

Scilab Textbook Companion for
Analog Electronics
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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.

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Chapter 1

Feedback Amplifiers

Scilab code Exa 1.1 transistor in the feedback amplifier

```
1 //Example 1.1
2 clc
3 disp("Step 1: Identity topology")
4 disp(" The feedback voltage is applied across the
      resistance R_e1 and it is in series with input
      signal. Hence feedback is voltage series feedback
      .")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit.")
7 disp(" To find input circuit , set  $V_o = 0$  (
      connecting C2 to ground), which gives parallel
      combination of  $R_e$  with  $R_f$  at E1. To find output
      circuit , set  $I_i = 0$  (opening the input node E1 at
      emitter of Q1), which gives series combination
      of  $R_f$  and  $R_{e1}$  across the output. The resultant
      circuit is shown in Fig.1.32")
8 disp("")
9 disp("Step 4: Find open loop voltage gain( $A_v$ )")
10 format(5)
11 r12=(4.7*10.1)/(4.7+10.1) // in k-ohm
```

```

12 disp(r12," R_L2(in k-ohm) = R_c2 || (R_e1+Rf) =")
13 disp(" A_i2 = -hfe = -100")
14 disp(" R_i2 = hie = 1100 ohm")
15 format(7)
16 av2=(-100*3.21*10^3)/1100
17 disp(av2," A_v2 = A_i2*R_L2 / R_i2 =")
18 disp(" A_i1 = -hfe = -100")
19 format(5)
20 r11=(22*220*22*1.100)/((220*22*1.100)+(22*22*1.100)
    +(22*220*1.100)+(22*220*22)) // in ohm
21 disp(r11*10^3," R_L1(in ohm) = R_c1 || R3 || R4 ||
    R_i2 =")
22 ri1=1.1+(101*((0.1*10)/(0.1+10))) // in k-ohm
23 format(5)
24 disp(ri1," R_i1(in k-ohm) = hie + (1+hfe)*R_e1eff =
    where Re1eff = (R_e1 || Rf)")
25 av1=(-100*995)/(11.099*10^3)
26 disp(av1," Therefore , A_v1 = A_i1*RL1 / Ri1 =")
27 disp("The overall voltage gain without feedback is
    given as,")
28 av=-291.82*-8.96
29 format(7)
30 disp(av," Av = A_v1 * A_v2 =")
31 disp("The overall voltage gain taking Rs in account
    is given as,")
32 aV=(2614.7*11.099*10^3)/((11.099*10^3)+100)
33 format(8)
34 disp(aV," Av = Vo / Vs = Av*R_i1 / R_i1+Rs =")
35 disp("")
36 disp("Step 5: Calculate beta")
37 disp("Looking at Fig.1.33.")
38 beta=100/(100+(10*10^3))
39 format(7)
40 disp(beta," beta = Vf / Vo =")
41 d=1+(0.0099*2591.35)
42 format(6)
43 disp(d," D = 1 + beta*Av =")
44 avf=2591.35/26.65

```

```

45 disp(avf," A_vf = Av/D =")
46 rif=26.65*11.099 // in k-ohm
47 format(8)
48 disp(rif," R_if(in k-ohm) = R_i1 * D =")
49 riff=(295.788*220*22)/((220*22)+(295.788*22)
      +(295.788*22)) // in k-ohm
50 format(6)
51 disp(riff," R''_if(in k-ohm) = R_if || R1 || R2 =")
52 disp(" R_of = Ro / D = infinity / D = infinity")
53 disp("Therefore, R''_of = R''_o / D where
      R''_o = RL2")
54 roff=(3.21*10^3)/26.65 // in omh
55 format(7)
56 disp(roff,"Therefore, R''_of(in ohm) = ")

```

Scilab code Exa 1.2 closed loop gain with negative feedback

```

1 //Example 1.2
2 clc
3 avf=600/(1+(600*0.01))
4 format(7)
5 disp(avf," A_vf = A / 1+A*beta =")

```

Scilab code Exa 1.3 open and closed loop gain

```

1 //Example 1.3
2 clc
3 disp("Given: beta = 0.04, Distortion with feedback
      = 3%, Distortion without feedback = 15%")
4 d=15/3
5 format(2)
6 disp(d,"Therefore, D =")
7 disp("where D = 1 + A*beta = 5")

```

```

8 a=4/0.04
9 format(4)
10 disp(a," Therefore , A =")

```

Scilab code Exa 1.4 gain with feedback

```

1 //Example 1.4
2 clc
3 disp("(a) Gain with feedback")
4 format(5)
5 av=1000/(1+(0.05*1000))
6 disp(av," AV_mid = Av_mid / 1+beta*Av_mid =")
7 flf=50/(1+(0.05*1000)) // in Hz
8 disp(flf,"(b) f_Lf(in Hz) = f_L / 1+beta*Av_mid =")
9 fhf=((50*10^3)*(1+(0.05*1000)))*10^-6 // in MHz
10 disp(fhf,"(c) f_Hf(in MHz) = f_H * (1+beta*Av_mid) =")

```

Scilab code Exa 1.5 input signal and second harmonic distortion with feedback

```

1 //Example 1.5
2 clc
3 disp("(a) beta: -40 = 20*log[1+beta*A]")
4 disp(" Therefore , 1+beta*A = 100")
5 b=99/1000
6 format(6)
7 disp(b," Therefore , beta =")
8 disp(" Gain of the amplifier with feedback is given as")
9 avf=1000/100
10 disp(avf," A_Vf = A_V / 1+beta*A_V =")

```

```

11 disp("(b) To maintain output power 10 W, we should
    maintain output voltage constant and to maintain
    output constant with feedback gain required Vs is
    ")
12 vsf=10*100*10^-3 // in V
13 disp(vsf,"      V_sf(in V) = Vs * 100 =")
14 disp("(c) Second harmonic distortion is reduced by
    factor 1 + beta*A")
15 d2f=(0.1/100)*100 // in percentage
16 disp(d2f,"      D_2f(in percentage) = D_2 / 1+beta*A
    =")

```

Scilab code Exa 1.6 beta and Af

```

1 //Example 1.6
2 clc
3 disp("(a) We know that")
4 disp("      dAf/Af = 0.1/1+beta*A * dA/A")
5 disp("Therefore , 1+beta*A = 37.5")
6 b=(36.5/2000)*100 // in percentage
7 format(6)
8 disp(b,"Therefore , beta(in percentage) =")
9 af=2000/(1+(0.01825*2000))
10 disp(af,"(b)      Af = A / 1+beta*A =")

```

Scilab code Exa 1.7 amount of feedback

```

1 //Example 1.7
2 clc
3 disp("The voltage gain of the amplifier with
    feedback is given as,")
4 disp("A_vf = A / 1+A*beta where beta = 0.1 and A =
    100")

```

```

5 avf=100/(1+(100*0.1))
6 format(5)
7 disp(avf," Therefore ,  A_vf =")
8 disp("The bandwidth of an amplifier with feedback is
given by,")
9 disp("B_wf = (1+A_mid*beta)f_H - f_L/(1+A_mid*beta)"
)
10 disp("Assuming f_H >> f_L we have")
11 disp("B_w = f_H  and  B_wf = (1+A_mid*beta)B_w")
12 bwf=(1+(100*0.1))*300
13 disp(bwf," Therefore ,  B_wf(in kHz) =")
14 disp("The gain bandwidth product before feedback can
be given as")
15 gbp=100*300*10^3
16 format(7)
17 disp(gbp," Gain bandwidth product = A_v*B_w =")
18 gbpf=9.09*3300*10^3
19 disp(gbpf," Gain bandwidth product after feedback=
A_vf*B_wf =")
20 disp("If bandwidth is to be limited to 800 kHz we
have f_Hf = 800 kHz assuming f_Hf >> f_Lf")
21 disp("We know that")
22 disp("B_wf = (1+A_vmid*beta)*f_H")
23 b=((8/3)-1)/100
24 format(8)
25 disp(b," Therefore ,  beta =")

```

Scilab code Exa 1.8 A1 and A2

```

1 //Example 1.8
2 clc
3 disp("For the above circuit voltage gain with
feedback is given as")
4 disp("A_f = A1[A2/1+A2*B2] / 1+A1[A2/1+A2B2]B1")
5 disp("(i)  deltaA_f = | A1[A2/1+A2*B2]/1+A1[A2/1+

```

$$\frac{A_2 B_2}{1 + A_2 B_2} B_1 - \frac{|A_1 - \Delta A_i|}{|A_2 / 1 + A_2 B_2|} \frac{1}{1 + |A_1 - \Delta A_i| \frac{A_2}{1 + A_2 B_2}} B_1$$

6 `disp`("(ii) $\Delta A_f = \frac{A_1 [A_2 / 1 + A_2 B_2] / 1 + A_1 [A_2 / 1 + A_2 B_2] B_1 - A_1 [|A_2 - \Delta A_2| / 1 + |A_2 - \Delta A_2| * B_2] / 1 + A_1 [|A_2 - \Delta A_2| / 1 + |A_2 - \Delta A_2| B_2] B_1}{|A_2 - \Delta A_2| / 1 + |A_2 - \Delta A_2| B_2} B_1$ ")

Scilab code Exa 1.9 voltage gain and input and output impedance

```

1 //Example 1.9
2 clc
3 disp("The voltage gain with feedback can be given as
   ")
4 avf=4000/(1+(4000*0.05))
5 format(5)
6 disp(avf,"A_vf = A_v / 1+A_v*beta =")
7 disp("In a voltage series feedback input resistance
   with feedback is given as")
8 rif=2*(1+(0.05*4000))
9 disp(rif,"R_if(in k-ohm) = R_i(1+beta*A_v) =")
10 rof=(60*10^3)/(1+(0.05*4000))
11 format(6)
12 disp("In a voltage series feedback output resistance
   with feedback is given as")
13 disp(rof,"R_of(in ohm) = R_o / 1+beta*A_v =")

```

Scilab code Exa 1.10 amplifier without feedback

```

1 //Example 1.10
2 clc
3 disp("The voltage gain of amplifier can be given as")
   )
4 av=36/0.028
5 format(7)

```

```

6 disp(av,"A_v = Vo/V_in =")
7 disp("(i) beta = 0.012")
8 disp("Therefore, The gain of the amplifier with
      feedback is given as")
9 af=1285.7/(1+(1285.7*0.012))
10 format(6)
11 disp(af,"A_f = A_v / 1+A_v*beta =")
12 disp("The output voltage with feedback is given as")
13 vo=78.26*0.028
14 disp(vo,"Vo(in V) = A_f * V_in =")
15 vin=7*0.028
16 disp("(ii) If the output remains constant at 36V,
      then the distortion produced within the active
      devices of the amplifier is unchanged. However,
      since the distortion at the output is less than
      in part (i) by a factor of 7, it follows that the
      feedback now increased by 7 and hence, the
      voltage gain decreased by 7. Thus, the input
      signal required to produce the same output (as in
      part(i)) without feedback must be:")
17 disp(vin,"V_in(in V) =")

```

Scilab code Exa 1.11 gain of the amplifier with feedback

```

1 //Example 1.11
2 clc
3 disp("(i) The gain of the amplifier is given as")
4 disp("60 dB = 20 log(Vo/V_s)")
5 disp("Therefore, A_v = Vo/V_s = 1000")
6 disp("beta = 1/20 = 0.05")
7 disp("Therefore, The gain of amplifier with
      feedback is")
8 avf=1000/(1+(1000*0.05))
9 format(5)
10 disp(avf,"A_vf = A_v / 1+A_v*beta =")

```



```

11 disp("(ii) The gain of the amplifier is directly
    proportional to the g_m. Therefore, the gain of
    the amplifier without feedback changes as same
    amount as g_m changes")
12 disp("Therefore, A_v = A_v / (1 + 0.5*A_v) = 1000 / (1 + 500
    ")
13 disp("The gain of the amplifier with feedback is now
    given as")
14 avf1=1500/(1+(1500*0.05))
15 avf2=500/(1+(500*0.05))
16 format(6)
17 disp(avf1,avf2,"A_vf = A_v / (1+A_v*beta) =")

```

Scilab code Exa 1.12 single stage RC coupled amplifier

```

1 //Example 1.12
2 clc
3 disp("A_v = 1000 and beta = 0.1")
4 fh=1/(1+(0.1*1000))
5 format(4)
6 disp(fh,"(i) f_Hf/f_H = 1 + beta*A_v =")
7 fl=1/(1+(0.1*1000))
8 format(7)
9 disp(fl,"and f_Lf/f_L = 1 / (1+beta*A_v) =")
10 disp("(ii) With f_L = 20 Hz and f_H = 50 kHz")
11 fl1=20*0.0099
12 format(6)
13 disp(fl1,"f_Lf(in Hz) =")
14 fhh=(50*101)*10^-3
15 format(5)
16 disp(fhh,"f_Hf(in MHz) =")

```

Scilab code Exa 1.13 feedback ratio and input voltage

```

1 //Example 1.13
2 clc
3 disp("The voltage gain of the amplifier is given as"
      )
4 av=50/0.2
5 format(4)
6 disp(av,"A_v = Vo/V_in =")
7 disp("We know that,")
8 b=((0.06/0.01)-1)/250
9 format(5)
10 disp(b,"B_2f = B_2 / 1+A_v*beta =")
11 disp("Therefore, feedback ratio, beta =")
12 avf=250/(1+(250*0.02))
13 format(6)
14 disp(avf,"A_vf = A_v / 1+A_v*beta =")
15 vin=50/41.66
16 format(4)
17 disp("To produce output voltage of 50 V V_in must be
      ")
18 disp(vin,"V_in = 50/A_vf =")

```

Scilab code Exa 1.14 Av and beta of amplifier

```

1 //Example 1.14
2 clc
3 disp("Given A_vf = 120")
4 disp("A_v = Vo/V_s = Vo/60mV")
5 disp("and A_vf = Vo/0.5")
6 vo=0.5*120
7 format(3)
8 disp(vo,"Therefore, Vo(in V) =")
9 disp("with Vo = 60 V we have,")
10 av=60/(60*10^-3)
11 format(5)
12 disp(av,"A_v =")

```

```

13 b=((1000/120)-1)/1000
14 format(8)
15 disp("We know that,")
16 disp("A_vf = A_v / 1+A_v*beta")
17 disp(b,"Therefore, beta =")

```

Scilab code Exa 1.15 determine Avf

```

1 //Example 1.15
2 clc
3 disp("Step 1: Identify topology")
4 disp(" By shorting output(Vo = 0), feedback voltage
      V_f becomes zero, hence it is a voltage sampling
      . Since feedback is mixed in series with input
      the topology is voltage series feedback amplifier
      ")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit.")
7 disp(" To find input circuit, set Vo = 0. This
      places the parallel combination of resistors 3.3K
      and 3.3K at the first emitter. To find output
      circuit, set Ii = 0. This places resistors 3.3K
      and 3.3K in series across the output. The
      resultant circuit is shown in fig 1.48")
8 disp("")
9 disp("Step 4: Replace transistor with its h-
      parameter equivalent as shown in fig.1.49")
10 disp("")
11 disp("Step 5: Find open loop transfer gain.")
12 disp("A_v = A_v1*A_v2")
13 disp("      = V_i2/V_i1 * Vo/V_i2")
14 disp("      = Vo/V_i2 = -h_fe*R_L2 / R_i2")
15 r12=3.3+3.3
16 format(4)

```

```

17 disp(r12," where  R_L2(in k-ohm) =")
18 disp("and  R_i2 = h_ie = 2 K")
19 voi=(-50*6.6)/2
20 disp(voi," Therefore ,  A_v2 = Vo/V_i2 =")
21 disp("V_i2/V_i1 = -h_fe*R_L1 / R_i1")
22 r11=((51*2)/(53))
23 format(5)
24 disp(r11," where  R_L1(in k-ohm) =")
25 disp("and  R_i = [h_ie + (1+h_fe)(3.3K||3.3K)]")
26 ri=2+(51*1.65)
27 format(6)
28 disp(ri," Therefore ,  R_i1(in k-ohm) = ")
29 vi21=(-50*1.92)/(86.15)
30 format(6)
31 disp(vi21," Therefore ,  A_v1 = V_i2/V_i1 =")
32 av=-165*-1.114
33 format(7)
34 disp(av," Therefore ,  A_v =")
35 disp(" ")
36 disp("Step 6: Calculate beta")
37 be=3.3/6.6
38 format(4)
39 disp(be," beta = V_f/V_o =")
40 disp("We know that ,  D = 1 + beta*A_v =")
41 avf=183.86/92.93
42 format(6)
43 disp(avf," A_vf = A_v/D =")

```

Scilab code Exa 1.16 Avf and Rif

```

1 //Example 1.16
2 clc
3 disp("Step 1: Identify topology")
4 disp(" By shorting output(Vo = 0), feedback voltage
      V_f becomes zero.The feedback is mixed in series

```

```

        feedback.")
5  disp("")
6  disp("Step 2 and Step 3: Find input and output
    circuit.")
7  disp(" To find input circuit , set Vo = 0. This
    places the parallel combination of resistors 10K
    and 1K at the first emitter. To find output
    circuit , set Ii = 0. This places resistors 10K
    and 1K in series across the output. The resultant
    circuit is shown in fig 1.51.")
8  disp("")
9  disp("Step 4: Replace transistor with its h-
    parameter equivalent as shown in fig.1.52.")
10 disp("")
11 disp("Step 5: Find open loop transfer gain.")
12 disp("A_v = A_v1*A_v2")
13 disp("      = V_i2/V_i1 * Vo/V_i2")
14 disp("Vo/V_i2 = -h_fe*R_L2 / R_i2")
15 r12=(5.1*11)/(16.1)
16 format(6)
17 disp(r12," where R_L2(in k-ohm) =")
18 disp("and R_i2 = h_ic = 1.1 K")
19 voi=(-50*3.484)/1.1
20 format(7)
21 disp(voi," Therefore , Vo/V_i2 =")
22 disp("V_i2/V_i1 = -h_fe*R_L1 / R_i1")
23 r11=((1.1*1)/(2.1))*10^3
24 format(6)
25 disp(r11," where R_L1(in ohm) =") //answer in text
    book is wrong
26 disp("and R_i = 82K || [h_ie + (1+h_fe)(1K||10K)]")
27 ri=((82*47.459)/(82+47.459))
28 format(3)
29 disp(ri," Therefore , R_i(in k-ohm) = ")
30 vi21=(-50*523.8)/(30*10^3)
31 format(6)
32 disp(vi21," Therefore , V_i2/V_i1 =")
33 av=-158.36*-0.888

```

```

34 format(7)
35 disp(av,"Therefore , A_v =")
36 disp("")
37 disp("Step 6: Calculate beta")
38 be=1/10
39 format(4)
40 disp(be,"beta = V_f/V_o =")
41 disp("")
42 disp("Step 7: Calculate A_vf, R_if and R''_of")
43 d=1+(0.1*140.62)
44 format(7)
45 disp(d,"D = 1 + beta*A_v =")
46 avf=140.62/15.062
47 format(6)
48 disp(avf,"A_vf = A/D =")
49 rif=30*15.062
50 format(7)
51 disp(rif,"R_if(in k-ohm) = R_i*D =")
52 disp("R''_o = R_L2 = 3.484 k-ohm")
53 rof=(3.484*10^3)/15.062
54 disp(rof,"R''_of(in ohm) = R''_o/D =")

```

Scilab code Exa 1.17 D and Avf anf Rif and Rof

```

1 //Example 1.17
2 disp("Step 1: Identify topology")
3 disp(" By shorting output voltage (V_o = 0),
      feedback voltage V_f becomes zero and hence it is
      voltage sampling. The feedback voltage is applied
      in series with the input voltage hence the
      topology is voltage series feedback.")
4 disp("")
5 disp("Step 2 and Step 3: Find input and output
      circuit.")
6 disp(" To find input circuit , set V_o = 0. This

```

places the parallel combination of resistor 10 K and 200 ohm at first source. To find output circuit, set $I_i = 0$. This places the resistor 10K and 200 ohm in series across the output. The resultant circuit is shown in fig 1.54.)

```

7 disp("")
8 disp("Step 4: Replace FET with its equivalent
      circuit as shown in fig.1.55.")
9 disp("")
10 disp("Step 5: Find open loop transfer gain.")
11 disp("  Av = Vo / Vs = A_v1 * A_v2")
12 disp("  A_v2 = -u*R_L2 / R_L2+r_d")
13 r12=(10.2*47)/(10.2+47) // in k-ohm
14 format(5)
15 disp(r12," where R_L2(in k-ohm) =")
16 av2=(-40*8.38)/18.38
17 format(7)
18 disp(av2,"  A_v2 =")
19 disp("  A_v1 = u*R_DeFF / r_d+R_DeFF+(1+u)*R_seff")
20 rdeff=(47*1000)/(47+1000) // in k-ohm
21 format(6)
22 disp(rdeff,"  R_DeFF(in k-ohm) = R_D || R_G2 =")
23 av1=(-40*44.98)/(10+44.89+(41*((0.2*10)/(10+0.2))))
24 disp(av1," Therefore ,  A_v1 =")
25 av=-28.59*-18.237
26 format(7)
27 disp(av," Therefore ,  Av = A_v1 * A_v2 =")
28 disp("")
29 disp("Step 6: Calculate beta")
30 beta=200/(10000)
31 format(5)
32 disp(beta,"  beta = Vf / Vo =")
33 disp("")
34 disp("step 7: Calculate D, A_vf, R_if, R' '_of")
35 d=1+(0.02*521.39)
36 format(8)
37 disp(d,"  D = 1 + Av*beta =")
38 avf=521.39/11.4278

```

```

39 format(6)
40 disp(avf," A_vf = Av / D =")
41 disp("Ri = R_G = 1 M-ohm")
42 rif=11.4278
43 format(8)
44 disp(rif," R_if(in M-ohm) = Ri * D =")
45 ro=10 // in k-ohm
46 format(3)
47 disp(ro," R' 'o(in k-ohm) = rd =")
48 rof=(10*10^3)/11.4278 // in ohm
49 format(4)
50 disp(rof," R' ' _of(in ohm) = R' 'o / D =")
51 rod=(10*8.38)/18.38
52 format(6)
53 disp(rod,"R' ' _o(in k-ohm) =")
54 rofd=(4.559*10^3)/11.4278
55 format(4)
56 disp(rofd,"Therefore , R' ' _of(in ohm) = R' ' _o/D =")

