

Scilab Textbook Companion for  
Modern Communication Circuits  
by J. R. Smith<sup>1</sup>

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# Book Description

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

**Exa** Example (Solved example)

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

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

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

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# Chapter 1

## Introduction to Radio Communication System

Scilab code Exa 1.3 IRCS Ex 1 3

```
1 clc
2 //Chapter 1:Introduction to Radio Communication
3 //example 1.3 page no 3
4 //given
5 disp('The transfer function has no finite zeros ')
6 p=poly([1 0.5 1], "s", "c")
7 x=roots(p)
8 disp('The poles ')
9 disp(x)
```

---

Scilab code Exa 1.4 IRCS Ex 1 4

```
1 clc
2 //Chapter 1:Introduction to Radio Communication
  Systems
```

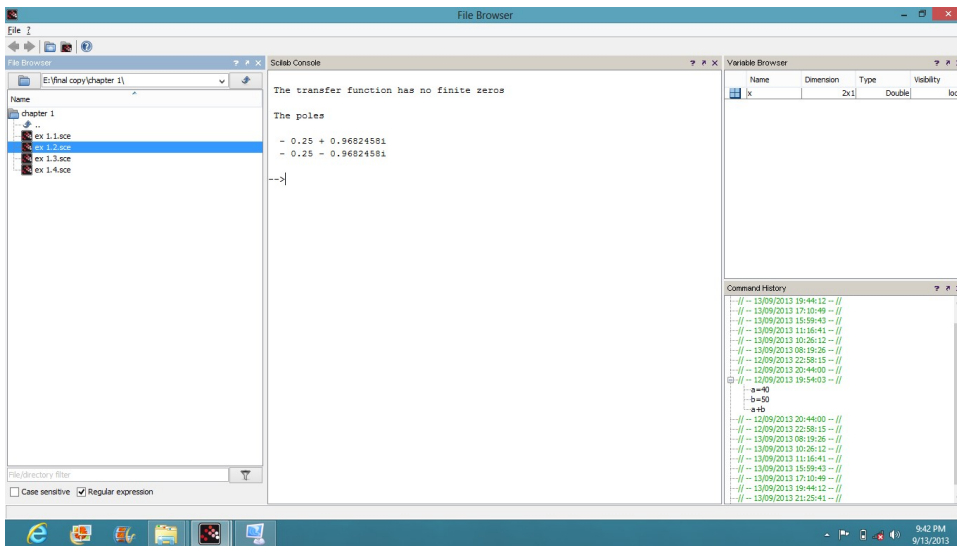


Figure 1.1: IRCS Ex 1 3

```

3 //example 1.4 page no 8
4 //given
5 fIF=455*10^3//intermediate frequency
6 f0=1.455*10^6//oscillator frequency
7 fIM=fIF+f0//image frequency
8 mprintf('the image frequency is %f MHz',fIM*1e-6)

```

---

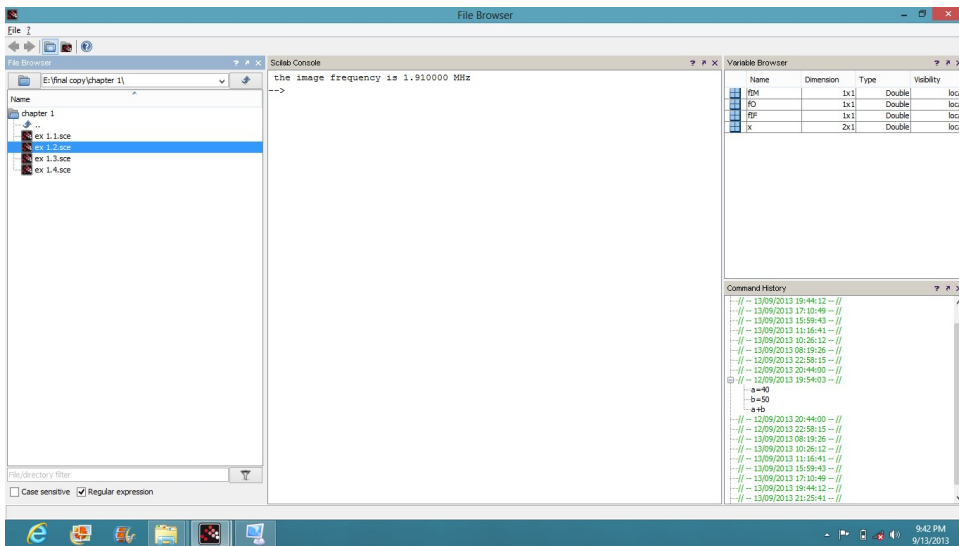


Figure 1.2: IRCS Ex 1 4

# Chapter 2

## Small Signal Amplifiers

Scilab code Exa 2.1 SSA Ex 2 1

```
1 clc
2 //Chapter 2:Small Signal Amplifiers
3 //example 2.1 page no 17
4 //given
5 B=100//current gain
6 Ic=10^-3//collector bias current
7 //kT/q=0.026 where as k=Boltzmanns constant T=
  temperature q=charge on an electron
8 rpi=(0.026*B)/Ic//base emitter resistance
9 mprintf('the base emitter resistance is %d ohm',rpi)
```

---

Scilab code Exa 2.2 SSA Ex 2 2

```
1 clc
2 //Chapter 2:Small Signal Amplifiers
```

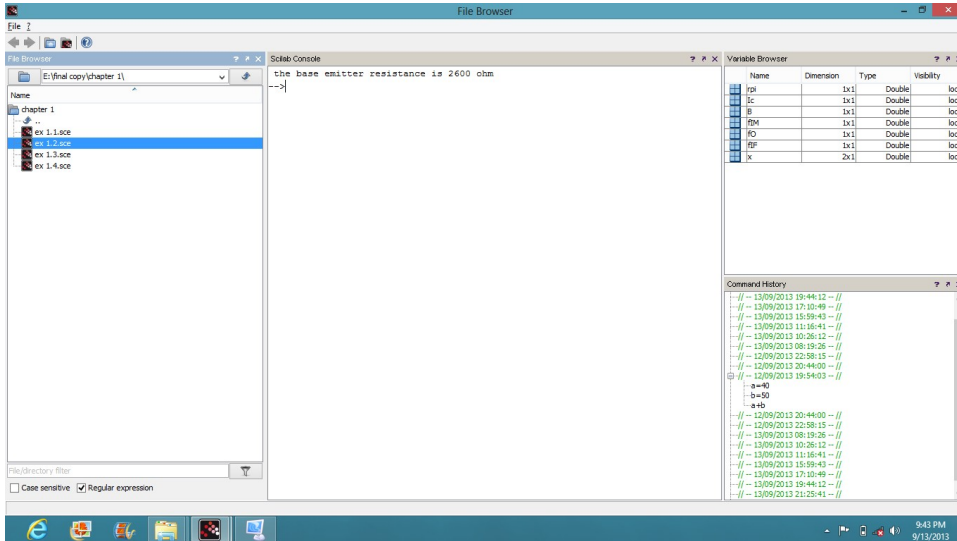


Figure 2.1: SSA Ex 2 1

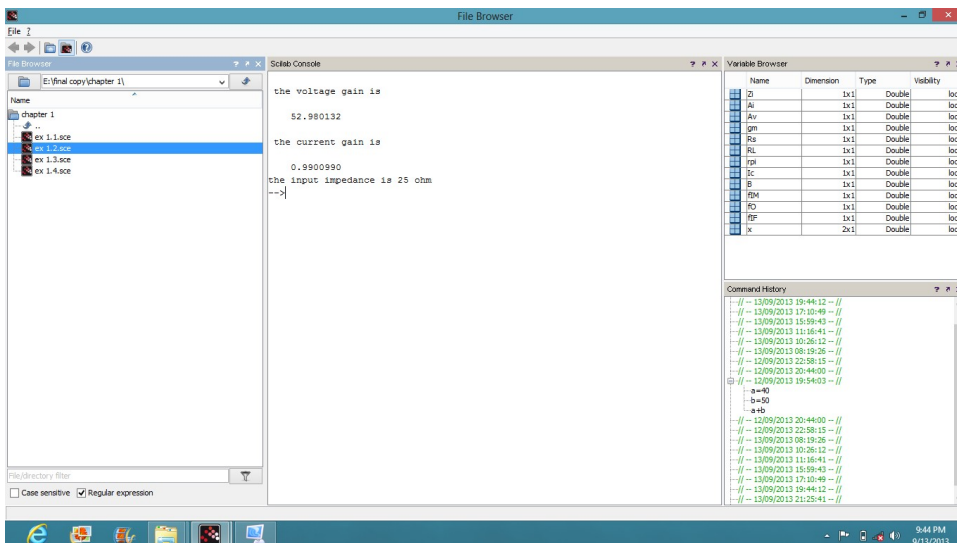


Figure 2.2: SSA Ex 2 2

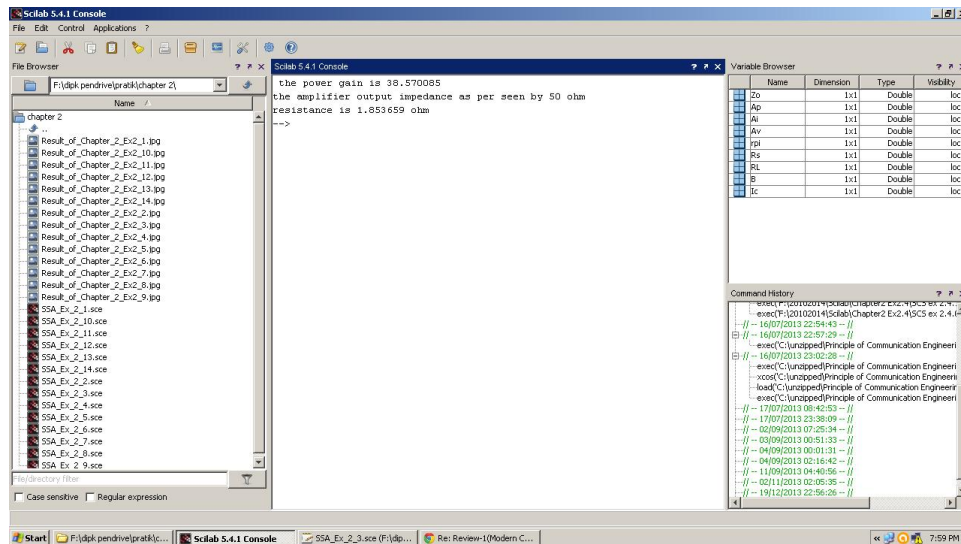


Figure 2.3: SSA Ex 2 3

```

3 //example 2.2 page no 22
4 //given
5 Ic=10^-3//collector bias current
6 B=100//current gain
7 RL=4*10^3//load resistance
8 Rs=50//source resistance
9 gm=40*Ic//transconductance
10 rpi=B/gm//base emitter resistance
11 Av=(B*RL)/(rpi+Rs*(1+B))//voltage gain
12 disp(Av,'the voltage gain is ')
13 Ai=B/(1+B)//current gain
14 disp(Ai,'the current gain is ')
15 Zi=1/gm//input impedance
16 mprintf('the input impedance is %d ohm',Zi)

```

Scilab code Exa 2.3 SSA Ex 2 3



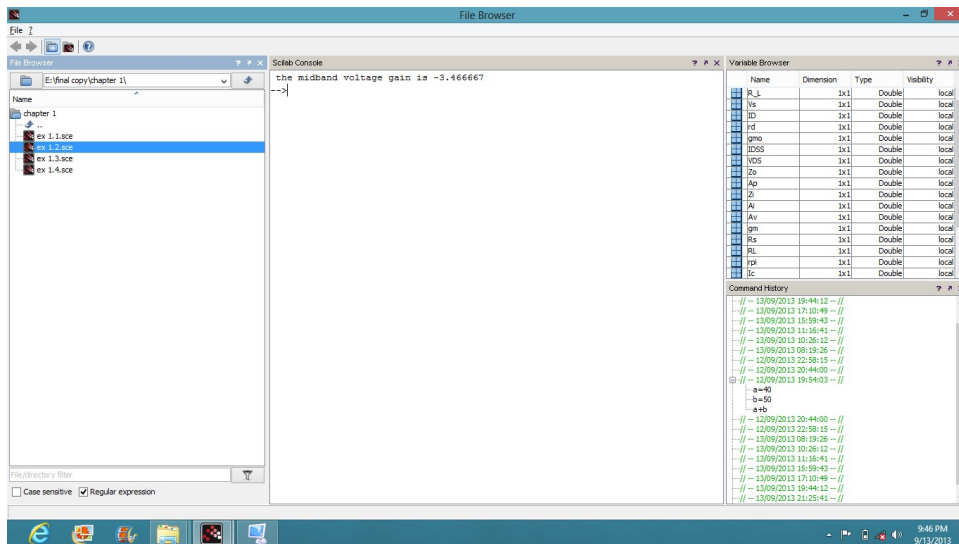


Figure 2.4: SSA Ex 2 4

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.3 page no 25
4  //given
5  Ic=40*10^-3//collector bias current
6  B=40//current gain
7  RL=50//load resistance
8  Rs=50//source resistance
9  rpi=(0.026*B)/Ic//base emitter resistance
10 Av=(B*RL)/(rpi+Rs+(1+B)*RL)//voltage gain
11 Ai=(1+B)//current gain
12 Ap=Ai*Av//power gain
13 mprintf('the power gain is %f \n',Ap)
14 Zo=(rpi+Rs)/(1+B)//output impedance
15 mprintf('the amplifier output impedance as per seen
    by 50 ohm \nresistance is %f ohm',Zo)

```

---

#### Scilab code Exa 2.4 SSA Ex 2 4

```
1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.4 page no 30
4  //given
5  VDS=15
6  IDSS=8*10^-3
7  gmo=4*10^-3
8  rd=13*10^3
9  ID=2*10^-3//drain current
10 Vs=0//source is grounded Vgs=Vg-Vs=Vi
11 RL=2*10^3//load resistance
12 R_L=(RL*rd)/(RL+rd)//equivalent load resistance
13 gm=gmo*sqrt(ID/IDSS)//transconductance
14 Av=-gm*R_L//voltage gain Av=Vo/Vi=-gm*R_L
15 mprintf('the midband voltage gain is %f ',Av)
```

---

#### Scilab code Exa 2.5 SSA Ex 2 5

```
1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.5 page no 32
4  //given
5  gm=60*10^-3//transconductance
6  Si=50//antenna source impedance
7  rd=2.5*10^3
8  Zo=rd/(1+gm*rd)//output impedance without load
9  RL=200//load resistance
10 zo1=200*Zo/(200+Zo)//output impedance with load
```

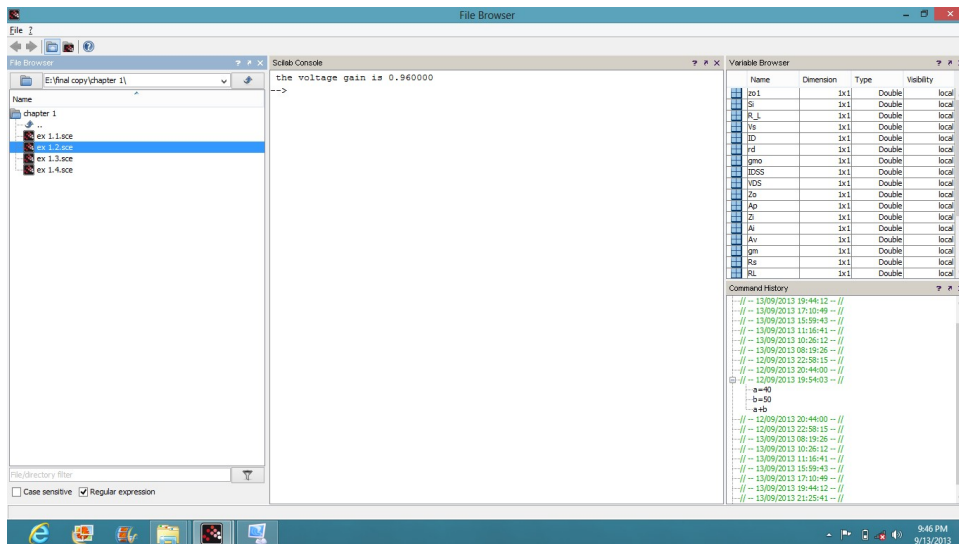


Figure 2.5: SSA Ex 2 5

```

11 Av=gm*(rd*RL/rd+RL)/(1+gm*(rd*RL/rd+RL)) // voltage
    gain
12 mprintf('the voltage gain is %f ',Av)

```

---

### Scilab code Exa 2.6 SSA Ex 2 6

```

1 clc
2 //Chapter 2:Small Signal Amplifiers
3 //example 2.6 page no 36
4 //given
5 RL=50//load resistance
6 gm=0.2//tranceconductance
7 B=100//current gain
8 rpi=B/gm//transistor input resistance
9 disp(rpi,'the transistor input resistance is ')
10 disp('The load resistance seen bythe first stage

```

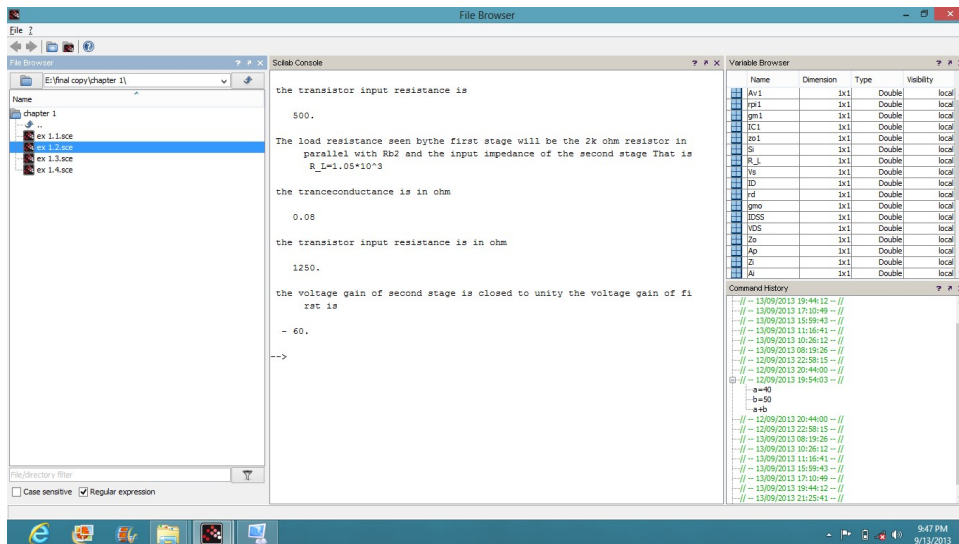


Figure 2.6: SSA Ex 2 6

will be the 2k ohm resistor in parallel with Rb2 and the input impedance of the second stage That is  $R_L=1.05*10^3$ ')

