given Data at 25degree C
6 Re=4.7;//in K
7 Rb=7.75;//in K
8 B1=55;//beta at 25degree C
9 Ic1=1.5;//in mA
10 Ico1=1;
11 Vbe1=0.6;//in V
12
13 //Part b
14
15 Ico2=33000;//in nA
16 Vbe2=0.225;//in V
17 M1=1/(1+(Rb/(Re*B1)));//Stability Factor
18 //Given Data at -65degree C
19 Ico2=1.95*(10^-3);
20 B2=25;
21 Vbe2=0.78;
22

```

```

23  M2=1/(1+(Rb/(Re*B2))); // Stability Factor
24
25  //Let k = (delta Ic)/(Ic1)
26  k=(1+(Rb/Re))*(M1*(Ico2-Ico1)*(10^-9)/Ic1*(10^-3))- (
      M1*(Vbe2-Vbe1)/(Ic1*Re))+(1+(Rb/Re))*(M2*(B2-B1)
      /(B2*B1));
27  deltaIc=k*Ic1;
28
29
30  //Given Data
31  Ico2=32; //in nA
32  Vbe2=0.10; //in V
33  M1=1/(1+(Rb/(Re*B1))); // Stability Factor
34  disp(M1, 'Stability Factor at 25 deree C=');
35  B2=90; //at 175 degree C
36  M2=1/(1+(Rb/(Re*B2))); // Stability Factor
37  disp(M2, 'Stability Factor at 75 degree C=');
38
39  if(M2>M1)
40      M1=1;
41      M2=1;
42  end
43
44  //Let k = (delta Ic)/(Ic1)
45  k=(1+(Rb/Re))*(M1*(Ico2-Ico1)*(10^-9)/Ic1*(10^-3))- (
      M1*(Vbe2-Vbe1)/(Ic1*Re))+(1+(Rb/Re))*(M2*(B2-B1)
      /(B2*B1));
46  deltaIc=k*Ic1;
47  disp('mA', deltaIc, 'Change in Collector Current at 75
      degree C is =');
48
49  //Given Data at -65 degree C
50  Ico2=1.95*(10^-3);
51  B2=20;
52  Vbe2=0.38;
53
54  M2=1/(1+(Rb/(Re*B2))); // Stability Factor
55  disp(M2, 'Stability Factor at -65 degree C=');

```

```

56
57 //Let k = (delta Ic)/(Ic1)
58 k=(1+(Rb/Re))*(M1*(Ico2-Ico1)*(10^-9)/Ic1*(10^-3))- (
    M1*(Vbe2-Vbe1)/(Ic1*Re))+(1+(Rb/Re))*(M2*(B2-B1)
    /(B2*B1));
59 deltaIc=k*Ic1;
60 disp('mA',deltaIc,'Change in Collector Current at
    -65degree C is =');
61
62 //End

```

Scilab code Exa 9.4 To design a self bias circuit

```

1 clear all;
2 clc;
3
4 //Caption: To design a self bias circuit
5
6 //Given Data at 25degree C
7 B1=150;//beta
8 Ico1=50;//in nA
9
10 //Given Data at 65degree C
11 B2=1200;//beta
12 Ico2=3;//in micro A
13
14 Vbe=0.65;//in mV
15 Vcc=20;//in V
16 M=1;
17 //Assumption: Each factor Ico ,B, and Vbe cuses the
    same percentge change(5%)
18
19 //Let Rb/Re=k
20 //((1+k)*((1200 - 150)/(1200*150))=0.05
21

```

```

22 k=((0.05)*((1200*150)/(1200-150)))-1;
23 disp(k, 'Rb/Re=');
24 //Let us check our assumption
25
26 if(M>(1/(1+(k/B1))))
27     M=1;
28 end
29
30 //(1+(Rb/Re))*((Ico2-Ico1)/Ic1)=0.05    Since Ico2>>
    Ico1, we consider only Ico2
31
32 Ic1=((1+k)*Ico2)/(0.05*1000);
33 disp('mA', Ic1, 'Ic1=');
34
35 //Vbe changes 2.5mV/degree
36 DVbe=2.5*40;
37 //Total increment
38 dVbe=2*DVbe*(10^-3);
39
40 //Let l=(Ic1*Re)
41 l=dVbe/0.05;
42
43 Re=l/Ic1;
44 disp(Re, 'Re=');
45 Rb=k*Re;
46 disp(Rb, 'Rb=');
47
48 B=(B1+B2)/2; //beta
49 V=((Ic1/B)*Rb)+(Vbe)+(((Ic1/B)+Ic1)*Re);
50 disp('Volts', V, 'V=');
51 R1=(Rb*Vcc)/V;
52 R2=(R1*V)/(Vcc-V);
53
54 disp('ohm', R1, 'R1=');
55 disp('ohm', R2, 'R2=');
56
57 //end

```

Scilab code Exa 9.5 Value of theta for Ge Transistor

```
1 clear all;
2 clc;
3
4 //Caption:Value of theta for Ge Transistor
5
6 //Given Data
7 Vcc=30;//in V
8 Rc=2;//in K
9 Re=4.7;//in K
10 Ic=1.5;//in mA
11
12 //We know that  $dP_c/dI_c = V_{cc} - (2*I_c*(R_c+R_e))$ 
13 //Let  $D=dP_c/dI_c$ 
14
15 D = Vcc - (2*Ic*(Re+Rc));
16 disp('Ic increases by 0.131mA over a temprature
      range of 35 to 75 degree C');
17 disp('theta <(A=(dPc/dIc)*(dIc/dTc))');
18 A=D*((0.131*(10^-3))/(75-25));
19
20 disp('degreeC/W',1/A,'theta<');
21 disp('The upper bound on theta is so high that
      transistor would not violate it and therefore
      circuit will be safe from thermal runaway');
22
23 //End
```

Scilab code Exa 9.6.a To find parameters of power amplifier using pnp germanium transistor

```

1  clear all;
2  clc;
3
4  //Caption: To find parameters of power amplifier
      using pnp gemanium transistor
5
6  //Given Data
7  B=100; //beta
8  Ico=-5; //in mA
9  Ic=-1; //in mA
10 Vcc=40;
11 Re=5; //in ohm
12 Rc=10; //in ohm
13
14 //Ic= BIb + (1+B)*Ico
15 //Ic=B(Ib+Ico)
16 Ib=-(Ic/B)+Ico;
17 disp('mA', Ib, 'Ib=');
18
19 //Neglecting Vbe
20 Rb=(5-Vcc)/(Ib*0.001);
21 disp('ohm', Rb, 'Rb=');
22
23 Vce=Vcc-15;
24 if(Vce>(Vcc/2))
25     S=(1+B)*(1+(Rb/Re))/(1+B+(Rb/Re));
26     disp(S, 'Stability Factor is=');
27 end
28
29 A=-(Vcc+(2*Ic*(Re+Rc)))*(S)*(0.007*Ico*0.01);
30
31 disp('degreeC/W', 1/A, 'theta=');
32
33 //end

```

Scilab code Exa 9.6.b To find parameters of power amplifier using pnp germanium transistor

```
1 clear all;
2 clc;
3
4 //Caption: To find parameters of power amplifier
   using pnp germanium transistor
5
6 //Given Data
7 B=100; //beta
8 Ico=-5; //in mA
9 Ic=-1; //in mA
10 Vcc=40;
11 Re=5; //in ohm
12 Rc=10; //in ohm
13
14 //Ic= BIb + (1+B)*Ico
15 //Ic=B(Ib+Ico)
16 Ib=-(Ic/B)+Ico;
17
18 //Neglecting Vbe
19 Rb=(5-Vcc)/(Ib*0.001);
20
21 Vce=Vcc-15;
22 if(Vce>(Vcc/2))
23     S=(1+B)*(1+(Rb/Re))/(1+B+(Rb/Re));
24     disp(S, 'Stability Factor is=');
25 end
26
27 A=-(Vcc+(2*Ic*(Re+Rc)))*(S)*(0.007*Ico*0.01);
28
29 disp('degreeC/W',1/A, 'theta=');
30
31 //end
```

Chapter 10

Field Effect Transistor

Scilab code Exa 10.1.a Pinch off V and channel half width of silicon FET