```

Scilab code Exa 1.18 voltage gain including feedback

```

1 //Example 1.18
2 clc
3 disp("Here, output voltage is sampled and fed in
      series with the input signal. Hence the topology
      is voltage series feedback.")
4 disp(" The open loop voltage gain for one stage is
      given as,")
5 disp(" Av = -gm*R_eq")
6 req=(8*40*1000)/((40*1000)+(8*1000)+(8*40)) // in k
      -ohm
7 format(5)
8 disp(req," R_eq(in k-ohm) = r_d || R_d || (R_i1+R_2
      ) =")
9 av=-5*6.62

```



```

10 format(6)
11 disp(av," Av =")
12 avm=-33.11^3
13 disp(avm,"Av = Overall voltage gain = |A_vmid|^3 =")
    // answer in textbook is wrong
14 beta=50/(10^6)
15 format(7)
16 disp(beta," beta = Vf / Vo = -R_1 / R_g = -R_1 /
    R_1+R_2 =")
17 d=1+((-5*10^-5)*-36306)
18 format(6)
19 disp(d," D = 1 + |Av|*beta =")
20 avf=-36306/2.8153
21 disp(avf," A_vf = Av / D =")

```

Scilab code Exa 1.19 Avf

```

1 //Example 1.19
2 clc
3 disp("Here, output terminals are B and ground, thus
    the forward gain is the gain of Q1 and it is,")
4 disp(" A_v= -33.11")
5 disp("Here beta = V_f / V_B = V_f/V_o * V_o/V_C *
    V_C/V_B")
6 disp("where V_B and V_C are voltages at point B and
    C, respectively.")
7 disp("Therefore, beta_BN = V_f/V_o * A_v3 * A_v2
    because V_o/V_C = A_v3 and V_C/V_B = A_v2
    ")
8 bbn=(5*10^-5)*(33.11^2)
9 format(7)
10 disp(bbn," Therefore, beta= ")
11 avf=-33.11/2.815
12 format(6)
13 disp(avf," Therefore, |A_vf| = A_vf / 1+|A_f|*beta =

```

)

Scilab code Exa 1.20 voltage gain with feedback

```
1 //Example 1.20
2 clc
3 disp("Step 1: Identify topology")
4 disp(" By shorting output( $V_o = 0$ ), feedback voltage
      does not become zero. By opening the output loop
      feedback becomes zero and hence it is current
      sampling. The feedback is applied in series with
      the input signal, hence topology used is current
      series feedback.")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit.")
7 disp(" To find input circuit, set  $I_o = 0$ . This
      places  $R_e$  in series with input. To find output
      circuit  $I_i = 0$ . This places  $R_e$  in output side.
      The resultant circuit is shown in fig.1.58.")
8 disp("")
9 disp("Step 4: Replace transistor with its h-
      parameter equivalent as shown in fig 1.59.")
10 disp("")
11 disp("Step 5: Find open loop transfer gain.")
12 disp(" From quation(13) of section 1.12 we have")
13 disp("  $A_{vf} = I_o * R_L / V_s = G_Mf * R_L$ ")
14 disp("  $= -h_{fe} * R_L / R' 's + h_{ie} + (1 + h_{fe}) * R_e$ ")
15 disp(" Here  $R' 's = R_s || R_1 || R_2$ ")
16 disp("  $= R_s || R_b$  because  $R_b = R_1$ 
      ||  $R_2$ ")
17 disp(" Therefore,  $V_o / V_s = V_o / V_i * V_i / V_s$ ")
18 disp(" where  $V_i / V_s = R_b / (R_s + R_b)$ ")
19 disp(" Therefore,  $V_o / V_s = (-h_{fe} * R_L / R' 's + h_{ie}
      + (1 + h_{fe}) * R_e) * (R_b / (R_s + R_b))$ ")
```

```

20 disp("Dividing both numerator and denominator by Rs+
      Rb we get ,")
21 disp("  A_vf = Vo / Vs = [-h_fe*Rc*(Rb/Rb+Rs)] / R' ,
      s+h_ie+(1+h_fe)*Re      because RL = Rc")
22 disp("      = -h_fe*Rc*[1/1+(Rs/Rb)] / R' , s+h_ie
      +(1+h_fe)*Re")

```

Scilab code Exa 1.21 Rif and Aif and Avf

```

1 //Example 1.21
2 clc
3 disp("Step 1: Identify topology")
4 disp("Making output voltage zero (Vo = 0); feedback
      does not become zero and hence it is not voltage
      sampling. By opening the output loop feedback
      becomes zero and hence it is a current sampling.
      As I_i = I_s - I_f, the feedback current appears in
      shunt with the input signal and hence the
      topology is current shunt feedback")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit")
7 disp("To find input circuit, set Vo = 0. This gives
      series combination of 20K and 1K across the input
      of the first transistor. To find output circuit,
      set V_i = 0. This gives parallel combination of
      20K and 1K at emitter of the second transistor.
      The resultant circuit is shown in fig 1.61")
8 disp("")
9 disp("Step 4: Find open circuit current gain")
10 disp("A_I = I_o/I_s = -I_c2/I_s = -I_c2/I_b2 * I_b2/
      I_c1 * I_c1/I_b1 * I_b1/I_s")
11 disp("-I_c2/I_b2 = -h_fe = -100")
12 disp("I_b2/I_c1 = -R_c1 / R_i2+R_c1")
13 ri2=2+(101*(20/21))

```

```

14 format(6)
15 disp(ri2," where  $R_{i2}(\text{in k-ohm}) = h_{ie} + (1+h_{fe})R_e$ 
    =")
16 ibc=(-12)/(98.19+12)
17 format(6)
18 disp(ibc," Therefore ,  $I_{b2}/I_{c1} =$ ")
19 disp("  $I_{c1}/I_{b1} = h_{fe} = 100$ ")
20 ibs=(21/22)/(2+(21/22))
21 disp(ibs,"  $I_{b1}/I_s =$ ")
22 ai=100*0.109*0.323*100
23 format(4)
24 disp(ai," Therefore ,  $A_I =$ ")
25 disp("")
26 disp("Step 5: Calculate beta")
27 b=4/(24)
28 format(7)
29 disp(b," beta =  $I_f/I_o = R_{e2}/R_{e2+R'}$  ")
30 disp("")
31 d=1+(0.1667*352)
32 format(6)
33 disp(d," Therefore ,  $D = 1 + \text{beta} * A_I =$ ")
34 aif=352/59.67
35 format(5)
36 disp(aif,"  $A_{if} = A_I/D =$ ")
37 ri=((1*21*2)/((21*2)+(1*2)+(21*1)))*10^3
38 format(4)
39 disp(ri,"  $R_i(\text{in ohm}) =$ ")
40 rif=646/59.67
41 format(6)
42 disp(rif,"  $R_{if}(\text{in ohm}) = R_i/D =$ ")
43 disp("Ro = infinity")
44 disp("Therefore ,  $R_{of} = \text{infinity}$  because  $h_{oe} =$ 
    0")
45 disp("R' _o = Ro ||  $R_{c2} = 4 \text{ k-ohm}$ ")
46 disp("R' _of = R' _o = 4 k-ohm")
47 avf=(5.9*4)
48 disp(avf,"  $A_{vf} = A_{If} * R_L / R_s =$ ")

```

Scilab code Exa 1.22 Avf and Rif and Rof

```
1 //Example 1.22
2 clc
3 disp("Step 1: Identify topology")
4 disp("Vo = 0, does not make feedback zero, but Io =
    0 makes feedback to become zero and hence it is
    current sampling. The feedback is fed in shunt
    with the input signal, hence topology is current
    shunt feedback")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
    circuit")
7 disp("To find input circuit, set Vo = 0. This gives
    series combination of R_e2 and 10K across the
    input. To find output circuit, set V1= 0. This
    gives parallel combination of R_e2 and 10K at E2.
    The resultant circuit is shown in fig 1.63")
8 disp("")
9 disp("Step 4: Replace transistor with its h-
    parameter equivalent as shown in fig 1.64")
10 disp("")
11 disp("Step 5 : Find open loop current gain")
12 disp("A.I = Io/I_s = -I_c/I_s = -I_o/I_b2 * I_b2/
    I_c1 * I_c1/I_b1 * I_b1/I_s")
13 disp("Io/I_b2 = -h_fe = -100")
14 disp("I_c2/I_b2 * I_b1/I_e1 = -h_ie*R_c1 / R_i2+R_c2
    because I_b2/I_c1 = R_c1/R_c1+R_i2")
15 ri2=1+(101*(10/11))
16 format(7)
17 disp(ri2," where R_i2 (in k-ohm) = h_ie + (1+h_fe)(1K
    ||10K) =")
18 ibb=(-100*2.2)/(92.818+2.2)
19 format(6)
```

```

20 disp(ibt," Therefore ,  I_b1/I_s =")
21 ibs=(11/12)/(1+(11/12))
22 disp(ibs," I_b1/I_s =")
23 ai=100*2.315*0.478
24 disp(ai," A_I =")
25 disp(" Step 6: Calculate beta")
26 b=1/(11)
27 format(5)
28 disp(b," beta = R_e2/R_e2+R' ' =")
29 disp("")
30 disp(" Step 6: Calculate D, A_If, A_vf, R_if, R_of")
31 d=1+(0.09*110.7)
32 format(7)
33 disp(d,"D = 1 + beta*A_I =") //answer in textbook
    is wrong
34 aif=110.7/11.063
35 format(3)
36 disp(aif," A_if = A_I/D =")
37 ri=((1*11*1)/((11*1)+(1*1)+(11*1)))*10^3
38 format(4)
39 disp(ri," R_i(in ohm) =")
40 rif=478/11.063
41 format(6)
42 disp(rif," R_if(in ohm) = R_i/D =")
43 disp("R_o = infinity")
44 disp(" Therefore ,  R_of = R_o*D = infinity      because
    h_oe = 0")
45 disp("R' ' _o = 2.2 k-ohm")
46 disp("R' ' _of = R' ' _o = 2.2 k-ohm")

```

Scilab code Exa 1.23 Rmf and Aof and Rif and Rof

```

1 //Example 1.23
2 clc
3 disp(" Step 1: Identify topology")

```

```

4 disp("Here output voltage is sampled and fed in
      shunt with the input signal such that,  $I_s - I_f = I_i$ , hence topology is voltage shunt feedback")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit")
7 disp("To find input circuit, set  $V_o = 0$ . This places
      resistor R across the input. To find output
      circuit, set  $V_i = 0$ . This places resistor R
      across output. The resultant circuit is shown in
      fig 1.69")
8 disp("")
9 disp("Step 4: Replace transistor with its h-
      parameter equivalent circuits as shown in fig
      1.67")
10 disp("")
11 disp("Step 5 : Find open loop transresistance")
12 disp(" $R_M = V_o/I_s = R_c \cdot I_o/I_s = -R_c \cdot I_c/I_s$ ")
13 disp("      =  $R_c \cdot -I_c/I_b \cdot I_b/I_s$ ")
14 icb=(-100*82)/94
15 format(6)
16 disp(icb," $-I_c/I_b = -h_{fe} \cdot R / R + R_c =$ ")
17 disp(" $I_b/I_s = R_o || R / R_s || (R + R_{i1})$ ")
18 ri1=1.1+(101*820*10^-3)
19 disp(ri1," $R_{i1}$  (in k-ohm) =  $h_{ie} + (1+h_{fe})R_e =$ ")
20 ibs=(82/83)/(83.92+(82/83))
21 format(7)
22 disp(ibs,"Therefore,  $I_b/I_s =$ ")
23 rm=-87.23*12*0.0116
24 format(7)
25 disp(rm,"Therefore,  $R_M$  (in k-ohm) =  $V_o/I_s =$ ")
26 disp("")
27 disp("Step 6: Calculate beta")
28 b=-1/(82*10^3)
29 format(10)
30 disp("beta =  $I_f/I_o = V_i - V_o/V_o \cdot R =$ ")
31 disp(b,"      =  $-1/R =$  because ( $V_o > V_i$ )")
      )

```

```

32 disp("")
33 disp("Step 7: Calculate D, R_Mf, A_vf, R_if, R''_of"
      )
34 d=1+(-1.22*-12.142*10^-2)
35 format(6)
36 disp(d,"D = 1 + beta*R_M =")
37 rmf=-12.142/1.148
38 format(6)
39 disp(rmf,"R_Mf(in k-ohm) = R_M/D =")
40 avf=-10.57
41 disp("A_vf = V0/V_s = V_o/I_s*R_s =")
42 disp(avf,"          = R_Mf/R_s =          because R_Mf =
          V_o/I_s")
43 ri=((1*82*83.92)/((82*83.92)+(1*83.92)+(82*1)))
44 disp(ri,"R_i(in k-ohm) = R_s || R_il || R =")
45 rif=(0.976*10^3)/1.148
46 format(4)
47 disp(rif,"R_if(in ohm) = R_i/D =")
48 disp("R_o = infinity")
49 disp("Therefore, R_of = infinity/D = infinity
      because h_oe = 0")
50 ro=(12*82)/(94)
51 format(7)
52 disp(ro,"R''_o(in k-ohm) = R || R_c =")
53 rof=(10.468)/1.148
54 format(6)
55 disp(rof,"R''_of(in k-ohm) = R''_o/D =")

```

Scilab code Exa 1.24 Avf and Rif and Rof

```

1 //Example 1.24
2 clc
3 disp("Step 1: Identify topology")
4 disp("Here output voltage is sampled and fed in
      shunt with the input signal such that, I_s-I_f =

```



```

    I_i , hence topology is voltage shunt feedback")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
    circuit")
7 disp("To find input circuit , set V_o = 0. This places
    resistor R across the input. To find output
    circuit , set V_i = 0. This places resistor R
    across output. The resultant circuit is shown in
    fig 1.69. The circuit shows voltage source
    replaced by current source")
8 disp("")
9 disp("Step 4: Replace transistor with their h-
    parameter equivalent circuits as shown in fig
    1.70")
10 disp("")
11 disp("Step 5 : Find open loop transfer gain")
12 disp("R_M = V_o/I_s = R_c2*I_o/I_s")
13 disp("      = R_c2 * I_o/I_b2 * I_b2/I_e1 * I_e1/I_b1 *
    I_b1/I_s")
14 iob=(-100*2.2)/7.3
15 format(7)
16 disp(iob,"I_o/I_b2 = -h_ie*R / R+R_c2 =")
17 iobe=(101*1.1)/3.1
18 format(6)
19 disp(iobe,"I_b2/I_e2 * I_e1/I_b1 = -h_ie*R / R+R_c2
    =")
20 disp("I_b1/I_s = R_s || R / (R_s || R)+R_i1")
21 ri1=2+(101*1.1)
22 disp(ri1,"where R_i1(in k-ohm) = h_ie + (1+h_fe)R_e
    =")
23 ibs=(2.2/3.2)/((2.2/3.2)+(113.1))
24 format(8)
25 disp(ibs,"I_b1/I_s =")
26 rm=5.1*-30.137*35.84*6.04*10^-3
27 format(7)
28 disp(rm,"Therefore , R_M(in k-ohm) =")
29 disp("")
30 disp("Step 6: Calculate beta")

```

```

31 b=-1/(2.2*10^3)
32 format(10)
33 disp("beta = I_f/I_o = V_i-V_o/V_o*R =")
34 disp(b,"      = -1/R =                because (V_o > V_i)"
      )
35 disp("")
36 disp("Step 7: Calculate D, R_Mf, A_vf, R_if, R''_of"
      )
37 d=1+(4.545*33.539*10^-1)
38 format(7)
39 disp(d,"D = 1 + beta*R_M =")
40 rmf=-33.539/16.245
41 format(6)
42 disp(rmf,"R_Mf(in k-ohm) = R_M/D =")
43 avf=-2.065
44 disp(avf,"A_vf = V_o/V_s = V_o/I_s*R_s =")
45 ri=((1*113.1*2.2)/((113.1*2.2)+(1*113.1)+(2.2*1)))
      *10^3
46 format(4)
47 disp(ri,"R_i(in ohm) = R_s || R_i1 || R =") //
      answer in textbook wrong
48 rif=(683)/16.245
49 format(3)
50 disp(rif,"R_if(in ohm) = R_i/D =")
51 disp("R_o = infinity")
52 disp("Therefore, R_of = infinity/D = infinity")
53 ro=(2.2*5.1)/(7.3)
54 format(6)
55 disp(ro,"R''_o(in k-ohm) = R || R_c2 =")
56 rof=(1.537*10^3)/16.245
57 disp(rof,"R''_of(in ohm) = R''_o/D =")

```

Scilab code Exa 1.25 D and Rmf and Avf and Rif and Rof

1 //Example 1.25

```

2  clc
3  disp("Step 1: Identify topology")
4  disp("By making Vo = 0, feedback current becomes
      zero. Hence it is a voltage sampling. The
      feedback is fed in shunt with the input signal
      and thus the topology is voltage shunt feedback")
5  disp("")
6  disp("Step 2 and Step 3: Find input and output
      circuit")
7  disp("To find input circuit , set Vo = 0. This places
      resistor R across the input. To find output
      circuit , set V_i = 0. This places resistor R
      across output. The resultant circuit is shown in
      fig 1.72")
8  disp("")
9  disp("Step 4: Replace FET with its equivalent
      circuit as shown in fig 1.73")
10 disp("")
11 disp("Step 5 : Find open loop transresistance")
12 disp("R_M = Vo/I_s = -g_m*V_gs*R_eff/I_s")
13 reff=(40*200*10)/((200*10)+(400)+(40*200))
14 format(5)
15 disp(reff,"where R_eff(in k-ohm) = r_d || R || R_D
      =")
16 disp("and V_gs = I_s*R_i = I_s * R_s || 1M || R")
17 disp("      = I_s * 10K || 1M || 200K")
18 disp("      = 9.43*10^3 I_s")
19 rm=-2.5*9.43*7.69
20 format(7)
21 disp(rm,"R_M(in k-ohm) =")
22 disp("")
23 disp("Step 6: Calculate beta")
24 b=-1/(200*10^3)
25 format(7)
26 disp("beta = I_f/I_o = V_i-V_o/V_o*R =")
27 disp(b,"      = -1/R =                because (Vo > V_i)"
      )
28 disp("")

```

```

29 disp("Step 7: Calculate D, R_Mf, A_vf, R_of, R''_of"
    )
30 d=1+(5*181.29*10^-3)
31 format(4)
32 disp(d,"D = 1 + beta*R_M =")
33 rmf=-181.29/1.9
34 format(7)
35 disp(rmf,"R_Mf(in k-ohm) = R_M/D =")
36 avf=-95.415/10
37 format(7)
38 disp(avf,"A_vf = V0/V_s = V_o/I_s*R_s = R_Mf/R_s =")
39 ri=(10*1000*200)/((1000*200)+(10*200)+(1000*10))
40 format(5)
41 disp(ri,"R_i(in k-ohm) = R_s || M || R =")
42 rif=(9.43)/1.9
43 format(6)
44 disp(rif,"R_if(in k-ohm) = R_i/D =")
45 ro=(40*200*10)/((200*10)+(400)+(40*200))
46 format(5)
47 disp(ro,"R''_o(in k-ohm) = r_eff = r_d || R || R_D =
    ")
48 rof=(7.69/1.9)
49 format(2)
50 disp(rof,"R''_of(in k-ohm) = R''_o/D =")

```

Scilab code Exa 1.26 Aof and Rif and Rof

```

1 //Example 1.26
2 clc
3 disp("Step 1: Identify topology")
4 disp("The feedback voltage is applied across the
    resistance R_e1 and it is in series with input
    signal. Hence feedback is voltage series feedback
    ")
5 disp("")

```

```

6 disp("Step 2 and Step 3: Find input and output
   circuit")
7 disp("To find input circuit , set Vo = 0, which gives
   parallel combination of R_e1 with R_f at E1 as
   shown in fig 1.75. To find output circuit , set
   I_i = 0 opening the input node E1 at emitter of
   Q1, which gives series combination of R_f and
   R_e1 across the output. The resultant circuit is
   shown in fig 1.75")
8 disp("")
9 disp("Step 4: Find open loop voltage gain (A_v)")
10 r12=(2.2*52.5)/54.7
11 format(5)
12 disp(r12,"R_L2(in k-ohm) = R_c2 || (R_f+R_e1) =")
13 disp("A_i2 = -h_fe = -50")
14 disp("R_i2 = h_ie = 1.2 k-ohm")
15 av2=(-50*2.11)/1.2
16 format(6)
17 disp(av2,"A_v2 = A_i2*R_L2 / R_i2 =")
18 r11=(100*1.2)/101.2
19 disp(r11,"R_L1(in k-ohm) = R_c1 || R_i2 =")
20 disp("A_i1 = -h_fe = -50")
21 ri2=1.2+(51*(51*1.5/52.5))
22 format(6)
23 disp(ri2,"R_i1(in k-ohm) = h_ie + (1+h_fe)R_e =")
24 av1=(-50*1.185)/75.51
25 disp(av1,"Therefore , A_v1 = A_i1*R_L1 / R_i1 =")
26 disp("The overall gain without feedback is given as")
   )
27 av=-0.784*-87.91
28 disp(av,"A_v = A_v1*A_v2 =")
29 disp("")
30 disp("Step 5: Calculate beta")
31 b=1.5/52.5
32 format(7)
33 disp(b,"beta = V_f/Vo =")
34 disp("")
35 disp("Step 6: Calculate D,A_vf, R_if, R_of")

```

```

36 d=1+(0.0285*68.92)
37 format(6)
38 disp(d,"D = 1 + beta*A_v =")
39 avf=68.92/2.964
40 disp(avf,"A_vf = A_v/D =")
41 ri=(75.51*200.1485)/(200.1485+75.51)
42 disp(ri,"R_i(in k-ohm) = R || R_i1 =")
43 rif=54.82*2.964
44 format(7)
45 disp(rif,"R_if(in k-ohm) = R_i/D =")
46 disp("Ro = infinity because h_oe = 0")
47 disp("R''_o = Ro || R_c2 || (R_f+R_e1) = Ro || R_L2
      = infinity || 2.11 K = 2.11 K")
48 rof=(2.11*10^3)/2.964
49 format(4)
50 disp(rof,"R''_of(in ohm) = R''_o/D =")

```

Scilab code Exa 1.27 Aif and Avf and Rif and Rof and Ai

```

1 //Example 1.27
2 clc
3 disp("Step 1: Identity topology")
4 disp("The feedback is given from emitter of Q2 to
      the base of Q2. If Io=0 then feedback current
      through 5K register is zero, hence it is current
      sampling. As feedback signal is mixed in shunt
      with input, the amplifier is current shunt
      feedback amplifier")
5 disp("")
6 disp("Step 2 and Step 3: Find input and output
      circuit")
7 disp("The input circuit of the amplifier without
      feedback is obtained by opening the output loop
      at the emitter of Q2(Io = 0). This places R''(5K)
      in series with R_s from base to emitter of Q1.