```

11 R_L=1.05*10^3
12 Rs=500//source resistance
13 IC1=2*10^-3//collector bias current
14 gm1=40*IC1//transeconductance
15 disp(gm1,'the transeconductance is in ohm ')
16 rpi1=B/gm1//transistor input resistance
17 disp(rpi1,'the transistor input resistance is in ohm
    ')
18 Av1=-gm1*R_L*(rpi1/(rpi1+Rs))//the voltage gain of
    first
19 disp(Av1,'the voltage gain of second stage is closed
    to unity the voltage gain of first is ')

```

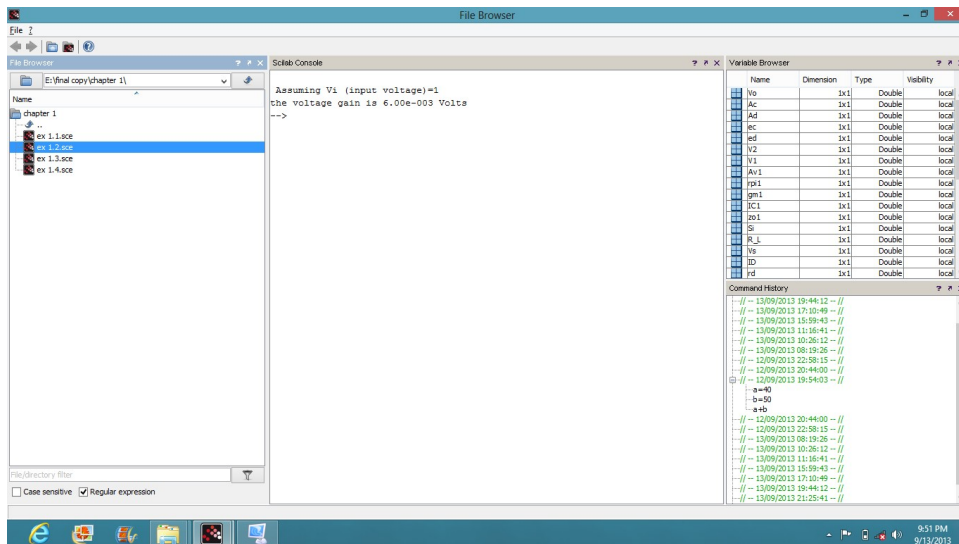


Figure 2.7: SSA Ex 2 8

### Scilab code Exa 2.8 SSA Ex 2 8

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.8 page no 42
4  //given
5  disp('Assuming Vi (input voltage)=1')
6  V1=(5+10^6)/(5+2*10^6)//voltage on the positive
   terminal
7  V2=10^6/(5+2*10^6)//the voltage on the inverting
   terminal
8  ed=V1-V2//differential voltage
9  ec=(V1+V2)/2//common-mode voltage
10 Ad=2*10^3//differentail gain
11 Ac=2*10^-3//common mode gain (here 20% of
   differentail gain)
12 Vo=Ad*ed+Ac*ec//actual amplifier output
13 mprintf('the voltage gain is %3.2e Volts',Vo)

```

---

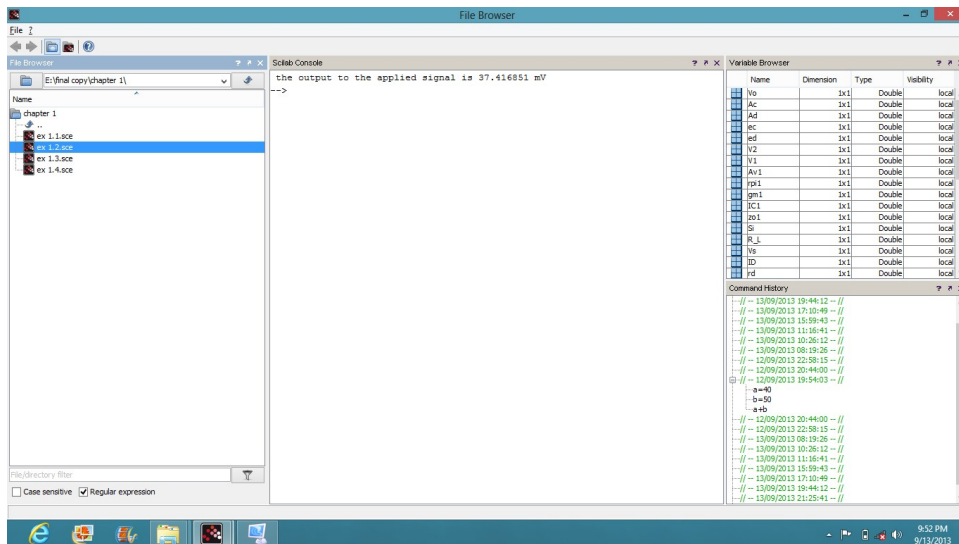


Figure 2.8: SSA Ex 2 9

### Scilab code Exa 2.9 SSA Ex 2 9

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.9 page no 45
4  //given
5  ed=5*10^-3//differential voltage
6  ec=2.5*10^-3//common-mode voltage
7  gm=1.5*10^-3//tranceconductance
8  rd=500*10^3
9  Rs=150*10^3//source resistance
10 RL=10*10^3//load resistance
11 Ac=-gm*RL/(1+2*gm*Rs)//common mode gain
12 Ad=gm*RL/2//differential gain
13 Vo=ec*Ac+ed*Ad//actual amplifier output

```

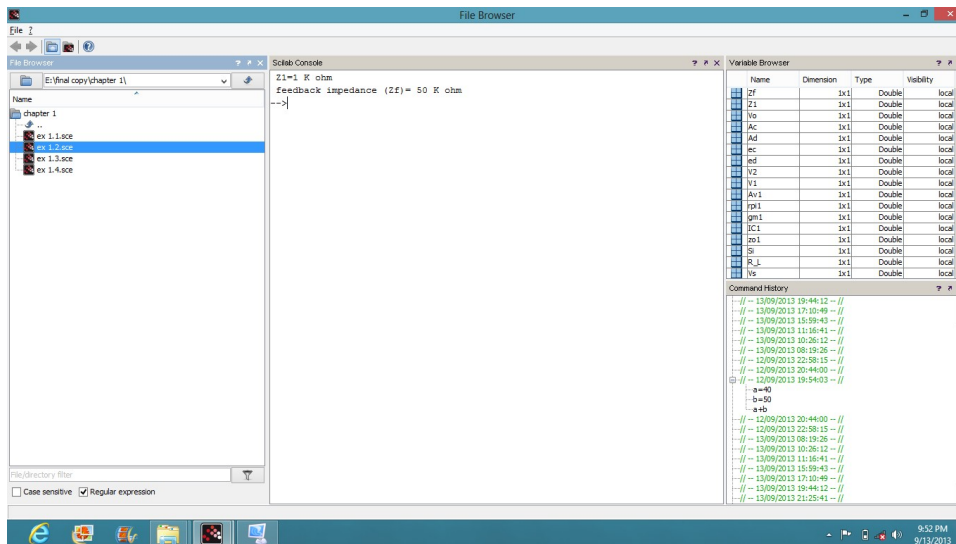


Figure 2.9: SSA Ex 2 10

- 14 `mprintf('the output to the applied signal is %f mV',  
Vo*1e3)`
- 

#### Scilab code Exa 2.10 SSA Ex 2 10

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.10 page no 51
4  //given
5  Z1=1*10^3//asumming impedance value for required
   specification
6  Av=-50//voltage gain
7  Zf=-Av*Z1//feedback impedance
8  mprintf('Z1=%d K ohm \n feedback impedance (Zf)= %d
   K ohm ',Z1*1e-3,Zf*1e-3)

```

---

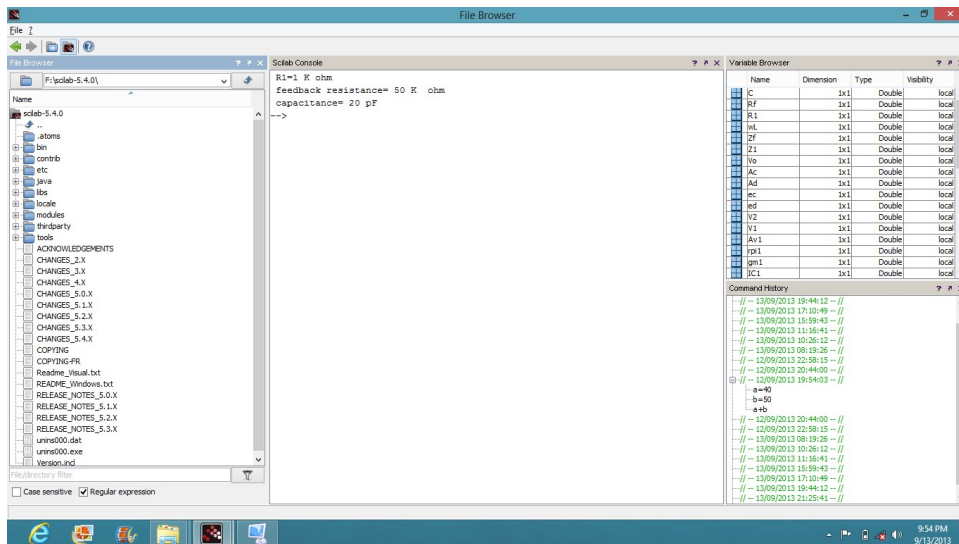


Figure 2.10: SSA Ex 2 11

### Scilab code Exa 2.11 SSA Ex 2 11

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.11 pag no 51
4  //given
5  wL=10^6//bandwidth
6  R1=1*10^3//taking resistance value for required
   specification
7  Av=-50//voltage gain
8  Rf=-Av*R1//feedback resistance
9  C=(wL*Rf)^-1//capacitance
10 mprintf('R1=%d K ohm \n feedback resistance= %d K
   ohm \n capacitance= %d pF ',R1*1e-3,Rf*1e-3,C*1e12
   )

```



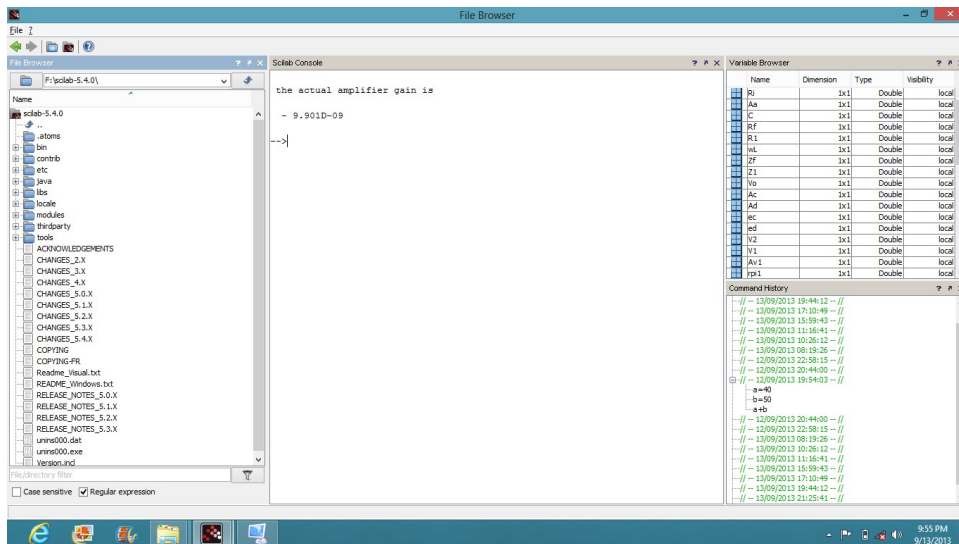


Figure 2.11: SSA Ex 2 12

### Scilab code Exa 2.12 SSA Ex 2 12

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.12 page no 53
4  //given
5  Aa=10^4//open loop gain
6  Rf=10^4//feedback resistance
7  Ri=100//input resistance
8  Av=-(Rf/Ri)/(1+(Ri+Rf)*(Aa*Ri))//actual amplifier
   gain
9  disp(Av,'the actual amplifier gain is ')

```

---

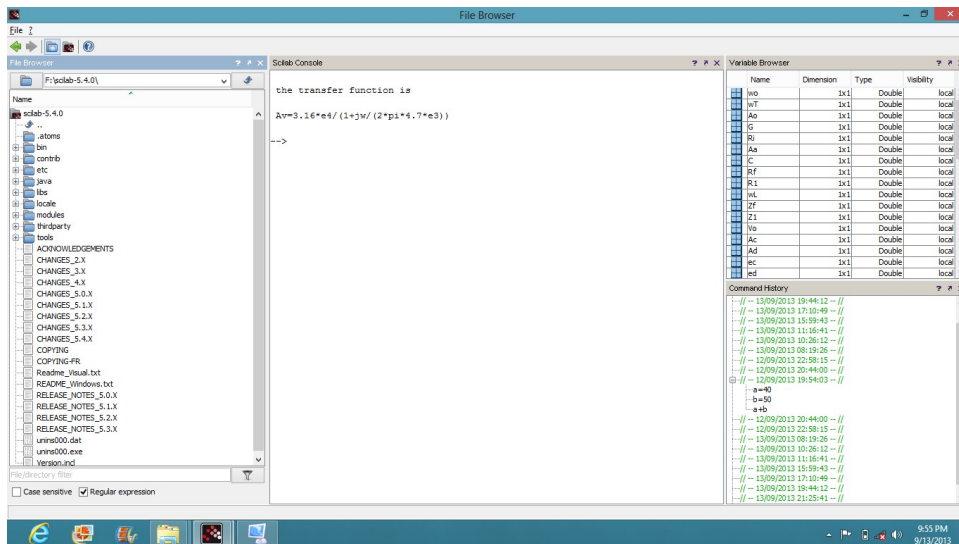


Figure 2.12: SSA Ex 2 13

### Scilab code Exa 2.13 SSA Ex 2 13

```

1  clc
2  //Chapter 2:Bipolar transistor amplifiers
3  //example 2.13 page no 53
4  //given
5  G=90//low frequency gain in dB
6  Ao=(G/20)//low frequency open loop gain
7  wT=150*10^6//gain bandwidth product
8  wo=wT/Ao//bandwidth
9  disp('the transfer function is')
10 disp('Av=3.16*e4/(1+jw/(2*pi*4.7*e3))')

```

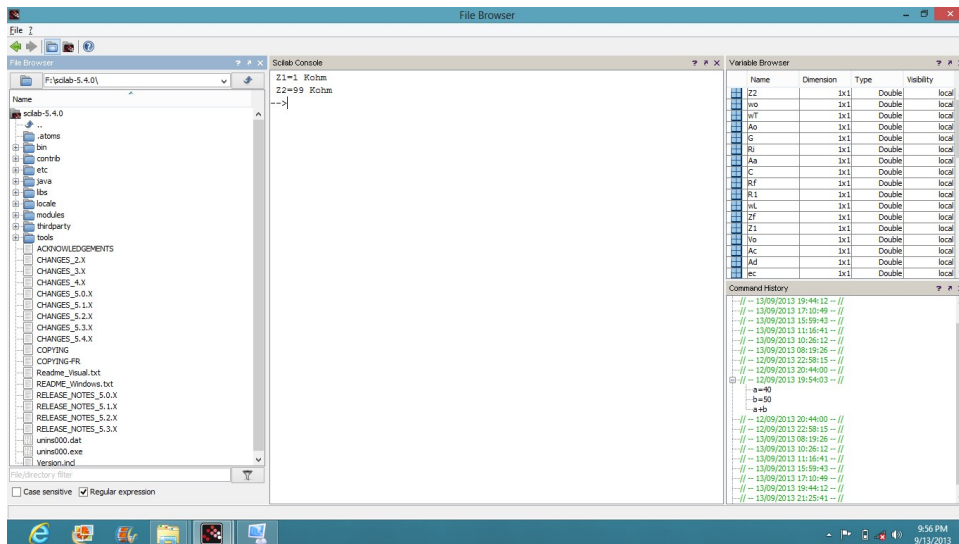


Figure 2.13: SSA Ex 2 14

### Scilab code Exa 2.14 SSA Ex 2 14

```

1  clc
2  //Chapter 2:Small Signal Amplifiers
3  //example 2.14 page no 57
4  //given
5  Z1=1*10^3//assuming impedance value for required
    specification
6  Av=100//voltage gain
7  Z2=(Av-1)*Z1
8  mprintf('Z1=%d Kohm \n Z2=%d Kohm',Z1*1e-3,Z2*1e-3)

```

# Chapter 3

## Network Noise and Intermodulation Distortion

Scilab code Exa 3.3 NNID Ex 3 3

```
1 clc
2 //Chapter 3:Network noise and intermodulation
  distortion
3 //example 3.3 page no 80
4 //given
5 NF1=2//first stage noise figure
6 NF2=6//second stage noise figure
7 F1=10^(NF1/10)//first stage noise factor
8 F2=10^(NF2/10)//second stage noise factor
9 G1=15.9//gain of first stage equivalent to 12dB
10 G2=10//gain of second stage equivalent to 10dB
11 F=F1+(F2-1)/G1//overall noise factor
12 NF=10*log10(F)//noise figure of the two-stage
  systemm
13 printf('the noise figure of the two-stage system is
  %f dB',round(NF*10)/10)
```