```
1 clear all;
2 clc;
3
4 //Caption: Pinch off V and channel half width of
   silicon FET
5
6 //Given Values
7 a=3*(10^-4); //in cm
8 Nd=10^15; //in electrons/cm^3
9 q=1.6*(10^-19) //in C
10 eo=8.85*(10^-12); //Permittivity of free space
11 e=12*eo; //Relative Permittivity
12
13 Vp=(q*Nd*a*a*10^6*10^-4)/(2*e); //in V
14 //a is in cm so 10^-4 is multiplied and Nd is in
   electrons/cm^3 so 10^6 is multiplied
15 disp('V',Vp,'Pinch off Voltage =');
16
17 //end
```

Scilab code Exa 10.1.b Pinch off V and channel half width of silicon FET

```
1 clear all;
2 clc;
3
4 //Caption: Pinch off V and channel half width of
   silicon FET
5
6 //Given Values
7 a=3*(10^-4); //in m
8 Nd=10^15; //in electrons/m^3
9 q=1.6*(10^-19) //in C
10 eo=8.85*(10^-12); //Permittivity of free space
11 e=12*eo; //Relative Permittivity
12
13 Vp=(q*Nd*a*a*10^6*10^-4)/(2*e); //in V
14 //a is in cm so 10^-4 is multiplied and Nd is in
   electrons/cm^3 so 10^6 is multiplied
15 Vgs= Vp/2;
16
17 b=a*(1-((Vgs/Vp)^(0.5))); //in cm
18
19 disp('cm',b,'Channel Half Width = ');
20
21 //end
```

Scilab code Exa 10.2.a Amplifier using n channel FET

```
1 clear all;
2 clc;
3
4 //Caption: amplifier using n channel FET
```

```

5
6 //Given Data
7
8 Vp=-2;//in V
9 Idss=1.65;//in mA
10 //it is desired to bias the circuit at Id=0.8mA
11 Ids=0.8;//in mA
12 Vdd=24;//in V
13 //Assumption: rd>Rd
14
15 Vgs=Vp*(1-(Ids/Idss)^0.5);//in V
16 disp('V',Vgs,'Vgs=');
17
18
19 //end

```

Scilab code Exa 10.2.b Amplifier using n channel FET

```

1 clear all;
2 clc;
3
4 //Caption: amplifier using n channel FET
5
6 //Given Data
7
8 Vp=-2;//in V
9 Idss=1.65;//in mA
10 //it is desired to bias the circuit at Id=0.8mA
11 Ids=0.8;//in mA
12 Vdd=24;//in V
13 //Assumption: rd>Rd
14
15 Vgs=Vp*(1-(Ids/Idss)^0.5);//in V
16
17 gmo=-(2*Idss/Vp);

```

```
18 disp('mA/V',gmo,'gmo=');
19 gm=gmo*(1-(Vgs/Vp));
20 disp('mA/V',gm,'gm=');
21
22 //end
```

Scilab code Exa 10.2.c Amplifier using n channel FET

```
1 clear all;
2 clc;
3
4 //Caption: amplifier using n channel FET
5
6 //Given Data
7
8 Vp=-2;//in V
9 Idss=1.65;//in mA
10 //it is desired to bias the circuit at Id=0.8mA
11 Ids=0.8;//in mA
12 Vdd=24;//in V
13 //Assumption: rd>Rd
14
15 Vgs=Vp*(1-(Ids/Idss)^0.5);//in V
16
17 gmo=-(2*Idss/Vp);
18 gm=gmo*(1-(Vgs/Vp));
19
20 Rs=-(Vgs/Ids);//in ohm
21 disp('K',Rs,'Rs=');
22
23 //end
```

Scilab code Exa 10.2.d Amplifier using n channel FET

```

1 clear all;
2 clc;
3
4 //Caption: amplifier using n channel FET
5
6 //Given Data
7
8 Vp=-2; //in V
9 Idss=1.65; //in mA
10 //it is desired to bias the circuit at Id=0.8mA
11 Ids=0.8; //in mA
12 Vdd=24; //in V
13 //Assumption: rd>Rd
14
15 Vgs=Vp*(1-(Ids/Idss)^0.5); //in V
16
17 gmo=-(2*Idss/Vp);
18 gm=gmo*(1-(Vgs/Vp));
19
20 Rs=-(Vgs/Ids); //in ohm
21
22 disp('20dB corresponds to voltage gain of i0');
23 Av=10;
24 Rd=Av/gm; //in ohm
25 disp('ohm', Rd, 'Rd=');
26
27 //end

```

Scilab code Exa 10.3.a To find the parameters of a FET 2N3684

```

1 clear all;
2 clc;
3
4 //Caption: To find the parameters of a FET 2N3684
5

```

```

6 //Given Values
7 Vpmin=-2;//in V
8 Vpmax=-5;//in V
9 Idssmin=1.6;//in mA
10 Idssmax=7.05;//in mA
11 Idmin=0.8;//in mA
12 Ia=Idmin;
13 Idmax=1.2;//in mA
14 Ib=Idmax;
15 Vdd=24;//in V
16 Vgs1=0;//in V
17 Id1=0.9;//in mA
18 Vgs2=-4;//in V
19 Id2=1.1;//in mA
20 //Slope determines Rs
21 Rs=(Vgs1-Vgs2)/(Id2-Id1);
22 disp('ohm',Rs,'Rs=');
23 Vgg=Id1*Rs;
24 disp('V',Vgg,'Vgg=');
25
26 //end

```

Scilab code Exa 10.3.b To find the range of possible values of I_d in FET 2N3684 from the graph

```

1 clear all;
2 clc;
3
4 //Caption:To find the range of possible values of Id
   in FET 2N3684 from the graph
5
6 //In the figure given The line of Rs=3.3K cuts Vp =
   -2V at Id = 0.4 mA
7 Idmin = 0.4;//in mA
8 disp('mA',Idmin,'Idmin=');

```

```

9
10 //In the figure given The line of  $R_s=3.3K$  cuts  $V_p =$ 
     $-5V$  at  $I_d = 1.2$  mA
11  $I_{dmax} = 1.2$ ; //in mA
12 disp('mA',  $I_{dmax}$ , 'Idmax=');
13
14 //end

```

Scilab code Exa 10.4 Voltage Gain of MOSFET as a single stage and then as first transistor

```

1 clear all;
2 clc;
3
4 //Caption: Voltage Gain of MOSFET as a single stage
    and then as first transistor
5
6 //Given Data
7  $R_d=100$ ; //in K
8  $f=20000$ ; //frequency in Hertz
9 //MOSFET parameters
10  $g_m=1.6$ ; //in mA/V
11  $r_d=44$ ; //in k
12  $C_{gs}=3*(10^{-12})$ ; //in F
13  $C_{ds}=1*(10^{-12})$ ; //in F
14  $C_{gd}=2.8*(10^{-12})$ ; //in F
15  $m=g_m*r_d$ ; //mew
16
17 //Required Formulae
18  $Y_{gs}=2*\pi*f*C_{gs}$ ; //in mho
19  $Y_{ds}=2*\pi*f*C_{ds}$ ; //in mho
20  $Y_{gd}=2*\pi*f*C_{gd}$ ; //in mho
21  $g_d=1/r_d$ ; //in mho
22  $Y_d=1/R_d$ ; //in mho
23  $g_m=1.6*(10^{-3})$ ; //in mho

```

```

24 disp('Gain of one stage amplifier ');
25 Av=(-gm+Ygd)/(gd+Yd+Yds+Ygd); //Voltage Gain
26 disp(Av, 'Av=');
27
28 disp('Gain after neglecting the interelectrode
      capacitance ');
29 Av=-(m*Rd)/(Rd+rd); //Voltage Gain
30 disp(Av, 'Av=');
31
32 //Let k= gm*Rd'
33 k=-Av;
34 Ci = (Cgs*(10^12)) +((1+k)*Cgd*(10^12));
35 disp('Value of Input Impedence Capacitance ');
36 disp('pF', Ci, 'Ci=');
37
38 //Now considering a two stage amplifier consisting
      of an FET operating
39 //New input Impedence taking into account various
      factors for present codition
40 Ci=200*(10^-12);
41 disp('Now considering a two stage amplifier
      consisting of an FET operating ');
42 Yl=(0.001/Rd)+(2*pi*f*Ci*i);
43 disp(Yl, 'Load Admittance =');
44
45 gd=gd*0.001;
46 disp('Gain ');
47 Av=-(gm)/(gd+Yl); //Voltage Gain
48 disp(Av, 'Av=');
49
50 //end

```

Chapter 12

MultiStage Amplifiers

Scilab code Exa 12.1.a Minimum value of coupling capacitance for a given FET