```

The output circuit is found by shorting the input node, i.e. making $V_1=0$. This places R' (5K) in parallel with R_e . The resultant equivalent circuit is shown in fig 1.78")

```

8 disp("Step 4: Find open circuit transfer gain")
9 disp("A_I = I_o/I_s = -I_c/I_s = -I_c2/I_b2 * I_b2/I_c1 * I_c1/I_b1 * I_b1/I_s")
10 disp("We know that -I_c2/I_b2 = A_i2 = -h_fe = -50 and")
11 disp("-I_c/I_b1 = A_i1 = -h_fe = -50")
12 disp("Therefore, I_c1/I_b1 = 50")
13 disp("Looking at fig 1.77 we can write")
14 disp("I_b2/I_c1 = -R_c1/R_c1+R_i2")
15 ri2=1.5+(51*(5*0.6/5.6))
16 format(6)
17 disp(ri2,"R_i2(in k-ohm) = h_ie + (1+h_fe)(R_e2 || R' ) =")
18 ibc=-2/30.82
19 format(7)
20 disp(ibc,"Therefore, I_b2/I_c1 =")
21 disp("Looking at fig 1.78 we can write")
22 disp("I_b1/I_s = R/R+R_i1")
23 r=(5.6*10^3)/6.6
24 format(4)
25 disp(r,"where R(in ohm) = R3 || (R'+R_e) =")
26 ri1=1.5+20.4
27 format(5)
28 disp(ri1,"and R_i1(in k-ohm) = h_ie + (1+h_fe)R_e1 =")
29 ib1=0.848/22.748
30 format(7)
31 disp(ib1,"Therefore, I_b1/I_s =")
32 disp("Substituting the numerical values obtained in equations of A_I we get,")
33 ai=50*0.0649*50*0.0372
34 format(2)
35 disp(ai,"A_I =")
36 disp("")

```

```

37 disp("Step 5: Calculate beta")
38 b=0.6/5.6
39 format(6)
40 disp(b,"beta = I_f/I_o = R_e2 / R_e2+R'' =")
41 disp("")
42 disp("Step 6: Calculate D, A_if, A_vI, R_sf, R_of")
43 d=1+(0.107*6)
44 format(6)
45 disp(d,"D = 1 + beta*A_I =")
46 aif=6/1.642
47 disp(aif,"A_if = A_I/D =")
48 avf=(3.654*12)/1
49 format(7)
50 disp(avf,"A_vf = V_o/V_s = -I_c2/I_s * R_c2/R_s =
    A_if*R_c2 / R_s =")
51 ri1=(848*21900)/(21900+848)
52 disp(ri1,"R_i1(in ohm) = R || R_i1 =")
53 rif=816.38/1.642
54 format(6)
55 disp(rif,"R_if(in ohm) = R_i/D =")
56 disp("R_o = infinity because h_oe = 0")
57 disp("Therefore, R_of = R_o*D = infinity")
58 disp("R''_o = R_o || R_c2 = infinity || 12 K = 12 K")
59 disp("R''_of = R''_o * 1+beta*A_i/1+beta*A1 = R''_o
    = R_c2 = 12K")

```

Scilab code Exa 1.28 Avf and Rif and Rof

```

1 //Example 1.28
2 clc
3 disp("Step 1: Identify topology")
4 disp(" The feedback voltage is applied across R_e1
    = 1.5 k-ohm, which is in series with input signal
    . Hence feedback is voltage series feedback")
5 disp("")

```



```

6 disp("Step 2 and step 3: Find input and output
   circuit")
7 disp(" To find input circuit , set Vo = 0, which
   gives parallel combination of R_e1 with R_f at E1
   as shown in fig.1.80. To find ouput circuit , set
   I_i = 0 by opening the input node, E1 at emitter
   of Q1, which gives the series combination of R_f
   and R_e1 across the output. The resultant
   circuit is shown in fig.1.80")
8 disp("")
9 disp("Step 4: Find the open loop voltage gain (Av)")
10 r12=(2.2*57.5)/(2.2+57.5) // in k-ohm
11 format(6)
12 disp(r12," R_L2(in k-ohm) = R_c2 || (Rf + R_e1) =")
13 disp("Since hoe*R_L2 = 10^-6*2.119 k-ohm = 0.002119
   is less than 0.1 we use approximate analysis.")
14 disp(" A_i2 = -h_fe = -200")
15 disp(" R_i2 = hie = 2 k-ohm")
16 av2=(-200*2.119)/2
17 disp(av2," A_v2 = A_i2*R_L2 / R_i2 =")
18 r11=(120*2)/(122) // in k-ohm
19 disp(r11," R_L1(in k-ohm) = R_C1 || R_i2 =")
20 disp("Since hoe*R_L1 = 10^-6*1.967 = 0.001967 is
   less than 0.1 we use approximate analysis.")
21 disp(" A_i1 = -hfe = -200")
22 ri1=2+(201*((1.5*56)/(57.5))) // in k-ohm
23 format(7)
24 disp(ri1," R_i1(in k-ohm) = hie + (1+hfe)*Re =")
25 av1=(-200*1.967)/295.63
26 format(5)
27 disp(av1," Therefore , A_v1 = A_i1*R_L1 / R_i1 =")
28 disp("The overall gain without feedback is")
29 av=-1.33*-211.9
30 format(7)
31 disp(av," Av = A_v1 * A_v2 =")
32 disp("")
33 disp("Step 5: Calculate beta")
34 beta=1.5/57.5

```

```

35 format(6)
36 disp(beta," beta = Vf / Vo =")
37 disp("")
38 disp("Step 6: calculate D, A_vf, R_if, R_of")
39 d=1+(0.026*281.82)
40 disp(d," D = 1 + Av*beta =")
41 avf=281.82/8.327
42 disp(avf," Therefore, A_vf = Av / D =")
43 ri=(295.63*150)/(295.63+150) // in k-ohm
44 format(5)
45 disp(ri," Ri(in k-ohm) = R_i1 || R =")
46 rif=99.5*8.327 // in k-ohm
47 format(7)
48 disp(rif," R_if(in k-ohm) = Ri *D =")
49 disp(" Ro = 1/hoe = 1 M-ohm")
50 rof=((1*10^6)/8.327)*10^-3 // in k-ohm
51 format(4)
52 disp(rof," R_of(in k-ohm) = Ro / D =")
53 ro=(1000*2.119)/(2.119+1000) // in k-ohm
54 format(7)
55 disp(ro," R' 'o(in k-ohm) = Ro || R_c2 || (Rf+R_e1)
= Ro || R_L2 =")
56 rof=(2.1145*10^3)/8.327 // in ohm
57 format(4)
58 disp(rof," R' ' _of(in ohm) = R' ' o / D =")

```

Scilab code Exa 1.29 Avf and Rif and Rof

```

1 //Example 1.29
2 clc
3 disp("Fig 1.83 shows current shunt feedback
amplifier open circuit transfer gain")
4 disp("A_I = -I_c2/I_s = -I_c2/I_b2 * I_b2/I_c1 *
I_c1/I_b1 * I_b1/I_s")
5 disp("I_c2/I_b2 = A_i2 = -h_fe = -100")

```

```

6 disp("-I_c1/I_b1 = 100")
7 ri2=1+(101*(1/10.1))
8 format(3)
9 disp(ri2,"R_i2(in k-ohm) = h_ie + (1+h_fe)(R_e2||R
    ' ') =")
10 ibc=-2.2/14.2
11 format(6)
12 disp(ibc,"I_b2/I_c1 = -R_c1 / R_c1+(R_i2+R_b2) =")
13 disp("I_b1/I_s = R/R+h_ie")
14 r=(10.1*10^3)/11.1
15 disp(r,"R(in ohm) = R_s || (R''+R_e) =")
16 ibs=0.9099/1.9099
17 disp(ibs,"Therefore , I''_b/I_s =")
18 ai=100*0.155*100*0.476
19 disp(ai,"Therefore , A_I =")
20 disp("Calculate of beta:")
21 disp("I_f = -I_o*R_e2 / R_e2+R''")
22 disp("beta = I_f/I_o = R_e2/R_e2+R'' = 100/100+10K")
23 d=1+(9.9*737.8*10^-3)
24 format(4)
25 disp(d,"D = 1 + beta*A_I =")
26 disp("A_if = A_I/D = 88.89")
27 avf=88.89*2.2
28 format(8)
29 disp(avf,"A_vf = V_o/V_s = -I_c2/I_s * R_c2/R_s =
    A_if*R_c2 / R_s =")
30 ri1=(909.9*1000)/1909.9
31 format(4)
32 disp(ri1,"R_i1(in ohm) = R || h_ie =")
33 rif=476/8.3
34 format(6)
35 disp(rif,"R_if(in ohm) = R_i/D =")
36 disp("R_of = R_c2 = 2.2 k-ohm")

```

Scilab code Exa 1.30 voltage gain and feedback voltage and output voltage

```

1 //Example 1.30
2 clc
3 disp("(i) Voltage gain with feedback  $A_f = A_v/D$ ")
4 d=1+(0.02*100)
5 format(2)
6 disp(d,"Where,  $D = 1 + \beta A_v =$ ")
7 avf=100/3
8 format(6)
9 disp(avf,"Therefore,  $A_{vf} =$ ")
10 vf=0.02*33.33*40
11 disp(vf,"(ii) Feedback voltage  $V_f(\text{in mV}) = \beta A_v V_o$ 
    =  $\beta A_{vf} V_i =$ ")
12 vo=33.33*40*10^-3
13 disp(vo,"(iii) Output voltage  $V_o(\text{in V}) = A_{vi} V_i =$ 
    ")

```

Scilab code Exa 1.31 voltage gain and input and output impedance

```

1 //Example 1.31
2 disp("For  $\beta = -0.01$ ,  $D = 1 + \beta A_v = 11$ ")
3 avf=-100/11
4 format(5)
5 disp(avf,"(i) Voltage gain  $A_{vf} = A_v/D =$ ")
6 rif=10*11
7 disp(rif,"(ii) Input impedance  $R_{if}(\text{in k-ohm}) = R_i$ 
    * $D =$ ")
8 rof=20/11
9 disp(rof,"(iii) Output impedance  $R_{of}(\text{in k-ohm}) =$ 
     $R_o/D =$ ")
10 disp("For  $\beta = -0.01$ ,  $D = 1 + \beta A_v = 51$ ")
11 avf=-100/51
12 disp(avf,"(i) Voltage gain  $A_{vf} = A_v/D =$ ")
13 rif=10*51
14 disp(rif,"(ii) Input impedance  $R_{if}(\text{in k-ohm}) = R_i$ 
    * $D =$ ")

```

```

15 rof=20/51
16 format(6)
17 disp(rof,"(iii) Output impedance R_of(in k-ohm) =
    Ro/D =")

```

Scilab code Exa 1.32 voltage

```

1
2 //Example 1.32
3 clc
4 disp("Voltage series feedback is the most commonly
    used feedback arrangement in cascaded amplifier.
    Voltage series feedback increases input
    resistance and decreases output resistance.
    Increase in input resistance reduces the loading
    effect of previous stage and decreases in output
    resistance reduces the loading effect of
    amplifier itself for driving the next stage.")

```

Scilab code Exa 1.33 feedback factor

```

1 //Example 1.33
2 clc
3 disp("We know that,")
4 disp("A_vf = A_v / 1+beta*A_v")
5 disp("Therefore, A_vf + beta*A_v*A_vf = A_v")
6 b=20/2400
7 format(8)
8 disp(b,"Therefore, beta = A_v-A_vf / A_v*A_vf =")

```

Scilab code Exa 1.34 gain with feedback and new bandwidth

```
1 //Example 1.34
2 clc
3 disp("Given: A_v mid = 40, f_L = 100 Hz, f_H = 15
      kHz and beta = 0.01")
4 avf=400/(1+(0.01*400))
5 format(3)
6 disp(avf,"(i) A_vf = A_v mid / 1+beta*A_v mid =")
7 flf=100/(1+(0.01*400))
8 disp(flf,"(ii) f_Lf = f_L / 1+beta*A_v mid =")
9 fhf=(15)*(1+(0.01*400)) // in kHz
10 disp(fhf,"(iii) f_Hf(in kHz) = f_H * (1+beta*A_v mid
      ) =")
11 bw=75-0.02 // in kHz
12 format(6)
13 disp(bw,"(iv) New Bandwidth(in kHz) = f_Hf - f_Lf =")
      )
```

Chapter 2

Oscillators

Scilab code Exa 2.1 verify barkhausen criterion

```
1 //example 2.1
2 clc
3 disp("From the given information we can write,")
4 disp("    A = -16*10^6/j*omega    and    beta =
    10^3/[2*10^3+j*omega]^2")
5 disp("To verify the Barkhausen condition means to
    verify whether |A*beta| = 1 at a frequency for
    which A*beta = 0 degree. Let us express, A*beta
    in its rectangular form.")
6 disp("    A*beta = -16*10^6*10^3 / j*omega*[2*10^3+j*
    omega]^2 = -16*10^9 / j*omega*[4*10^6+4*10^3*j*
    omega+(j*omega)^2]")
7 disp("                = -16*10^9 / j*omega*[4*10^6+4*10^3*j
    *omega-omega^2]          as j^2 = -1")
8 disp("                = -16*10^9 / 4*10^6*j*omega+4*10^3*j
    ^2*omega^2-j*omega^3")
9 disp("                = -16*10^9 / j*omega*[4*10^6-omega
    ^2]-[omega^2*4*10^3]")
10 disp("Rationalising the denominator function we get,
    ")
11 disp("    A*beta = -16*10^9[-omega^2*4*10^3 - j*omega
```

```

    *[4*10^6 - omega ^ 2]] / [-[omega ^ 2*4*10^3] - j*omega
    *[4*10^6 - omega ^ 2]]*[-omega ^ 2*4*10^3 - j*omega
    *[4*10^6 - omega ^ 2]]")
12 disp("Using (a-b)(a+b) = a^2 - b^2 in the
    denominator ,")
13 disp(" A*beta = 16*10^9[omega ^ 2*4*10^3+j*omega
    *[4*10^6 - omega ^ 2]] / [-omega ^ 2*4*10^3]^2 - [j*
    omega*[4*10^6 - omega ^ 2]^2")
14 disp(" A*beta = 16*10^9[omega ^ 2*4*10^3+j*omega
    *[4*10^6 - omega ^ 2]] / 16*10^6*omega ^ 4 + omega
    ^2(4*10^6 - omega ^ 2)^2")
15 disp("Now to have A*beta = 0 degree , the imaginary
    part of A*beta must be zero. This is possible
    when ,")
16 disp(" Therefore , omega*(4*10^6 - omega ^ 2) = 0")
17 disp(" Therefore , omega = 0 or 4*10^6 - omega ^ 2 =
    0")
18 disp(" Therefore , omega ^ 2 = 4*10^6
    Neglecting zero value of frequency")
19 disp(" Therefore , omega = 2*10^3 rad/sec")
20 disp("At this frequency |A*beta| can be obtained as ,
    ")
21 disp(" |A*beta| = 16*10^9[4*10^3*omega ^ 2] /
    16*10^6*omega ^ 4+omega ^ 2[4*10^6 - omega ^ 2]^2
    at omega = 2*10^3")
22 ab=(2.56*10^20)/(2.56*10^20)
23 disp(ab," |A*beta| =")
24 disp(" Therefore , At omega = 2*10^3 rad/sec , A*beta
    = 0 degree as imaginary part is zero while |A*
    beta| = 1. Thus Barkhausen Criterion is satisfied
    .")
25 disp("The frequency at which circuit will oscillate
    is the value of omega for which |A*beta| = 1 and
    A*beta = 0 degree at the same time")
26 disp(" i.e. omega = 2*10^3 rad/sec")
27 disp(" But omega = 2*pi*f")
28 f=(2*10^3)/(2*pi) // in Hz
29 format(9)

```



```
30 disp(f,"Therefore , f(in Hz) = omega / 2pi =")
```

Scilab code Exa 2.2 C and hfe

```
1 //Example 2.2
2 clc
3 disp("Refering to equation(1),")
4 ri=(25*57*1.8)/((57*1.8)+(25*1.8)+(25*57)) // in k-
    ohm
5 format(6)
6 disp(ri," R' ' _i(in k-ohm) = R1 || R2 || h_ie =")
7 disp("Now R' ' _i + R3 = R")
8 r3=7.1-1.631 // in k-ohm
9 format(5)
10 disp(r3,"Therefore , R3(in k-ohm) = R - R' ' _i =")
11 k=20/7.1
12 format(6)
13 disp(k," K = R_C / R =")
14 disp("Now f = 1 / 2*pi*R*C*sqrt(6+4K)")
15 c=(1/(sqrt(6+(4*2.816))*2*%pi*7.1*10*10^6))*10^12
    // in pF
16 format(8)
17 disp(c,"Therefore , C(in pF) =")
18 disp(" h_fe >= 4K + 23 + 29/K")
19 hfe=(4*2.816)+23+(29/2.816)
20 format(7)
21 disp(hfe," h_fe >=")
```

Scilab code Exa 2.3 frequency of oscillations

```
1 //Example 2.3
2 clc
```

```

3 disp("The given values are , R = 4.7 k-ohm and C =
      0.47 uF")
4 f=1/(2*%pi*sqrt(6)*(4.7*10^3)*(0.47*10^-6)) // in
      Hz
5 format(7)
6 disp(f," f(in Hz) = 1 / 2*pi*sqrt(6)*R*C =")

```

Scilab code Exa 2.4 R and C

```

1 //Example 2.4
2 clc
3 disp("f = 1 kHz")
4 disp("Now f = 1 / 2*pi*sqrt(6)*R*C")
5 disp("Choose C = 0.1 uF")
6 r=1/(sqrt(6)*2*%pi*0.1*1*10^-3) // in ohm
7 format(8)
8 disp(r,"Therefore , R(in ohm) = ")
9 disp("Choose R = 680 ohm standard value")

```

Scilab code Exa 2.5 C and RD

```

1 //Example 2.5
2 clc
3 disp("Using the expression for the frequency")
4 disp("Now, f = 1 / 2*pi*R*C*sqrt(6)")
5 f=(1/(sqrt(6)*2*%pi*9.7*5*10^6))*10^9 // in nF
6 format(5)
7 disp(f,"Therefore , C(in nF) =")
8 disp("Now using the equation(27)")
9 disp(" |A| = g_m * R_L")
10 disp("Therefore , |A| >= 29")
11 disp("Therefore , g_m * R_L >= 29")
12 r1=(29/(5000*10^-6))*10^-3 // in k-ohm

```

```

13 format(4)
14 disp(r1,"Therefore , R_L(in k-ohm) >= 29 / g_m =")
15 disp(" R_L = R_D*r_d / R_D+r_d")
16 rd=(40)/4.8823
17 format(5)
18 disp(rd," Therefore , R_D(in k-ohm) = ")
19 disp(" While for minimum value of R_L = 5.8 k-ohm")
20 disp(" R_D = 6.78 k-ohm")

```

Scilab code Exa 2.6 frequency of oscillator

```

1 //exmaple 2.6
2 clc
3 disp("The circuit is Wien bridge oscillator using op
  -amp. The gain of the op-amp is")
4 a=1+3
5 disp(a,"A = 1 + R3/R4 =")
6 disp("So A > 3")
7 disp("This satisfies the required oscillating
  condition. The feedback is given to non-inverting
  terminal ensuring the zero phase shift. Hence
  the circuit will work as the oscillator.")
8 f=1/(2*%pi*5.1*0.001)
9 format(8)
10 disp(f,"f(in kHz) = 1 / 2*pi*R*C =")
11 disp("This will be the frequency of oscillations")

```

Scilab code Exa 2.7 min and max R2

```

1 //Example 2.7
2 clc
3 disp("The frequency of the oscillator is given by,")
4 disp(" f = 1 / 2*pi*sqrt(R1*R2*C1*C2)")

```

```

5 disp("For      f = 10 kHz,")
6 r2=(1/(4*(%pi^2)*(100*10^6)*(10*10^3)*(0.001*10^-12)
    )) // in k-ohm
7 format(6)
8 disp(r2,"Therefore ,  R2(in k-ohm) =")
9 disp("For      f = 50 kHz,")
10 r2=(1/(4*(%pi^2)*(2500*10^6)*(10*10^3)
    *(0.001*10^-12))) // in k-ohm
11 format(6)
12 disp(r2,"Therefore ,  R2(in k-ohm) =")
13 disp("So minimum value of R2 is 1.013 k-ohm while
    the maximum value of R2 is 25.33 k-ohm")

```

Scilab code Exa 2.8 range over which capacitor is varied

```

1 //Example 2.8
2 clc
3 disp("The frequency is given by,")
4 disp("  f = 1 / 2*pi*sqrt(C*L_eq)")
5 leq=(2*10^-3)+(20*10^-6)
6 format(8)
7 disp(leq,"where  L_eq(in kHz) = L1 + L2 =")
8 disp("For  f = f_max = 2050 kHz")
9 format(5)
10 c=(1/(4*(%pi^2)*((2050*10^3)^2)*0.00202))*10^12 //
    in pF
11 disp(c,"Therefore ,  C(in pF) =")
12 disp("For  f = f_min = 950 kHz")
13 c=(1/(4*(%pi^2)*((950*10^3)^2)*0.00202))*10^12 //
    in pF
14 format(6)
15 disp(c,"Therefore ,  C(in pF) =")
16 disp("Hence C must be varied from 2.98 pF to 13.89
    pF, to get the required frequency variation.")