---

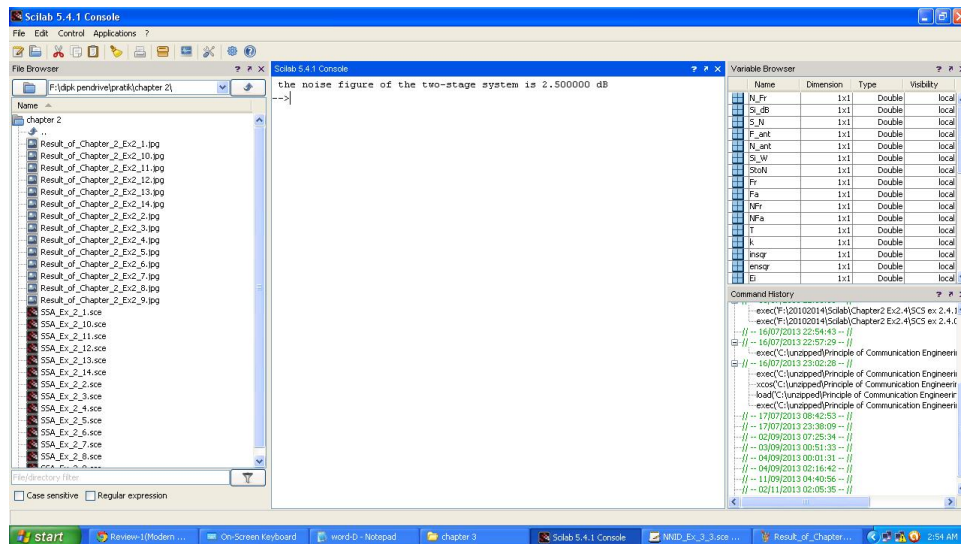


Figure 3.1: NNID Ex 3 3

### Scilab code Exa 3.4 NNID Ex 3 4

```

1  clc
2  //Chapter 3:Network noise and intermodulation
   distortion
3  //example 3.4 page no 81
4  //given
5  k=1.37*10^-23//boltzmann's onstant
6  T=290//operating tempreture
7  B=3*10^3//bandwidth
8  F=1.779//overall noise factor(from previous ex)
9  G1=15.9//gain of first stage(from previous ex)
10 G2=10//gain of second stage(from previous ex)
11 Ni_Na=F*k*T*B//noise at the input (addition of Ni
   and Na)
12 No=G1*G2*(Ni_Na)//the output noise
13 mprintf('the output noise is %3.2e W',No)

```

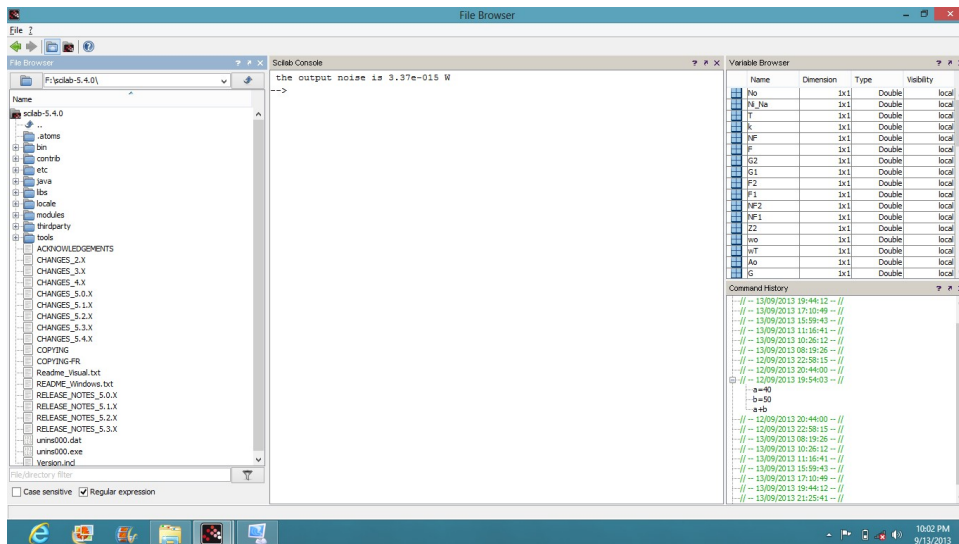


Figure 3.2: NNID Ex 3 4

### Scilab code Exa 3.5 NNID Ex 3 5

```

1  clc
2  //Chapter 3:Network noise and intermodulation
   distortion
3  //example 3.5 page no 82
4  //given
5  F=1.6//noise factor
6  T=290//referance temperture
7  Tr=(F-1)*T//system noise temperture
8  mprintf('the system noise temperture is %d K',Tr)

```

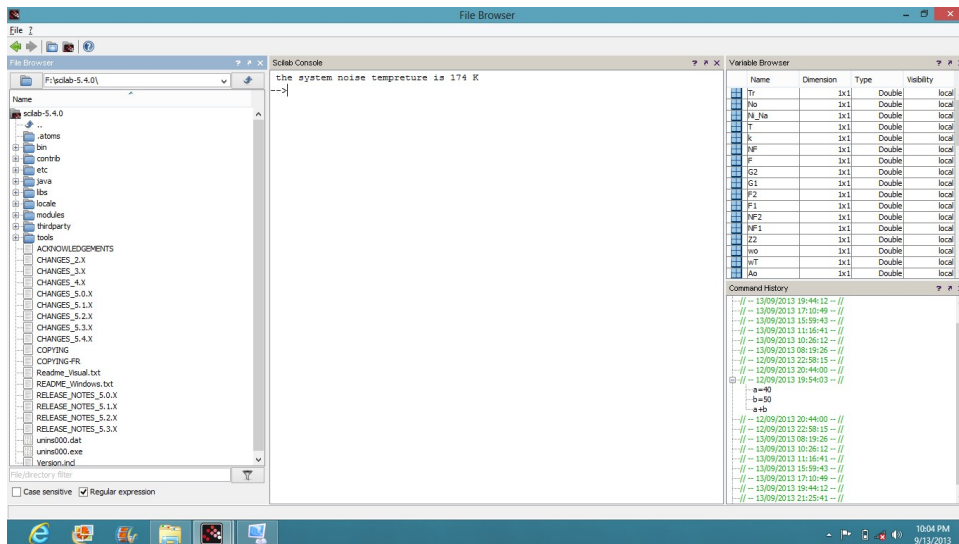


Figure 3.3: NNID Ex 3 5

### Scilab code Exa 3.6 NNID Ex 3 6

```

1  clc
2  //Chapter 3:Network noise and intermodulation
   distortion
3  //example 3.6 page no 82
4  //given
5  NF=8//noise figure in dB
6  B=2.1*10^3//bandwidth
7  Rs=50//source resistance
8  Si_dB=NF-144+log10(B)//available input power in dBm
9  Si_W=(10^(Si_dB/10))/10^3//available input power in
   W
10 Ei=sqrt(Si_W*4*Rs)//minimum detectable signal
11 mprintf('the minimum detectable signal is %f uV',
   round(Ei*1e6*100)/100)

```

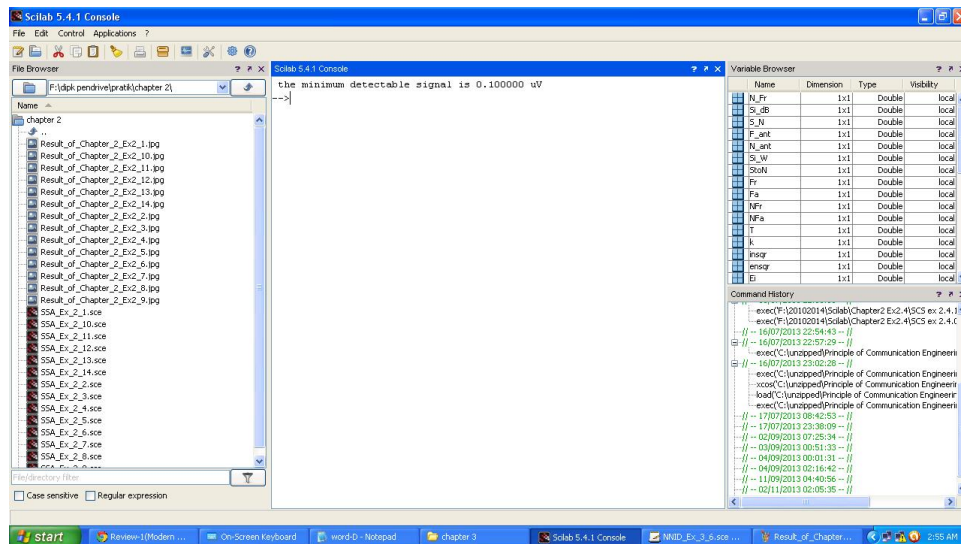


Figure 3.4: NNID Ex 3 6

### Scilab code Exa 3.7 NNID Ex 3 7

```

1  clc
2  //Chapter 3:Network noise and intermodulation
   distortion
3  //example 3.7 page no 83
4  //given
5  NF=8//noise figure in dB
6  B=2.1*10^3//bandwidth
7  Rs=50//source resistance
8  Si_dB=NF-134+log10(B)//available input power in dBm
9  Si_W=(10^(Si_dB/10))/10^3//available input power in
   Watts
10 Ei=sqrt(Si_W*4*Rs)//minimum detectable signal
11 mprintf('the minimum detectable signal is %f uV',

```



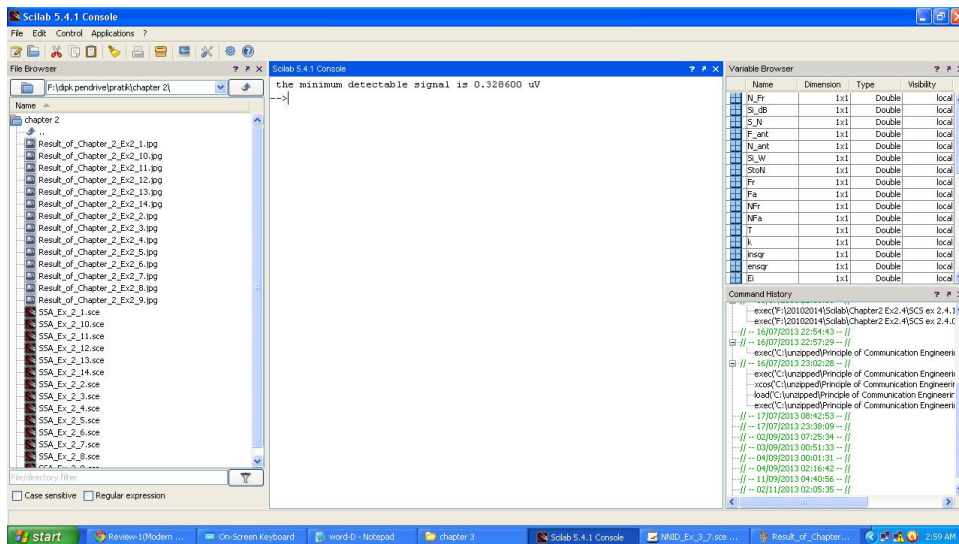


Figure 3.5: NNID Ex 3 7

`round(Ei*1e7*1000)/10000)`

### Scilab code Exa 3.8 NNID Ex 3 8

```

1  clc
2  //Chapter 3:Network noise and intermodulation
   distortion
3  //example 3.8 page no 83
4  //given
5  NF=4//noise figure in dB
6  B=3*10^3//bandwidth
7  Rs=50//source resistance
8  k=1.38*10^-23//Boltzmmans constant
9  T=290//tempreture
10 //For si of -125dBm the value of Ei is 0.245uV will
    produce a 10dB output to noise ratio. now

```

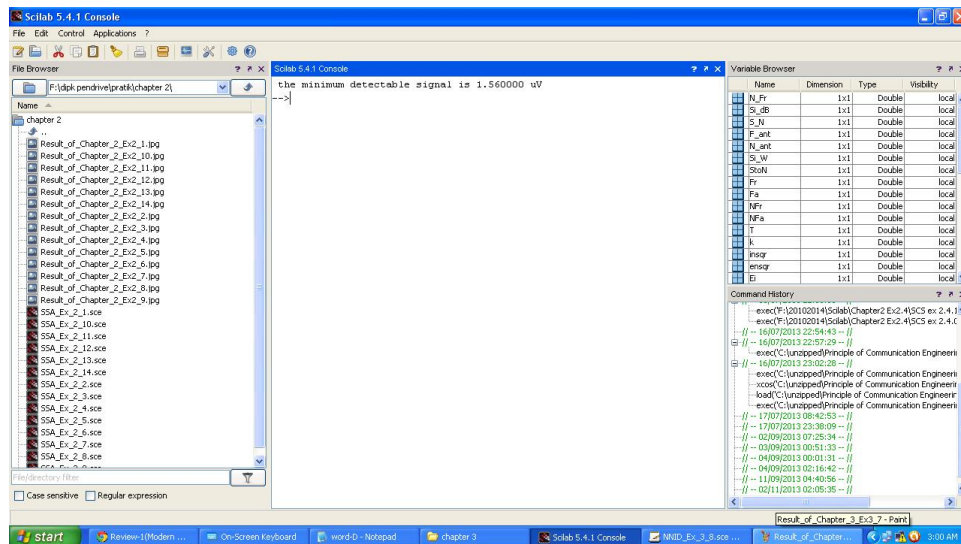


Figure 3.6: NNID Ex 3 8

consider the performance of this receiver when it is connected to an antenna with a noise figure of 20dB

```

11 N_ant=20//antenna noise figure
12 N_Fr=4//receiver noise figure
13 F_ant=10^(N_ant/10)//antenna noise factor
14 Fr=10^(N_Fr/10)//receiver noise factor
15 S_N=10//output signal to noise ratio
16 Si_W=(S_N)*(F_ant+Fr-1)*k*T*B//available input power
    in Watts
17 Ei=sqrt(Si_W*4*Rs)//minimum detectable signal
18 mprintf('the minimum detectable signal is %f uV',
    round(Ei*1e6*100)/100)

```

Scilab code Exa 3.9 NNID Ex 3 9

```

1  clc
2  //Chapter 3:Network noise and intermodulation
    distortion
3  //example 3.8 page no 84
4  //given
5  NF=4//noise figure in dB
6  B=3*10^3//bandwidth
7  Rs=50//source resistance
8  k=1.38*10^-23//Boltzmanns constant
9  T=290//temperature
10 NFa=20//antenna noise figure
11 NFr=10//receiver noise figure
12 Fa=10^(NFa/10)//antenna noise factor
13 Fr=10^(NFr/10)//receiver noise factor
14 S_N=10//output signal to noise ratio
15 Si_W=(S_N)*(Fa+Fr-1)*k*T*B//available input power in
    Watts
16 Ei=sqrt(Si_W*4*Rs)//minimum detectable signal
17 mprintf('the minimum detectable signal is %f uV',
    round(Ei*1e6*10)/10)

```

---

### Scilab code Exa 3.10 NNID Ex 3 10

```

1  clc
2  //Chapter 3:Design of low noise networks
3  //example 3.10 page no 86
4  //given
5  ensqr=8*10^-16//noise voltage
6  insqr=9*10^-25//rms noise current
7  Rs=10*10^4//source resistance
8  k=1.37*10^-23//Boltzmanns constant
9  T=290//temperature
10 F=(ensqr+(insqr*Rs^2))/(4*k*T*Rs)//amplifier noise

```

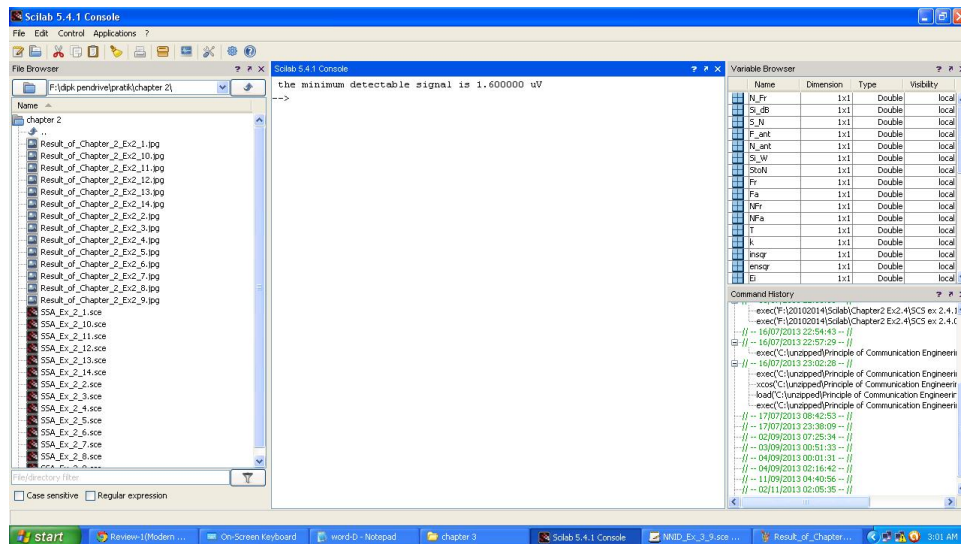


Figure 3.7: NNID Ex 3 9

factor  
 11 `disp(F, 'the amplifier noise factor is ')`

---

Scilab code Exa 3.11 NNID Ex 3 11

```

1 clc
2 //Chapter 3:Network noise and intermodulation
   distortion
3 //example 3.11 page no 88
4 //given
5 ensqr=8*10^-16//noise voltage
6 insqr=9*10^-25//rms noise current
7 Rs=sqrt(ensqr/insqr)//source resistance
8 k=1.38*10^-23//Boltzmmans constant
9 T=290//tempreture

```

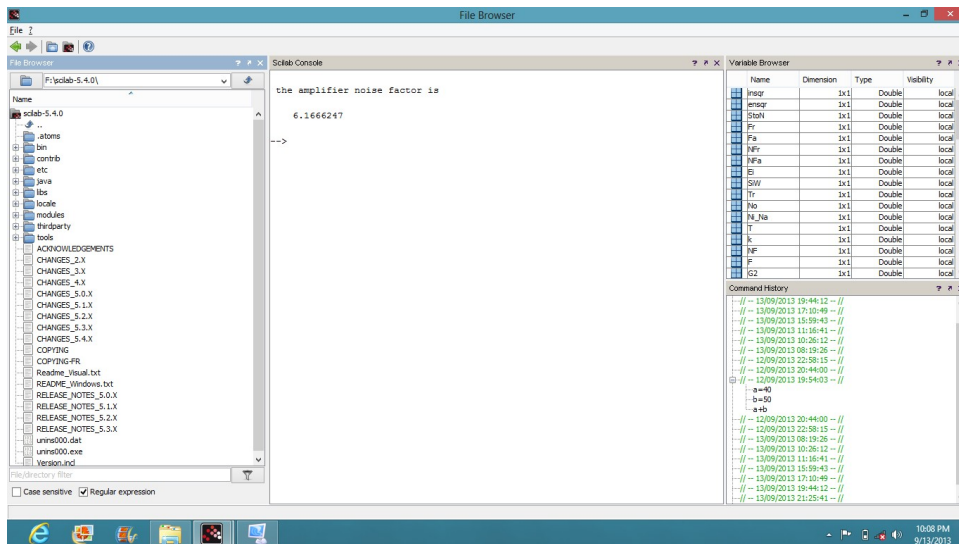


Figure 3.8: NNID Ex 3 10

```

10 F=(ensqr+insqr*Rs^2+4*k*T*Rs)/(4*k*T*Rs) // amplifier
    noise factor
11 NF=10*log10(F) // noise figure
12 mprintf('the minimum minimum noise figure is %f dB',
    round(NF*10)/10)