```
1 clear all;
2 clc;
3
4 //Caption:Minimum value of coupling capacitance for
   a given FET
5 //Given Value
6 Ry=1;//in K
7 Rg=1;//in M
8 Ri=1;//in K
9 h0E=1/40;//in K-1
10
11 //fL=1/(2*%pi*(ro+ri)*Cb)<=10
12 //Since ri=1M , ro<Ry=1K , then ro+ri=1M
13
14 Cb=1/(2*%pi*1*10);
15 disp(Cb,'Minimum Value of coupling Capacitance for
   given FET=');
16
17 //end
```

Scilab code Exa 12.1.b Minimum value of coupling capacitance for a given FET

```
1 clear all;
2 clc;
3
4 //Caption:Minimum value of coupling capacitance for
   a given FET
5 //Given Value
6 Ry=1;//in K
7 Rg=1;//in M
8 Ri=1;//in K
9 hOE=1/40;//in K-1
10
11 //fL=1/(2*%pi*(ro+ri)*Cb)<=10
12
13 //Ro>1/hOE=40K ro=Rc=1K. Rb>Ri=1K then ri=1K
14
15 ro=1000;//in ohm
16 ri=1000;//in ohm
17
18 Cb=1/(2*%pi*10*(ro+ri));
19 disp('pF',Cb*(10^6),'Coupling Capacitance for given
   transistor=');
20
21 //end
```

Chapter 13

Feedback Amplifier

Scilab code Exa 13.1 parameters of a Second collector to first emitter feedback amplifier

```
1 clear all;
2 clc;
3
4 //Caption : parameters of a Second collector to
   first emitter feedback ampkifier
5 //Given Data
6 Rs=0; //in V
7 hfe=50; //in K
8 hie=1.1; //in K
9 hre=0; //in K
10 hoe=0; //in K
11
12 disp('We first calculate the effective load Rl1 at
   the first calculator');
13 r1=10; //in K
14 r2=47; //in K
15 r3=33; //in K
16 r4=1+0.1; //in K
17
18 Rl1=(r1*r2*r3*r4)/((r1*r2*r3)+(r1*r2*r4)+(r1*r3*r4))
```

```

    +(r2*r3*r4));
19 disp('K',R11,'R11=');
20
21 disp('Similarly for 2nd Transistor');
22 R1=0.1;//in K
23 R2=4.7;//in K
24 Rc1=R1+R2;
25 Rc2=4.7;//in K
26
27 R12=(Rc1*Rc2)/(Rc1+Rc2);
28 disp('K',R12,'R12=');
29
30 Re=(R1*R2)/(R1+R2);
31
32 disp('Voltage Gain of Transistor Q1');
33 Av1 = -(hfe*R11)/(hie+((1+hfe)*Re));
34 disp(Av1,'Av1=');
35
36 disp('Voltage Gain of Transistor Q2');
37 Av2=- (hfe*R12)/hie;
38 disp(Av2,'Av2=');
39
40 disp('Voltage Gain of two transistors in cascade
    without feedback');
41 Av=Av1*Av2;
42 disp(Av,'Av=');
43
44 B=R1/(R1+R2);//beta which is feedback
45 D=1+(B*Av);
46
47 Avf=Av/D;
48 disp(Avf,'Avf=');
49
50 disp('Input resistance without external feedback');
51 Ri=hie+(1+hfe)*Re;
52 disp('K',Ri,'Ri=');
53
54 Rif=Ri*D;

```

```

55 disp('K',Rif,'Rif=');
56
57 Ro=Rl2;
58 Rof=Ro/D;
59 disp('K',Rof,'Rof=');
60
61 //end

```

Scilab code Exa 13.2.a To find parameters of Current series Feedback Amplifier

```

1 clear all;
2 clc;
3
4 //Caption:To find parameters of Current series
  Fwwdback Amplifier
5 //Given Data
6 Gmf=-1;//Transconductance in mA/V
7 D=50;//Desensivity
8 Avf=-4;//Voltage Gain
9 Rs=1;//in K
10 hfe=150;
11 Vt=0.026;//in V
12
13 Gm=Gmf*D;
14 disp('mA/V',Gm,'Gm=');
15
16 //B=-Re, D = 1+B*Gm = 1-B*Gm
17 Re=(1-D)/Gm;//in K
18 disp('K',Re,'Re=');
19
20 //end

```

Scilab code Exa 13.2.b To find parameters of Current series Feedback Amplifier

```
1 clear all;
2 clc;
3
4 //Caption:Gain of second emitter to first
   basefeedback pair
5 //Given Data
6 Rc1=3;//in K
7 Rc2=0.5;//in K
8 Re=0.05;//in K
9 Rs=1.2;//in K
10 hfe=50;
11 hie=1.1;//in K
12 hre=0;
13 hoe=0;
14
15 R=Rs;
16
17 //Ai=-Ic2/Is=-(Ic2/Ib2)*(Ib2/Ic1)*(Ic1/Ib1)*(Ib1/Is)
18 // -Ic2/Ib2 == hfe = -50
19 // Ic1/Ib1 = hfe
20 //Let Ib2/Ic1 = k
21 Ri2= hie + ((1+hfe)*(Re*R/(Re+R)));
22 k=-Rc1/(Rc1+Ri2);
23
24 r= Rs*(Rs+Re)/(Rs+R+Re);
25 //Let Ib1/Is = l
26 l=r/(r+hie);
27
28 Ai=(-hfe)*(k)*(hfe)*(l);
29
30 B=Re/(Re+R);//beta
31 D=1+(B*Ai);
32
33 Aif=Ai/D;
34
```

```

35 Avf=(Aif*Rc2)/Rs;
36
37 //To find Rif
38
39 Ri=(r*hie)/(r+hie);
40 Rif=Ri/D;
41 disp('ohm',Rif*1000,'Rif=');
42
43 //End

```

Scilab code Exa 13.2.c To find parameters of Current series Feedback Amplifier

```

1 clear all;
2 clc;
3
4 //Caption:To find parameters of Current series
   Fwedback Amplifier
5 //Given Data
6 Gmf=-1;//Transconductance in mA/V
7 D=50;//Desensivity
8 Avf=-4;//Voltage Gain
9 Rs=1;//in K
10 hfe=150;
11 Vt=0.026;//in V
12
13 Gm=Gmf*D;
14
15 //B=-Re, D = 1+B*Gm = 1-B*Gm
16 Re=(1-D)/Gm;//in K
17
18 Rl=Avf/Gmf;//in K
19
20 // Gm= -hfe/(Rs+hie+Re)
21 hie= -(hfe/Gm)-Rs-Re;

```

```

22 Ri = Rs + hie +Re;
23 Rif = Ri*D
24 disp('K',Rif,'Rif=');
25
26
27 //end

```

Scilab code Exa 13.2.d To find parameters of Current seris Feedback Amplifier

```

1 clear all;
2 clc;
3
4 //Caption:To find parameters of Current seris
  Feedback Amplifier
5 //Given Data
6 Gmf=-1;//Transconductance in mA/V
7 D=50;//Desensivity
8 Avf=-4;//Voltage Gain
9 Rs=1;//in K
10 hfe=150;
11 Vt=0.026;//in V
12
13 Gm=Gmf*D;
14
15 //B=-Re, D = 1+B*Gm = 1-B*Gm
16 Re=(1-D)/Gm;//in K
17
18 Rl=Avf/Gmf;//in K
19
20 // Gm= -hfe/(Rs+hie+Re)
21 hie= -(hfe/Gm)-Rs-Re;
22 Ri = Rs + hie +Re;
23 Rif = Ri*D
24

```



```

25 Ic=(hfe*Vt)/hie;
26 disp('mA',Ic,'Quiscent Collector Current = ');
27
28 //end

```

Scilab code Exa 13.3.a Gain of second emitter to first basefeedback pair

```

1 clear all;
2 clc;
3
4 //Caption:Gain of second emitter to first
   basefeedback pair
5 //Given Data
6 Rc1=3;//in K
7 Rc2=0.5;//in K
8 Re=0.05;//in K
9 Rs=1.2;//in K
10 hfe=50;
11 hie=1.1;//in K
12 hre=0;
13 hoe=0;
14
15 R=Rs;
16
17 //Ai=-Ic2/Is=-(Ic2/Ib2)*(Ib2/Ic1)*(Ic1/Ib1)*(Ib1/Is)
18 // -Ic2/Ib2 =- hfe = -50
19 // Ic1/Ib1 = hfe
20 //Let Ib2/Ic1 = k
21 Ri2= hie + ((1+hfe)*(Re*R/(Re+R)));
22 k=-Rc1/(Rc1+Ri2);
23
24 r= Rs*(Rs+Re)/(Rs+R+Re);
25 //Let Ib1/Is = l
26 l=r/(r+hie);
27

```