```

Scilab code Exa 2.9 Frequency of oscillations of a Hartley oscillator

```
1 //Example 2.9
2 clc
3 disp("The given values are,")
4 disp(" L1 = 0.5 mH, L2 = 1 mH, C = 0.2 uF")
5 disp("Now f = 1 / 2*pi*sqrt(C*L_eq)")
6 leq=0.5+1 // in mH
7 disp(leq,"and L_eq(in mH) = L1 + L2 =")
8 f=(1/(2*pi*sqrt(1.5*0.2*10^-9)))*10^-3 // in kHz
9 format(5)
10 disp(f,"Therefore, f(in kHz) =")
```

Scilab code Exa 2.10 range of C

```
1 //Example 2.10
2 clc
3 disp("L1 = 20 uH, L2 = 2 mH")
4 leq=(20*10^-6)+(2*10^-3)
5 format(10)
6 disp(leq,"Therefore, L_eq(in H) = L1 + L2 =")
7 disp("For f = f_max = 2.5 MHz")
8 disp("f = 1 / 2*pi*sqrt(C*L_eq)")
9 c=(1/(((2*pi*2.5*10^6)^2)*(2.002*10^-3)))*10^12
10 format(7)
11 disp(c,"Therefore, C(in pF) =")
12 disp("For f = f_min = 1 MHz")
13 c=(1/(((2*pi*1*10^6)^2)*(2.002*10^-3)))*10^12
14 format(8)
15 disp(c,"Therefore, C(in pF) =")
16 disp("This C must be varied from 2.0244 pF to
17 12.6525 pF")
```

Scilab code Exa 2.11 Frequency of oscillations of a transistorised Colpitts oscill

```
1 //Example 2.11
2 clc
3 disp("The equivalent capacitance is given by,")
4 ceq=(150*1.5*10^-21)/((150*10^-12)+(1.5*10^-9)) //
   in F
5 format(12)
6 disp(ceq," C_eq(in F) = C1*C2 / C1+C2 =")
7 disp("Now, f = 1 / 2*pi*sqrt(L*C_eq)")
8 f=(1/(2*%pi*sqrt(50*136.363*10^-18)))*10^-6 // in
   MHz
9 format(6)
10 disp(f," f(in MHz) =")
```

Scilab code Exa 2.12 value of C

```
1 //Example 2.12
2 clc
3 disp("The given values are,")
4 disp(" L = 100 uH, C1 = C2 = C and f = 500
   kHz")
5 disp("Now, f = 1 / 2*pi*sqrt(L*C_eq)")
6 ceq=1/(4*(%pi^2)*(100*10^-6)*((500*10^3)^2)) // in
   F
7 format(11)
8 disp(ceq," Therefore , C_eq(in F) =")
9 disp(" but C_eq = C1*C2 / C1+C2 and C1 = C2 = C
   ")
10 disp(" Therefore , C_eq = C / 2")
11 c=1.0132*2
```

```
12 format(6)
13 disp(c,"Therefore , C(in nF) =")
```

Scilab code Exa 2.13 value of inductor

```
1 //Example 2.13
2 clc
3 disp("Given , C1 = 100 pF, C2 = 50 pF, f = 10 MHz,
      L = ?")
4 ceq=(5000*10^-24)/(150*10^-12)
5 format(10)
6 disp(ceq,"C_eq(in F) = C1*C2 / C1+C2 = ")
7 disp("f = 1 / 2*pi*sqrt(L*C_eq)")
8 l=(1/(4*(%pi^2)*(33.33*10^-12)*((10*10^6)^2)))*10^6
   // in F
9 format(4)
10 disp(l,"Therefore , L(in uH) =")
```

Scilab code Exa 2.14 range of tuning capacitor

```
1 //Example 2.14
2 clc
3 disp("For a tuned collector oscillator ,")
4 disp("f_r = 1 / 2*pi*sqrt(L*C)")
5 disp("where L = 30 uH and f_r to be varied 300 kHz
      to 1.5 MHz")
6 disp("For f_r = 300 kHz")
7 c1=(1/(4*(%pi^2)*(30*10^-6)*((300*10^3)^2)))*10^9
   // in nF
8 format(7)
9 disp(c1,"Therefore , C1(in nF) =")
10 disp("For f_r = 1.5 MHz")
```

```

11 c2=(1/(4*(%pi^2)*(30*10^-6)*((1.5*10^6)^2)))*10^12
    // in pF
12 format(8)
13 disp(c2,"Therefore , C2(in pF) =")
14 disp("Hence C must be varied over 375.264 pF to
    9.3816 nF, to achieve frequency variations")

```

Scilab code Exa 2.15 series and parallel resonant frequency

```

1 //Example 2.15
2 clc
3 fs=(1/(2*%pi*sqrt(0.4*0.085*10^-12)))*10^-6 // in
    MHz
4 format(6)
5 disp(fs,"(i) f_s (in MHz) = 1 / 2*pi*sqrt(L*C) =")
6 ceq=0.085/1.085 // in pF
7 disp(ceq,"(ii) C_eq (in pF) = C*CM / C+CM =")
8 fp=(1/(2*%pi*sqrt(0.4*0.078*10^-12)))*10^-6 // in
    MHz (the answer in textbook is wrong)
9 disp(fp,"Therefore , f_p (in MHz) = 1 / 2*pi*sqrt(L*
    C_eq) =")
10 inc=((0.899-0.856)/0.856)*100 // in percentage
11 disp(inc,"(iii) %increase =")
12 q=(2*%pi*0.4*0.856*10^6)/(5*10^3)
13 format(8)
14 disp(q,"(iv) Q = omega_s*L / R = 2*pi*f_s*L / R =")

```

Scilab code Exa 2.16 series and parallel resonating frequency

```

1 //Example 2.16
2 clc
3 disp("    CM = 2 pF")
4 fs=(1/(2*%pi*sqrt(2*0.01*10^-12)))*10^-6 // in MHz

```



```

5 format(6)
6 disp(fs,"Now f_s (in MHz) = 1 / 2*pi*sqrt(L*C) =")
7 ceq=(2*0.01*10^-24)/(2.01*10^-12) // in F
8 format(9)
9 disp(ceq," C_eq (in F) = C_M*C / C_M+C =")
10 fp=(1/(2*pi*sqrt(2*9.95*10^-15)))*10^-6 // in MHz
11 format(6)
12 disp(fp," f_p = 1 / 2*pi*sqrt(L*C_eq) =")
13 disp("So f_s and f_p values are almost same.")

```

Scilab code Exa 2.17 frequency of oscillations and min value of hfe

```

1 //Example 2.17
2 clc
3 disp("R = 6 k-ohm, C = 1500 pF, R_C = 18 k-ohm")
4 k=18/6
5 disp(k,"Now K = R_C / R =")
6 disp("Therefore, f = 1 / 2*pi*R*C*sqrt(6+4K)")
7 f=(1/(2*pi*(6*10^3)*(1500*10^-12)*sqrt(6+12)))
   *10^-3 // in kHz
8 format(6)
9 disp(f," f (in kHz) =")
10 hfe=(4*3)+23+(29/3)
11 disp(hfe," (h_fe)min = 4K + 23 + 29/K =")

```

Scilab code Exa 2.18 R and hfe

```

1 //Example 2.18
2 clc
3 disp("Referring to equation(1) of section 4.5.3, the
   input impedance is given by,")
4 disp("R' _i = R1 || R2 || h_ie")

```

```

5 disp("Now R1 = 25 k-ohm, R2 = 47 k-ohm, and h_ie
      = 2 k-ohm")
6 format(7)
7 ri=(25*47*2)/((47*2)+(25*2)+(25*47)) // in k-ohm
8 disp(ri,"Therefore, R'_i(in k-ohm) =")
9 disp("K = R_C / R")
10 disp("Now R_C = 10 k-ohm ... given")
11 disp("Now f = 1 / 2*pi*R*C*sqrt(6+4K)")
12 disp("Therefore, R*sqrt(6+4K) = 31830.989")
13 disp("Now K = R_C / R = 10*10^3 / R")
14 disp("Therefore, R*sqrt(6+(40*10*10^3/R)) =
      31830.989")
15 disp("Therefore, R^2*(6+(40*10*10^3/R)) =
      (31830.989)^2")
16 R=poly(0,'R')
17 p1=6*R^2+(40*10^3)*R-(31830.989)^2
18 t1=roots(p1)
19 ans1=t1(1)
20 format(6)
21 disp((-ans1)*10^-3,"Therefore, R(in k-ohm)=
      Neglecting negative value")
22 k=10/16.74
23 format(7)
24 disp(k,"Therefore, K = R_C / R =")
25 disp("Therefore, h_fe >= 4K + 23 + 29/K")
26 hfe=(4*0.5973)+23+(29/0.5973)
27 format(6)
28 disp(hfe," h_fe >=")

```

Scilab code Exa 2.19 change in frequency of oscillations

```

1 //Example 2.19
2 clc
3 ceq=((0.02*12*10^-24)/(12.02*10^-12))*10^12 // in
      pF

```

```

4 format(8)
5 disp(ceq," C_eq(in pF) = C1*C2 / C1+C2 =")
6 fs=(1/(2*%pi*sqrt(50*0.02*10^-15)))*10^-6 // in MHz
7 format(7)
8 disp(fs," Therefore , f_s(in MHz) = 1 / 2*pi*sqrt(L*
C1) =")
9 fp=(1/(2*%pi*sqrt(50*0.01996*10^-15)))*10^-6 // in
MHz
10 format(7)
11 disp(fp," Therefore , f_p(in MHz) = 1 / 2*pi*sqrt(L*
C_eq) =")
12 disp("Let C_s = 5 pF connected across the crystal")
13 c2=12+5
14 disp(c2," Therefore , C''^2(in pF) = C2 + C_x =")
15 format(10)
16 ceq1=0.019976
17 disp(ceq1," Therefore , C''_eq(in pF) = C1*C''^2 / C1+
C''^2 =")
18 fp1=5.03588
19 disp(fp1," Therefore , f''_p(in MHz) = 1 / 2*pi*sqrt(
L*C_eq) =")
20 disp("New C_x = 6 pF is connected then,")
21 c21=12+6
22 disp(c21," C''''^2(in pF) = C2 + C_x =")
23 ceq2=0.0199778
24 disp(ceq2," Therefore , C''''_eq(in pF) = C1*C''''^2 /
C1+C''''^2 =")
25 fp2=5.035716
26 disp(fp2," Therefore , f''''_p(in MHz) = 1 / 2*pi*
sqrt(L*C''''_eq) =")
27 c=(5.03588-5.035716)*10^6
28 disp(c," Therefore , Change(in Hz) = f''_p - f''''_p
=")

```

Scilab code Exa 2.20 C and hfe

```

1 //Example 2.20
2 clc
3 ri=(22*68*2)/((68*2)+(22*2)+(22*68))
4 format(7)
5 disp(ri,"R' ' _i (in k-ohm) = R1 || R2 || h_fe =") //
   answer in textbook is wrong
6 disp("Now R' ' _i + R3 = R")
7 r3=6.8-1.8243
8 disp(r3,"Therefore , R3(in k-ohm) = R - R' ' _i =")
9 k=20/6.8
10 disp(k,"K = R_C / R =")
11 disp("Therefore , f = 1 / 2*pi*RC*sqrt(6+4K)")
12 c=(1/(2*%pi*6.8*50*sqrt(6+(4*2.9411))*10^6))*10^12
13 format(8)
14 disp(c,"Therefore , C(in pF) =")
15 hfe=(4*2.9411)+23+(29/2.9411)
16 disp(hfe,"And h_fe >= 4 K + 23 + 29/K >=")

```

Scilab code Exa 2.21 min and max value of R2

```

1 //Example 2.21
2 clc
3 disp("The frequency of the oscillator is given by,")
4 disp(" f = 1 / 2*pi*sqrt(R1*R2*C1*C2)")
5 disp("For f = 20 kHz,")
6 r2=(1/(4*(%pi^2)*((20*10^3)^2)*(10*10^3)
   *((0.001*10^-6)^2)))*10^-3
7 format(5)
8 disp(r2,"Therefore , R2(in k-ohm) =")
9 disp("For f = 70 kHz,")
10 r2=(1/(4*(%pi^2)*((70*10^3)^2)*(10*10^3)
   *((0.001*10^-6)^2)))*10^-3
11 format(6)
12 disp(r2,"Therefore , R2(in k-ohm) =")
13 disp("So minimum value of R2 is 0.517 k-ohm while

```

the maximum value of R2 is 6.33 k-ohm")

Scilab code Exa 2.22 gain of the transistor

```
1 //Example 2.22
2 clc
3 disp("For a Hartley oscillator,")
4 disp("  f = 1 / 2*pi*sqrt(L_eq*C)           where L_eq
      = L1 + L2 + 2M")
5 leq=(1/(4*(%pi^2)*((168*10^3)^2)*(50*10^-12)))*10^3
      // in mH
6 format(6)
7 disp(leq,"Therefore,  L_eq(in mH) =")
8 l2=((17.95*10^-3)-(15*10^-3)-(5*10^-6))*10^3 // in
      mH
9 disp(l2,"Therefore,  L2(in mH) =")
10 hfe=((15*10^-3)+(5*10^-6))/((2.945*10^-3)+(5*10^-6))
11 format(5)
12 disp(hfe,"Now      h_fe = L1+M / L2+M =")
```

Scilab code Exa 2.24 percentage change in frequency

```
1 //Example 2.24
2 clc
3 disp("(i) Assume one particular coupling direction
      for which,")
4 disp("  L_eq = L1 + L2 + 2M = 0.25 mH")
5 format(8)
6 f=(1/(2*%pi*sqrt(0.25*100*10^-15)))*10^-6 // in MHz
7 disp(f,"Therefore,  f(in MHz) = 1 / 2*pi*sqrt(L_eq*C
      ) =")
8 disp("Let the direction of coupling is reversed,")
9 disp("  L_eq = L1 + L2 - 2M = 0.15 mH")
```

```

10 fd=(1/(2*%pi*sqrt(0.15*100*10^-15)))*10^-6 // in
    MHz
11 format(7)
12 disp(fd,"Therefore , f''(in MHz) = 1 / 2*pi*sqrt(
    L_eq*C) =")
13 pc=((1.2994-1.00658)/1.00658)*100 // in percentage
14 format(6)
15 disp(pc,"Therefore , % change = f''-f/f * 100 =")
16 disp("(ii) Let us assume direction of coupling such
    that,")
17 disp(" L_eq = L1 + L2 + 2M = 0.25 mH")
18 disp(" C_t = Trim capacitor = 100 pF")
19 disp("Therefore , C_eq = C*C_t / C+C_t = 50 pF")
20 f1=(1/(2*%pi*sqrt(0.25*50*10^-15)))*10^-6 // in MHz
21 format(7)
22 disp(f1,"Therefore , f = 1 / 2*pi*sqrt(L_eq*C_eq) =")
    )
23 disp("If now direction of coupling is reversed,")
24 disp(" L_eq = L1 + L2 - 2M = 0.15 mH")
25 f2=(1/(2*%pi*sqrt(0.15*50*10^-15)))*10^-6 // in MHz
26 format(8)
27 disp(f2,"Therefore , f'' = 1 / 2*pi*sqrt(L_eq*C_eq)
    =")
28 pc1=((1.83776-1.4235)/1.4235)*100
29 format(7)
30 disp(pc1,"Therefore , % change = f''-f/f * 100 =")

```

Scilab code Exa 2.25 design a RC phase shift oscillator

```

1 //Example 2.25
2 clc
3 disp("For RC phase shift oscillator,")
4 disp(" h_fe = 4K + 23 + 29/K ... given
    h_fe = 150")
5 disp("Therefore , 150 = 4K + 23 + 29/K")

```

```

6 disp(" Therefore ,  $4K^2 - 127K + 29 = 0$ ")
7 K=poly(0, 'K')
8 p1=4*K^2-127*K+29
9 t1=roots(p1)
10 format(6)
11 disp(t1," Therefore , K =")
12 disp(" f = 1 / 2*pi*R*C*sqrt(6+4K)          ... given
      f = 5 kHz")
13 disp(" Therefore , Choose C = 100 pF")
14 r=(1/(2*%pi*(1000*10^-12)*(5*10^3)*sqrt(6+(4*0.23)))
      )*10^-3 // in k-ohm
15 format(3)
16 disp(r," Therefore , R(in k-ohm) =")
17 disp(" K = R_C / R i.e. R_C = KR = 2.7 k-ohm")
18 disp(" Neglecting effect of biasing resistances
      assuming them to be large and selecting
      transistor with h_ie = 2 k-ohm")
19 disp(" R' ' _i = h_ie = 2 k-ohm")
20 disp(" Therefore , Last resistance in phase network")
21 r3=12-2
22 disp(r3," R3 = R - R' ' _i =")
23 disp(" Using the back to back connected zener diodes
      of 9.3 V (Vz) each at the output of emitter
      follower and using this at the output of the
      oscillator , the output amplitude can be
      controlled to 10 V i.e. 20 V peak to peak. The
      zener diode 9.3V and forward biased diode of 0.7
      V gives total 10 V")
24 disp(" The designed circuit is shown in fig.2.58")

```

This code can be downloaded from the website www.scilab.in

Scilab code Exa 2.26 frequency of oscillations and feedback voltage and C1

```

1 //Example 2.26
2 clc
3 disp("(1) f = 1 / 2*pi*sqrt(L*C_eq)")
4 ceq=(100*500)/600
5 format(7)
6 disp(ceq,"Where C_eq(in pF) = C1*C2 / C1+C2 =")
7 f=(1/(2*%pi*sqrt(40*83.333*10^-15)))*10^-3
8 format(8)
9 disp(f,"f(in kHz) =")
10 disp("(2) The input voltage is not required for the
        oscillator. The feedback voltage, which is the
        part of the output voltage is enough to drive the
        oscillator")
11 disp("V0 = 10 V")
12 disp("For Colpitts oscillator , gain = C2 / C1")
13 gain=500/100
14 disp(gain,"Therefore , Gain =")
15 fv=10/5
16 disp(fv,"Therefore , Feedback voltage(in V) = V0 /
        Gain =")
17 disp("(3) Minimum gain = C2/C1 = 5")
18 disp("h_fe(min) = C2/C1 = 5")
19 disp("(4) Gain = 10 = C2/C1")
20 c1=500/10
21 disp(c1,"Therefore , C1(in pF) =")
22 disp("(5) For C1 = 50 pF and C2 = 500 pF")
23 ceq=(50*500)/550
24 format(8)
25 disp(ceq,"Where C_eq(in pF) = C1*C2 / C1+C2 =")
26 f=(1/(2*%pi*sqrt(40*45.4545*10^-15)))*10^-3
27 disp(f,"f(in kHz) = 1 / 2*pi*sqrt(L*C_eq) =")

```

Scilab code Exa 2.27 design colpitts oscillator

```

1 //Example 2.27

```



```

2  clc
3  disp("The frequency required is , f = 1 MHz and for
      FET, u = 20")
4  disp("Now u = C2/C1 for oscillations")
5  disp("Therefore , 20 = C2/C1")
6  disp("Therefore , C2 = 20*C1      ....(1)")
7  disp("Let C1 = 0.01 uF hence C2 = 0.2 uF")
8  ceq=((0.01*0.2)/(0.21))*10^3
9  format(7)
10 disp(ceq,"Therefore , C_eq(in nF) = C1*C2 / C1+C2 ="
      )
11 disp("Now f = 1 / 2*pi*sqrt(L*C_eq)")
12 l=(1/(((2*pi*1*10^6)^2)*(9.5238*10^-9)))*10^6
13 format(5)
14 disp(l,"Therefore , L(in uH) =")
15 disp("The biasing resistances can be selected as,")
16 disp("R1 = 12 M-ohm and R2 = 8 M-ohm")
17 disp("These resistances must be large")
18 disp("The designed circuit is shown in the fig 2.59"
      )

```

This code can be downloaded from the website www.scilab.in

Scilab code Exa 2.28 frequency of oscillations

```

1  //Example 2.28
2  clc
3  leq=500+5000+600
4  format(5)
5  disp(leq,"L_eq(in uH) = L1 + L2 + 2M=")
6  f=(1/(2*pi*sqrt(150*6100*10^-18)))*10^-3
7  format(9)
8  disp(f,"f(in kHz) = 1 / 2*pi*sqrt(C*L_eq) =")

```

Scilab code Exa 2.29 resonating frequencies

```
1 //Example 2.29
2 clc
3 disp("L_s = 0.8 H, C_s = 0.08 pF, R_s = 5 k-ohm,
      C_M = 1 pF")
4 fs=(1/(2*pi*sqrt(0.8*0.08*10^-12)))*10^-3
5 format(9)
6 disp(fs,"f_s(in kHz) = 1 / 2*pi*sqrt(C_s*L_s) =")
7 ceq=(0.08*10^-12)/1.08
8 format(11)
9 disp(ceq,"C_eq(in F) = C_M*C_s / C_M+C_s =")
10 fp=(1/(2*pi*sqrt(0.8*7.4074*10^-14)))*10^-3
11 format(9)
12 disp(fp,"Therefore , f_p(in kHz) = 1 / 2*pi*sqrt(C*
      L_eq) =")
```

Scilab code Exa 2.31 determine percentage

```
1 //Example 2.31
2 clc
3 disp("The series and parallel resonating frequencies
      are ,")
4 disp("f_s = 1 / 2*pi*sqrt(C*L) while f_p = 1 / 2*
      pi*sqrt(L*C_eq)")
5 disp("f_p/f_s = 1/2*pi*sqrt(L*C_eq) * 2*pi*sqrt(LC)
      = sqrt(c/C_eq) but C_eq = C*C_M/C+C_M")
6 fp=sqrt(1+(0.04/2))
7 format(8)
8 disp(fp,"f_p/f_s = sqrt(C/(C*C_M/C+C_M)) = sqrt(C*(C
      +C_M)/C*C_M) = sqrt(1+(C/C_M)) =")
9 disp("f_p = 1.00995*f_s")
```

```

10 inc=0.00995*100
11 disp(inc," Therefore ,   %increase = (1.00995*f_s - f_s /
      f_s)*100 =")