```

### Scilab code Exa 3.12 NNID Ex 3 12

```

1 clc
2 //Chapter 3:Network noise and intermodulation
  distortion
3 //example 3.12 page no 89
4 //given
5 ensqr=8*10^-16 //noise voltage
6 insqr=9*10^-25 //rms noise current
7 Rs=9.42*10^3 //source resistance

```

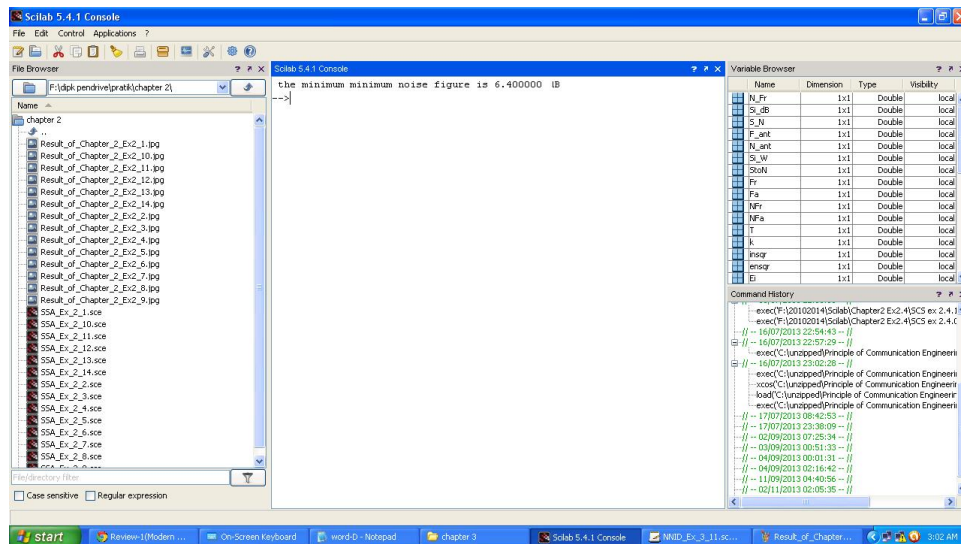


Figure 3.9: NNID Ex 3 11

```

8 k=1.38*10^-23//Boltzmmans constant
9 T=290//tempreture
10 N=ensqr+insqr*Rs^2+4*k*T*Rs//total noise
11 disp(N,'the total noise is ')
12 disp('If the source resistance is zero ,the total
    noise is ')
13 disp('N=ensqr=8*10^-16')

```

### Scilab code Exa 3.13 NNID Ex 3 13

```

1 clc
2 //Chapter 3:Network noise and intermodulation
  distortion
3 //example 3.13 page no 96
4 //given
5 PI=20//intercept point in dBm

```

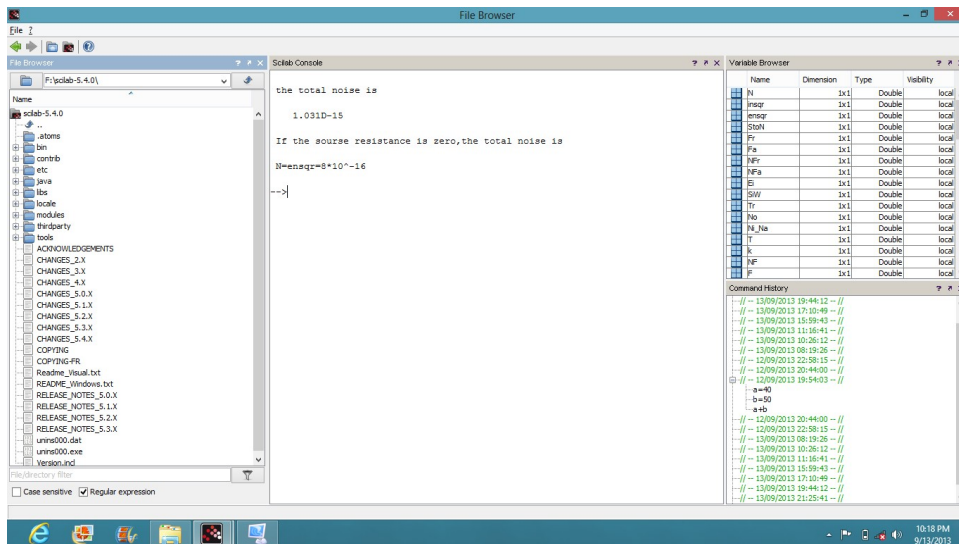


Figure 3.10: NNID Ex 3 12

- 6 `Pi=0` //input signal power dBm
- 7 `PIMR=-2*PI` //intermodulation distortion ratio (by the rules of logarithm as values are already given in dBm)
- 8 `mprintf('the intermodulation distortion ratio is %d dB', PIMR)`

### Scilab code Exa 3.14 NNID Ex 3 14

- 1 `clc`
- 2 //Chapter 3:Network noise and intermodulation distortion
- 3 //example 3.14 page no 97
- 4 //given
- 5 `PI=20` //intercept point in dBm
- 6 `Nf=-123` //noise floor in dBm

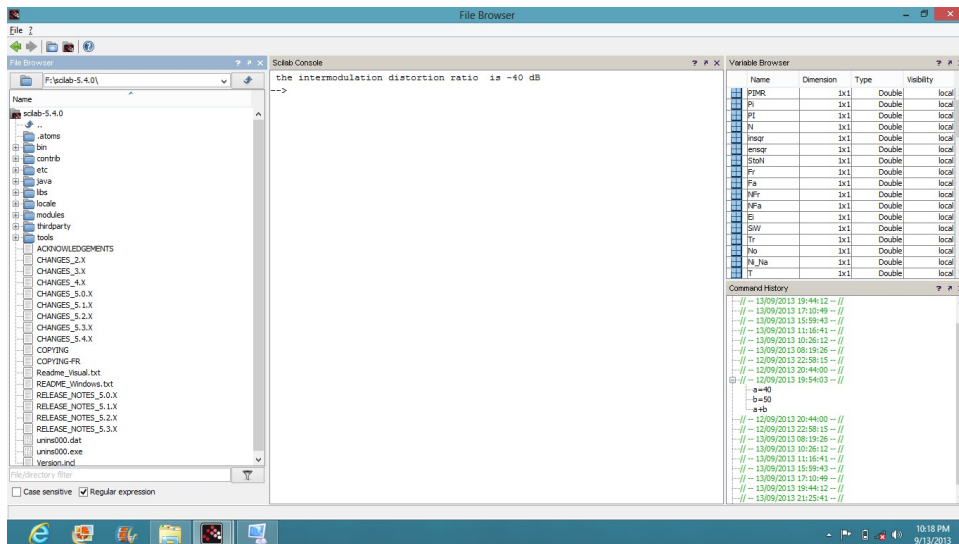


Figure 3.11: NNID Ex 3 13

- 7  $DR=2/3*(PI-Nf)$  //dynamic range (by the rules of logarithms as value are already given in dBm)
  - 8 `mprintf('the dynamic range is %f dB',DR)`
-



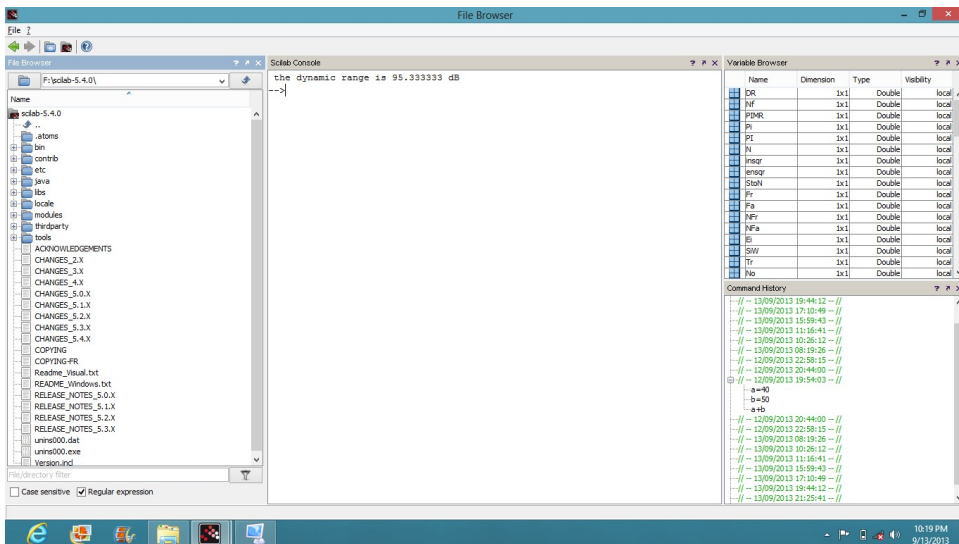


Figure 3.12: NNID Ex 3 14

## Chapter 4

# Frequency Selective Network and Transformers

Scilab code Exa 4.1 FSNT Ex 4 1

```
1 clc
2 //Chapter 4:Frequency selective networks and
   transformers
3 //example 4.1 page no 108
4 //given
5 R=50//load resistance in ohm
6 B=100//bandwidth in KHz
7 Cf=5//filter center frequency in MHz
8 L=R/(2*%pi*10^5)//inductance in micro henry
9 C=((L)*(2*%pi*Cf*10^6)^2)^-1//capacitance
10 mprintf('the inductance is %f uH \n the capacitance
   is %f pF ',L*1e6,C*1e12)
```

---

Scilab code Exa 4.2 FSNT Ex 4 2

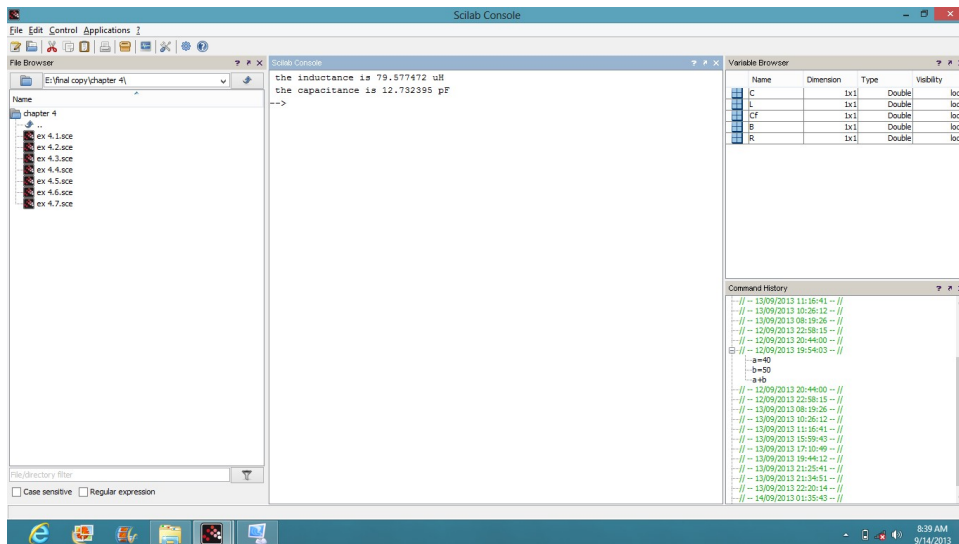


Figure 4.1: FSNT Ex 4 1

```

1  clc
2  //Chapter 4:Frequency selective networks and
   transformers
3  //example 4.2
4  //given
5  //Forty decibels corresponds to a voltage ratio of
   100:1 therefore since  $A(j\omega)=1$ 
6  Ajwo=0.01
7  n=5//no. of harmonics
8  Q=n/(Ajwo*(n^2-1))//quality point
9  mprintf('the minimum circuit Q is =Qmin = %f ',Q)

```

### Scilab code Exa 4.3 FSNT Ex 4 3

```

1  clc

```

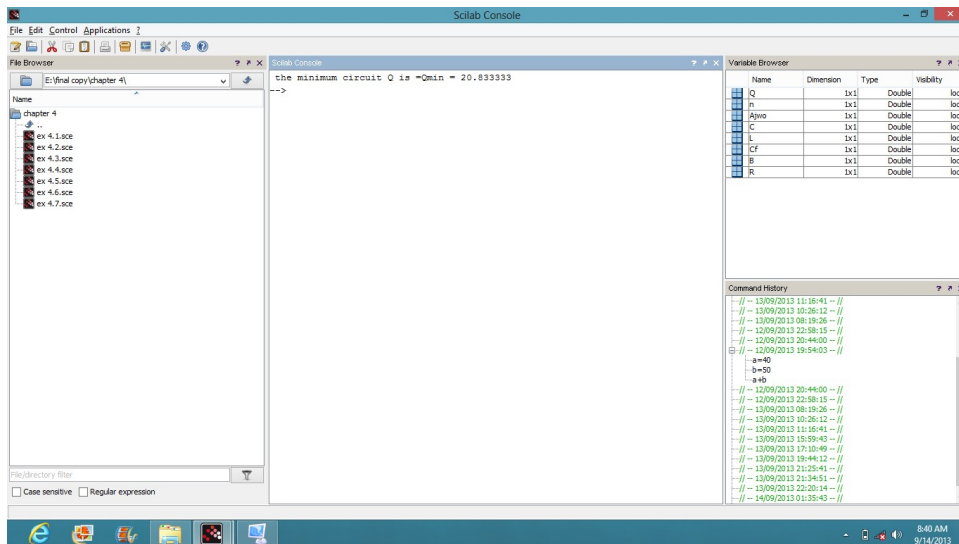


Figure 4.2: FSNT Ex 4 2

```

2 //Chapter 4:Frequency selective networks and
  transformers
3 //example 4.3 page no 115
4 //given
5 L=10*10^-6//inductance
6 C=10*10^-12//capacitance
7 wo=(sqrt(L*C))^(-1)//resonant frequency(ignore the
  finite resistance)
8 Q=100
9 rs=wo*L/Q//series resistance
10 Rp=(wo*L)^2/rs//parallel resistance
11 QL=50*10^3/(wo*L)//loaded Q
12 mprintf('the loaded Q is %f ',QL)

```

---

Scilab code Exa 4.4 FSNT Ex 4 4

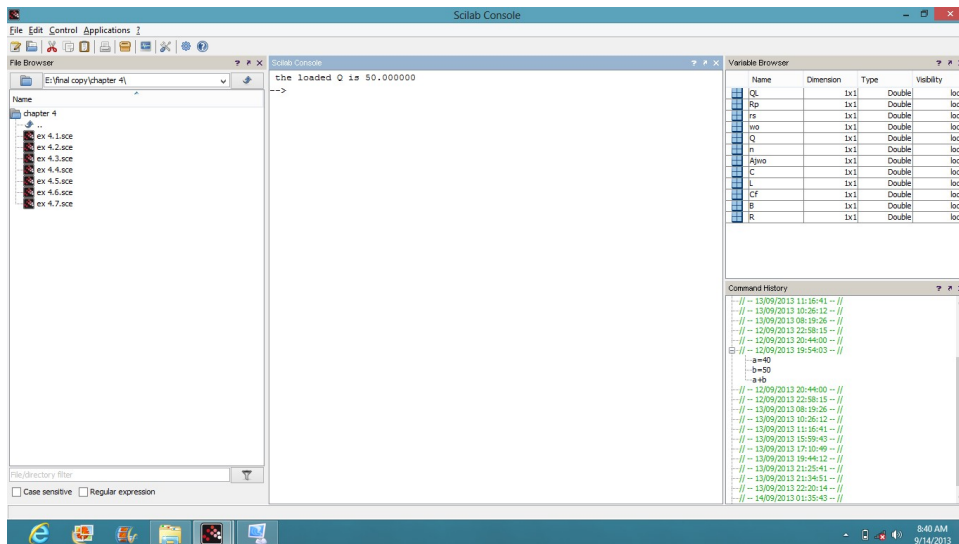


Figure 4.3: FSNT Ex 4 3

```

1  clc
2  //Chapter 4:Frequency selective networks and
   transformers
3  //example 4.4 page no 121
4  //given
5  L1=25*10^-6//primary inductance
6  L2=400*10^-6//secondary inductane
7  n=(sqrt(L1/L2))//equivalent turns ratio
8  CT=(8+(2/n^2))*1e-12//total primary capacitance
9  RL=25*10^3//load resistance reflected to the primary
10 wo=(sqrt(L1*CT))^-1//resonant frequency
11 Q=RL/(wo*L1)//quality point
12 mprintf('the resonant frequency is %3.2e rad/s \n Q
   = %f',wo,Q)