```

28 Ai=(-hfe)*(k)*(hfe)*(1);
29 disp(Ai,'Ai=');
30
31 B=Re/(Re+R); //beta
32 D=1+(B*Ai);
33
34 Aif=Ai/D;
35 disp(Aif,'Aif=');
36
37 Avf=(Aif*Rc2)/Rs;
38 disp(Avf,'Avf=');
39
40 //End

```

Scilab code Exa 13.3.b Gain of second emitter to first basefeedback pair

```

1 clear all;
2 clc;
3
4 //Caption:Gain of second emitter to first
   basefeedback pair
5 //Given Data
6 Rc1=3; //in K
7 Rc2=0.5; //in K
8 Re=0.05; //in K
9 Rs=1.2; //in K
10 hfe=50;
11 hie=1.1; //in K
12 hre=0;
13 hoe=0;
14
15 R=Rs;
16
17 //Ai=-Ic2/Is=-(Ic2/Ib2)*(Ib2/Ic1)*(Ic1/Ib1)*(Ib1/Is)
18 // -Ic2/Ib2 =- hfe = -50

```

```

19 // Ic1/Ib1 = hfe
20 //Let Ib2/Ic1 = k
21 Ri2= hie + ((1+hfe)*(Re*R/(Re+R)));
22 k=-Rc1/(Rc1+Ri2);
23
24 r= Rs*(Rs+Re)/(Rs+R+Re);
25 //Let Ib1/Is = l
26 l=r/(r+hie);
27
28 Ai=(-hfe)*(k)*(hfe)*(l);
29
30 B=Re/(Re+R); //beta
31 D=1+(B*Ai);
32
33 Aif=Ai/D;
34
35 Avf=(Aif*Rc2)/Rs;
36
37 //To find Rif
38
39 Ri=(r*hie)/(r+hie);
40 Rif=Ri/D;
41 disp('ohm ',Rif*1000, ' Rif=');
42
43 //End

```

Scilab code Exa 13.3.c Gain of second emitter to first basefeedback pair

```

1 clear all;
2 clc;
3
4 //Caption:Gain of second emitter to first
   basefeedback pair
5 //Given Data
6 Rc1=3; //in K

```

```

7 Rc2=0.5; //in K
8 Re=0.05; //in K
9 Rs=1.2; //in K
10 hfe=50;
11 hie=1.1; //in K
12 hre=0;
13 hoe=0;
14
15 R=Rs;
16
17 //Ai=-Ic2/Is=-(Ic2/Ib2)*(Ib2/Ic1)*(Ic1/Ib1)*(Ib1/Is)
18 // -Ic2/Ib2 =- hfe = -50
19 // Ic1/Ib1 = hfe
20 //Let Ib2/Ic1 = k
21 Ri2= hie + ((1+hfe)*(Re*R/(Re+R)));
22 k=-Rc1/(Rc1+Ri2);
23
24 r= Rs*(Rs+Re)/(Rs+R+Re);
25 //Let Ib1/Is = 1
26 l=r/(r+hie);
27
28 Ai=(-hfe)*(k)*(hfe)*(l);
29
30 B=Re/(Re+R); //beta
31 D=1+(B*Ai);
32
33 Aif=Ai/D;
34
35 Avf=(Aif*Rc2)/Rs;
36
37 Ri=(r*hie)/(r+hie);
38 Rif=Ri/D;
39
40 rif=(Rif*Rs)/(Rs-Rif);
41 disp('K',rif+Rs,'Resistance with feedback seen by
      voltage source');
42
43 //End

```

Scilab code Exa 13.3.d Gain of second emitter to first basefeedback pair

```
1 clear all;
2 clc;
3
4 //Caption:Gain of second emitter to first
   basefeedback pair
5 //Given Data
6 Rc1=3; //in K
7 Rc2=0.5; //in K
8 Re=0.05; //in K
9 Rs=1.2; //in K
10 hfe=50;
11 hie=1.1; //in K
12 hre=0;
13 hoe=0;
14
15 R=Rs;
16
17 //Ai=-Ic2/Is=-(Ic2/Ib2)*(Ib2/Ic1)*(Ic1/Ib1)*(Ib1/Is)
18 // -Ic2/Ib2 == hfe = -50
19 // Ic1/Ib1 = hfe
20 //Let Ib2/Ic1 = k
21 Ri2= hie + ((1+hfe)*(Re*R/(Re+R)));
22 k=-Rc1/(Rc1+Ri2);
23
24 r= Rs*(Rs+Re)/(Rs+R+Re);
25 //Let Ib1/Is = l
26 l=r/(r+hie);
27
28 Ai=(-hfe)*(k)*(hfe)*(l);
29
30 B=Re/(Re+R); //beta
31 D=1+(B*Ai);
```

```

32
33 Aif=Ai/D;
34
35 Avf=(Aif*Rc2)/Rs;
36
37 Rof=(Avf*Rs)/Aif;
38 disp('K',Rof,'Output Resistance = ');
39
40 //End

```

Scilab code Exa 13.4.a To find gain and resistance of Voltage Shunt Feedback

```

1 clear all;
2 clc;
3
4 //Caption: To find gain and resistance of Voltage
   Shunt Feedback
5 //Given Values
6 Rc=4; //in K
7 r=40; //in K
8 Rs=10; //in K
9 hie=1.1; //in K
10 hfe=50;
11 hre=0;
12 hoe=0;
13
14 //Required Formulae
15 rc=(Rc*r)/(Rc+r);
16 R=(Rs*r)/(Rs+r);
17 Rm=-(hfe*rc*R)/(R+hie);
18 disp('K',Rm,'Rm=');
19 B=-1/r; //in mA/V
20 D=1+(B*Rm);
21 Rmf=Rm/D;

```

```

22
23 //Avf = Vo/Vs = Vo/( Is*Rs) = Rmf/Rs
24 Avf=Rmf/Rs;
25 disp(Avf , 'Avf=');
26
27
28 //End

```

Scilab code Exa 13.4.b To find gain and resistance of Voltage Shunt Feedback

```

1 clear all;
2 clc;
3
4 //Caption: To find gain and resistance of Voltage
   Shunt Feedback
5 //Given Values
6 Rc=4; //in K
7 r=40; //in K
8 Rs=10; //in K
9 hie=1.1; //in K
10 hfe=50;
11 hre=0;
12 hoe=0;
13
14 //Required Formulae
15 rc=(Rc*r)/(Rc+r);
16 R=(Rs*r)/(Rs+r);
17 Rm=-(hfe*rc*R)/(R+hie);
18 B=-1/r; //in mA/V
19 D=1+(B*Rm);
20 Rmf=Rm/D;
21
22 //Avf = Vo/Vs = Vo/( Is*Rs) = Rmf/Rs
23 Avf=Rmf/Rs;

```

```

24
25 Ri = (R*hie)/(R+hie);
26 Rif=Ri/D;
27 disp('K',Rif,'Rif=');
28
29 //End

```

Scilab code Exa 13.4.c To find gain and resistance of Voltage Shunt Feedback

```

1 clear all;
2 clc;
3
4 //Caption: To find gain and resistance of Voltage
   Shunt Feedback
5 //Given Values
6 Rc=4;//in K
7 r=40;//in K
8 Rs=10;//in K
9 hie=1.1;//in K
10 hfe=50;
11 hre=0;
12 hoe=0;
13
14 //Required Formulae
15 rc=(Rc*r)/(Rc+r);
16 R=(Rs*r)/(Rs+r);
17 Rm=-(hfe*rc*R)/(R+hie);
18 disp('K',Rm,'Rm=');
19 B=-1/r;//in mA/V
20 D=1+(B*Rm);
21 Rmf=Rm/D;
22
23 //Avf = Vo/Vs = Vo/(Is*Rs) = Rmf/Rs
24 Avf=Rmf/Rs;

```