```

Scilab code Exa 2.32 operating frequency and feedback fraction

```

1 //Example 2.32
2 clc
3 disp("C = 20 pF,   L2 = 1000 uH,   L1 = 100 uH,   M =
      20 uH")
4 leq=100+1000+40
5 format(5)
6 disp(leq," Therefore ,   L_eq(in uH) = L1 + L2 + 2M =")
7 f=(1/(2*%pi*sqrt(1140*20*10^-18)))*10^-6
8 format(6)
9 disp(f," Therefore ,   f(in MHz) = 1 / 2*pi*sqrt(L_eq*C
      ) =")
10 disp("The feedback fraction beta is given by,")
11 b=100/1100
12 format(7)
13 disp(b," beta = V_f/V0 = X_L1 / X_L1+X_L2 = L1 / L1+
      L2 =")
14 disp("It is a Hartley oscillator")

```

Scilab code Exa 2.33 value of C and RD

```

1 //Example 2.33
2 clc
3 disp("Using the expression of the frequency,")
4 disp("f = 1 / 2*pi*RC*sqrt(6)")
5 c=(1/(2*%pi*10*sqrt(6)*10^6))*10^9
6 format(7)
7 disp(c," Therefore ,   C(in nF) =")

```

```

8 disp("For FET phase shift oscillator,")
9 disp("|A| = g_m*R_L and |A| >= 29")
10 r1=(29/5000)*10^3
11 format(4)
12 disp(r1,"Therefore, g_m*R_L >= 29 i.e. R_L(in k-
    ohm) >=")
13 disp("With R_L = 5.8 k-ohm,")
14 disp("R_L = R_D*r_d / R_D+r_d")
15 rd=40/5.8965
16 format(7)
17 disp(rd,"Therefore, R_D(in k-ohm) =")

```

Scilab code Exa 2.34 value of inductance

```

1 //Example 2.34
2 clc
3 disp("The name of the oscillator is Pierce
    oscillator")
4 disp("C1 = 1000 pF, C2 = 100 pF, f_s = 1 MHz")
5 ceq=(1000*100*10^-12)/1100
6 format(11)
7 disp(ceq,"C_eq(in F) = C1*C2 / C1+C2 =")
8 disp("At resonance, X_L = X_Ceq i.e. 2*pi*f*L = 1
    / 2*pi*f*C_eq")
9 l=(1/(((2*pi*10^6)^2)*(90.909*10^-12)))*10^6
10 format(4)
11 disp(l,"Therefore, L(in uH) = 1/(2*pi*f)^2*C_eq =")
12 disp("The fig 2.61(a) shows the electrical
    equivalent of the crystal")
13 disp("At series resonance,")
14 disp("X_L = X_C for crystal")
15 disp("Therefore, C = 90.909 pF for crystal")
16 disp("The mounting capacitance is about 1 to 2 pF")

```

Scilab code Exa 2.36 design phase shift oscillator

```
1 //Example 2.36
2 clc
3 disp("f = 2 kHz")
4 disp("f = 1/ 2*pi*R*c*sqrt(6)           ... For
   phase shift oscillator")
5 disp("Choose C = 1 nF")
6 r=(1/(2*%pi*2*sqrt(6)*10^-6))*10^-3
7 format(7)
8 disp(r,"Therefore , r(in k-ohm) =")
9 disp("Select FET with g_m = 5000 us and r_d = 50 k-
   ohm")
10 disp("For phase shift oscillator , |A| >= 29 and |A|
   = g_m*R_L")
11 disp("Therefore , g_m*R_L >= 29")
12 r1=(29/(5000*10^-6))*10^-3
13 disp(r1,"i.e. R_L(in k-ohm) >= 29/g_m >=")
14 disp("Select R_L = 6.8 k-ohm")
15 disp("But R_L = R_D*r_d / R_D+r_d")
16 rd=7.87
17 disp(rd,"Therefore , R_D(in k-ohm) =")
```

Chapter 3

Multivibrators and Blocking Oscillators

Scilab code Exa 3.1 stable state currents and voltages

```
1 //Example 3.1
2 clc
3 disp("The circuit is similar to the circuit shown in
      the fig 3.2. Assume that Q1 is OFF and Q2 is ON"
      )
4 disp("Case i : Junction voltages of ON transistor
      are neglected")
5 disp("i.e. V_CE2 = 0 V and V_BE2 = 0 V")
6 disp("As emitter is grounded we can say,")
7 disp(" V_C2 = 0 V and V_B2 = 0")
8 disp("Now draw the equivalent circuit in a part from
      base of Q1 to the collector of Q2 as shown in
      fig. 3.4(a)")
9 vb1=-8*(10/60)
10 format(5)
11 disp(vb1,"Now V_B1(in V) = - V_BB * (R1 / R1+R2) =")
12 disp("As V_B1 < V_BE (cut-off) i.e. 0.7 V, it
      ensures that Q1 is OFF. To verify whether Q2 is
```

```

    ON or not, calculate I_C2")
13 i1=12/(2.2)
14 disp(i1,"I1(in mA) = V_CC/R_C = ")
15 i2=(8/60)
16 format(6)
17 disp(i2,"I2(in mA) = V_BB / R1+R2 = ")
18 ic=5.45-0.133
19 disp(ic,"Therefore, I_C2(in mA) = I1 - I2 =")
20 ib=(5.316/30)*10^3
21 disp(ib,"Therefore, (I_B2)min(in mA) = I_C2 / h_fe(
    min) =")
22 disp("Now to calculate actual I_B2 and verify that
    I_B2 > I_B2(min) let us draw part of circuit
    showing collector of Q1 to base of Q2")
23 disp("Now I3 = current through R_C and R1, as I_C1
    = 0")
24 i3=12/12.2
25 format(7)
26 disp(i3,"Therefore, I3(in mA) = V_CC / R_C+R1 =
    ... as V_B2 = 0 V")
27 i4=8/50
28 format(5)
29 disp(i4,"and I4(in mA) = V_B2-V_BB / R2 =")
30 ib2=0.9836-0.16
31 format(7)
32 disp(ib2,"Therefore, I_B2(in mA) = I3 - I4 =")
33 disp("As I_B2 > I_B2(min), the transistor Q2 is
    indeed in saturation")
34 vc1=12-(0.98396*2.2)
35 format(6)
36 disp(vc1,"Therefore, V_C1(in V) = V_CC - I3*R_C =")
37 disp("Hence the stable state current and voltages
    are:")
38 disp("I_C1 = 0 A      I_C2 = 5.316 mA      I_B1 = 0
    A      I_B2 = 0.8236 mA")
39 disp("V_C1 = 9.836 V  V_C2 = 0 V      V_B1 =
    -1.33 V  V_B2 = 0 V")
40 disp("Output swing = V_C1 - V_C2")

```

```

41 disp(" Therefore ,  V_W = 9.836 V")
42 disp("")
43 disp(" Case ii : V_CE(sat) = 0.2 V  and  V_BE(sat) =
      0.7 V")
44 disp(" For the transistor Q2, as emitter is grounded ,
      from these voltages we can write ,")
45 disp("  V_C2 = 0.2 V  and  V_B2 = 0.7 V")
46 disp(" Referring to fig 3.4(a), we can write the
      equations to obtain the stable state currents and
      voltages")
47 disp(" Now V_B1 will be due to V_BB and V_C2 hence
      using superposition principle , considering effect
      of each independently we can write ,")
48 vb1=(-8*(10/60))+(0.2*(50/60))
49 format(5)
50 disp(vb1," V_B1 = -V_BB(R1 + R1+R2) | V_C2=0 + V_C2(R2
      / R1+R2) | V_BB=0 =")
51 i1=11.8/2.2
52 disp(i1," I1 (in mA) = V_CC-V_C2 / R_C =")
53 i2=8.2/60
54 format(6)
55 disp(i2," I2 (in mA) = V_C2+V_BB / R1+R2 =")
56 ic2=5.36-0.136
57 disp(ic2," Therefore ,  I_C2 (in mA) = I1 - I2 =")
58 ib2=5.223/30
59 disp(ib2," Therefore ,  I_B2 (min) (in mA) = I_C2 / h_fe
      (min) =")
60 disp(" To calculate I_B2 , refer fig .3.4(b) , with V_B2
      = 0.7 V")
61 i3=11.3/12.2
62 disp(i3," Therefore ,  I3 (in mA) = V_CC-V_B1 / R_C+R1
      =")
63 i4=8.7/50
64 disp(i4," and  I4 (in mA) = V_B2-V_BB / R2 =")
65 ib2=0.926-0.174
66 disp(ib2," Therefore ,  I_B2 (in mA) = I3 - I4 =")
67 vc1=12-(0.926*2.2)
68 format(7)

```



```

69 disp(vc1,"Therefore , V_C1(in V) = V_CC - I3*R_C =")
70 disp("Hence the stable state current and voltages
are:")
71 disp("I_C1 = 0 A      I_C2 = 5.223 mA      I_B1 =
0 mA      I_B2 = 0.752 mA")
72 disp("V_C1 = 9.9628 V  V_C2 = 0.2 V      V_B1 =
-1.16 V  V_B2 = 0.7 V")
73 vw=9.9628-0.2
74 disp(vw,"V_W(in V) = V_C1 - V_C2 =")

```

This code can be downloaded from the website www.scilab.in This code

can be downloaded from the website www.scilab.in

Scilab code Exa 3.2 min value of hfe and stable state currents and voltages

```

1 //Example 3.2
2 clc
3 disp("Assume that the transistor Q1 is cut-off and
the transistor Q2 is in saturation. Let us draw
again the equivalent circuit from the base of Q1
to the collector of Q2")
4 disp("This is shown in the fig. 3.8")
5 disp("Another equivalent circuit from collector of
Q1 to base of Q2 is shown in the fig 3.9")
6 disp("To calculate the various voltages it is
necessary to calculate the current I_C1, I_B2 as
Q2 is ON. The current I_C1 = I_B1 = 0 as Q1 is
OFF")
7 disp("Now it is not very easy to calculate these
currents by writing the equations from the
equivalent circuits shown in the fig 3.8 and 3.9.
So to calculate let us obtain Thevenin's

```

```

equivalent circuit once across collector and
ground while another across base and ground for
the same transistor Q2 assuming it as the load.")
8 disp("To replace collector circuit of Q2 by Thevenin
's equivalent, consider Q2 as open shown in the
fig 3.10")
9 disp("Referring to fig 3.10,")
10 voc=(12*40)/44
11 format(5)
12 disp(voc,"V_OC(in V) = I*(R1 + R2) = V_CC/(R1+R2+R_C
) * (R1+R2) =")
13 rth=160/44
14 format(6)
15 disp(rth,"and R_TH(in k-ohm) = (R1+R2) || R_C =
with V_CC-N short")
16 disp("To replace base circuit of Q2 by Thevenin's
equivalent, consider Q2 open and draw circuit as
shown in the fig 3.11")
17 voc=(12*10)/44
18 format(5)
19 disp(voc,"V_OC(in V) = I*R2 = V_CC/(R1+R2+R_C) * R2
=")
20 rth=340/44
21 format(6)
22 disp(rth,"and R_TH(in k-ohm) = (R2) || (R1+R_C) =")
23 disp("Thus the equivalent circuit for Q1 ON, using
Thevenin's result calculated above, is as shown
in the fig 3.12")
24 disp("For silicon transistor,")
25 disp("V_BE(sat) = 0.8 V and V_CE(sat) = 0.4 V")
26 disp("Applying KVL to base-emitter loop,")
27 disp("-7.727*I_B2 - V_BE2 - (I_C2 + I_B2)*0.5 + 2.73
= 0")
28 disp("With V_BE2 = 0.8 V, I_B2 + 0.06075*I_C2 =
0.2345 ... (1)")
29 disp("Applying KVL to collector-emitter loop,")
30 disp("-3.636*I_C2 - V_CE2 - (I_C2 + I_B2)*0.5 + 10.9
= 0")

```

```

31 disp("With V_CE2 = 0.4 V,  $4.14 \cdot I_{C2} + 0.5 \cdot I_{B2} =$ 
      10.5          ... (2)")
32 disp("Solving equation (1) and (2) simultaneously we
      get,")
33 disp("I_C2 = 2.526 mA and I_B2 = 0.0847 mA")
34 hfe=2.526/0.0847
35 format(7)
36 disp(hfe,"Therefore,  $h_{fe}(\text{min}) = I_{C2} / I_{B2} =$ ")
37 disp("The various voltages can be obtained now by
      referring fig 3.8 and 3.9")
38 disp("V_EN =  $(I_{B2} + I_{C2}) \cdot R_E = 1.305 \text{ V}$ ")
39 vcn2=0.4+1.305
40 format(6)
41 disp(vcn2,"V_CN2(in V) = V_CE2 + V_EN =")
42 vbn2=0.8+1.305
43 disp(vbn2,"V_BN2(in V) = V_BE2 + V_EN =")
44 vbn1=1.705*(10/40)
45 format(7)
46 disp(vbn1,"V_BN1(in V) = V_CN2 *  $(R_2 / (R_1 + R_2)) =$ ")
47 vbe1=0.4262-1.305
48 disp(vbe1,"V_BE1(in V) = V_BN1 - V_EN =")
49 disp("As V_BE1 < V_BE(sat) which is about 0.8 V, the
      transistor Q1 is indeed OFF")
50 vcn1=(360/34)+((2.105*4)/34)
51 format(8)
52 disp(vcn1,"V_CN1(in V) =  $V_{CC} \cdot R_1 / (R_C + R_1) + V_{BN2} \cdot$ 
       $R_C / (R_C + R_1) =$           ... usinf superposition
      principle")
53 disp("Thus the stable state voltages and currents
      are:")
54 disp("I_C1 = 0 mA          I_C2 = 2.526 mA          I_B1 =
      0 mA          I_B2 = 0.0847 mA")
55 disp("V_CN1 = 10.835 V    V_CN2 = 1.705 V          V_BN1
      = 0.4262 V    V_BN2 = 2.105 V")
56 disp("and V_EN = +1.305 V")
57 disp("The voltage V_EN provides the required self
      bias")

```

Scilab code Exa 3.3 component values of monostable multivibrator

```
1 //Example 3.3
2 clc
3 disp("Assume Q2 ON and Q1 in OFF condition")
4 disp("Therefore ,  $I_{C2} = I_C(\text{sat}) = 6 \text{ mA}$ ")
5 disp("Now  $I_{C2} = V_{CC} - V_{CE}(\text{sat}) / R_C$ ")
6 disp("For the silicon npn transistors ,")
7 disp(" $V_{CE}(\text{sat}) = 0.3 \text{ V}$ ,  $V_{BE}(\text{sat}) = V_0 = 0.7 \text{ V}$ ")
8 disp(" $V_{BE}(\text{cut-in}) = V_T = 0.5 \text{ V}$ ")
9 rc=(5.7*10^3)/6
10 format(4)
11 disp(rc,"R_C(in ohm) =")
12 ib2s=6/20
13 disp(ib2s,"(I_B2)sat (in mA) =  $I_C(\text{sat}) / (h_{fe})_{\text{min}}$  =")
14 disp("Therefore ,  $(I_{B1})_{\text{sat}} = 0.3 \text{ mA}$ ")
15 disp("Now  $I_{B2} = V_{CC} - V_{BE}(\text{sat}) / R$ ")
16 r=5.3/0.3
17 format(6)
18 disp(r,"Therefore , R(in k-ohm) =")
19 disp("In quasi-stable , Q1 is ON and Q2 is OFF")
20 disp("T = 0.69 RC")
21 c=120/(0.69*17.67)
22 format(5)
23 disp(c,"Therefore , C(in nF) =")
24 disp("Consider the equivalent circuit in quasi-state")
25 disp("As Q2 is OFF,  $V_{C2} = V_{CC}$ ")
26 disp("Therefore ,  $I_3 = V_{CC} - V_0 / R_1 = 5.3 / R_1$ ")
27 disp("and  $I_4 = V_0 - V_{BB} / R_2 = 2.2 / R_2$ ")
28 disp("Assume  $I_4 = (I_{B1})_{\text{sat}} = 0.3 \text{ mA}$ ")
29 r2=2.2/0.3
30 format(5)
```

```

31 disp(r2," Therefore , R2(in k-ohm) =")
32 i3=0.3+0.3
33 disp(i3,"and I3(in mA) = I4 + I_B1 =")
34 r1=5.3/0.6
35 format(6)
36 disp(r1," Therefore , R1(in k-ohm) = ")
37 disp("The speed-up capacitor C1 can be chosen such
that R1C1 = 1 usec hence")
38 c1=1000/8.833
39 format(7)
40 disp(c1,"C1(in pF) = ")
41 rb=(5.5/1100)*10^3
42 disp(rb,"Now r''_B(in mA) = V_CC-V_CE(sat)-V0-V_Y /
R_C+r''_bb =")
43 del=(150*5*10^-3)+0.2
44 disp(del," Therefore , delta(in V) = Overshoot = I''
_B*r''_bb + V0 - V_Y =")

```

Scilab code Exa 3.4 pulse width and period and frequency of output

```

1 //Example 3.4
2 clc
3 disp("The components are,")
4 disp(" C1 = C2 = C = 100 pF")
5 disp("R1 = R2 = 10 k-ohm")
6 t1=(0.69*10*100*10^-9)*10^6
7 format(5)
8 disp(t1," Therefore , T1(in usec) = T2 = 0.69*RC =")
9 p=2*0.69
10 disp(p," Therefore , Period(in usec) = T = T1+T2 =")
11 f=1/1.38
12 format(7)
13 disp(f," Therefore , f(in MHz) = 1/T =")

```

Scilab code Exa 3.5 various voltage levels and frequency of oscillations

```

1 //Example 3.5
2 clc
3 disp("(a) For a silicon transistor,")
4 disp("VY = 0.5 V, VBE2 = 0.6 V, V0 = 0.7 V,
      VCE(sat) = 0.3 V")
5 disp("This is a practical circuit")
6 disp("Therefore, VCC2 = VCC = 30 V")
7 vbb=60/3
8 format(3)
9 disp(vbb,"VBB(in V) = R2*VCC / R1+R2 =")
10 vcc1=15+10
11 format(4)
12 disp(vcc1,"and VCC1(in V) = (R1' / R1' + R2'') * VCC
      + (R2' / R1' + R2'') * VBB =")
13 disp("RC1 = R1' * R2' / R1' + R2' = 550 ohm")
14 disp("Assume that Q1 saturates and Q2 is in active
      region.")
15 disp("IC2 = VCC1/Re and Re = Re1 || Re2 =
      1.65 k-ohm")
16 ic2=25/1.65
17 format(6)
18 disp(ic2,"Therefore, IC2(in mA) =")
19 ib2=15.15/30
20 disp(ib2,"IB2(in mA) =")
21 mul=0.505*0.55
22 disp(mul,"Therefore, IB2*RC1(in V) =")
23 mull=15.15*0.22
24 disp(mull,"and IC2*RC2(in V) =")
25 disp("The highest level of VEN1 is V1 given by,")
26 v1=25-0.277-0.6-0.3+0.5
27 disp(v1,"V1(in V) = VCC1 - IB2*RC1 - VBE2 - VCE
      (sat) + VY =")

```

```

28 disp("The lowest level of V_EN1 is ,")
29 ven1=20-0.7
30 disp(ven1,"V_EN1(t_-1)(in V) = V_BB - V0 =")
31 vcn1=20-0.7+0.3
32 disp(vcn1,"V_CN1(t_-1)(in V) = V_BB - V0 - V_CE(sat)
    =")
33 format(7)
34 vcn=25-0.277
35 disp(vcn,"V_CN1(t_+1)(in V) = V_CC1 - I_B2*R_C1 =")
36 disp("V_CN1 = V_BN2")
37 ven2=19.6-0.5
38 disp(ven2,"V_EN(t_-1)(in V) = V_BN2(t_-1) - V_Y =")
39 ven=25-0.277-0.6
40 disp(ven,"V_EN(t_+1)(in V) = V_CC1 - I_B2*R_C1 -
    V_BE2 =")
41 vd=24.123-19.1
42 disp(vd,"V_D(in V) = V_EN2(t_+1) - V_EN2(t_-1) =")
43 disp("(b) The frequency of oscillations ,")
44 disp("f = 1/T = 1/(T1+T2)")
45 t1=((3.3*0.1*10^-3)*log(24.323/19.5))*10^6
46 format(6)
47 disp(t1,"T1(in usec) = R_e1*C*ln(V1/V_BB-V_Y) =")
48 disp("and T2 = T1 as R_e1 = R_e2")
49 t=(2*72.93)*10^-3
50 format(7)
51 disp(t,"Therefore , T(in ms) = 2*T1 =")
52 f=1/0.1458
53 format(7)
54 disp(f,"Therefore , f(in kHz) = 1/T =")

```

Scilab code Exa 3.7 peak voltages and currents

```

1 //Example 3.7
2 clc
3 disp("(a) T = t_p + t_f + t_a")

```

```

4 tp=(5/470)*10^3
5 format(8)
6 disp(tp,"Now t_p(in usec) = nL/R =")
7 tf=(50/(470*6*2))*10^3
8 format(6)
9 disp(tf,"t_f(in usec) = (n/n+1)*L/R*V_CC/V_Y =")
10 ta=(1.57*sqrt(5*90*10^-15))*10^6
11 disp(ta,"t_a(in usec) = 1.57*sqrt(LC) =")
12 t=10.6383+8.865+1.053
13 format(8)
14 disp(t,"T(in usec) =")
15 f=(1/20.5564)*10^3
16 disp(f,"Therefore, f(in kHz) = 1/T =")
17 dc=10.6383/20.5564
18 format(7)
19 disp(dc,"Duty cycle = t_p/T =")
20 disp("So duty cycle is 51.75% which is very close to
      50% giving an indication that Q ON and OFF times
      are equal and the output is almost symmetrical
      square wave.")
21 disp("(b) The collector voltage varies from V_CC-V
      to V_CC+V_Y")
22 v=10/2
23 disp(v,"Now V(in V) = V_CC / n+1 =")
24 disp("Therefore, V_C varies from 10-5 i.e. +5 V to
      10+6 = 16 V")
25 disp("The base voltage varies from nV to -nV_Y i.e.
      +5 V to -6 V")
26 disp("The emitter current is constant given by,")
27 ie=(5/470)*10^3
28 format(7)
29 disp(ie,"I_E(in mA) = nV/R =")
30 ib=(10/(4*470))*10^3
31 disp("i_B = V_CC/(n+1)^2 * [n/R - t/L]")
32 format(5)
33 disp(ib,"So i_B(max)(in mA) = i_B | t=0 =")
34 ib=((10/4)*((1/470)-((10.63*10^-3)/5)))*10^6
35 format(6)