```

---

Scilab code Exa 4.6 FSNT Ex 4 6

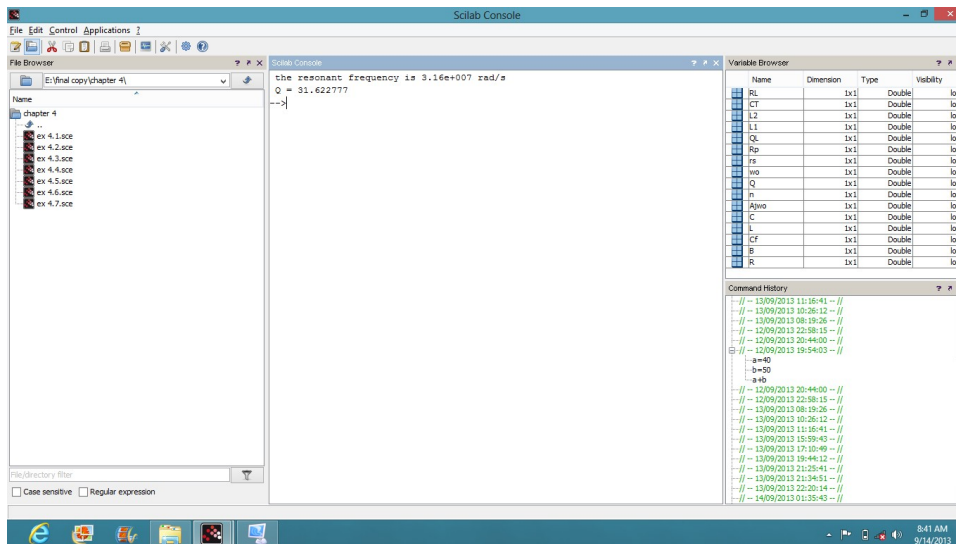


Figure 4.4: FSNT Ex 4 4

```

1  clc
2  //Chapter 4:Frequency selective networks and
   transformers
3  //example 4.6 paga no 130
4  //given
5  Rs=10//source resistance
6  L=0.2*10^-6//inductor
7  f=20*10^6//given frequency
8  XL=(2*%pi*f*L)//inductive reactance
9  Rp=50//input impedance
10 Xs=sqrt(Rp*Rs-Rs^2)//series reactance
11 Xcs=5.1//series capacitive reactance
12 CS=(2*%pi*f*Xcs)^-1//series capacitance
13 Xp=(Rs^2+Xs^2)/Xs//equivalent parallel reactance
14 mprintf('the value of series reactance is j%f ohm \n
   the value equivalent parallel reactance is j%f
   ohm ',Xs,Xp)

```

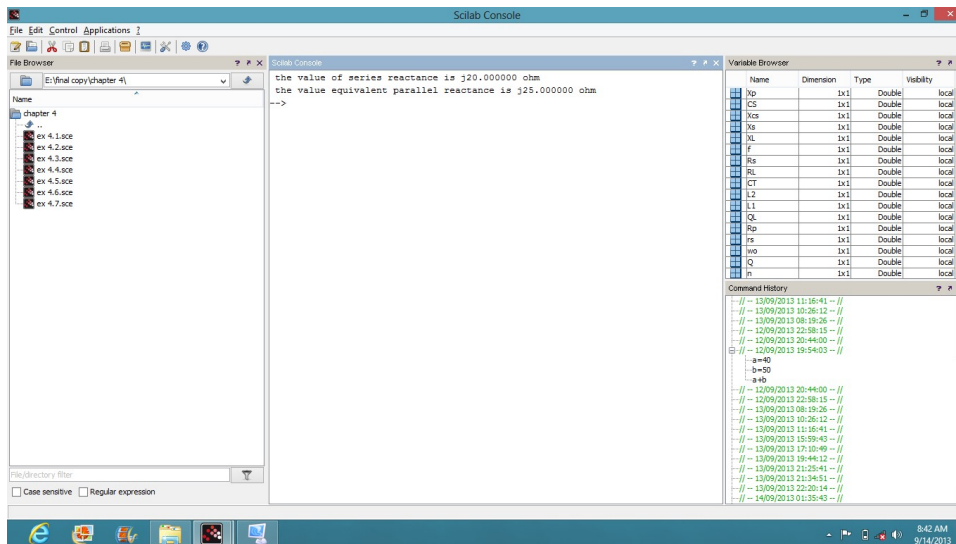


Figure 4.5: FSNT Ex 4 6

#### Scilab code Exa 4.7 FSNT Ex 4 7

```

1  clc
2  //Chapter 4:Frequency selective networks and
   transformers
3  //example 4.7 page no 132
4  //given
5  Rs=50//series resistance
6  Rp=100//parallel resistance
7  Xp=sqrt(Rs*Rp^2/(Rp-Rs))//equivalent parallel
   reactance
8  disp(Xp,'the equivalent parallel reactance in ohm is
   ')

```

---

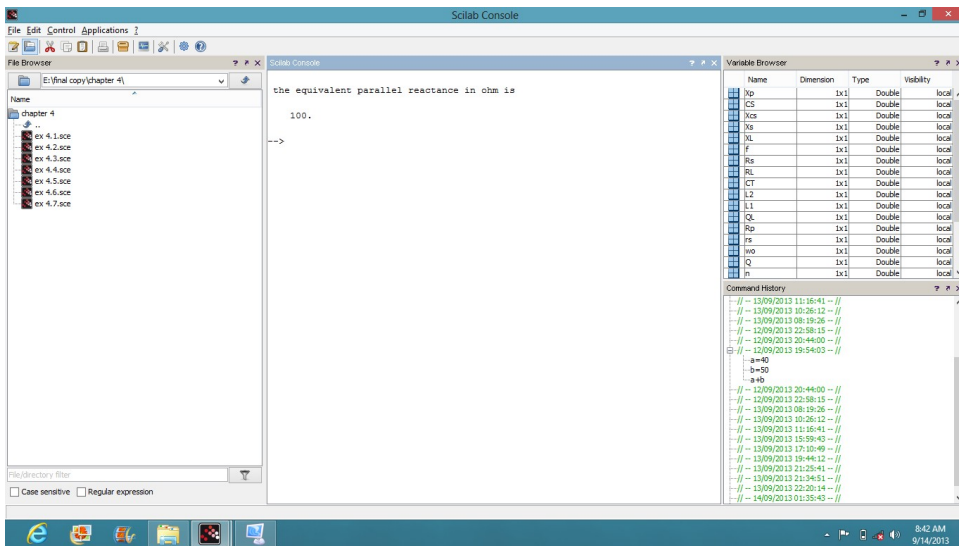


Figure 4.6: FSNT Ex 4 7



## Chapter 5

# High Frequency Amplifiers and Automatic Gain Control

Scilab code Exa 5.1 HFAAGC Ex 5 1

```
1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
   Gain Control
3 //example 5.1 page no 147
4 //given
5 B=100
6 fT=3*10^8//transistor frequency
7 Cu=4*10^-12//output capacitance common base
   configuration
8 Ic=10*10^-3//collector direct current
9 rpi=0.026*B/Ic//base emitter resistance
10 gm=40*Ic//transconductance
11 wT=0.4/(2*pi*3*10^8)//gain bandwidth product
12 Cpi=wT-Cu//base emitter capacitance
13 mprintf('the base emitter resistance is %d ohm \n
   the transconductance is %f S \n the base emitter
   capacitance is %3.2e pF',rpi,gm,Cpi)
```

---

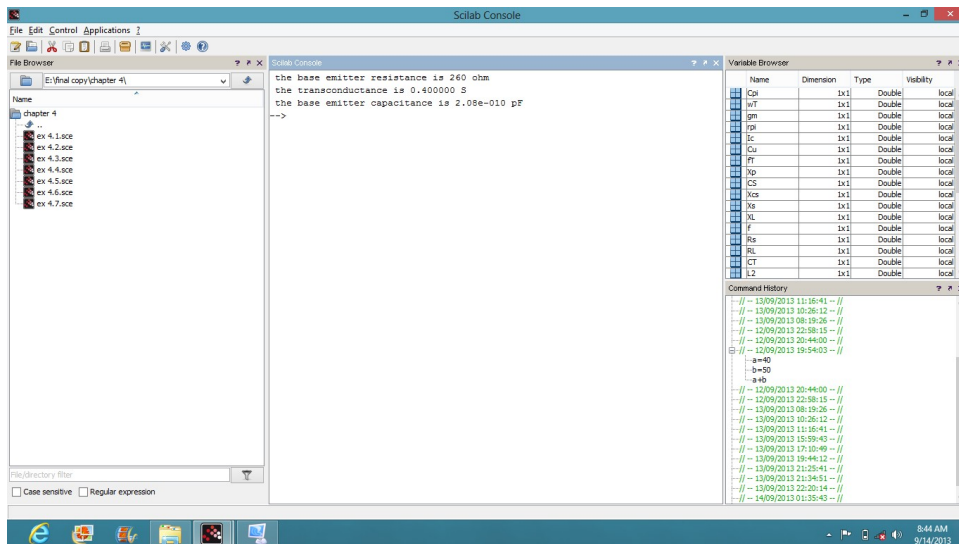


Figure 5.1: HFAAGC Ex 5 1

### Scilab code Exa 5.2 HFAAGC Ex 5 2

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.2 page no 148
4 //given
5 wT=3*10^8//gain bandwidth product
6 w=10*10^6//given frequency
7 Ai=wT/w//short circuit current gain
8 mprintf('the short circuit current gain is %d ',Ai)

```

---

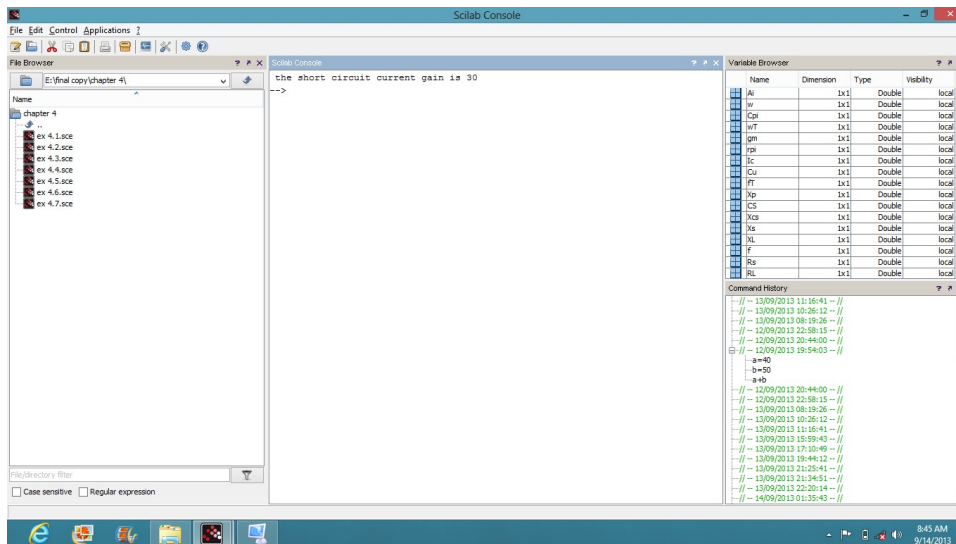


Figure 5.2: HFAAGC Ex 5 2

### Scilab code Exa 5.3 HFAAGC Ex 5 3

```

1  clc
2  //Chapter 5: High Frequency Amplifiers and Automatic
   //    Gain Control
3  //example 5.3 page no 153
4  //given
5  gm=2*10^-3//transconductance
6  Cgs=5*10^-12//equivalent Miller's input capacitance
7  Cgd=1*10^-12//equivalent Miller's output capacitance
8  Cds=1*10^-12
9  rd=13*10^3
10 R=5*10^3//source resistance
11 RL=(6*10^3*13*10^3)/(6*10^3+13*10^3)//total load
   //    resistance
12 Av=-gm*RL//voltage gain
13 R_L=RL*rd/(RL+rd)

```

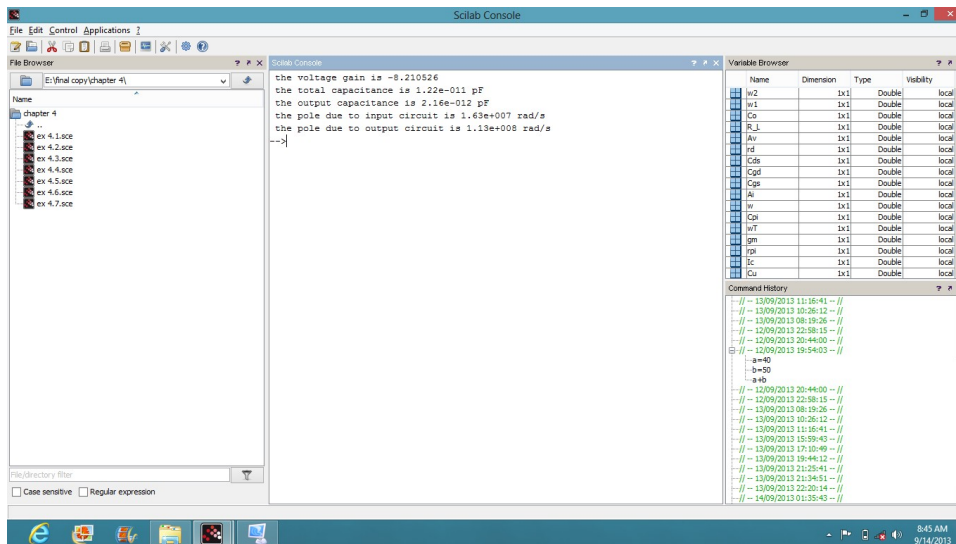


Figure 5.3: HFAAGC Ex 5 3

```

14 CT=Cgs+Cgd*(1+gm*R_L)//total capacitance
15 Co=Cds+(Cgd*(1+gm*R_L)/(gm*R_L))//output capacitance
16 w1=(R*CT)^-1//pole due to input circuit
17 w2=(RL*Co)^-1//pole due to output circuit
18 mprintf('the voltage gain is %f \n the total
           capacitance is %3.2e pF \n the output capacitance
           is %3.2e pF \n the pole due to input circuit is
           %3.2e rad/s \n the pole due to output circuit is
           %3.2e rad/s ',Av,CT,Co,w1,w2)

```

#### Scilab code Exa 5.4 HFAAGC Ex 5 4

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.4 page no 155

```

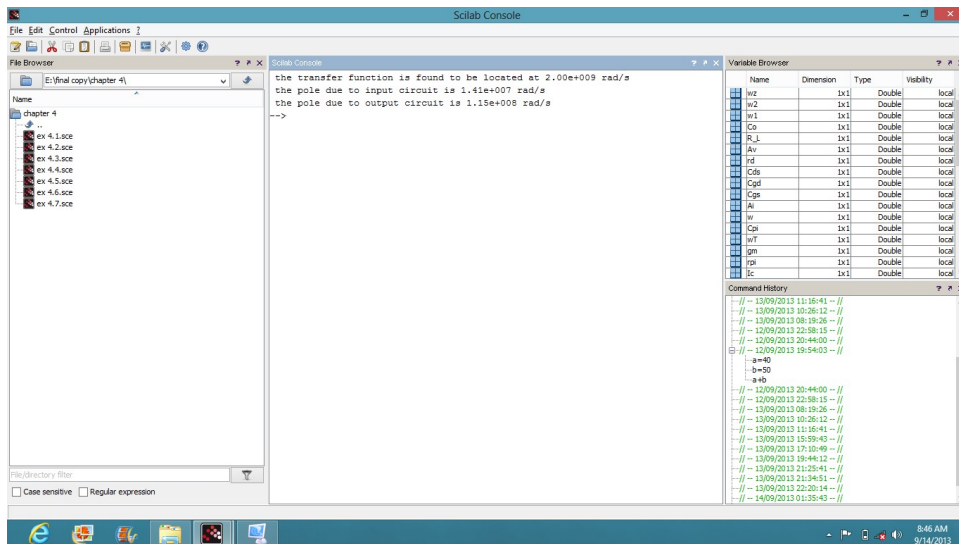


Figure 5.4: HFAAGC Ex 5 4

```

4 //given
5 gm=2*10^-3 //transconductance
6 Cgs=5*10^-12 //equivalent Miller's input capacitance
7 Cgd=10^-12 //equivalent Miller's output capacitance
8 Cds=10^-12
9 R=5*10^3
10 R_L=4.1*10^3
11 wz=2*10^9
12 CT=Cgs+Cgd*(1+gm*R_L) //total capacitance
13 Co=Cds+(Cgd*(1+gm*R_L)/(gm*R_L)) //output capacitance
14 w1=(R*CT)^-1 //pole due to input circuit
15 w2=(R_L*Co)^-1 //pole due to output circuit
16 mprintf('the transfer function is found to be
    located at %3.2e rad/s \n the pole due to input
    circuit is %3.2e rad/s \n the pole due to output
    circuit is %3.2e rad/s ',wz,w1,w2)

```

Scilab code Exa 5.5 HFAAGC Ex 5 5

```
1  clc
2  //Chapter 5:High Frequency Amplifiers and Automatic
   Gain Control
3  //example 5.5 page no 157
4  //given
5  gm=0.4//transconductance
6  rpi=260
7  Re=237//emitter resistance
8  RL=600//load resistance
9  Rs=500//source resistance
10 Vi=1//input voltage(assume Vi=1)
11 R=rpi*Rs/(rpi+Rs)
12 Vo=-gm*RL*Re/(Re+Rs)//output voltage
13 Cgs=960*10^-12//equivalent Miller's input
   capacitance
14 Ci=206*10^-12//input capacitance
15 CT=Cgs+Ci//total capacitance
16 Co=4*10^-12//output capacitance
17 w1=(R*CT)^-1//pole due to input circuit
18 w2=(RL*Co)^-1//pole due to output circuit
19 disp('The high-frequency performance is determined
   by the input circuit The upper -3dB frequency of
   this amplifier is equal to w1')
20 mprintf('the upper 3dB frequency is %3.2e rad/s ',w1
   )
```

---

Scilab code Exa 5.6 HFAAGC Ex 5 6

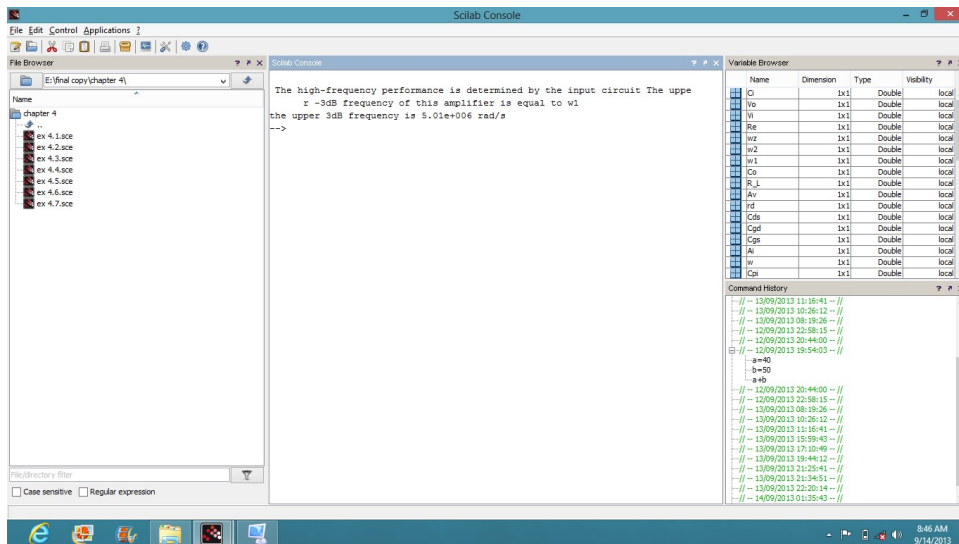


Figure 5.5: HFAAGC Ex 5 5

```
1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.5 page no 159
4 //given
5 s=poly(0,"s")
6 Vo=-(0.4-s*4*10^-12)*(966*10^3)
7 Vth=s^2*(79.6*10^-18)+s*(190.2*10^-9)+1
8 disp(Vo/Vth,'the transfer function is ')
9 wz=10^11//transfer function zero
10 w1=-5.5*10^6//pole due to input circuit
11 w2=-2.41*10^9//pole due to output circuit
12 mprintf('the transfer function zero is found to be
  located at %3.2e rad/s \n the pole due to input
  circuit is %3.2e rad/s \n the pole due to output
  circuit is %3.2e rad/s ',wz,w1,w2)
```