```

25
26 Ri = (R*hie)/(R+hie);
27 Rif=Ri/D;
28
29 //If the input resistance looking to the right of Rs
    is rif then Rif=(rif*Rs)/(rif+Rs)
30 rif=(Rif*Rs)/(Rs-Rif);
31
32 disp('K',Rs+rif,'The impedance seen by the voltage
    source=Rif=');
33
34 Ro=40;//in K
35 r=40;//in K
36
37 Rm = -(hfe*r*R)/(R+hie);
38 Rof=Ro/(1+(B*Rm));
39 //We are writting Rof' = rof
40 rof=(Rof*Rc)/(Rof+Rc);
41 disp('K',rof,'rof=');
42
43 //End

```

Chapter 14

Stability and Oscillators

Scilab code Exa 14.1.a Lowest poles of an Amplifier

```
1 clear all;
2 clc;
3
4 //Caption:Lowest poles of an Amplifier
5 //Given Data
6
7 //Poles in radians per sec
8 s1 = -46.2*(10^5);
9 s2 = -45.9*(10^6);
10 s3 = -11.4*(10^8);
11 s4 = -30.4*(10^8);
12
13 //Zeros
14 s5 = 16.65*(10^9);
15 s6 = 15.4*(10^8);
16 s7 = -22.55*(10^8);
17 s = 6.28*(10^6);
18 B = 0.040;
19 Ai = 410; //Gain
20
21 n = s2/s1;
```

```

22 disp(n, 'n=');
23 Q = (n*(1+(B*Ai)))^0.5/(n+1);
24 disp(Q, 'Q=');
25 k = 1/(2*Q);
26 disp(k, 'k=');
27
28 s1f = s1*((n+1)/2)*(1-%i*((4*Q*Q)-1)^0.5);
29 disp(s1f, 'The first pole is ');
30 s2f = s1*((n+1)/2)*(1+%i*((4*Q*Q)-1)^0.5);
31 disp(s2f, 'The second pole is ');
32
33
34 //end

```

Scilab code Exa 14.1.b Frequency Response Peak

```

1 clear all;
2 clc;
3
4 //Frequency Response Peak
5 //Given Data
6
7 //Poles in radians per sec
8 s1 = -46.2*(10^5);
9 s2 = -45.9*(10^6);
10 s3 = -11.4*(10^8);
11 s4 = -30.4*(10^8);
12
13 //Zeros
14 s5 = 16.65*(10^9);
15 s6 = 15.4*(10^8);
16 s7 = -22.55*(10^8);
17 s = 6.28*(10^6);
18 B = 0.040;
19 Ai = 410; //Gain

```

```

20
21 n = s2/s1;
22 Q = (n*(1+(B*Ai)))^0.5/(n+1);
23 k = 1/(2*Q);
24
25 s1f = s1*((n+1)/2)*(1-%i*((4*Q*Q)-1)^0.5);
26 s2f = s1*((n+1)/2)*(1+%i*((4*Q*Q)-1)^0.5);
27
28 //Frequency Response Peak
29 wo = -Q*(s1+s2);
30 disp(wo, 'wo=');
31 w = wo*(1-(2*k*k))^0.5//frequency at which frequency
    response peak occurs
32 disp(w, 'w=');
33 fpeak = (wo/s)*(1-(2*k*k))^0.5;
34 disp('MHz', fpeak, 'fpeak=');
35 //At peak
36 a = 1/(2*k*(1-(k*k))^0.5);
37 overshoot = 20*log10(a);
38 disp('dB', overshoot, 'Overshoot is ');
39
40
41 //end

```

Chapter 15

Operational Amplifier

Scilab code Exa 15.1.a difference in output voltage for two set of output signals

```
1 clear all;
2 clc;
3
4 //Caption:difference in output voltage for two set
   of output signals
5 //Given Data
6 //First Set of Input Signal
7 v11=50;//in microV
8 v21=-50;//in microV
9 //Second Set of Input Signal
10 v12=1050;//in microV
11 v22=950;//in microV
12 p=100;//Common Mode Rejection Ratio
13
14 //Required Formulae
15 //vo = Ad*vd*(1+vc/p*vd) .... p = commom mode
   rejection ratio
16 //Ad will be same for both case , So let us write Vo
   = vo/Ad = Ad*(1+vc/p*vd)
17
```

```

18 //First Set of Values
19 vd1=v11-v21;//in microV
20 vc1=(v11+v21)/2;//in microV
21 Vo1 = vd1*(1+vc1/(p*vd1));
22
23 //Second Set of Values
24 vd2=v12-v22;//in microV
25 vc2=(v12+v22)/2;//in microV
26 Vo2 = vd2*(1+vc2/(p*vd2));
27
28 disp(100*(Vo2-Vo1)/Vo1,'Percentage difference in
    output signal=');
29
30
31 //end

```

Scilab code Exa 15.1.b difference in output voltage for two set of output signals

```

1 clear all;
2 clc;
3
4 //Caption:difference in output voltage for two set
    of output signals when Common Mode Rejection
    Ratio =10000
5 //Given Data
6 //First Set of Input Signal
7 v11=50;//in microV
8 v21=-50;//in microV
9 //Second Set of Input Signal
10 v12=1050;//in microV
11 v22=950;//in microV
12 p=100;//Common Mode Rejection Ratio
13
14 //Required Formulae

```

```

15 //vo = Ad*vd*(1+vc/p*vd) .... p = common mode
    rejection ratio
16 //Ad will be same for both case , So let us write Vo
    = vo/Ad = Ad*(1+vc/p*vd)
17
18 //First Set of Values
19 vd1=v11-v21;//in microV
20 vc1=(v11+v21)/2;//in microV
21 Vo1 = vd1*(1+vc1/(p*vd1));
22
23 //Second Set of Values
24 vd2=v12-v22;//in microV
25 vc2=(v12+v22)/2;//in microV
26 Vo2 = vd2*(1+vc2/(p*vd2));
27
28
29 //Now we have to calculate the same thing with
    common mode rejection ratio = 10000
30
31 p=10000;//Common Mode Rejection Ratio
32
33 //First Set of Values
34 vd1=v11-v21;//in microV
35 vc1=(v11+v21)/2;//in microV
36 Vo1 = vd1*(1+vc1/(p*vd1));
37
38 //Second Set of Values
39 vd2=v12-v22;//in microV
40 vc2=(v12+v22)/2;//in microV
41 Vo2 = vd2*(1+vc2/(p*vd2));
42
43 disp(100*(Vo2-Vo1)/Vo1,'Percentage difference in
    output signal=');
44
45 //end

```

Scilab code Exa 15.2 Design an amplifier using yA702A

```
1 clear all;
2 clc;
3
4 //Caption:Design an amplifier using yA702A
5 //Given Data
6 f=32;//feedback in dB
7 //from the Bodes plot we get that Avo = 2510
8 Avo = 2510;//gain
9 disp('The parameters are R , r (for Rdash), C (for
      Cdash)');
10 //Desensivity D = B*Rmo = Avo*(R/(R+r))
11 //20log10(D ) = f
12 k = f - (20*log10(Avo));
13 //Let (R+r)/R = l
14 l = 1/(10^(k/20));
15 //R/(R+r) = fp/fz
16 //For 45degree phase margin and 32dB of low
      frequency feedback we find by trial and error
      method from the graph
17 fz = 10;//in MHz
18 fp = fz*l;
19 //to determine c we can arbitrarily choose R
20 R = 1000;//in ohm
21 disp('ohm',R,'R = ');
22 r = (l-1)*R
23 disp('ohm',r,'r = ');
24 C = 1/(2*pi*fz*r*10^-6);
25 disp('pF',C,'C = ');
26
27
28 //end
```

Chapter 16

Integrated Circuits as Analog System Building blocks

Scilab code Exa 16.1 Fourth Order Butterworth Filter

```
1 clear all;
2 clc;
3
4 //Caption:Fourth Order Butterworth Filter
5 //Given Data
6 fo=1;//Cutoff Frequency in Hz
7 //For n = 4
8 k1=0.765;
9 k2=1.848;
10
11 Av1 = 3-k1;
12 Av2 = 3-k2;
13 disp('For a fourth order Buttworth filter we cacade
      2 second order Buttworth filter with parameters
      R1 R2 R1d R2d R C');
14 //we arbitrarily choose
15 R1=10;//in K
16 disp('K',R1,'R1=');
17 //Av1=(R1+R1d)/R1
```

```

18 R1d=(Av1*R1)-R1;
19 disp(R1d, 'R1d = ');
20
21 R2 = 10; //in K
22 disp('K',R2, 'R2=');
23 R2d=(Av2*R2)-R2;
24 disp(R2d, 'R2d = ');
25
26 //To satisfy fo = 1/(2*%pi*r*c) = 1kHz
27 R=1; //in K
28 C = 1/(2*%pi*R*fo);
29 disp('K',R, 'R=');
30 disp('microF',C, 'C = ');

```

Scilab code Exa 16.2 Design a second order bandpass filter