```



```

36 disp(ib,"i_B(t=t_p)(in uA) =")
37 disp("i_C = V_CC/(n+1)^2 * [n^2/R + t/L]")
38 ic=((10/4)*((1/470)+((10.63*10^-3)/5)))*10^3
39 format(7)
40 disp(ic,"i_C(t=t_p)(in mA) =")
41 i0=(10/940)*10^3
42 disp(i0,"I_0 = Peak magnetizing current = n*V_CC / (
      n+1)*R =")
43 disp("(c) I''_m which is the magnetizing current at
      the end of one cycle is given by")
44 im=(6*sqrt(90/5))
45 disp(im,"I''_m(in mA) = V_Y*sqrt(C/L) =") //answer
      in textbook is wrong

```

Scilab code Exa 3.8 design a free running blocking oscillator

```

1 //Example 3.8
2 clc
3 disp("f = 20 kHz hence T = 1/f = 50*10^-6 sec")
4 disp("Now T = t_p+t_f+t_a = t_p+t_f      ...
      Neglecting t_a")
5 disp("Therefore, 50*10^-6 = t_p+t_f")
6 disp("Now Duty cycle = t_p/T = 1/10")
7 disp("Therefore, t_p = T/10 = 5*10^-6 sec")
8 tf=50-5
9 disp(tf,"Therefore, t_f(in usec) = ")
10 disp("i_E(max) = nV/R")
11 disp("Therefore, nV/R = 5*10^-3      ...(1)")
12 disp("t_p = nL/R")
13 disp("Therefore, nL/R = 5*10^-6      ...(2)")
14 disp("Dividing equations (1) and (2), V = 1000 L
      ...(3)")
15 disp("And V = V_CC / n+1 = 30 / n+1      ...(4)")
16 disp("The collector voltage pulse extents from V_CC-
      V to V_CC+V_Y")

```

```

17 disp(" Therefore , Peak of the pulse = [V_CC+V_Y] - [
    V_CC-V] = V + V_Y")
18 disp(" Therefore , V + V_Y = 10 (Given)")
19 disp(" and t_f = (n/n+1)*L/R*V_CC/V_Y = 45*10^-6")
20 disp(" Therefore , nL/R*V_CC/(n+1)*1/V_Y = 45*10^-6")
21 disp(" (5*10^-6)*V/V_Y = 45*10^-6")
22 disp(" Using equation (5) , (5*10^-6)*(10-V_Y/V_Y) =
    45*10^-6")
23 disp(" 10 - V_Y = 9 V_Y")
24 disp(" V_Y = 1 V")
25 disp(" V = 10 - V_Y = 9 V")
26 disp(" Using equation (4) , n = 2.3333")
27 disp(" Using equation (3) , L = 9 mH")
28 disp(" Using equation (2) , R = 4.2 k-ohm")
29 disp(" The designed circuit can be shown as in the
    fig 3.73")
30 disp(" Neglecting base current ,")
31 disp(" V_BE = V_CC*R2 / R1+R2")
32 disp(" Therefore , 1 = 30*R2 / R1+R2")
33 disp(" Therefore , R1 = 29 R2")
34 disp(" So let R2 = 1 k-ohm")
35 r1=29
36 disp(r1,"R1(in k-ohm) =")
37 disp(" This is required potential divider components"
    )

```

Scilab code Exa 3.10 max I

```

1 //example3.10
2 clc
3 disp("The circuit of self biased binary is shown in
    the fig. 3.80")
4 disp("Assume Q1 is OFF and Q2 is ON. As Q2 is in
    saturation ,")
5 disp("V_CE(sat)=V_CE2=0.4V")

```

```

6 disp("V_BE(sat)=V_BE2=0.8V")
7 disp("a) Calculation for the stable state currents
and voltages")
8 disp("Draw equivalent circuit from base of Q1 to
collector of Q2.")
9 disp("Another equivalent circuit from collector of
Q1 to base of Q2 is shown in the fig.3.81")
10 disp("To calculate the various voltages, is
necessary to calculate the currents I_c2, I_B2
for ON transistor Q2. The currents I_C1=I_B1=0 mA
as Q1 is OFF.")
11 disp("To obtain I_c2, I_B2 let us obtain. Thevenins
equivalent once across collector and ground and
other across base and ground, for ON transistor
Q2.")
12 disp("Consider Thevenins equivalent across collector
of Q2 and ground as shown in the fig. 3.83(a)
while Thevenins equivalent across base of Q2 and
ground as shown in the fig. 3.83(b).")
13 disp("Referring fig 3.83(a) we can write,")
14 i=(20*45)/49.7
15 format(7)
16 disp(i,"V_oc(in volts)=I(R1+R2)=(V_cc*(R1+R2))/(R1+
R2+R_c)=")
17 r=(45*4.7)/(45+4.7)
18 format(6)
19 disp(r,"R_th(in k ohms) = (R1+R2) parallel to R_c
with V_cc -N short =")
20 disp("Referring fig 3.83(b),")
21 v=(20*15)/(30+15+4.7)
22 format(6)
23 disp(v,"V_OC(in V)=I*R2=(V_CC * R2)/(R1+R2+R_c)=")
24 t=(15*34.7)/(15+34.7)
25 format(7)
26 disp(t,"And, R_th(in k ohm)=R2 parallel to(R1+R2)="
)
27 disp("Applying KVL to base-emitter loop,")
28 disp("-I_B2(10.473) -0.8 -0.39(I_B2+I_C2)+6.036=0")

```

```

29 disp(" 0.863(I_B2)+0.39(I_C2)=5.236")
30 disp(" I_B2+0.0359(I_C2)=0.482    Now multiply by
    0.39,")
31 disp(" 0.39(I_b2)+0.014(I_C2)=0.1879    ..(1)")
32 disp(" Applying KVL to collector emitter loop,")
33 disp(" (-I_C2)(4.255) -0.4 -0.39(I_B2+I_C2)+18.108=0")
34 disp(" -0.39(I_B2) -4.645(I_c2)=-17.708    ..(2)")
35 disp(" Adding equations (1) and (2) we get,")
36 disp(" -4.631(I_C2)=-17.5201")
37 c=(-17.5201)/(-4.631)
38 format(6)
39 disp(c," I_C2 (in mA)=")
40 b=(-17.708+((4.645)*(3.783)))/(-0.39)
41 disp(b," and,    I_B2 (in mA)=")
42 disp(" From this, the various voltages can be
    obtained as,")
43 v=((0.346+3.783))*(0.390)
44 format(5)
45 disp(v," V_EN (in V)=(I_B2+I_C2)*R_E =")
46 n=0.4+1.61
47 disp(n," V_CN2 (in V)=(V_CE2+V_EN)=")
48 b=0.8+1.61
49 disp(b," V_BN2 (in V)=(V_BE2+V_EN)=")
50 w=(2.01*15)/45
51 disp(w," V_BN1 (in V)=(V_CN2*R2)/(R1+R2)=")
52 v=0.67-1.61
53 format(5)
54 disp(v," V_BE1 (in V)=(V_BN1-V_EN)=0.61-1.61=")
55 disp(" For cut-off, V_BE1 is 0V given, but actually
    it is still less i.e. -0.94 V. This ensures that
    Q1 is still OFF.")
56 a=((20*30)/(4.7+30))+((2.41*4.7)/(4.7+30))
57 format(7)
58 disp(a," V_CN1 (in V)=")
59 disp(" b) To find (h_fe)_min")
60 disp(" For the ON transistor Q2")
61 disp(" I_C2=3.783mA,    I_B2=0.346mA")
62 h=3.783/0.346

```

```

63 format(3)
64 disp(h,"Therefore , (h_fe)_min = (I_C2)/(I_B2)=")
65 disp("Calculation of (I_CBO)_max")
66 disp("To calculate (I_CBO)_max consider the circuit
        shown in the fig 3.85")
67 disp("Obtain the Thevenins equivalent across
        terminal A and ground.The Thevenin voltage is V_A
        =V_B1=0.67 V")
68 disp("Looking into terminals A and ground,")
69 r=(34.7*15)/(34.7+15)
70 format(7)
71 disp(r,"R_th(in kohms)=(R_1+R_c) parallel to R2 =")
72 disp("Hence Thevenin equivalent is: To find
        I_CBO_max, ")
73 disp("V_BE(cut-off)=0V and V_EN =1.61 V ...
        Calculated earlier")
74 disp("As V_BE= 0, base must be also at same
        potential as emitter with respect to ground.")
75 disp("V_B1=V_EN=1.61 V for(I_CBO)_max,")
76 o=(1.61-0.67)/(10.472*10^3)
77 format(11)
78 disp(o,"I_CBO_max(in A)=(V_B1-V_TH)/(R_TH)=")
79 disp("This is the maximum I_CBO")

```

Scilab code Exa 3.11 find V

```

1 //example3.11
2 clc
3 disp("For the npn silicon transistors,")
4 disp("V_CE(sat)=0.3 V and V_BE(sat)=0.7 V = V_rho")
5 disp("While V_BE(cut-in)=0.5 V= V_gamma ...
        Referring Table 3.1")
6 i=(12-0.3-0.7+0.5)/(2000+200)
7 format(6)

```

```

8 disp(i,"(I''_B)(in mA)=(V_CC-V_CE(sat)-V_rho-V_gamma
   )/(R_c+r''_bb)=")
9 disp("Hence the overshoot in base voltage of Q2 is:")
   )
10 d=(5.227*200*10^-3)+0.7-0.5
11 format(7)
12 disp(d,"delta(in V)=(I''_b*r''_bb)+(V_rho)-(V_gamma)
   =")
13 v=12-(5.227*2)
14 disp(v,"V_C1(in V)=(V_CC)-(I''_B*R_C)=")
15 disp("These are the values of various voltages just
   after the circuit returns back to stable state i.
   e at t=T.")
16 disp("The width of the output pulse")
17 t=(0.69*20*10^3)*(1000*10^-12)
18 format(11)
19 disp(t,"T(in sec)=(0.69*20*10^-3)*(1000*10^-12)=")
20 disp("The voltage waveforms at base of Q2, Q1 and
   collector of Q2, Q1 are shown in the fig 3.87 on
   previous page.")
21 disp("The overshoot in V_C1 is (delta'') and is same
   as (delta) ")
22 disp("Therefore, (delta'')=1.2454 V")
23 f=(-(14.7*20*10^3)/(40*10^3))+((12*20*10^3)
   /(40*10^3))
24 format(5)
25 disp(f,"V_F(in V)=((-V_BB*R1)/(R1+R2))+((V_CC*R2)/(
   R1+R2))= ")
26 disp("V_C2=V_CE(sat)=0.3 in stable state")
27 c=(((12*20000)/(40000))+((54.692*2000)/(22000)))
28 format(7)
29 disp(c,"V_C2(in V)[in quasi-stable state]=((V_CC*R1)
   /(R1+R2))+((V_delta*R_C)/(R1+R_C))= ")

```

Scilab code Exa 3.13 waveform at the base Q2 and and value of RC

```

1 //Exmaple 3.13
2 clc
3 disp("Assume Q1 is normally OFF and Q2 is ON")
4 disp("The given waveform is at collector of Q1 i.e.
   V_C1")
5 disp("Therefore , V_CE(sat) = 0.1 V and V_CC = 3 V
   ")
6 vc1=0.6-0.1
7 format(4)
8 disp(vc1,"The overshoot in V_C1(in V) = delta ' ' =")
9 disp("delta = delta ' ' = 0.5 V")
10 disp("For germanium, V_BE(sat) = V_0 = 0.3 V")
11 disp("V_BE(cut-in) = V_Y = 0.1 V")
12 disp("r ' ' _bb = 200 ohm")
13 disp("Now delta = I ' ' _B*r ' ' _bb + V_0 + V_Y")
14 ib=(0.3/200)*10^3
15 disp(ib,"Therefore , I ' ' _B(in mA) =")
16 rc=(3-0.6)/(1.5)
17 disp("While delta ' ' = V_CC - I_B ' ' *R_C - V_CE(sat)"
   )
18 disp(rc,"Therefore , R_C(in k-ohm) =")
19 disp("The waveform at base of Q2 is shown in fig
   3.91")

```

Scilab code Exa 3.14 find R

```

1 //example3.14
2 clc
3 disp("The duty cycle is given as 60% i.e. 0.6")
4 disp("Therefore duty cylcle = T2/(T1+T2)")
5 disp("Therefore 0.6=T2/(T1+T2)")
6 disp("Therefore 0.6(T1+T2)=T2")
7 disp("Therefore T1=0.66*T2")
8 disp("f=1 kHz")
9 t=1/(10^3)

```

```

10 format(6)
11 disp(t,"T(in sec)=1/(1*10^3)=")
12 disp("Now, T=T1+T2")
13 disp("Therefore T1+T2=1 msec")
14 disp("Therefore 0.66T2+T2=1 msec")
15 o=(10^-3)/1.66
16 format(7)
17 disp(o,"Therefore T2(in sec)=")
18 t=1-0.6
19 disp(t,"T1(in msec)=")
20 disp("Consider the circuit diagram shown in the fig
      3.92")
21 disp("Assume Q2 ON and Q1 OFF")
22 disp("For ON transistor, assuming npn silicon
      transistor,")
23 disp("V_CE(sat)=V_C2=0.3V")
24 disp("V_BE(sat)=V_B2=0.7V")
25 disp("I_C(sat)=I_C2=2 mA")
26 disp("(h_fe)_min=30")
27 disp("I2=(V_CC-V_C2)/R_c")
28 disp("Neglecting through C1,")
29 disp("I2=I_C2=2 mA")
30 disp("Therefore, (2*10^-3)=(10-0.3)/R_C")
31 r=9.7/(2*10^-3)
32 disp(r,"Therefore R_C(in ohms)= ")
33 h=(1.5*2)/30
34 disp(h,"Now I_B2(in mA)=1.5*(I_B2)_min=1.5*(I_C2)
      /(h_fe)_min= ")
35 disp("Now, I_B2=(V_cc-V_B2)/R2")
36 r=9.3/(0.1*10^-3)
37 disp(r,"Therefore R2(in ohms)=")
38 disp("Now assume C1=C2=C")
39 disp("Therefore T1=0.69(R1*C1) and T2=0.69(R2*C2)")
40 disp("Therefore T2=0.69(R2*C)")
41 c=(0.6*10^-3)/(0.69*93*10^3)
42 disp(c,"Therefore C(in F)= ")
43 disp("Therefore T1=0.69*(R1*C)")
44 disp("Therefore (0.4*10^-3)=(0.69*R1)*(9.35*10^-9)")

```



```

    )
45 r=(0.4*10^-3)/(0.69*9.35*10^-9)
46 disp(r," Therefore R1(in ohms)=")

```

Scilab code Exa 3.15 find Voltage

```

1 //example4.15
2 clc
3 disp("UTP=5 V, LTP=3 V, V_CC=12 V")
4 disp(" V_i=V_B2=UTP=5 V when Q2 is ON.")
5 v=5-0.7
6 disp(v," V_E(in V)=(V_i)-(V_BE1)=V_B2-V_BE2=5-0.7=")
7 disp(" Let I_C2=I_E2=1 mA          ... In ON state")
8 r=4.3/(10^-3)
9 disp(r," Therefore R_E(in ohms)=V_E/I_E2=")
10 disp(" Now, (I_C2)*(R_C2)=(V_CC)-(V_E)-(V_CE2)_sat
      .. Let (V_CE2)_sat =0.2V")
11 disp("(1*10^-3)*(R_C2)=12-4.3-0.2")
12 c=(12-4.3-0.2)/(10^-3)
13 disp(c," Therefore R_C2(in ohms)= ")
14 i=(10^-3)/10
15 disp(i," Now I2(in A)=0.1(I_C2)=")
16 r=5/(10^-4)
17 disp(r," Therefore R2(in ohms)= ")
18 i=(10^-3)/100
19 disp(i," I_B2(in A)=(I_C2)/(h_fe)_min =")
20 disp(" Therefore I2+I_B2=(V_CC-V_B2)/(R_C1-R1)")
21 disp(" Therefore R_C1+R1=(12-5)/((10^-4)+(10^-5))
      =63.6363*10^3 .. (1)")
22 disp(" Now V_B2=B_B1=LTP=3 V and Q1 is ON.")
23 i=3/(50*10^3)
24 disp(i," I1(in A)=(V_B2)/R2=")
25 c=(3-0.7)/(4.3*10^3)
26 format(10)
27 disp(c," amd I_C1(in A)=I_E1=(V_B1-V_BE1)/R_E= ")

```

```

28 disp(" Therefore V_CC=(R_C1)*(I_C1+I1)+I1*(R1+R2)
    ..(2)")
29 disp(" Using equation (1) in equation (2),")
30 disp(" Therefore V_CC=(I_C1*R_C1)+I1*(R_C+R1)+I1*R2")
31 disp(" 12=(5.348*10^-4*R_C1)+(60*10^-6*63.6363*10^3)
    +(60*10^-4*50*10^3)")
32 r=(12-(60*63.6363*10^-3)-(60*50*10^-3))
    /(5.348*10^-4)
33 format(7)
34 disp(r," Therefore R_c1(in ohm)=")
35 r=(63.6363*10^3)-(9.6892*10^3)
36 disp(r," Therefore R1(iin ohms)=")
37 disp(" Thus when Q2 is ON,")
38 v=12-(7.5)
39 disp(v," V_o(in V)=V_CC-(I_C2(on))*R_C2=")
40 disp(" And when Q2 is OFF,")
41 disp(" V_o=V_CC=12 V")
42 disp(" The designed circuit is shown ib the fig 3.93"
    )

```

Chapter 4

High Frequency Amplifiers

Scilab code Exa 4.1 gm and rbe and Ce and omegaB

```
1 //Example 4.1
2 clc
3 gm=(1/26)*10^3
4 format(6)
5 disp(gm,"(i) g_m(in mA/V) = I_C / V_T =")
6 rbe=200/(38.46)
7 format(5)
8 disp(rbe,"(ii) r_b''e(in k-ohm) = h_fe / g_m =")
9 cc=((38.46*10^-3)/(500*10^6))*10^12
10 format(6)
11 disp(cc,"(iii) (C_e + C_C)(in pF) = g_m / 2*pi*f_T =
      g_m / omega_T =")
12 cbe=76.92-3
13 disp(cbe,"Therefore, C_b''e(in pF) = C_e =")
14 disp("(iv) We know that,")
15 disp("f_T = h_fe*f_beta")
16 disp("Therefore, 2*pi*f_T = h_fe*2*pi*f_beta")
17 disp("omega_T = h_fe*omega_beta")
18 ob=((500*10^6)/200)*10^-3
19 format(5)
20 disp(ob,"omega_beta(in rad/sec) = omega_T / h_fe =")
```

Scilab code Exa 4.2 fT and hfe and Ai

```
1 //Example 4.2
2 clc
3 ft=25*2
4 format(3)
5 disp(ft,"(i) f_T(in MHz) = |A_i|*f =")
6 hfe=50000/200
7 format(4)
8 disp(hfe,"(ii) h_fe(in kHz) = f_T / f_beta =")
9 disp("(iii) |A_i| = h_fe / sqrt(1+((f/f_beta)^2)) =")
10 disp("At f = 10 MHz")
11 ai=250/sqrt(1+(((10*10^6)/(200*10^3))^2))
12 format(2)
13 disp(ai,"|A_i| =")
14 disp("At f = 100 MHz")
15 ai=250/sqrt(1+(((100*10^6)/(200*10^3))^2))
16 format(4)
17 disp(ai,"|A_i| =")
```

Scilab code Exa 4.10 find gain

```
1 //example4.10
2 clc
3 disp("a) The 3dB frequency for circuit gain and
      voltage gain is given as,")
4 disp("(f_H)=1/(2*pi*R_eq*C_eq)")
5 r=(200*1000)/(200+1000)
6 disp(r,"where R_eq(in ohm)=(R_s+r_bb'') parallel to r
      +b''e =")
```

```

7 c=(100*10^-12)+((1+50)*3*10^-12)
8 format(10)
9 disp(c,"and C_eq(in F)=(C_b''e)+(1+(g_m*R_L)*C_b''c
    )=")
10 f=1/((2*%pi*166.67*253*10^-12))
11 disp(f,"f_H(in Hz)=")
12 disp("b) Voltage gain is given as,")
13 a=(-50*1)
14 disp(a,"A=(-g_m*R_L)=")

```

Scilab code Exa 4.12 find resistance

```

1 //example4.12
2 clc
3 disp("f_H=1/(2*pi*R_eq*C_eq)")
4 disp("and f_H''=2(f_H)")
5 disp("1/(2*pi*R_eq*C_eq) = 2/(2*pi*R_eq*C_eq)")
6 disp("R_eq'' = R_eq/2")
7 disp("R_eq=(r_b''e) parallel to (r_bb''+R_s)")
8 disp("= (r_b''e)=1000 ohm")
9 disp("Therefore R_eq'' =500 ohm")
10 disp("Therefore 500=((r_b''e)*(r_bb''+R_s))/((r_b''e)+(r_bb''+R_s)")
11 disp(" = 1000(100+R_s)/(1000+100+R_s)")
12 r=(4.5*10^5)/500
13 disp(r,"R_s(in ohms)=")

```

Scilab code Exa 4.16 mid frequency voltage gain and fb and fT

```

1 //Example 4.16
2 clc
3 disp("Hybrid-pi Equivalent is as shown in fig.4.29")
4 disp("(i) Mid frequency voltage gain :")

```

```

5 disp("V_o / V_s = -h_fe*R_L / R_s+h_ie")
6 hie=(100+1000)*10^-3
7 format(4)
8 disp(hie,"h_ie(in k-ohm) = r_bb'' + r_b''e =")
9 hfe=0.2*1000
10 disp(hfe,"h_fe = g_m * r_b''e =")
11 vo=-200/2
12 disp(vo,"Therefore , V_o / V_s =")
13 fb=(1/(2*pi*1000*(204*10^-12)))*10^-3
14 format(7)
15 disp(fb,"(ii) f_beta(in kHz) = 1 / 2*pi*r_b''e*(C_e+
      C_C) =")
16 format(4)
17 disp(fb,"f_beta(in kHz) = ")
18 ft=(200*780)*10^-3
19 disp(ft,"(iii) f_T(in kHz) = h_fe * f_beta =")