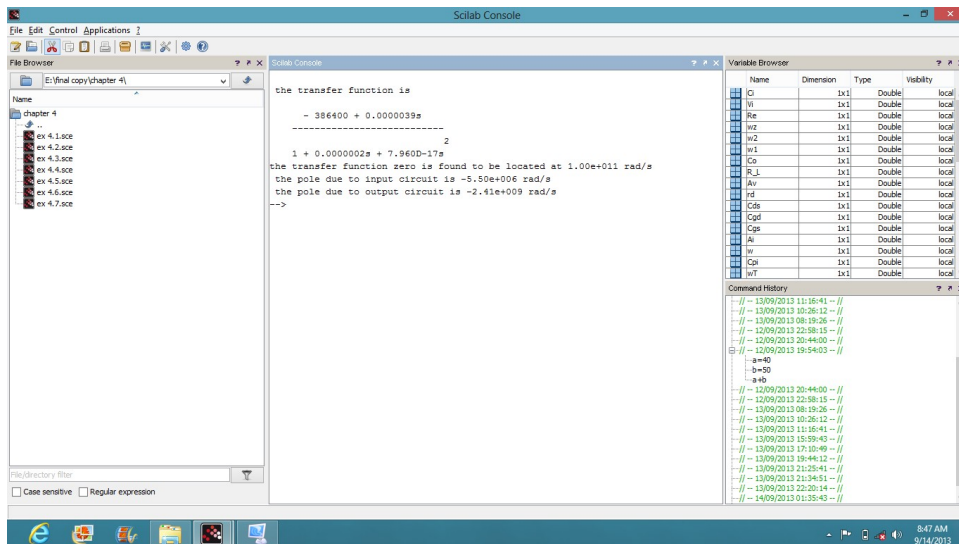


Figure 5.6: HFAAGC Ex 5 6

### Scilab code Exa 5.7 HFAAGC Ex 5 7

```

1  clc
2  //Chapter 5:High Frequency Amplifiers and Automatic
   Gain Control
3  //example 5.7 page no 162
4  //given
5  gm=0.4//transconductance
6  RL=600//load resistance
7  Rs=500//source resistance
8  AVEC=gm*RL//midband emitter to collector voltage
   gain
9  CM=(1-AVEC)*10^-12//miller capacitance
10 C_M=CM/AVEC//collector to ground miller capacitance
11 Ri=gm^-1
12 Av=AVEC*(Ri/Rs)//midfrequency voltage gain
13 Co=(4+1)*10^-12//output capacitance

```



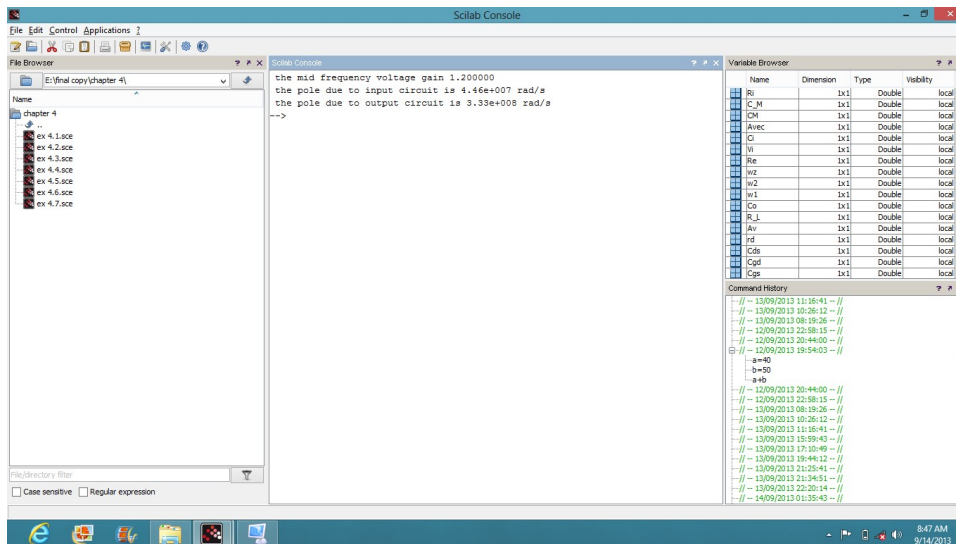


Figure 5.7: HFAAGC Ex 5 7

```

14 CT=(206+CM)*10^-12 //toatl capacitance
15 R=(500^-1+300^-1+260^-1)^-1
16 w1=(R*CT)^-1 //pole due to input circuit)
17 w2=(RL*Co)^-1 //pole due to output circuit
18 mprintf('the mid frequency voltage gain %f \n the
    pole due to input circuit is %3.2e rad/s \n the
    pole due to output circuit is %3.2e rad/s ',Av,w1
    ,w2)

```

#### Scilab code Exa 5.8 HFAAGC Ex 5 8

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.8 page no 166
4 //given

```

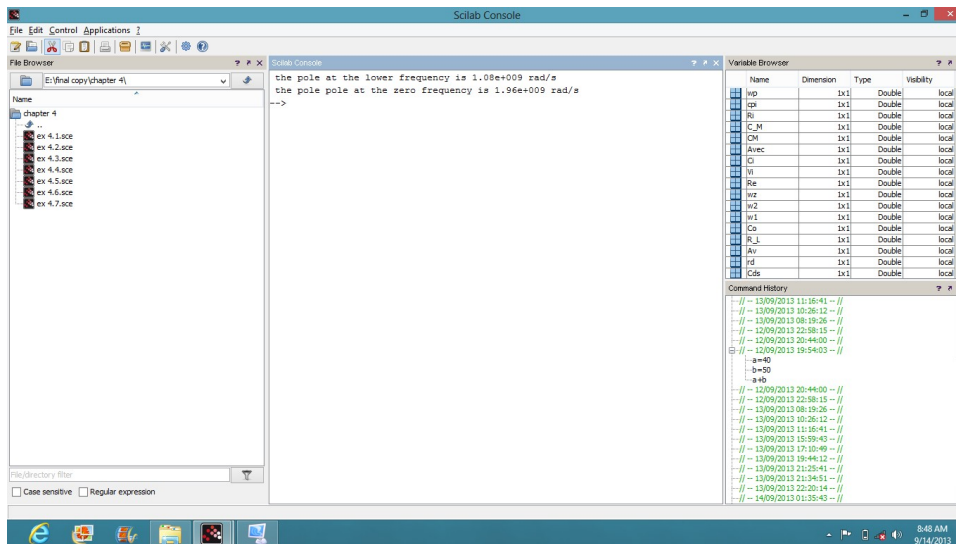


Figure 5.8: HFAAGC Ex 5 8

```

5 Rs=500//source resistance
6 rpi=260
7 gm=0.4//transconductance
8 RL=600//load resistance
9 cpi=206*10^-12
10 wp=(Rs+rpi+(1+gm*rpi)*RL)/(rpi*cpi*(Rs+RL))//pole at
    the lower frequency
11 wz=(1+gm*rpi)/(rpi*cpi)//pole at the zero frequency
12 mprintf('the pole at the lower frequency is %3.2e
    rad/s \n the pole pole at the zero frequency is
    %3.2e rad/s ',wp,wz)

```

Scilab code Exa 5.10 HFAAGC Ex 5 10

```
1 clc
```

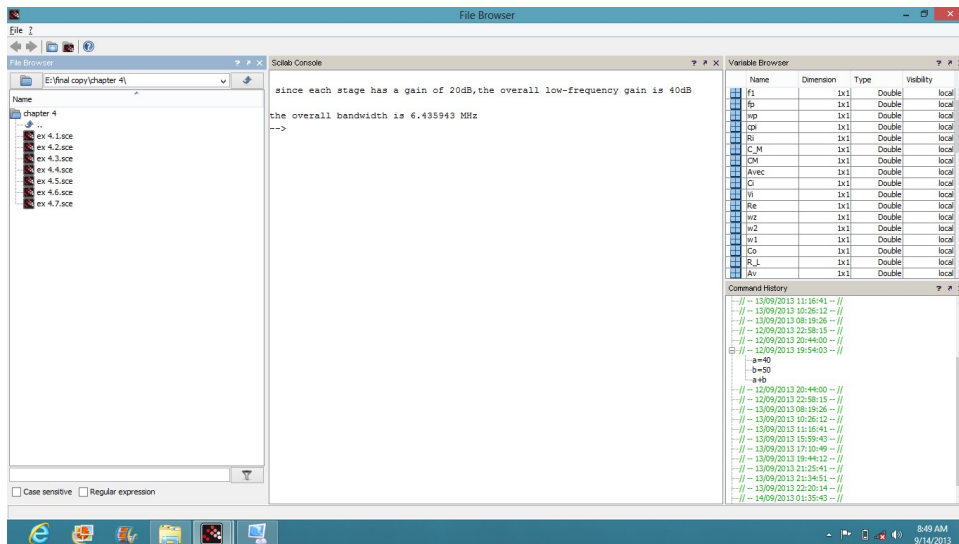


Figure 5.9: HFAAGC Ex 5 10

```

2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.10 page no 178
4 //given
5 fp=10*10^6//upper corner frequency
6 n=2//no. of stages
7 f1=fp*sqrt(2^(1/n)-1)//overall bandwidth
8 disp('since each stage has a gain of 20dB, the
  overall low-frequency gain is 40dB ')
9 mprintf('the overall bandwidth is %f MHz',f1*1e-6)

```

Scilab code Exa 5.11 HFAAGC Ex 5 11

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control

```

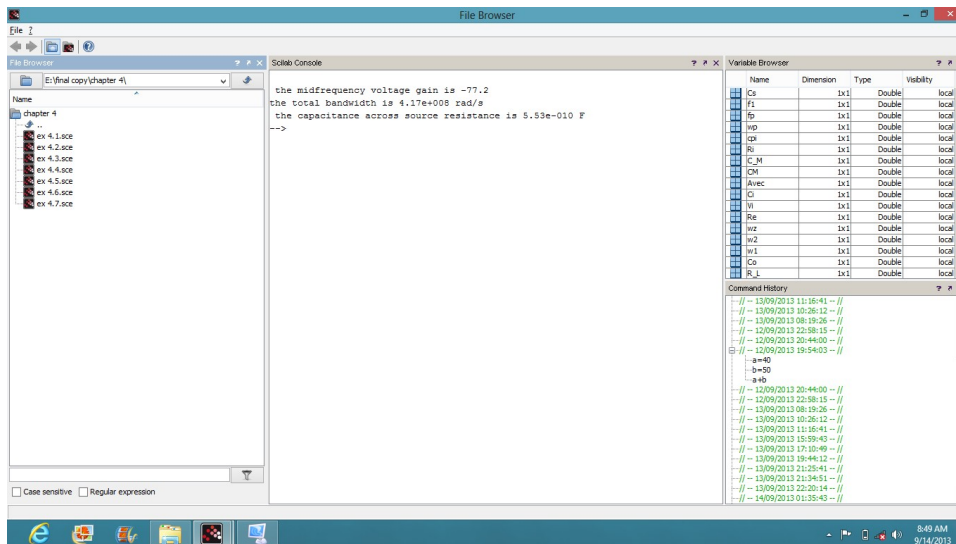


Figure 5.10: HFAAGC Ex 5 11

```

3 //example 5.11 page no 181
4 //given
5 rpi=237
6 CM=1166*10^-12//miller capacitance
7 Co=4*10^-12//equivalent miller capacitance reflected
   at output side
8 Rs=500//source resistance
9 RL=600//load resistance
10 Cs=rpi*CM/Rs//capacitance across source resistance
11 B=(RL*Co)^-1//total bandwidth
12 disp('the midfrequency voltage gain is -77.2')
13 mprintf('the total bandwidth is %3.2e rad/s \n the
   capacitance across source resistance is %3.2e F',
   B,Cs)

```

Scilab code Exa 5.12 HFAAGC Ex 5 12

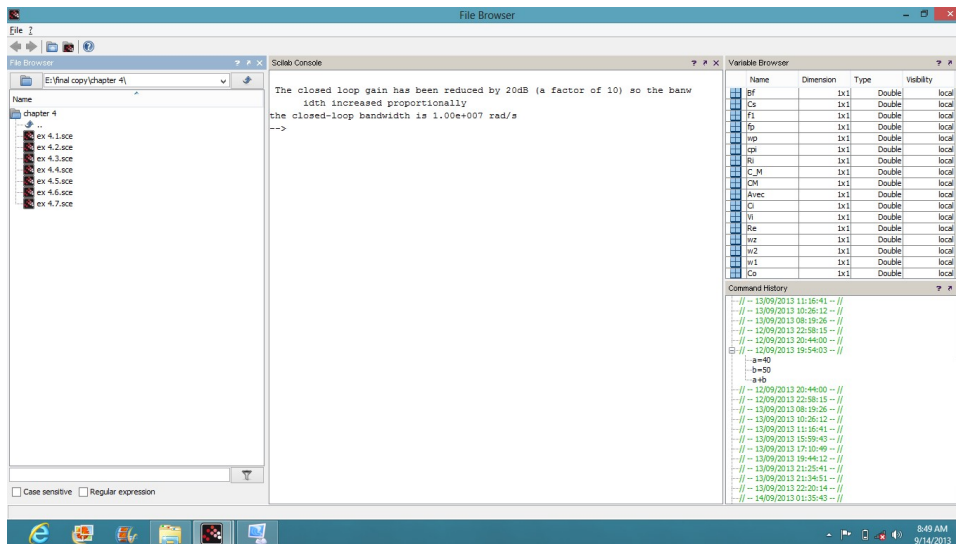


Figure 5.11: HFAAGC Ex 5 12

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.12
4 //given
5 B=10^7//amplifier bandwidth
6 Bf=10*B//closed loop bandwidth
7 disp('The closed loop gain has been reduced by 20dB
  (a factor of 10) so the bandwidth increased
  proportionally')
8 mprintf('the closed-loop bandwidth is %3.2e rad/s',B
  )

```

Scilab code Exa 5.13 HFAAGC Ex 5 13

```

1 clc

```

```

2 //Chapter 5:High Frequency amplifiers and automatic
  gain control
3 //Example 5.13 page no 184
4 //Example on emitter feedback
5 disp('The parallel combination of the two base
  biasing resistors is 2.66k ohm resistor. The
  parallel combination of this resistor and the 260
  ohm emitter resistance is 237ohm i.e.rpi=237ohm'
  )
6 gm=0.4//transconductance
7 rpi=237//base emitter resistance
8 RL=600//load resistance (values of resistance are
  taken from the figure)
9 Rs=500//source resistance
10 Av=gm*RL*rpi/(rpi+Rs)//Voltage gain
11 B=0.84*10^6//Bandwidth (The value of Bandwidth is
  taken from the Graph figure 5.51)
12 GB=Av*B//Gain bandwidth product
13 mprintf('The gain bandwidth product is %3.2e Hz ',GB
  )

```

---

#### Scilab code Exa 5.14 HFAAGC Ex 5 14

```

1 clc
2 //Chapter 5:High Frequency amplifiers and automatic
  gain control
3 //Example 5.14 page no 189
4 //Example on voltage to current feedback
5 gm=0.4//transconductance
6 RL=600//load resistance
7 Rs=500//source resistance (refer figure 5.54)
8 disp('Av=-gm*RL/(1+gf*RL+gm*RL*(Rs/RF))')//Voltage
  gain

```

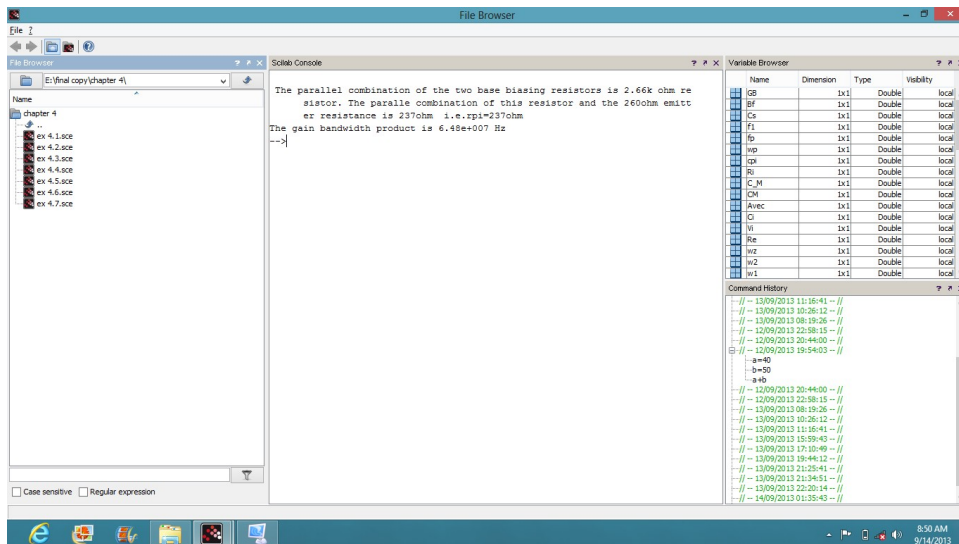


Figure 5.12: HFAAGC Ex 5 13