```

1 clear all;
2 clc;
3 //Caption : Design a second order bandpass filter
4 //Given Value
5 Ao=50; //Gain
6 fo=160; //center frequency
7 B=16; //Bandwidth in Hz
8 C1=0.1; //in microF
9 C2=0.1; //in microF
10
11 //Required Formulae
12
13 Q=fo/B;
14 R1=(1000*Q)/(Ao*2*%pi*fo*C1);
15 R3=(1000*Q)/((2*%pi*fo)*(C1*C2/(C1+C2)));
16 //As C is in microFarad to compensate for it 1000 is
    multiplied
17 //Let r = R'
18 r=(10^6)/((2*%pi*fo)^2*R3*C1*C2);

```

```

19 R2=(R1*r)/(R1-r);
20
21 disp('K',R1,'R1=');
22 disp('K',R3,'R3=');
23 disp('K',r,'r=');
24 disp('K',R2,'R2=');
25
26 //end

```

Scilab code Exa 16.3 Design a video amplifier using MC1550

```

1 clear all;
2 clc;
3
4 //Caption:Design a video amplifier using MC1550
5 //Given Data
6 Avo=-25;
7 Vagc=20;//in V
8 Vcc=6;//in V
9 hfe=50;
10 rbb=50;//in ohm
11 Cs=5;//in pF
12 Cl=5;//in pF
13 Ie1=1;//in mA
14 ft=900;//in MHz
15 Vt=26;//in V
16 n=2;//eeta
17 //re2 = infinity
18
19 //Since Vagc=0 , transistor Q2 is in cut off region
    and collector current of Q1 flows through Q3....
    So
20 Ie2=0;
21 Ie3=1;//in mA
22 re3 = (n*Vt)/Ie3;//in ohm

```

```

23 disp('ohm',re3,'re3=');
24 gm = (Ie1)/Vt;//in ohm^-1
25 disp('ohm^-1',gm,'gm=');
26 rbe=hfe/gm;
27 disp('ohm',rbe,'rbe=');
28 Ce=gm/(2*pi*ft*10^-6);
29 disp('pF',Ce,'Ce=');
30 a3=1;//we make an assumption that alpha is one
31 s=0;
32 //Av0 = -((a3*gm)/(re3*rbb))*(1/(((1/rbb)+(1/rbe)+(s
      *Ce))*((1/re3)+(s*Cs))*((1/Rl)+(s*(Cs+Cl))))))
33 //From here we can find Rl
34 k = -((a3*gm)/(re3*rbb))*(1/(((1/rbb)+(1/rbe)+(s*Ce)
      )*((1/re3)+(s*Cs))));
35 Rl=Avo/k;
36 disp('ohm',Rl,'Rl=');
37
38 //C is in picoFarad so to compensate the whole
      equation some constants are multiplied
39 f1 = 1/(2*pi*Rl*(Cs+Cl)*10^-6);
40 disp('MHz',f1,'f1=');
41 f2 = 1/(2*pi*Ce*10^-6*((rbe*rbb)/(rbe+rbb)));
42 disp('MHz',f2,'f2=');
43 f3 = 1/(2*pi*Cs*re3*10^-6);
44 disp('MHz',f3,'f3=');
45
46
47 //end

```

Scilab code Exa 16.4.a Logic Level Output of an ECL gate

```

1 clear all;
2 clc;
3
4 //Caption:Logic Level Output of an ECL gate

```

```

5 //Given Data
6 Vbb = 1.15;//in V
7 Vee=5.20;//in V
8 Vbe5=0.7;//in V
9 R=1.18;//in K
10 r=300;//in ohm
11 Vbecutin=0.5;//in V
12
13 //If all inputs are low then we assume that Q1,Q2
    and Q3 are cutoff and Q4 is conducting
14 Ve=-Vbb-Vbe5;//Voltage at Common Emitter in V
15 //Current I in 1.18K Resistor
16 I = (Ve+Vee)/R;//in mA
17 I1=I;
18 disp('mA',I,'Current in 300 ohm resistance I=');
19 //Output Voltage at Y
20 vy = -(r*I/1000)-Vbe5;//I is in mA so 1000 is
    multiplied
21 Vbe = vy-Ve;
22 disp('V',Vbe,'Vbe = ');
23 if(Vbe<Vbecutin)
24     disp('Input transistors are non conducting as
        was assumed');
25     disp('If atleast one input is high then it is
        assumed that curent in 1.18K resistance is
        switched to R and Q4 is cutoff');
26     disp('Drop in 300 ohm resistance is zero.Since
        the base aand collector are tied together Q5
        now behaves as a diode');
27     disp('Across Q5');
28     v=0.7;//voltage across Q5 in V
29     rQ5 = 1.5;//in K
30     i = (Vee-v)/rQ5;
31     v = 0.75;//from the graph in V
32     disp('mA',i,'i=');
33     disp('V',v,'v=');
34     Ve = -v-Vbe5;
35     Vbe4=-Vbb-Ve;

```

```

36     disp('V',Vbe4,'Vbe4=');
37 end
38 disp('The total output swing between two logic gates
      ');
39 vo = -vy-v;
40 disp('V',vo,'vo=');
41
42
43 //end

```

Scilab code Exa 16.4.b Calculation of noise margin

```

1  clear all;
2  clc;
3
4  //Calculation of noise margin
5  //Given Data
6  Vbb = 1.15; //in V
7  Vee=5.20; //in V
8  Vbe5=0.7; //in V
9  R=1.18; //in K
10 r=300; //in ohm
11 Vbecutin=0.5; //in V
12
13 //If all inputs are low then we assume that Q1,Q2
    and Q3 are cutoff and Q4 is conducting
14 Ve=-Vbb-Vbe5; //Voltage at Common Emitter in V
15 //Current I in 1.18K Resistor
16 I = (Ve+Vee)/R; //in mA
17 I1=I;
18 //Output Voltage at Y
19 vy = -(r*I/1000)-Vbe5; //I is in mA so 1000 is
    multiplied
20 Vbe = vy-Ve;
21 if(Vbe<Vbecutin)

```

```

22     v=0.7; //voltage across Q5 in V
23     rQ5 = 1.5; //in K
24     i = (Vee-v)/rQ5;
25     v = 0.75; //from the graph in V
26     Ve = -v-Vbe5;
27     Vbe4=-Vbb-Ve;
28 end
29 vo = -vy-v;
30
31 //Calculation of noise margin
32 vn = Vbecutin-Vbe4;
33 disp('Positive noise spike which will cause the gate
      to malfunction ');
34 disp('V',vn,'vn=');
35
36 //end

```

Scilab code Exa 16.4.c Verify that conducting transistor is in active region

```

1 clear all;
2 clc;
3
4 //Verify that conducting transistor is in active
   region
5 //Given Data
6 Vbb = 1.15; //in V
7 Vee=5.20; //in V
8 Vbe5=0.7; //in V
9 R=1.18; //in K
10 r=300; //in ohm
11 Vbecutin=0.5; //in V
12
13 //If all inputs are low then we assume that Q1,Q2
   and Q3 are cutoff and Q4 is conducting

```

```

14 Ve=-Vbb-Vbe5;//Voltage at Common Emitter in V
15 //Current I in 1.18K Resistor
16 I = (Ve+Vee)/R;//in mA
17 I1=I;
18 //Output Voltage at Y
19 vy = -(r*I/1000)-Vbe5;//I is in mA so 1000 is
    multiplied
20 Vbe = vy-Ve;
21 if(Vbe<Vbecutin)
22     v=0.7;//voltage across Q5 in V
23     rQ5 = 1.5;//in K
24     i = (Vee-v)/rQ5;
25     v = 0.75;//from the graph in V
26     Ve = -v-Vbe5;
27     Vbe4=-Vbb-Ve;
28 end
29 vo = -vy-v;
30
31 Vb4 = Vbb;
32 Vc4 = -(I*r)/1000;//in V
33 Vcb4 = Vc4+Vb4;
34 disp('V',Vcb4,'Vcb4 = ');
35 if(Vcb4>0)
36     disp('For on npn transistor this represents a
        reverse bias and Q4 must be in active region'
        );
37 end
38 Vb1 = v;
39 Vc1 = vy+Vbe5;
40 Vcb1 = Vc1 + Vb1;
41 disp('V',Vc1,'Vc1=');
42 disp('V',Vcb1,'Vcb1=');
43 if(Vcb1<0)
44     disp('For an npn transistor this represents a
        forward bias.... therefore Q1 is in
        saturation region');
45 end
46

```


47 //end

Scilab code Exa 16.4.d Calculation of R