```

Scilab code Exa 4.17 source resistance and R_s and midband voltage gain

```

1 //Example 4.17
2 clc
3 disp("(i) We know that ,")
4 disp(" f_H = 1 / 2*pi*R_eq*C_eq")
5 disp("where R_eq = (R_s+r_bb'')*r_b''e / R_s+r_bb
      ''+r_b''e")
6 disp("and C_eq = C_e + C_C*[1+g_m*R_L]")
7 rbe=100/100
8 format(2)
9 disp(rbe," r_b''e(in k-ohm) = h_fe / g_m = ")
10 disp("C_eq = C_e + C_C*[1+g_m*R_L] = C_e + C_C
      [1+100*10^-3*500]")
11 disp(" = C_e + 51 pF")
12 ce=((100*10^-3)/(2*pi*(400*10^6)))*10^12
13 format(6)
14 disp(ce,"C_e(in pF) = g_m / 2*pi*f_T =")

```

```

15 ceq=39.79+51i
16 disp(ceq," Therefore , C_eq(in pF) =")
17 req=1/(2*%pi*5*90.79*10^-6)
18 disp(req," R_eq(in ohm) = 1 / 2*pi*f_H*C_eq =")
19 disp(" Therefore , 350.6 = (R_s+100)*1000 / R_s+1100")
20 rs=(285.66*10^3)/649.4
21 format(7)
22 disp(rs," Therefore , R_s(in ohm) =")
23 disp("(ii) The mid-band voltage gain V_o/V_s is
      given as")
24 disp(" V_o/V_s = -h_fe*R_L / R_s+h_ie")
25 hie=(100+1000)*10^-3
26 format(4)
27 disp(hie," where h_ie(in K) = r_bb'' + r_b''e =")
28 vo=(-100*500)/(439.88+1100)
29 format(6)
30 disp(vo," Therefore , V_o/V_s =")

```

Scilab code Exa 4.20 voltage gain

```

1 //Example 4.20
2 clc
3 disp("Assume that the output time-constant is
      negligible as compared to the time constant.
      When this is the case")
4 disp("A_vs = V_o/V_s = -g_m*R''_L*G''_s / G''_s+g_b
      ''_e+sC")
5 gs=6.66*10^-3
6 format(8)
7 disp(gs," where G''_s = 1 / (R_s||R_b)+r_bb'' =")
8 gbe=1/1000
9 format(6)
10 disp(gbe," g_b''_e = 1 / r_b''_e =")
11 rl=(0.5/1.5)*10^3
12 format(7)

```

```

13 disp(r1,"R' 'L(in ohm) = R_L || R_C =")
14 disp(" sC = admittance of C")
15 c=100+(3*(1+(50*333.33*10^-3)))
16 format(4)
17 disp(c,"where C = C_e + C_C*(1+g_m*R' 'L) =")
18 disp("At 10 kHz,")
19 sc=2*%pi*10*153*10^-9
20 format(8)
21 disp(sc,"sC = 2*pi*f*C =")
22 disp("Therefore , At 10kHz signal frequency")
23 avs=(-50*333.33*6.66*10^-6)/((6.66*10^-3)+(10^-3)
    +(9.613*10^-6))
24 format(6)
25 disp(avs,"A_vs = V_o / V_s =")

```

Chapter 5

Tuned Amplifier

Scilab code Exa 5.1 Rs and Rp of inductor

```
1 //Example 5.1
2 clc
3 rp=2*%pi*10^6*250*300*10^-9
4 format(7)
5 disp(rp,"R_p(in k-ohm) = omega_0 * L * Q =")
6 rs=(2*%pi*250)/300
7 format(6)
8 disp(rs,"R_s(in ohm) = omega_0*L / Q =")
```

Scilab code Exa 5.2 design single tuned amplifier

```
1 //Example 5.2
2 clc
3 disp("From equation 9 we have")
4 disp(" BW = 1 / 2*pi*R*C")
5 rc=1/(2*%pi*10*10^3)
6 format(12)
7 disp(rc,"Therefore , R*C = 1 / 2*pi*BW =")
```

```

8 disp("From equation 3 we have")
9 disp(" R = r_i || R_p || r_b''e")
10 disp(" where r_i = 4 k-ohm")
11 rbe=100/0.04
12 disp(rbe,"r_b''e(in ohm) = h_fe / g_m =")
13 disp("R_p = Q_c * omega_0 * L = Q_c / omega_0*C")
14 disp("Therefore, R = 4*10^3 || 2500 || Q_c/omega_0*
      C")
15 disp("C = 1 / 2*pi*10*10^3*R")
16 disp("Therefore, C = 1 / 2*pi*10*10^3*[4*10^3 ||
      2500 || Q_c/2*pi*500*10^3*C]")
17 disp("The typical range for Q_c is 10 to 150.
      However, we have to assume Q such that value of
      C_p should be positive. Let us assume Q = 100")
18 disp("Therefore, C = 1 / 2*pi*10*10^3*[1538.5 ||
      1/2*pi*5000*C]")
19 disp("          = 1 / 2*pi*10*10^3*[1 /
      1/1538.5+2*pi*5000*C]")
20 disp("Solving for C we get")
21 disp(" C = 0.02 uF")
22 disp("We have")
23 disp(" C = C'' + C_b''e + (1+g_m*R_L)*C_b''e")
24 disp("Therefore, C'' = C - [C_b''e + (1+g_m*R_L)*
      C_b''e]")
25 c=((0.02*10^-6) - [(1000*10^-12) + ((1+(0.04*510))
      *100*10^-12)])*10^6
26 format(8)
27 disp(c,"Therefore, C''(in uF) =")
28 disp("We have,")
29 disp("omega_0^2 = 1 / L*C")
30 l=(1/(((2*pi*500*10^3)^2)*(0.02*10^-6)))*10^6
31 format(2)
32 disp(l,"Therefore, L(in uH) = 1 / omega_0^2*C =")
33 disp("From equation 2 we have,")
34 rp=2*pi*500*5*100*10^-3
35 format(5)
36 disp(rp,"R_p(in ohm) = omega*L*Q_c =")
37 r=(4000*1570*2500)/((1570*2500)+(4000*2500))

```

```

    +(4000*1570))
38 format(4)
39 disp(r,"Therefore , R(in ohm) = r_i || R_p || r_b ' 'e
    =")
40 disp("We have mid frequency gain as")
41 av=-0.04*777
42 disp(av,"A_v(max) = -g_m*R =")

```

Scilab code Exa 5.3 bandwidth for four stages

```

1 //Example 5.3
2 clc
3 disp("(i) We know that ,")
4 bw=((20*10^3)*sqrt(((2)^(1/3))-1))*10^-3
5 format(7)
6 disp(bw,"BW_n(in kHz) = BW_1 * sqrt(2^1/n - 1) =")
7 bw1=((20*10^3)*sqrt(((2)^(1/4))-1))*10^-3
8 format(4)
9 disp(bw1,"(ii) BW_n(in kHz) = BW_1 * sqrt(2^1/n - 1)
    =")

```

Scilab code Exa 5.6 find frequency

```

1 //example5.6
2 clc
3 disp("a) We have ,")
4 disp("A_vmid=(-g_m*R)= -15")
5 r=15/(5*10^-3)
6 disp(r,"Therefore R(in ohms)=(-15)/(-5*10^-3)= ")
7 disp("b) The Miller effect capacitance is given by ")
8 disp("C_d(in F)=C_gs+(1+g_m*R)*(C_g*d)")
9 c=(10^-12)+((1+15)*(3*10^-12))

```

```

10 format(8)
11 disp(c," = (1*10^-12)+(1+15)*(3*10^-12)=")
12 disp("c) The limit frequency of the uncompensated
    amplifier is ")
13 f=1/(2*%pi*49*3*10^-9)
14 format(9)
15 disp(f," f2 (in Hz)=1/(2*pi*C_d*R)= ")
16 l=0.414*((3*10^3)^2)*(49*10^-12)
17 format(12)
18 disp(l," d) L(in H)=q*C_d*R^2= ")
19 disp("e) Possible extension of frequency range")
20 e=1.72*1.08*10^6
21 disp(e," f' '2(in Hz)=1.72*f2= ")

```

Scilab code Exa 5.8 resonant frequency and impedance and voltage gain

```

1 //Example 5.8
2 clc
3 disp("(i) Resonant frequency:")
4 fr=(1/(2*%pi*sqrt(20*500*10^-18)))*10^-6
5 format(5)
6 disp(fr," f_r(MHz) = 1 / 2*pi*sqrt(LC) =")
7 disp("(ii) We know that")
8 disp("Q_r = R_p / omega_r*L")
9 rp=30*2*%pi*1.59*20
10 format(5)
11 disp(rp," Therefore , Impedance of tuned circuit R_p
    = Q_r * omega_r * L =")
12 disp("(iii) Voltage gain of stage A_v,")
13 av=(-50*((5994*1500)/(5994+1500)))/200
14 format(4)
15 disp(av," A_v = A_I*R' ' _L / R' ' _i =")

```

Scilab code Exa 5.10 find BW

```
1 //example5.10
2 clc
3 disp(" i) f_r=Resonant frequency")
4 f=1/((2*%pi)*sqrt(0.0004*2500*10^-12))
5 format(9)
6 disp(f,"= 1/(2*pi*sqrt(L*C))= ")
7 disp(" ii) Tuned circuit dynamic resistance=R_p=L/CR"
      )
8 r=(80*10^6)/2500
9 disp(r,"= (400 microH)/(2500pF)*(5ohm)= ")
10 disp(" iii) Gain at resonance=A_v=(-g_m*R_L)=(-g_m*
      R_p)")
11 a=-6*32
12 disp(a," = 6mA/V * 32kohm = ")
13 disp(" iv) The signal bandwidth =BW=(f_r)/Q")
14 q=(2*%pi*0.159*400)/5
15 format(6)
16 disp(q,"Q=(omega_r*L)/R= ")
17 b=159000/79.92
18 format(7)
19 disp(b,"BW(in Hz)=(f_r)/Q= ")
```

Scilab code Exa 5.11 resonant frequency and omega

```
1 //Example 5.11
2 clc
3 disp("(i) R_L = r_d || R_p")
4 disp("R_p = Tank circuit impedance at resonance = L
      / CR")
5 disp("f_r = 1 / 2*pi*sqrt(L*C)")
6 c=(1/(4*%pi^2*200*1.59^2*10^6))*10^12
7 format(3)
8 disp(c,"Therefore , C(in pF) = 1 / 4*pi^2*f_r^2*L =")
```

```

    )
9  disp("Q = omega_r*L / R = 2*pi*f_r*L / R")
10 r=(2*pi*200*1.59)/50
11 disp(r,"Therefore , R(in ohm) = 2*pi*f_r*L / Q =")
12 rf=((200*10^-6)/(50*40*10^-12))*10^-3
13 format(4)
14 disp(rf,"R_F(in k-ohm) = L / C*R =")
15 rl=(500*100)/600
16 format(6)
17 disp(rl,"R_L(in k-ohm) = r_d*R_p / r_d+R_p =")
18 av=5*83.33
19 format(7)
20 disp(av,"A_v = -g_m*R_L =          at resonance
    frequency omega_r")
21 disp("(ii) At f = f_r+10 kHz = 1.6 MHz")
22 disp("|A_v / A_v(at resonance)| = 1 / sqrt(1+(f/f_r)
    ^2)")
23 ava=416.67/sqrt(1+((1.6/1.59)^2))
24 format(6)
25 disp(ava,"Therefore , |A_v| = |A_v(at resonance)| /
    sqrt(1+(f/f_r)^2) =")

```

Scilab code Exa 5.12 resonant frequency and tank circuit impedance

```

1 //Example 5.12
2 clc
3 fr=1/(2*pi*sqrt(100*1000*10^-18))
4 format(8)
5 disp(fr,"(i) Resonant frequency f_r(in kHz) = 1 / 2*
    pi*sqrt(L*C) =")
6 disp("(ii) Tank circuit impedance at resonance can
    be given as")
7 rp=((100*10^6)/5000)*10^-3
8 disp(rp,"R_P(in k-ohm) = L / C*R =")
9 av=(-5*10^-3)*((500*20*10^3)/(520))

```

```

10 format(6)
11 disp(av,"(iii)  $A_v = -g_m R_L = -g_m (r_d || R_P)$  =")
12 bw=(5/(2*pi*100*10^-6))*10^-3
13 disp("(iv)  $BW = f_r / Q$ ")
14 disp("       $BW = f_r R / \omega_r L$       Therefore ,  $Q =$ 
       $\omega_r L / R$ ")
15 disp(bw,"       $BW(\text{in kHz}) = R / 2\pi L$  =")

```

Scilab code Exa 5.13 tank circuit elements

```

1 //Example 5.13
2 clc
3 disp("BW = f_r / Q")
4 q=10700/200
5 format(5)
6 disp(q,"Therefore ,  $Q = f_r / BW$  =")
7 disp("Q =  $\omega_r L / R = 2\pi f_r L / R$ ")
8 lr=53.5/(2*pi*10.7*10^6)
9 format(9)
10 disp(lr,"Therefore ,  $L/R = Q / 2\pi f_r$  =")
11 disp("|A_v| =  $g_m R_L = 30$ ")
12 rl=(30/5)
13 disp(rl,"Therefore ,  $R_L(\text{in k-ohm}) = (r_d || R_p)$  =")
14 disp("Therefore ,  $R_p = 6383 \text{ ohm}$ ")
15 disp("We know that")
16 disp("R_p = L/C*R")
17 c=((795*10^-9)/6383)*10^12
18 format(6)
19 disp(c,"Therefore ,  $C(\text{in pF})$  =")
20 disp("We know that")
21 l=(1/(4*pi^2*((10.7*10^6)^2)*124.5*10^-12))*10^6
22 disp("f_r =  $1 / 2\pi \sqrt{LC}$ ")
23 format(6)
24 disp(l,"Therefore ,  $L(\text{in uH})$  =")

```

```
25 disp("We have")
26 disp("R_p = L / C*R")
27 r=(1.777*10^-6)/(6383*124.5*10^-12)
28 disp(r,"Therefore , R(in ohm) = L / C*R_p =")
29 disp("Therefore , elements of tank circuit are:")
30 disp("L = 1.777 uH, C = 124.5 pF and R = 2.236
      ohm")
```

Chapter 6

Power Amplifier Large Signal Amplifiers

Scilab code Exa 6.1 ICQ and VCEQ and PDC and Pac and efficiency

```
1 //Example 6.1
2 clc
3 ibq=(20-0.7)/1.5
4 format(6)
5 disp(ibq,"(i) I_BQ(in mA) = V_CC-V_BE / R_B =")
6 icq=50*12.87
7 format(7)
8 disp(icq,"I_CQ(in mA) = beta * I_BQ =")
9 disp("(ii) V_CC = I_CQ*R_L + V_CEQ")
10 vceq=20-(643.5*16*10^-3)
11 format(5)
12 disp(vceq,"Therefore, V_CEQ(in V) = V_CC - I_CQ*R_L
    =")
13 format(6)
14 pdc=20*643.5*10^-3
15 disp(pdc,"(iii) P_DC(in W) = V_CC * I_CQ =")
16 disp("(iv) P_ac Peak current i_b = 9 mA")
17 ic=50*9
18 format(4)
```

```

19 disp(ic,"i_c(in mA) = beta * i_b =")
20 icm=450/sqrt(2)
21 format(8)
22 disp(icm,"Therefore , i_c(rms) = I_rms(in mA) = i_c(
    peak) / sqrt(2) =")
23 pac=318.19^2*16*10^-6
24 format(7)
25 disp(pac,"Therefore , P_ac(in W) = (I_rms)^2 * R_L =
    ")
26 n=(1.619*100)/12.87
27 disp(n,"(v) Efficiency eta(in percentage) = P_ac/
    P_DC * 100 =")

```

Scilab code Exa 6.2 reflected load impedance

```

1 //Example 6.2
2 clc
3 disp("R_L = 4 ohm, N1 = 200, N2 = 20")
4 n=20/200
5 format(4)
6 disp(n,"Therefore , n = N2 / N1 =")
7 r1=4/(0.1^2)
8 disp(r1,"Therefore , R''_L(in ohm) = R1 / n^2 =")
9 disp("As N2 < N1, the transformer is step down and
    hence R''_L > R_L, as the primary winding is high
    voltage winding.")

```

Scilab code Exa 6.3 turns ratio

```

1 //Example 6.3
2 clc
3 disp("R_L = 8 ohm, R''_L = 648 ohm")
4 disp("Now R''_L = R_L / n^2")

```

```

5 n=8/648
6 format(8)
7 disp(n,"Therefore , n^2 = R_L / R' _L =")
8 disp("Therefore , n = 0.1111 = Turn ratio")
9 disp("But , n = N2 / N1 = 0.1111")
10 disp("Therefore , N1/N2 = 9")
11 disp("Generally the turns ratio is specified as Ni/
      N2 : 1 i.e. for this transformer it is 9:1")

```

Scilab code Exa 6.4 find power dissipation

```

1 //example6.4
2 clc
3 disp("R_L=8ohm, I_CQ=140 mA, V_CC=10V")
4 disp("P_ac= 0.48 W")
5 disp("The turns ratio are specified as N1/N2:1 i.e
      3:1")
6 disp("Therefore N1/N2=3")
7 n=1/3
8 disp(n,"n=N2/N1=1/3=")
9 r=8/(0.333)^2
10 disp(r,"Therefore R' _L=R_L/n^2=")
11 disp("1. As the transformer is ideal , whatever is
      the power delivered to the load,same is the power
      developed across primary.")
12 disp("Therefore P_ac(across primary)=0.48W")
13 disp("2. Using equation (9),")
14 disp("we get , P_ac=(V_1rms^2)/(R' _L)")
15 disp("Therefore 0.48=(V_1rms^2)/72")
16 v=sqrt(34.56)
17 disp(v,"Therefore V_1rms(in V)=")
18 disp("But rms value of the load voltage is V_2rms")
19 disp("So (V1_rms)/(V2_rms)=N1/N2=3/1")
20 v=5.8787/3
21 disp(v,"Therefore (V2_rms)(in V)=(V1_rms)/3=")

```

```

22 disp("This is the rms value of the load voltage.")
23 disp("3. The rms value of the primary voltage is (
    V1_rms) as calculated above.")
24 disp("Therefore (V1_rms)=5.8787 V")
25 disp("4. The power delivered to the load = (I_2rms
    ^2)*R_L .. Refer equation 13.")
26 disp("0.48=(I_2rms^2)*8")
27 i=sqrt(0.06)
28 disp(i,"(I_2rms)[in A]=")
29 disp("This is the rms value of the load current as
    the resistance value used is R_L and not R'_'_L")
30 disp("5. The rms values of primary and secondary are
    related through the transformation ratio.")
31 disp("Therefore (I_1rms)/(I_2rms)=N2/N1=n=0.333")
32 i=0.2449*0.333
33 disp(i,"Therefore (I_1rms)[in A]=0.2449*0.333= ")
34 disp("6. The dc power input is,")
35 p=140*10^-2
36 disp(p,"P_DC(in W)=(V_CC)*(I_CQ)=")
37 n=(0.48*100)/1.4
38 disp(n,"7. %eta=(P_ac *100)/(P_dc)=")
39 d=1.4-0.48
40 disp(d,"P_d(in W)=")
41 disp("This is the power dissipation.")