```

9 disp('GB=Av*B')
10 disp('The gain bandwidth product varies from a low
    of 59.5*10^6 Hz for a gain of unity 265.1*10^6 Hz
    for a closed loop gain of 17.9 ')/(refer figure
    5.55)

```

#### Scilab code Exa 5.15 HFAAGC Ex 5 15

```

1 clc
2 //Chapter 5:High Frequency amplifiers and automatic
  gain control
3 //Example 5.15 page no 193
4 disp('Gain bandwidth product of a common base
  amplifier with lossless feedback ')
5 //All the Bandwidth values are taken by graph
6 m1=0//i.e. for no turns ratio

```

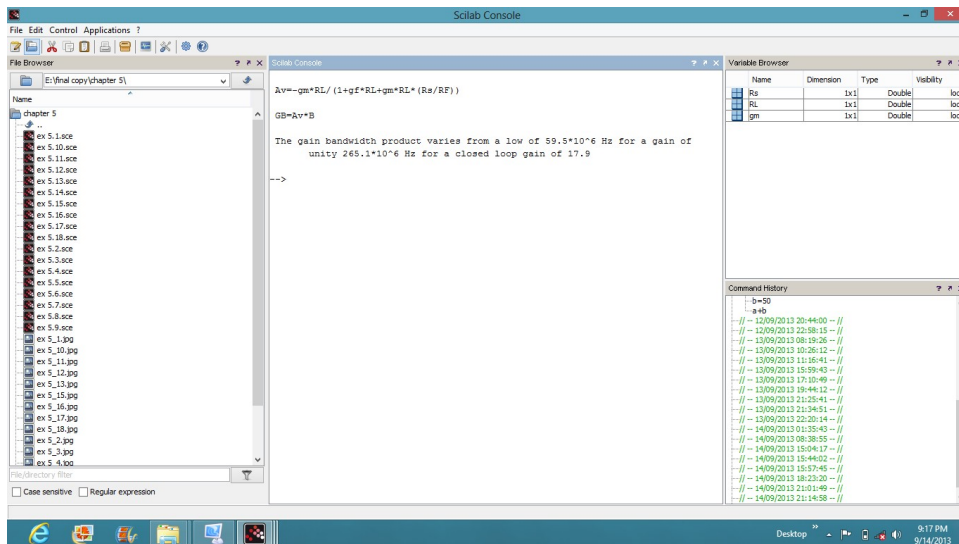


Figure 5.13: HFAAGC Ex 5 14

- 7 Av1=1//for no turns ratio voltage gain is approx unity
- 8 B1=79.4\*10<sup>6</sup>//bandwidth
- 9 GB1=Av1\*B1//Gain bandwidth product
- 10 m2=4//i.e. for turns ratio is 4
- 11 Av2=m2/2//voltage gain
- 12 B2=11.22\*10<sup>6</sup>//bandwidth
- 13 GB2=Av2\*B2//Gain bandwidth product
- 14 m3=6//i.e. for turns ratio is 6
- 15 Av3=m3/2//voltage gain
- 16 B3=4.67\*10<sup>6</sup>//bandwidth
- 17 GB3=Av3\*B3//Gain bandwidth product
- 18 m4=10//i.e. for turns ratio is 10
- 19 Av4=m4/2//voltage gain
- 20 B4=1.6\*10<sup>6</sup>//bandwidth
- 21 GB4=Av4\*B4//Gain bandwidth product
- 22 m5=20//i.e. for turns ratio is 20
- 23 Av5=m5/2//voltage gain
- 24 B5=4.22\*10<sup>5</sup>//bandwidth
- 25 GB5=Av5\*B5//Gain bandwidth product



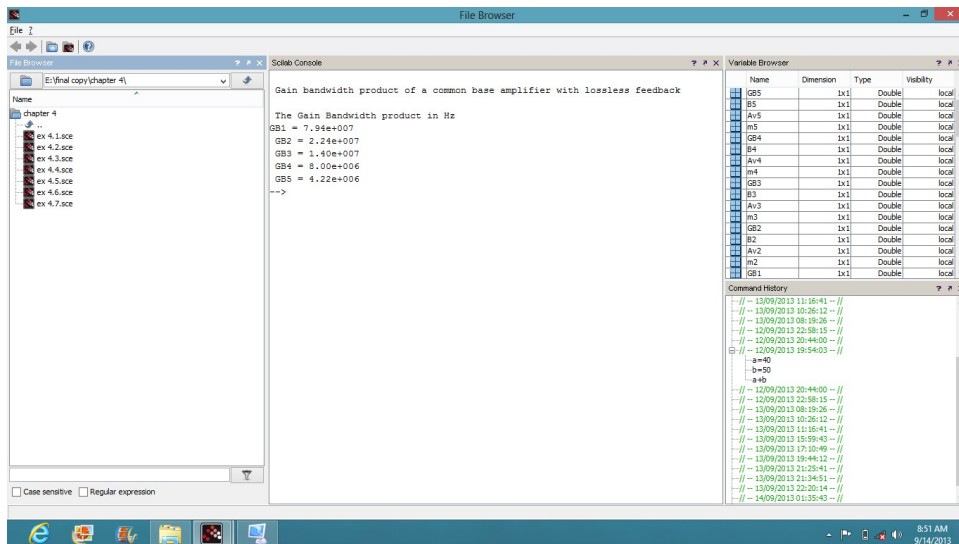


Figure 5.14: HFAAGC Ex 5 15

```

26 disp('The Gain Bandwidth product in Hz')
27 mprintf('GB1 = %3.2e \n GB2 = %3.2e \n GB3 = %3.2e \n
    n GB4 = %3.2e \n GB5 = %3.2e ',GB1,GB2,GB3,GB4,
    GB5)

```

#### Scilab code Exa 5.18 HFAAGC Ex 5 18

```

1 clc
2 //Chapter 5:High Frequency Amplifiers and Automatic
  Gain Control
3 //example 5.18
4 //given
5 Vr=1//reference voltage
6 Vc=0.5
7 Vo=Vr-Vc//output voltage
8 Vi=Vo/Vc^2//input voltage

```

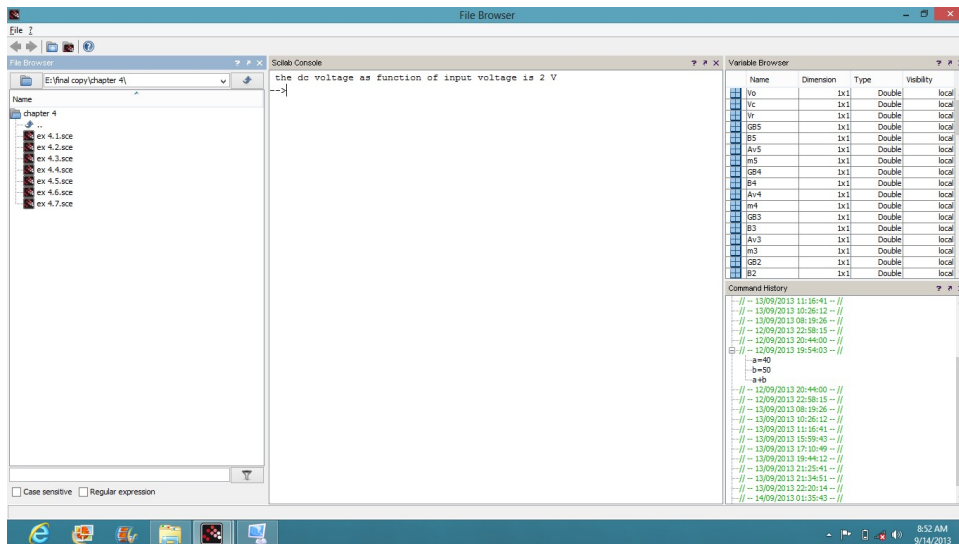


Figure 5.15: HFAAGC Ex 5 18

9 `mprintf('the dc voltage as function of input voltage is %d V',Vi)`

---

# Chapter 6

## Hybrid and Transmission Line Transforms

Scilab code Exa 6.2 HTLT Ex 6 2

```
1 clc
2 //Chapter 6:Three winding transformer
3 //example 6.2 page no 221
4 //given
5 k=1
6 R=50//resistor
7 R1=R*k
8 R2=R
9 R3=100
10 R4=R1/(1+k)
11 N=sqrt(R1/(2*R3))//turns ratio
12 mprintf('the turns ratio %f \n R4=%d ',N,R4)
13 disp('the output voltage  $E_o = -I_3.R_L = E_1/2$ ')
```

---

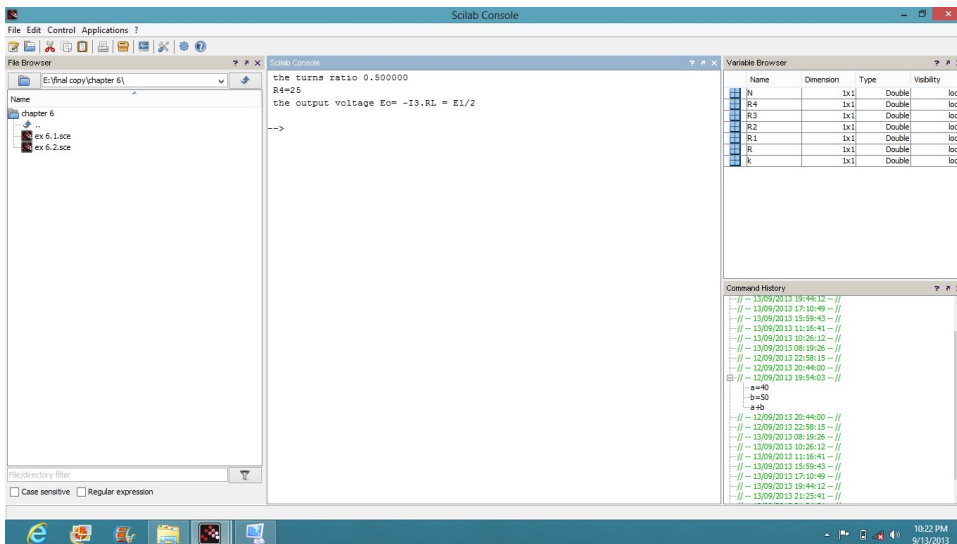


Figure 6.1: HTLT Ex 6 2

# Chapter 7

## Oscillators

Scilab code Exa 7.1 Oscillators Ex 7 1

```
1  clc
2  //Chapter 7:Conditions for Oscillation
3  //example 7.1 page no 247
4  //given
5  B=100//current gain
6  f=20*10^6//oscillator frequency
7  VT=26*10^-3
8  Ic=1*10^-3//dc bias current
9  ri=VT/Ic//common base inout resistance
10 gm=ri^-1//transconductance
11 GH=3//In oscillator design the loop gain is usually
    selected to be about 3,which allow for some error
    in the approximation so that (C1+C2)/C1=3
12 C2=(2*pi*f*8)^-1//second capacitor
13 C1=C2/2//first capacitor
14 Req=ri*((C1+C2)/C1)^2//equivalent resistor
15 L=((2*pi*f)^2)*((C1*C2)/(C1+C2))^-1//inductor
16 mprintf('the value of second capacitor is %f pF \n
    the value of first capacitor is %f pF \n the
    value of equivalent resistor is %d ohm \n the
    value of indicator is %f uH',C2*1e12,C1*1e12,Req,
```

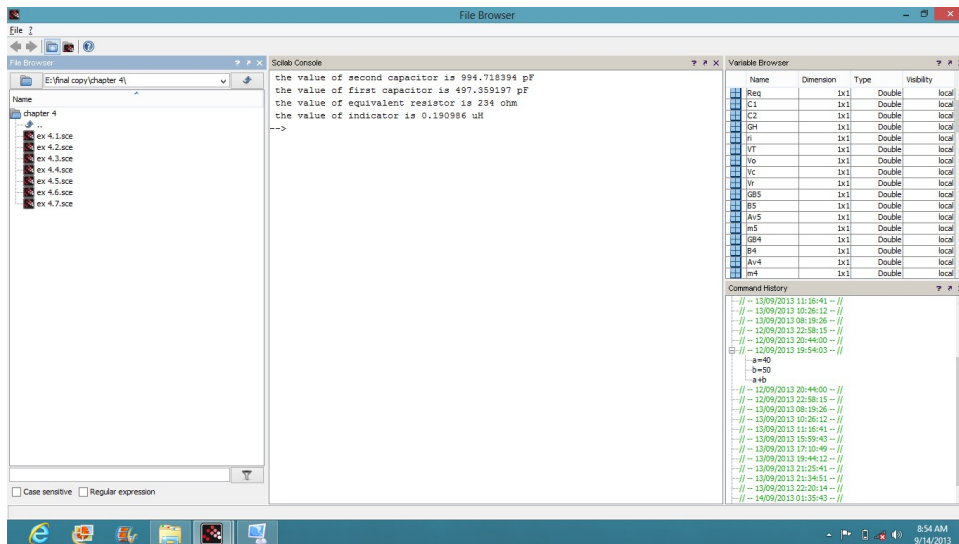


Figure 7.1: Oscillators Ex 7 1

$L \cdot 10^6$ )

### Scilab code Exa 7.2 Oscillators Ex 7 2

```

1  clc
2  //Chapter 7: Conditions for Oscillation
3  //example 7.2 page no 251
4  //given
5  B=100
6  f=5*10^6//oscillator frequency
7  L=10*10^-6//inductor
8  X=(L*(2*pi*f)^2)^-1//Taking X=C1'*C2/(C1'+C2)
9  r=3.14//series resistance of inductor
10 C1=200*10^-12//first capacitor(assuming values of
    capacitors)
11 C2=200*10^-12//second capacitor

```

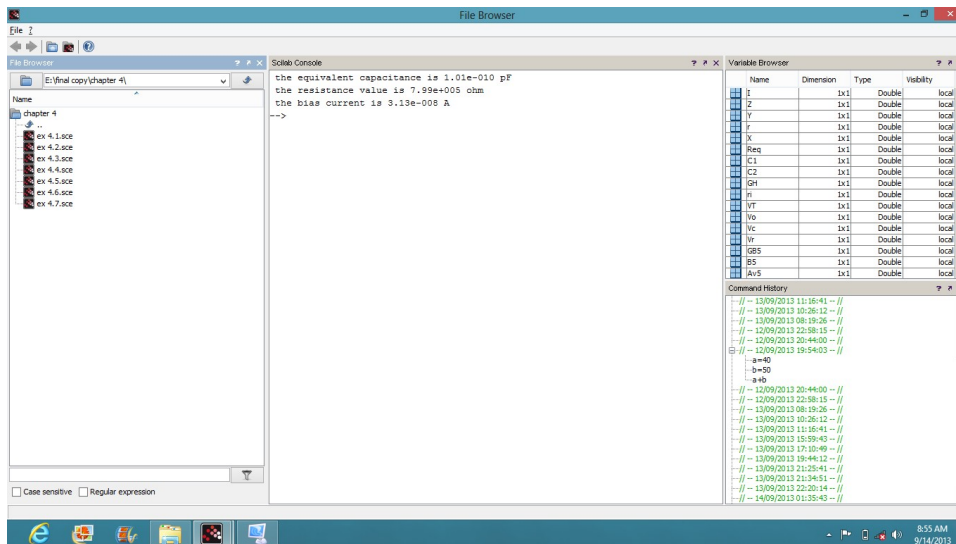


Figure 7.2: Oscillators Ex 7 2

```

12 Y=(1+B)/(((2*%pi*f)^2)*C1*C2)
13 Z=L/C1
14 rpi=(Y-Z)*r^-1//resistance
15 gm=rpi^-1//transconductance
16 I=gm/40//bias current
17 mprintf('the equivalent capacitance is %3.2e pF \n
           the resistance value is %3.2e ohm \n the bias
           current is %3.2e A',X,rpi,I)

```

### Scilab code Exa 7.3 Oscillators Ex 7 3

```

1 clc
2 //Chapter 7:Conditions for Oscillation
3 //example 7.3
4 //given
5 rpi=1000

```

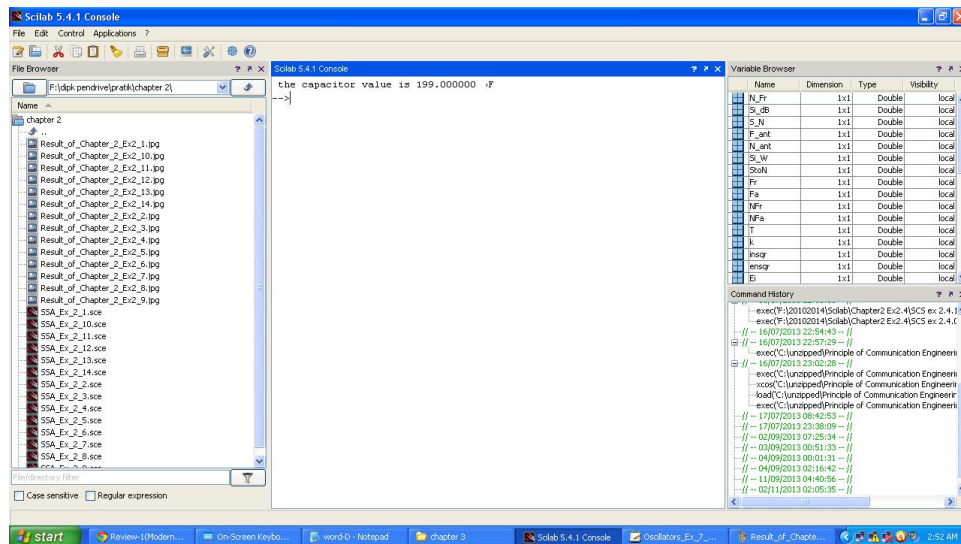


Figure 7.3: Oscillators Ex 7 3

```

6 C1=200*10^-12
7 r=3.14//series resistance
8 C_1=C1/(1+(r/rpi))//capacitance
9
10 mprintf('the capacitor value is %f pF',round(C_1*1
    e12))

```

#### Scilab code Exa 7.4 Oscillators Ex 7 4