```
1 clear all;
2 clc;
3
4 //Calculation of R
5 //Given Data
6 Vbb = 1.15; //in V
7 Vee=5.20; //in V
8 Vbe5=0.7; //in V
9 R=1.18; //in K
10 r=300; //in ohm
11 Vbecutin=0.5; //in V
12
13 //If all inputs are low then we assume that Q1,Q2
    and Q3 are cutoff and Q4 is conducting
14 Ve=-Vbb-Vbe5; //Voltage at Common Emitter in V
15 //Current I in 1.18K Resistor
16 I = (Ve+Vee)/R; //in mA
17 I1=I;
18 //Output Voltage at Y
19 vy = -(r*I/1000)-Vbe5; //I is in mA so 1000 is
    multiplied
20 Vbe = vy-Ve;
21 if(Vbe<Vbecutin)
22     v=0.7; //voltage across Q5 in V
23     rQ5 = 1.5; //in K
24     i = (Vee-v)/rQ5;
25     v = 0.75; //from the graph in V
26     Ve = -v-Vbe5;
27     Vbe4=-Vbb-Ve;
28 end
29 vo = -vy-v;
```

```

30
31 //Verify that conducting transistor is in active
    region
32 Vb4 = Vbb;
33 Vc4 = -(I*r)/1000; //in V
34 Vcb4 = Vc4+Vb4;
35 Vb1 = v;
36 Vc1 = vy+Vbe5;
37 Vcb1 = Vc1 + Vb1;
38
39 Vbe1 = Vbe5;
40 Ve = -(Vb1+Vbe1);
41 disp('V',Ve,'Ve=');
42 I = (Ve + Vee)/R;
43 I2=I;
44 R = -Vc1/I;
45 disp('ohm',R,'R=');
46
47 //end

```

Scilab code Exa 16.4.e Average power dissipated by the gate

```

1 clear all;
2 clc;
3
4 //Average power dissipated by the gate
5 //Given Data
6 Vbb = 1.15; //in V
7 Vee=5.20; //in V
8 Vbe5=0.7; //in V
9 R=1.18; //in K
10 r=300; //in ohm
11 Vbecutin=0.5; //in V
12
13 //If all inputs are low then we assume that Q1,Q2

```

```

    and Q3 are cutoff and Q4 is conducting
14 Ve=-Vbb-Vbe5;//Voltage at Common Emitter in V
15 //Current I in 1.18K Resistor
16 I = (Ve+Vee)/R;//in mA
17 I1=I;
18 //Output Voltage at Y
19 vy = -(r*I/1000)-Vbe5;//I is in mA so 1000 is
    multiplied
20 Vbe = vy-Ve;
21 if(Vbe<Vbecutin)
22     v=0.7;//voltage across Q5 in V
23     rQ5 = 1.5;//in K
24     i = (Vee-v)/rQ5;
25     v = 0.75;//from the graph in V
26     Ve = -v-Vbe5;
27     Vbe4=-Vbb-Ve;
28 end
29
30 vo = -vy-v;
31
32 Vb4 = Vbb;
33 Vc4 = -(I*r)/1000;//in V
34 Vcb4 = Vc4+Vb4;
35 Vb1 = v;
36 Vc1 = vy+Vbe5;
37 Vcb1 = Vc1 + Vb1;
38
39 Vbe1 = Vbe5;
40 Ve = -(Vb1+Vbe1);
41 I = (Ve + Vee)/R;
42 I2=I;
43
44 I =(I1+I2)/2;
45 disp('mA',I,'I=');
46 I2 = (Vee-v)/rQ5;
47 I3 = (Vee+vy)/rQ5;
48 I = I + I2 + I3;
49 P = Vee*I;

```

```
50 disp('mW',P,'Power dissipated = ');  
51  
52 //end
```

Chapter 18

Power Circuits and Systems

Scilab code Exa 18.1.a Design a series regulated power supply

```
1 clear all;
2 clc;
3
4 //Caption:Design a series regulated power supply
5 //Given Data
6 Vo=25;//in V
7 ro=10;//in ohm
8
9 disp('select a silicon reference diode');
10 disp('two IN7555 diodes are provided');
11 Rz = 12;//in ohm
12 Vo=25;//output voltage in V
13 Vr = 7.5 + 7.5;//because two diodes are used
14 Iz = 20;//in mA
15 Ie2=10;//in mA
16 Ic2 = Ie2;
17 Icmax=30;//in mA
18 Vcemax=45;//in V
19 hFE2=220;
20 hfe2=200;
21 hie2=800;//in ohm
```

```

22 Id=10; //in mA
23 I1 = 1000; //in mA
24 Vi = 50; //in V
25 dVi = 10; //change in input voltage
26 dI1 = 1; //change in load current
27
28 //For D1 and D2 operate
29 Iz = Id + Id;
30 Rd = (Vo-Vr)/Id;
31 disp('K',Rd,'Rd=');
32
33 Ib2 = (1000*Ic2)/hFE2;
34 disp('microA',Ib2,'Ib2=');
35
36 //Since we require I1>Ib2 , we select
37 I1=10*(10^-3); //in A
38 Vbe = 0.7; //in V
39
40 V2 = Vbe + Vr;
41 disp('V',V2,'V2=');
42
43 R1 = (Vo-V2)/I1;
44 R2 = V2/I1;
45 disp('ohm',R1,'R1=');
46 disp('ohm',R2,'R2=');
47
48 //We are selecting Texas Instruments 2N1722 silicon
    power transistor , so following parameters are
    required
49 disp('We are selecting Texas Instruments 2N1722
    silicon power transistor');
50 Ic1 = 1; //in A
51 hFE1=125;
52 hfe1=100;
53 hie1=20;
54
55 Ib1 =(1000*I1 + I1 + Id)/hFE1;
56 disp('mA',Ib1+Ic2,'The current through resistor R3

```

```

        is ');
57 I=Ib1 + Ic2;
58
59 R3 = (Vi - (Vbe + Vo))/I;
60 disp('K',R3,'The value of R3 is ');
61
62 //End

```

Scilab code Exa 18.1.b Calculation of Sv

```

1 clear all;
2 clc;
3
4 //Caption: Calculation of Sv
5 //Given Data
6 Vo=25; //in V
7 ro=10; //in ohm
8
9 Rz = 12; //in ohm
10 Vo=25; //output voltage in V
11 Vr = 7.5 + 7.5; //because two diodes are used
12 Iz = 20; //in mA
13 Ie2=10; //in mA
14 Ic2 = Ie2;
15 Icmax=30; //in mA
16 Vcemax=45; //in V
17 hFE2=220;
18 hfe2=200;
19 hie2=800; //in ohm
20 Id=10; //in mA
21 I1 = 1000; //in mA
22 Vi = 50; //in V
23 dVi = 10; //change in input voltage
24 dI1 = 1; //change in load current
25

```

```

26 //For D1 and D2 operate
27 Iz = Id + Id;
28 Rd = (Vo-Vr)/Id;
29
30 Ib2 = (1000*Ic2)/hFE2;
31
32 //Since we require I1>Ib2 , we select
33 I1=10*(10^-3); //in A
34 Vbe = 0.7; //in V
35
36 V2 = Vbe + Vr;
37
38 R1 = (Vo-V2)/I1;
39 R2 = V2/I1;
40
41 //We are selecting Texas Instruments 2N1722 silicon
    power transistor , so following parameters are
    required
42 Ic1 = 1; //in A
43 hFE1=125;
44 hfe1=100;
45 hie1=20;
46
47 Ib1 =(1000*I1 + I1 + Id)/hFE1;
48 //The current through resistor R3
49 I=Ib1 + Ic2;
50
51 R3 = (Vi - (Vbe + Vo))/I;
52 Gm = hfe2*(R2/(R2+R1))*(1/((R1*R2/(R1+R2))+hie2+(1+
    hfe2)*Rz)) ;
53 Sv = (10^-3)/(Gm*R3);
54 disp(Sv, 'Sv=');
55
56 //End

```

Scilab code Exa 18.1.c Find output resistance Ro