```

Scilab code Exa 6.6 second harmonic distortion

```

1 //Example 6.6
2 clc
3 disp("R_L = 4 k-ohm, (P_ac)_D = 0.85 W")
4 disp("The current without signal is I_CQ = 31 mA")
5 disp("The current with signal is I_CQ + B0 = 34 mA")
6 disp("The increase is due to harmonic content in the
    signal")
7 disp("Therefore, B0 = 34 - 31 = 3 mA")

```

```

8 disp("But, B2 = B0 = 3 mA")
9 disp("Now (P_ac)_D = P_ac * [1+D2^2] ...
    Assuming only second harmonic")
10 disp("Therefore, (P_ac)_D = 1/2*B1^2*R_L * [1 + B2
    ^2/B1^2]")
11 disp("Therefore, (P_ac)_D = 1/2*B1^2*R_L + 1/2*B2
    ^2*R_L")
12 disp("0.85 = 1/2*B1^2*(4*10^3) + 1/2*(9*10^-6)
    *(4*10^3)")
13 disp("Therefore, B1 = 20.396 mA")
14 d2=300/20.396
15 format(7)
16 disp(d2,"Therefore, D2(in percentage) = |B2|/|B1| *
    100 =")

```

Scilab code Exa 6.7 class B amplifier

```

1 //Example 6.7
2 clc
3 disp("The maximum power dissipation occurs when the
    value of V_m is")
4 disp("V_m = 2/pi * V_CC")
5 disp("Now P_ac = V_m*I_m / 2")
6 disp("So at the time of maximum power dissipation ,
    it is")
7 disp("P_ac = 2/pi * V_CC*I_m/2 = V_CC*I_m / pi")
8 disp("Now P_DC = 2/pi * V_CC * I_m")
9 disp("Hence, %eta = P_ac/P_DC * 100 = (V_CC*I_m/pi)
    /(2*V_CC*I_m/pi)*100 = 50%")
10 disp("Thus efficiency is just 50% when the power
    dissipation is maximum. While the maximum
    efficiency of the class B operation is 78.5%")

```

Scilab code Exa 6.8 max power output and max power dissipation and max base and co

```

1 //Example 6.8
2 clc
3 disp("R_L = 12 ohm, n = N2/N1 = 1/3 = 0.333 ,
      eta_trans = 78.5%")
4 r1=12/(0.333^2)
5 format(4)
6 disp(r1,"Therefore , R' _L = R_L / n^2 =")
7 pac=(0.5*20^2)/108
8 format(7)
9 disp("(i) For P_max, V_m = V_CC")
10 disp(pac,"Therefore , (P_ac)_max(in W) = 1/2 * V_CC
      ^2/R' _L =")
11 disp("But eta_trans = 78.5%")
12 p1=0.785*1.8518
13 disp(p1,"Therefore , P_L(in W) = eta_trans * (P_ac)
      _max =")
14 vm=(2*20)/%pi
15 format(8)
16 disp(vm,"(ii) Condition for (P_d)_max is V_m(in V) =
      2*V_CC/pi =")
17 pd=(2*20^2)/(108*%pi^2)
18 format(7)
19 disp(pd,"Therefore , (P_d)_max(in W) = 2*V_CC^2 / pi
      ^2*R' _L =")
20 pdm=0.7505/2
21 disp(pdm,"Therefore , (P_d)_max(in W) per transistor
      =")
22 disp("(iii) (P_ac)_max = V_rms * I_rms = V_m/sqrt(2)
      * I_m/sqrt(2) = V_m*I_m / 2 and V_m = V_CC")
23 disp("Therefore , 1.8518 = 20*I_m / 2")
24 im=(2*1.8518)/20
25 disp(im,"Therefore , I_m(in A) = (I_c)_max =")
26 ibm=(0.1851/25)*10^3
27 disp(ibm,"and (i_b)_max(in mA) = (i_c))max / h_fe =
      ")

```

Scilab code Exa 6.9 find power developed

```
1 //example6.9
2 clc
3 disp("R_L=16 ohm, V_CC=25 V")
4 disp("Now 2N1=200, N2=50")
5 n=200/2
6 disp(n," Therefore N1=")
7 n=50/100
8 disp(n," Therefore n=N2/N1=")
9 r=16/(0.5^2)
10 disp(r," Therefore R' ' _L =(R_L)/(n^2)=")
11 disp(" For maximum power output, V_m=V_CC")
12 p=(25^2)/(2*64)
13 disp(p," i) (P_ac)_max [in W]=(V_CC^2)/(2*R_L)=")
14 disp(" ii) (P_dc)=(2*V_CC*I_m)/pi")
15 disp(" Now (V_m)/(I_m)=(R' ' _L)")
16 disp(" and V_m=V_CC")
17 i=25/64
18 disp(i," Therefore (I_m)=(V_CC)/(R' ' _L)=")
19 p=(2*25*0.3906)/(%pi)
20 disp(p," Therefore (P_DC) [in W]=")
21 n=(4.8848*100)/6.2169
22 disp(n," iii) %eta=(P_ac*100)/(P_DC)=")
23 p=(2*4.8828)/(%pi^2)
24 disp(p," iv) (P_d)_max [in W]=(2*(P_ac)_max)/(pi^2)=")
```

Scilab code Exa 6.12 Pac and PD and efficiency

```
1 //Example 6.12
2 clc
```

```

3 disp("R_L = 8 ohm, V_CC = +-12 V hence dual supply
      version")
4 pac=0.5*(12^2/8)
5 format(2)
6 disp(pac,"(1) (P_ac)_max(in W) = 1/2 * V_CC^2/R_L =
      ")
7 disp("(2) P_DC = V_CC*I_DC but I_DC = 2*I_m / pi")
8 disp("      = V_CC * (2*I_m/pi)")
9 disp("Now R_L = V_m/I_m i.e. I_m = V_m/R_L and V_m
      = V_CC")
10 pdc=(12^2*2)/(8*pi)
11 format(8)
12 disp(pdc,"Therefore, P_DC(in W) = V_CC * 2 * V_CC/
      R_L * 1/pi =")
13 pdt=11.4591-9
14 disp(pdt,"Therefore, Total P_D(in W) = P_DC - P_ac
      =")
15 pd=2.4591/2
16 format(7)
17 disp(pd,"Therefore, P_D per transistor(in W) =")
18 n=900/11.4591
19 format(5)
20 disp(n,"(3) %eta(in percentage) = P_ac/P_DC * 100 =
      ")

```

Scilab code Exa 6.13 find dc power developed

```

1 //example6.13
2 clc
3 disp("V_CC=10V ,R_L=5 ohm")
4 p=100/10
5 disp(p,"i) (P_ac)_max[in W]= (V_CC^2)/(2*R_L)=(10^2)
      /(2*5)=")
6 disp("ii) To decide Power rating of transistors
      means to find (P_D)_max")

```



```

7 v=(2*10)/(%pi)
8 disp(v,"V_m(in V)=")
9 disp("Now, R_L=(V_m)/(I_m)")
10 i=6.3662/5
11 disp(i,"Therefore (I_m)[in A]=")
12 disp("Therefore (P_DC)=(V_CC)*(I_DC)=(V_CC)*(2*I_m)/
      pi (I_DC)=(2*I_m)/pi")
13 p=(10*2*1.2732)/(%pi)
14 disp(p,"=(10*2*1.2732)/(pi) =")
15 p=(6.3662*1.2732)/2
16 disp(p,"and (P_ac)[in W]=(V_m*I_m)/2=")
17 p=8.1056-4.5027
18 disp(p,"(P_D)_max[in W]=(P_DC)-(P_ac)=")
19 p=4.0528/2
20 disp(p,"Therefore P_D rating for a each transistor =(
      P_D)_max/2=")
21 disp("iii) For (P_ac)_max, V_m=V_CC=10 V")
22 i=10/5
23 disp(i,"I_m(in A)=(V_m)/R_L=")
24 p=(10*2*2)/%pi
25 disp(p,"P_DC(in W)=")

```

Scilab code Exa 6.15 power dissipated

```

1 //Example 6.15
2 clc
3 disp("V_CC = 20 V, R_L = 4 ohm")
4 vm=(2*20)/%pi
5 format(8)
6 disp(vm,"For (P_d)max, V_m(in V) = 2/pi * V_CC = ")
7 disp("R_L = V_m / I_m")
8 im=12.7324/4
9 format(6)
10 disp(im,"Therefore, I_m(in A) = V_m / R_L =")
11 idc=(2*3.183)/%pi

```

```

12 format(7)
13 disp(idc," Therefore ,  $I_{dc}(\text{in A}) = 2*I_m / \pi =$ ")
14 pac=(0.5*12.7324^2)/4
15 format(8)
16 disp(pac," Therefore ,  $P_{ac}(\text{in W}) = 1/2 * V_m^2/R_L =$ 
    ")
17 pdc=20*2.0254
18 format(7)
19 disp(pdc," and  $P_{dc}(\text{in W}) = V_{CC} * I_{DC} =$ ")
20 pdm=40.508-20.2542
21 format(8)
22 disp(pdm," Therefore , Total  $(P_d)_{\text{max}}(\text{in W}) = P_{dc} -$ 
     $P_{ac} =$ ")
23 pdma=20.2538/2
24 disp(pdma," Therefore ,  $(P_d)_{\text{max}}(\text{in W})$  per transistor
    =")

```

Scilab code Exa 6.16 find turns ratio

```

1 //example6.16
2 clc
3 disp("For a given transistor,")
4 disp("Maximum collector current = $I_{cm} = 1\text{A}$ ")
5 disp("Maximum power dissipation = $P_d = 10\text{W}$ ")
6 disp("Maximum  $V_{CEO} = 40\text{V}$ ")
7 disp("For maximum output power,")
8 disp("  $I_{cm} = 2*I_{CQ}$ ")
9 i=1/2
10 disp(i,"  $I_{CQ} = 1/2 =$ ")
11 disp(" and  $V_{CEO} = 2*V_{CC}$ ")
12 v=40/2
13 disp(v,"  $V_{CC}(\text{in V}) = V_{CEO}/2 =$ ")
14 disp(" and  $V_{cc} = V_m = 20\text{V}$  for  $(P_{ac})_{\text{max}}$ ")
15 disp("  $(P_{ac})_{\text{max}} = (V_{cc}^2)/(2*R_L)$ ")
16 disp("  $R'_{L} = (V_m)/I_m$  and  $I_m = I_{CQ} = 0.5 \text{ A}$ ")

```

```

17 r=20/0.5
18 disp(r,"R' ' _L(in ohm)=")
19 p=(20^2)/80
20 disp(p,"(P_ac)_max(in W)=(20^2)/(2*40)=")
21 disp("Now, R' ' _L=R_L/n^2")
22 n=sqrt(0.0625)
23 disp(n,"n=N2/N1=")
24 n=1/0.25
25 disp(n,"Therefore N1/N2=1/n=")
26 disp("Hence the turns ratio of output transformer is
      4:1")

```

Scilab code Exa 6.19 find efficiency

```

1 //example6.19
2 clc
3 disp("Using equation (2) from section 6.7, we can
      determine I_BQ.")
4 i=(18-0.7)/(1.2*10^3)
5 format(10)
6 disp(i,"I_BQ(in A)=")
7 i=40*14.4167
8 format(7)
9 disp(i,"Now (I_CQ)[in mA]=(beta*I_BQ)=")
10 v=18-(576.67*16*10^-3)
11 disp(v,"And (V_CEQ)[in V]=(V_CC)-(I_CQ*R_L)=")
12 p=18*576.67
13 disp(p,"So P_dc(in W)=(V_CC)*(I_CQ)=")
14 disp("This is the input power.")
15 disp("Now input a.c. voltage causes a base current
      of 5mA rms")
16 disp("Therefore (I_b)_rms=5 mA")
17 i=40*5
18 disp(i,"Therefore i_c_rms(in mA)=40*5=")
19 disp("This is nothing but the output collector

```

```

    current ,rms value I_rms")
20 disp(" Therefore I_rms = 200mA")
21 disp(" Using equation (13) from section 6.8, we can
    write ,")
22 p=16*(200*10^-3)^2
23 disp(p," P_ac(in W)=(I_rms ^2)^R.L=")
24 disp(" This is the power delivered to the load.")
25 disp(" Hence the efficiency of the amplifier is ,")
26 n=(64000*10^-3)/10.38
27 disp(n," %eta=(P_ac*100)/P_dc= ")

```

Scilab code Exa 6.20 base current and power delivered and efficiency

```

1 //Example 6.20
2 clc
3 disp("V_CC = 20 V, R_L = 20 ohm, turns ratio 1.58:1
    ")
4 n=1/1.58
5 format(7)
6 disp(n," n = 1/1.58 = ")
7 r1=20/0.6329^2
8 disp(r1," Therefore , R' _L(in ohm) = R_L / n^2 =")
9 disp("(i) For maximum possible peak to peak output
    voltage, the power output is also maximum
    possible. For this condition the slope of the a.c
    . load line can be expressed as")
10 disp("R' _L = V_m/I_m = V_CC/I_CQ")
11 icq=20/49.928
12 format(4)
13 disp(icq," Therefore , I_CQ(in A) =")
14 ibq=0.4/40
15 format(5)
16 disp(ibq," Therefore , I_BQ(in A) = I_CQ/beta =")
17 disp("This is the required value of the base current
    ")

```

```

18 disp("(ii) P_ac = I_Irms^2 * R' 'L")
19 disp("But for maximum power output condition,")
20 irms=0.4/sqrt(2)
21 format(8)
22 disp(irms,"I_Irms(in A) = I_Im/sqrt(2) = I_CQ/sqrt
      (2) =")
23 pac=49.928*0.2828^2
24 format(2)
25 disp(pac,"Therefore , P_ac(in W) =")
26 disp("(iii) %eta = P_ac/P_DC * 100")
27 pdc=20*0.4
28 disp(pdc,"Now P_DC(in W) = V_CC * I_CQ =")
29 eta=400/8
30 format(3)
31 disp(eta,"%eta(in percentage) =")

```

Scilab code Exa 6.21 value of Vcc

```

1 //Example 6.21
2 clc
3 disp("R_L = 8 ohm, P_ac(max) = 40 W")
4 disp("2*N1 = 160, N2 = 40")
5 disp("N1 = 80")
6 n=40/80
7 format(4)
8 disp(n,"n = N2/N1 =")
9 r1=8/0.5^2
10 disp(r1,"Therefore , R' 'L(in ohm) = R_L / n^2 =")
11 disp("Under maximum condition , V_CC = V_m")
12 disp("Therefore , P_ac(max) = 1/2 * V_CC^2/R' 'L")
13 vcc=sqrt(40*2*32)
14 format(6)
15 disp(vcc,"Therefore , V_CC(in V) =")
16 disp("This is the required value of V_CC")

```

Scilab code Exa 6.22 input and output power and efficiency

```
1 //Example 6.22
2 clc
3 disp("For a common collector configuration the
      voltage gain is 1")
4 disp("Therefore ,  $V_{in}(\text{peak}) = V_{out}(\text{peak}) = 20 \text{ V}$ ")
5 disp("i.e.  $V_m = 20 \text{ V}$ ")
6 disp("Now  $V_m/I_m = R_L$ ")
7 im=20/16
8 format(5)
9 disp(im,"Therefore ,  $I_m(\text{in A}) = V_m/R_L =$ ")
10 disp("while  $V_{CC} = 25 \text{ V}$ ")
11 pdc=(2*25*1.25)/%pi
12 format(8)
13 disp(pdc,"Now  $P_{DC}(\text{in W}) = 2*V_{CC}*I_m / \text{pi} =$ ")
14 pac=(20*1.25)/2
15 format(5)
16 disp(pac," $P_{ac}(\text{in W}) = V_m*I_m / 2 =$ ")
17 eta=1250/19.8943
18 format(7)
19 disp(eta,"Therefore ,  $\%eta(\text{in percentage}) = P_{ac}*100$ 
      /  $P_{DC} =$ ")
```

Scilab code Exa 6.26 total harmonic distortion

```
1 //Example 6.26
2 clc
3 disp("(i) As single transistor is used, even
      harmonic components will not get eliminated")
4 d2=1000/120
5 d3=400/120
```

```

6 d4=200/120
7 d5=100/120
8 format(5)
9 disp(d2," D2(in percentage) = |B2| / |B1| =")
10 disp(d3," D3(in percentage) = |B3| / |B1| =")
11 format(6)
12 disp(d4," D4(in percentage) = |B4| / |B1| =")
13 disp(d5," D5(in percentage) = |B5| / |B1| =")
14 disp("The total harmonic distortion is,")
15 disp("%D = sqrt(D2^2 + D3^2 + D4^2 + D5^2) * 100")
16 d=sqrt((0.0833^2)+(0.0333^2)+(0.01667^2)+(0.00833^2)
        )*100
17 format(7)
18 disp(d,"Therefore, %D(in percentage) =")
19 disp("(ii) When identical second transistor is used,
        then all even harmonics get eliminated. So only
        D3 and D5 will present")
20 dp=sqrt((0.033^2)+(0.00833^2))*100
21 disp(dp,"Therefore, %D(in percentage) = sqrt(D3^2 +
        D5^2)*100 =")

```

Scilab code Exa 6.27 find min breakdown voltage

```

1 //example6.27
2 clc
3 disp("From the fig 6.50 we can write,")
4 disp("VCC=20V and RL=12 ohm")
5 disp("i) The maximum ac power that can be delivered
        to the load is,")
6 p=(20^2)/24
7 disp(p,"(Pac)max[in W]= ")
8 disp("Let new power delivered to load be (Pac)''.")
9 disp("The corresponding new supply voltage be (V'
        _cc)")
10 disp("(Pac)''[in W]=1.36(Pac)max ..36% more")

```

```

11 p=1.36*16.67
12 disp(p,"= 1.36*16.67=")
13 disp("And (P_ac) '=(V' '_cc ^2)/R_L")
14 disp("Therefore 22.67=(V' '_cc ^2)/(2*12)")
15 v=sqrt(544.1088)
16 disp(v,"V' '_cc (in V)=")
17 disp("Hence the percentage increase in supply
      voltage is,")
18 p=(23.326-20)/0.2
19 disp(p,"= ((V' '_cc-V_cc)*100)/V_cc=")
20 disp("The minimum breakdown voltage per transistor
      this condition is,")
21 v=2*23.326
22 disp(v,"=2*V' '_cc=2*23.326=")

```

Scilab code Exa 6.30 find efficiency

```

1 //example6.30
2 disp("The circuit used for providing proper biasing
      is self bias, for which the various currents can
      be shown in the fig 6.52")
3 disp("Applying KVL to base emitter loop,")
4 disp("(-V_BE)-(I_E*R_E)+(I*R2)=0")
5 disp("Therefore (I*100)-(1+beta)*I_B*10=V_BE")
6 disp("100I-210(I_B)=0.5      ..(1)")
7 disp("Applying KVL through R1 and R2,")
8 disp("(-R1(I+I_B))-(R2*I)+V_cc=0")
9 disp("-1000(I+I_B)-100I=-V_cc")
10 disp("1100I+1000(I_B)=25      ..(2)")
11 disp("Multiplying equation (1) by 11 and subtracting
      from equation (2) we get,")
12 disp("3310(I_B)=19.5")
13 i=19.5/3310
14 disp(i,"Therefore I_B (in A)=")
15 format(8)

```



```

16 disp(" Therefore I_C=(beta*I_B)=117.82 mA=I_CQ")
17 disp(" Now n=N2/N1=1/8")
18 r=5*(8^2)
19 disp(" Therefore (R' _L)=(R_L)/(n^2)=")
20 disp(" i) For maximum power delivered to load,")
21 disp(" V_1m=V_CEQ")
22 disp(" Apply KVL to collector-emitter loop,")
23 disp(" (-10I_C)-(V_CEQ)-(10*I_E)+V_CC=0")
24 v=25-(20*(117.82*10^-3))
25 format(7)
26 disp(v," V_CEQ=V_cc-20*I_C      ... I_C=I_E")
27 p=(22.643^2)/640
28 disp(p," (P_ac)_pri [in W]=(V_CEQ^2)/(2*R' _L)=")
29 p=0.9*0.8011
30 disp(p," (P_ac)_max [in W]=0.9*0.8011=")
31 disp(" This is maximum power delivered to the load.")
32 p=25*117.82*10^-3
33 format(7)
34 disp(" ii) Now (P_DC) [in W]=V_CC*I_CQ=")
35 n=(0.721*100)/2.9455
36 format(6)
37 disp(n," %eta=(P_ac*100)/(P_dc)=")

```

Scilab code Exa 6.32 find R

```

1 //example6.32
2 clc
3 disp("When no signal is applied, current drawn is")
4 disp("I_CQ =200mA from V_cc= 10V")
5 p=10*200*10^-3
6 disp("P_DC(in W)=V_CC*I_CQ=")
7 disp(" For maximum power output,")
8 disp(" V_1m=V_cc=10V and I_1m=I_CQ=200mA")
9 p=2/2
10 disp(p," P_ac (in W)=(V_1rms*I_1rms)=(V_1m*I_1m)

```

```

/2=(10*200*10^-3)/2=")
11 disp(" i) P_ac(max)=Maximum output power =1W")
12 n=100/2
13 disp(n," ii) %eta=(P_ac*100)/(P_DC)=")
14 disp(" P_d(max)=V_cc*I_CQ= 2W")
15 disp("The power dissipation rating of the transistor
      must be higher than 2W")
16 r=10/(200*10^-3)
17 disp(r,"Now R' '_L(in ohm)=(V_1m)/(I_1m)=")
18 n=1/5
19 disp(n,"Now R.L=2 ohm and n =N2/N1=1/5=")
20 r=2/(0.2^2)
21 disp(r,"R' '_L(in ohm)=(R.L)/n^2=")
22 disp("As R' '_L required matches with the R' '_L of
      the circuit , impedance matching is perfect")

```

Scilab code Exa 6.33 distortion factor

```

1 //Example 6.33
2 clc
3 disp("B1 = 5*10^-2, B2 = 10^-4, B3 = 3*10^-6")
4 disp("These are the amplitudes of various frequency
      components")
5 d2=10^-4/(50*10^-2)
6 d3=(3*10^-6)/(50*10^-2)
7 d=sqrt((2*10^-4)^2+(6*10^-6)^2)*100
8 format(7)
9 disp(d2," Therefore , D2 = |B2|/|B1| =")
10 disp(d3," Therefore , D2 = |B3|/|B1| =")
11 format(5)
12 disp(d," Therefore , %D(in percentage) = sqrt(D2^2 +
      D3^2)*100 =")

```

Scilab code Exa 6.34 power transfer

```
1 //Example 6.34
2 clc
3 disp("VCC = 12 V, IPP = 100 mA, RL = 5 ohm")
4 disp("Therefore, Im = IPP/2 = 50 mA")
5 pac=((2500*10-6)*5)/2
6 format(8)
7 disp(pac,"(i) Pac(in W) = Im2*RL / 2 =")
8 disp("(ii) Pac(max) = 1/2 * VCC2/RL")
9 disp("But Pac = Vm*Im/2 and Vm = VCC for
    maximum power")
10 r1=122/0.6
11 format(4)
12 disp(r1,"Therefore, R'L(in ohm) = ")
13 disp("But R'L = RL/n2 i.e. 240 = 5/n2")
14 disp("Therefore, n2 = 0.02083 i.e. n = 0.1443 =
    N2/N1")
15 disp("Therefore, N1/N2 = 6.928 : 1")
```

Scilab code Exa 6.35 output and input power and collector efficiency and power dis

```
1 //Example 6.35
2 clc
3 disp("ICQ = 250 mA, VCEQ = 8 V")
4 disp("Vmax = 15 V, Vmin = 1 V, Imax = 450 mA,
    Imin = 40 mA")
5 ipp=450-40
6 disp(ipp,"Therefore, Ipp(in mA) = Imax - Imin =")
7 vpp=15-1
8 disp(vpp,"Therefore, Vpp(in V) = Vmax - Vmin =")
9 vm=14/2
10 disp(vm,"Therefore, Vm(in V) = Vpp/2 =")
11 im=410/2
```

```

12 disp(im," Therefore ,  I_m(in mA) = I_pp/2 =")
13 pac=(7*205*10^-3)/2
14 pdc=250*8*10^-3
15 n=71.75/2
16 pd=2-0.7175
17 format(7)
18 disp(pac," (i)  P_ac(in W) = V_m*I_m/2 =
                ... output power")
19 disp(pdc," (ii) P_DC(in W) = I_CQ*V_CEQ =
                ... input power")
20 disp(n," (iii) %eta(in %) = P_ac/P_DC * 100 =
                ... efficiency")
21 disp(pd," (iv)  P_d(in W) = P_DC - P_ac =
                ... power dissipation")

```