```
1 clear all;
2 clc;
3
4 //Caption:Find output resistance Ro
5 //Given Data
6 Vo=25;//in V
7 ro=10;//in ohm
8 Rz = 12;//in ohm
9 Vo=25;//output voltage in V
10 Vr = 7.5 + 7.5;//because two diodes are used
11 Iz = 20;//in mA
12 Ie2=10;//in mA
13 Ic2 = Ie2;
14 Icmax=30;//in mA
15 Vcemax=45;//in V
16 hFE2=220;
17 hfe2=200;
18 hie2=800;//in ohm
19 Id=10;//in mA
20 I1 = 1000;//in mA
21 Vi = 50;//in V
22 dVi = 10; //change in input voltage
23 dI1 = 1;//change in load current
24
25 //For D1 and D2 operate
26 Iz = Id + Id;
27 Rd = (Vo-Vr)/Id;
28
29 Ib2 = (1000*Ic2)/hFE2;
30
31 //Since we require I1>Ib2 , we select
32 I1=10*(10^-3);//in A
33 Vbe = 0.7;//in V
34
35 V2 = Vbe + Vr;
36
```

```

37 R1 = (Vo-V2)/I1;
38 R2 = V2/I1;
39
40 //We are selecting Texas Instruments 2N1722 silicon
    power transistor , so following parameters are
    required
41 Ic1 = 1; //in A
42 hFE1=125;
43 hfe1=100;
44 hie1=20;
45
46 Ib1 =(1000*I1 + I1 + Id)/hFE1;
47 //The current through resistor R3 is
48 I=Ib1 + Ic2;
49
50 R3 = (Vi - (Vbe + Vo))/I;
51
52 Gm = hfe2*(R2/(R2+R1))*(1/((R1*R2/(R1+R2))+hie2+(1+
    hfe2)*Rz)) ;
53 disp(Gm, 'Gm=');
54
55 Ro = (ro + (((1000*R3) + hie1)/(1+hfe1)))/(1 + (Gm
    *((1000*R3) + ro)));
56 disp('K',Ro, 'The output impedance is = ');
57
58 //End

```

Scilab code Exa 18.1.d Calculation of change in output voltage due to change in input voltage and load current

```

1 clear all;
2 clc;
3
4 //Caption: Calculation of change in output voltage
    due to change in input voltage and load current

```

```

5 //Given Data
6 Vo=25;//in V
7 ro=10;//in ohm
8
9 Rz = 12;//in ohm
10 Vo=25;//output voltage in V
11 Vr = 7.5 + 7.5;//because two diodes are used
12 Iz = 20;//in mA
13 Ie2=10;//in mA
14 Ic2 = Ie2;
15 Icmax=30;//in mA
16 Vcemax=45;//in V
17 hFE2=220;
18 hfe2=200;
19 hie2=800;//in ohm
20 Id=10;//in mA
21 I1 = 1000;//in mA
22 Vi = 50;//in V
23 dVi = 10; //change in input voltage
24 dI1 = 1;//change in load current
25
26 //For D1 and D2 operate
27 Iz = Id + Id;
28 Rd = (Vo-Vr)/Id;
29
30 Ib2 = (1000*Ic2)/hFE2;
31
32 //Since we require I1>Ib2 , we select
33 I1=10*(10^-3);//in A
34 Vbe = 0.7;//in V
35
36 V2 = Vbe + Vr;
37
38 R1 = (Vo-V2)/I1;
39 R2 = V2/I1;
40
41 //We are selecting Texas Instruments 2N1722 silicon
    power transistor , so following parameters are

```

```

        required
42 Ic1 = 1; //in A
43 hFE1=125;
44 hfe1=100;
45 hie1=20;
46
47 Ib1 =(1000*I1 + I1 + Id)/hFE1;
48 //The current through resistor R3 is
49 I=Ib1 + Ic2;
50
51 R3 = (Vi - (Vbe + Vo))/I;
52
53 Gm = hfe2*(R2/(R2+R1))*(1/((R1*R2/(R1+R2))+hie2+(1+
    hfe2)*Rz)) ;
54 Sv = (10^-3)/(Gm*R3);
55
56 Ro = (ro + (((1000*R3) + hie1)/(1+hfe1)))/(1 + (Gm
    *((1000*R3) + ro)));
57
58 dVo = (Sv*dVi)+(Ro*dI1);
59 disp('V',dVo,'Change in output voltage = ');
60
61 //End

```

Scilab code Exa 18.2.a SCR half wave power control circuit

```

1 clear all;
2 clc;
3
4 //Caption:SCR half wave power control circuit
5 //Given Data
6 Vs=230; //in V
7 R1=200; //in ohm
8 //Trigger is adjusted so that conduction starts
    after 60degree of start of cycle

```

```

9 //Instantaneous Current  $i_l = (230*2^{0.5}*\sin(a))/200$ 
10
11 // to find rms value
12  $x_0 = \pi/3$ ; //lower limit of integration
13  $x_1 = \pi$ ; //upper limit of integration
14
15 X = integrate('((230*(2^0.5)*sin(x))/200)^2', 'x',  $x_0$ ,
    x1);
16  $I_{rms} = (X/(2*\pi))^{0.5}$ ;
17 disp('A',  $I_{rms}$ , 'Irms = ');
18
19 //End

```

Scilab code Exa 18.2.b SCR half wave power control circuit

```

1 clear all;
2 clc;
3
4 //Caption:SCR half wave power control circuit
5 //Given Data
6  $V_s=230$ ; //in V
7  $R_l=200$ ; //in ohm
8 //Trigger is adjusted so that conduction starts
    after 60degree of start of cycle
9 //Instantaneous Current  $i_l = (230*2^{0.5}*\sin(a))/200$ 
10 //It is noted that between 0 to  $\pi/3$  SCR voltage
    equals line voltage and between  $\pi/3$  to  $\pi$  it is
    zer and for the rest it is equal to line voltage
11 // $V_l = 230*2^{0.5}*\sin(x)$ 
12 //To find instantaneous power
13
14  $x_0=\pi/3$ ; //lower limit of integral
15  $x_1=\pi$ ; //upper limit of integral
16 X = integrate('(230*230*2*(sin(x)^2))/200', 'x',  $x_0$ ,  $x_1$ 
    );

```

```

17 P = X/(2*3.14);
18 disp('W',P,'P=');
19
20 //End

```

Scilab code Exa 18.2.c SCR half wave power control circuit

```

1 clear all;
2 clc;
3
4 //Caption:SCR half wave power control circuit
5 //Given Data
6 Vs=230;//in V
7 Rl=200;//in ohm
8 //Trigger is adjusted so that conduction starts
   after 60degree of start of cycle
9 //Instantaneous Current  $i_l = (230*2^{0.5}*\sin(a))/200$ 
10
11 //To find Vrms
12
13 //It is noted that between 0 to  $\pi/3$  SCR voltage
   equals line voltage and between  $\pi/3$  to  $\pi$  it is
   zer and for the rest it is equal to line voltage
14 xo=0;//lower limit of first integral
15 x1=%pi/3;//upper limit of first integral
16 x2=%pi;//lower limit of second integral
17 x3=2*(%pi);//upper limit of second integral
18 X1 = integrate('(230*(2^0.5)*sin(x))^2','x',xo,x1);
19 X2 = integrate('(230*(2^0.5)*sin(x))^2','x',x2,x3);
20 Vrms = ((X1+X2)/(2*%pi))^0.5;
21 disp('V',Vrms,'Vrms=');
22
23 //End

```

Scilab code Exa 18.3 SCR Relaxation Oscillator Phase control Circuit

```
1 clear all;
2 clc;
3
4 //Caption:SCR Relaxation Oscillator Phase control
   Circuit
5 //Given Data
6 C=0.1;//in microF
7 V=60;//in V
8 Vb=32;//in V
9 Vh=10;//holding voltage in V
10 Ih=100;//in microA
11 c=45;//conductance angle in degree
12 cd = 360 - c;//angle in which capacitor will get
   charged
13 td = (cd/360)*(1/60);//in ms
14
15 //if the anode voltage is positive ,the SCR will fire
   when vc=32V
16 vc=32;//in V
17 //let time constant = t = R*C
18 //vc-Vh = (V-Vh)(1-exp(-td/t))
19 t = -td/log(1-((vc-Vh)/(V-Vh)));
20 disp('sec',t,'time constant = ');
21 R = t/C;//Resistance in K
22 disp('K',R*1000,'R=');
23
24
25 //end
```