```

1 clc
2 //Chapter 7: Conditions for Oscillation
3 //example 7.4 page no 255
4 //given
5 gm=6*10^-3
6 r=4
7 f=10^6

```



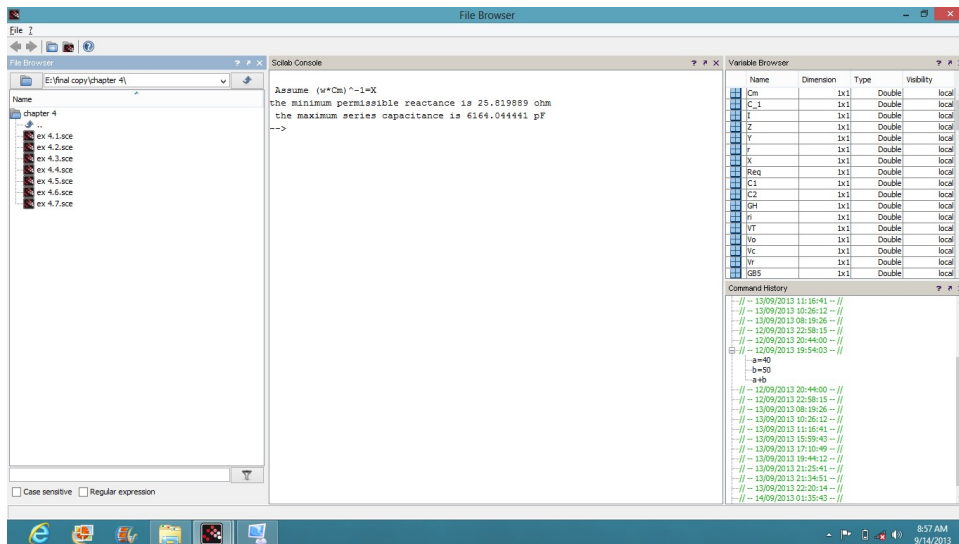


Figure 7.4: Oscillators Ex 7 4

```

8 disp('Assume (w*Cm)^-1=X')
9 X=sqrt(r/gm)//minimum permissible reactance
10 Cm=(2*%pi*f*X)^-1//maximum series capacitance
11 mprintf('the minimum permissible reactance is %f ohm
    \n the maximum series capacitance is %f pF',X,Cm
    *1e12)

```

#### Scilab code Exa 7.5 Oscillators Ex 7 5

```

1 clc
2 //Chapter 7: Conditions for Oscillation
3 //example 7.5 page no 265
4 //given
5 Co=3.2//shunt capacitance
6 C1=0.008
7 k=Co/C1//ratio

```

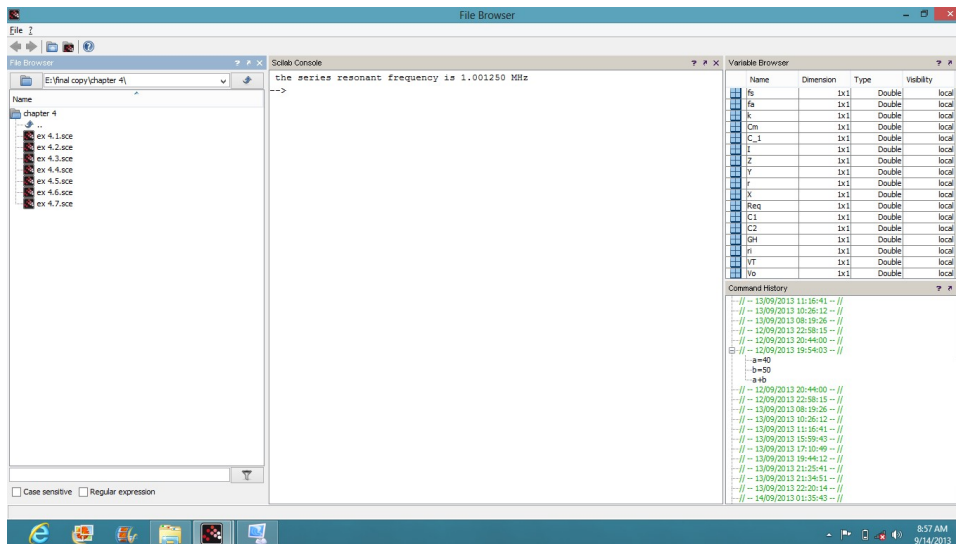


Figure 7.5: Oscillators Ex 7 5

```

8 fa=10^6//crystai's antiresonant frequency
9 fs=1+(2*k)^-1//series resonant frequency
10 mprintf('the series resonant frequency is %f MHz',fs
    )

```

---

### Scilab code Exa 7.6 Oscillators Ex 7 6

```

1 clc
2 //Chapter 7:Conditions for Oscillation
3 //example 7.6 page no 265
4 //given
5 f=5.7*10^6//given frequency
6 Xs=4654//shunt reactance for shunt capacitacne of 6
    pF
7 r=25//series resistance

```

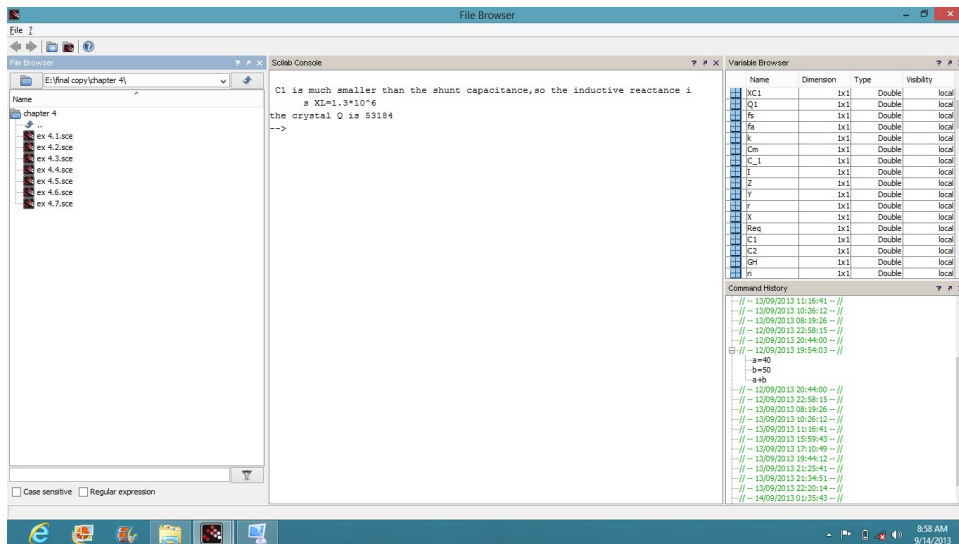


Figure 7.6: Oscillators Ex 7 6

```

8 Q1=Xs/r//equivalent to crystal Q for easily
  expressing
9 C1=21*10^-15
10 XC1=(C1*2*%pi*f)^-1//capacitive reactance
11 disp('C1 is much smaller than the shunt capacitance ,
      so the inductive reactance is XL=1.3*10^6 ')
12 Q=XC1/r//crystal Q
13 mprintf('the crystal Q is %d ',Q)

```

#### Scilab code Exa 7.7 Oscillators Ex 7 7

```

1 clc
2 //chapter 7:Crystal Oscillator Characteristics
3 //Example 7.7 page no 266
4 //given
5 f=20*10^6//given frequency

```

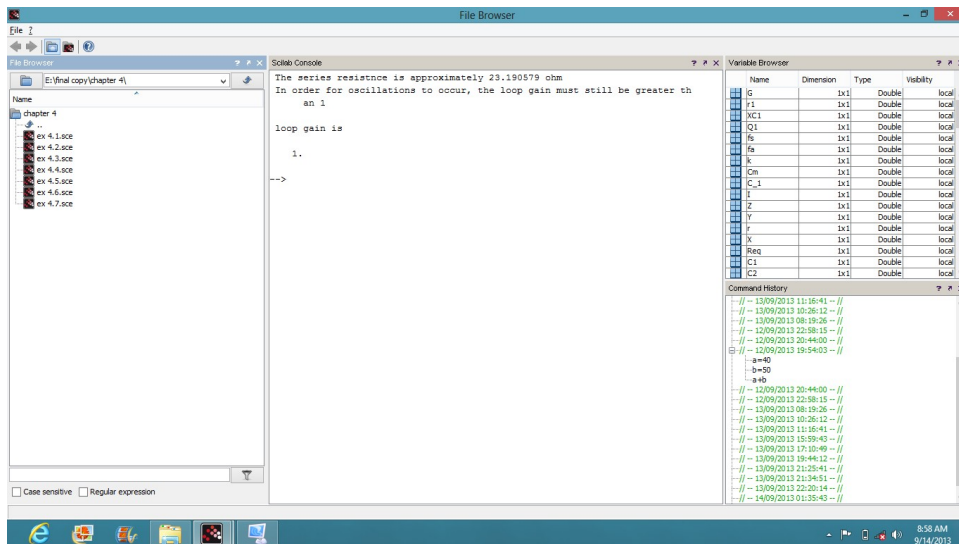


Figure 7.7: Oscillators Ex 7 7

```

6 //If the crystal load capacitance is specified to be
   32pF, then the series combination of C1 and C2
   must be 32pF. this could be satisfied by using 64
   pF capacitors for both C1 and C2.
7 gm=1.5*10^-3//transconductance
8 C1=64*10^-12
9 C2=64*10^-12
10 r1=gm/((2*pi*f)^2*C1*C2)//series resistance of the
   crystal
11 mprintf('The series resistance is approximately %f
   ohm ',r1)
12 disp('In order for oscillations to occur, the loop
   gain must still be greater than 1')
13 G=gm*((2*pi*f*C1)^-1)^2/r1//loop gain
14 disp(G,'loop gain is ')

```

### Scilab code Exa 7.8 Oscillators Ex 7 8

```
1 clc
2 //Chapter 7:Conditions for Oscillation
3 //example 7.8 page no 270
4 //given
5 fa=5.7*10^6//parallel antiresonant frequency
6 C1=21*10^-15
7 Co=37.1*10^-12//here 32pF is parallel with 5.1pF so
   they get added
8 CL=22*10^-12
9 f_a=fa*((1+C1/(2*(Co+CL)))/(1+C1/(2*Co)))//new
   parallel antiresonant frequency
10 r1=25
11 Rp=r1*(1+((r1*2*%pi*f_a*(Co+CL))^-1)^2)//equivalent
   parallel resistance
12 mprintf('the new parallel antiresonant frequency is
   %f MHz \n the equivalent parallel resistance is
   %f Kohm',f_a*1e-6,Rp*1e-3)
```

---

### Scilab code Exa 7.9 Oscillators Ex 7 9

```
1 clc
2 //Chapter 7:Conditions for Oscillation
3 //example 7.9 page no 284
4 //given
5 rd=50*10^3
6 gm=5*10^-3//transconductance
7 f=16*10^6//frequency of oscillation
8 Rs=15
9 XC1=1*10^3//capacitive reactance of first capacitor
10 XC2=Rs/(gm*XC1)//capacitive reactance of second
   capacitor
```

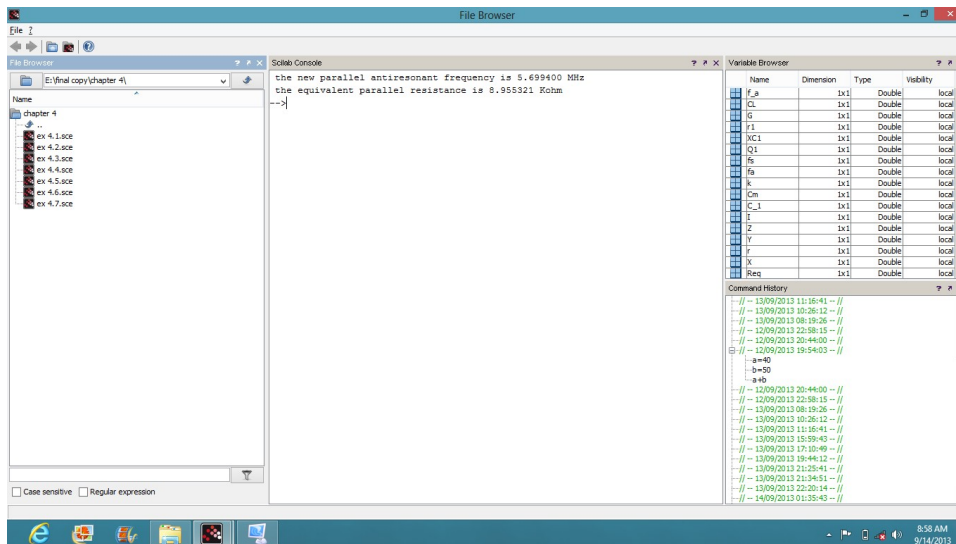


Figure 7.8: Oscillators Ex 7 8

```

11 C1=(2*%pi*f*XC1)^-1//value of first capacitor
12 C2=(2*%pi*f*XC2)^-1//value of second capacitor
13 mprintf('the value of first capacitor is %3.2e pF\n
    the value of second capacitor is %3.2e pF\n ',C1,
    C2)
14 disp('This value of C1 may be so small that the
    transistor output capacitance has a effect.
    therefore it is desirable to increase C1.If C1 is
    increased by a factor of 10,so that XC1=100,then
    C2 must also be increased ')
15 XC_2=Rs/(gm*100)//new value of reactance
16 XL=100+XC_2//inductive reactance
17 L=XL/(2*%pi*f)//value of inductor
18 mprintf('the value of inductor is %3.2e H',L)

```

---

Scilab code Exa 7.11 Oscillators Ex 7 11

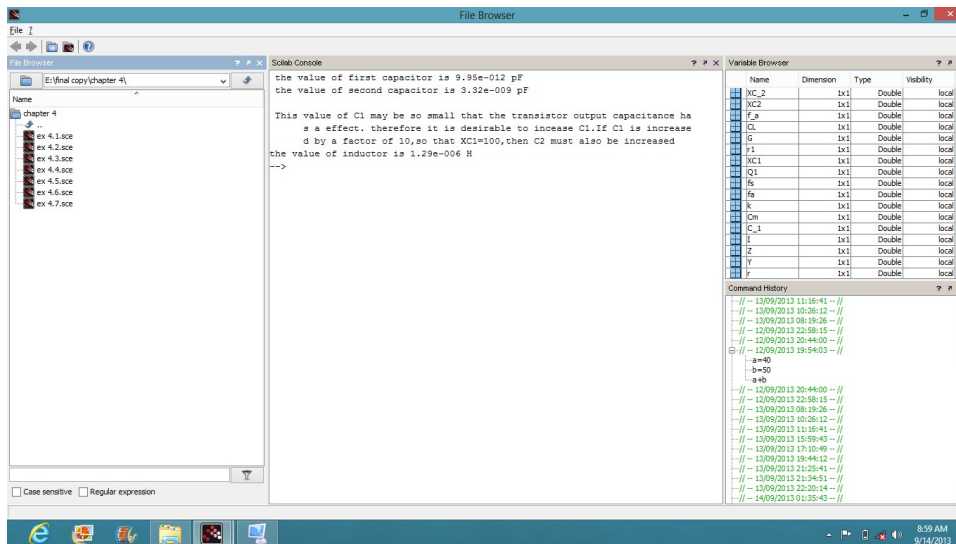


Figure 7.9: Oscillators Ex 7 9

```

1  clc
2  //Chapter 7: Oscillators
3  //Example 7.11 page no 292
4  disp('In order to convert the input waveform from
      87.5MHz to 10.7MHz the local oscillator would
      need to be 76.8MHz(low side injection) or 98.2MHz
      (high side injection).To convert the input
      waveform from 108.0MHz the local oscilltor would
      need to be 97.3MHz (low side injection) or 118.7
      MHz (high side injection) ')
5  L=0.05*10^-6//choosing value of indicator
6  f1=76.8*10^6//starting frequency
7  f2=97.3*10^6//ending frequency
8  C1=((1/(2*pi*f1))^2)/L//Capacitor value for
      starting frequency
9  C2=((1/(2*pi*f2))^2)/L//Capacitor value for ending
      frequency
10 mprintf('The value of C is varies between %3.2e F to
      %3.2e F ',C1,C2)

```

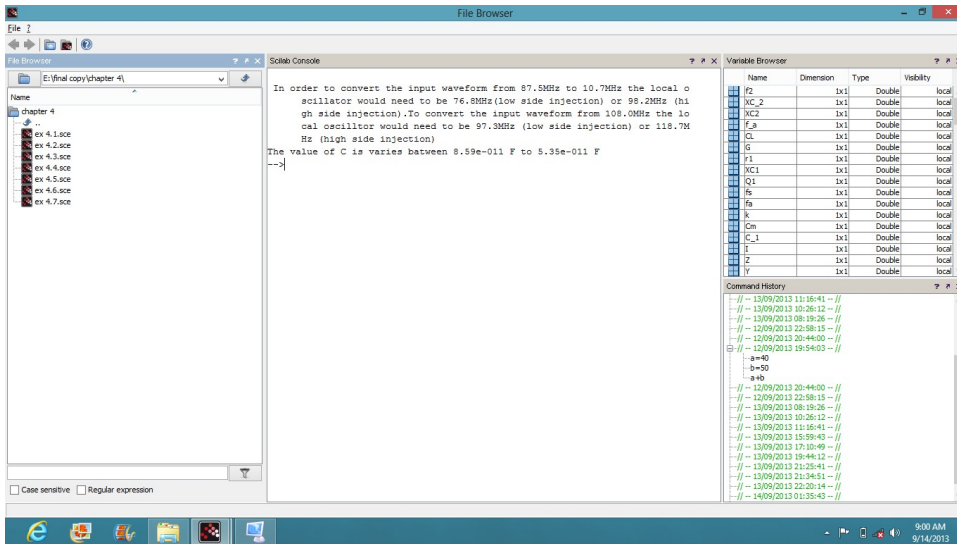


Figure 7.10: Oscillators Ex 7 11



# Chapter 8

## Phase Locked Loops

Scilab code Exa 8.1 PLL Ex 8 1

```
1  clc
2  //Chapter 8:Linear model of phase locked loop
3  //example 8.1 page no 314
4  //given
5  fo=1*10^6//output frequency
6  fr=25*10^3//reference frequency
7  N=fo/fr
8  Kd=2//phase detector gain factor
9  Ko=100//VCO gain factor
10 thetao=(2*100*2*%pi)//output phase
11 s=poly(0,"s")
12 thetar=s+(2*100*2*%pi)/N//input phase
13 Tf=thetao/thetar
14 disp(Tf,'the closed loop transfer function is ')
15 Kv=Kd*Ko/N//bandwidth
16 mprintf('the synthesizer bandwidth will be %d Hz',Kv
    )
```

---

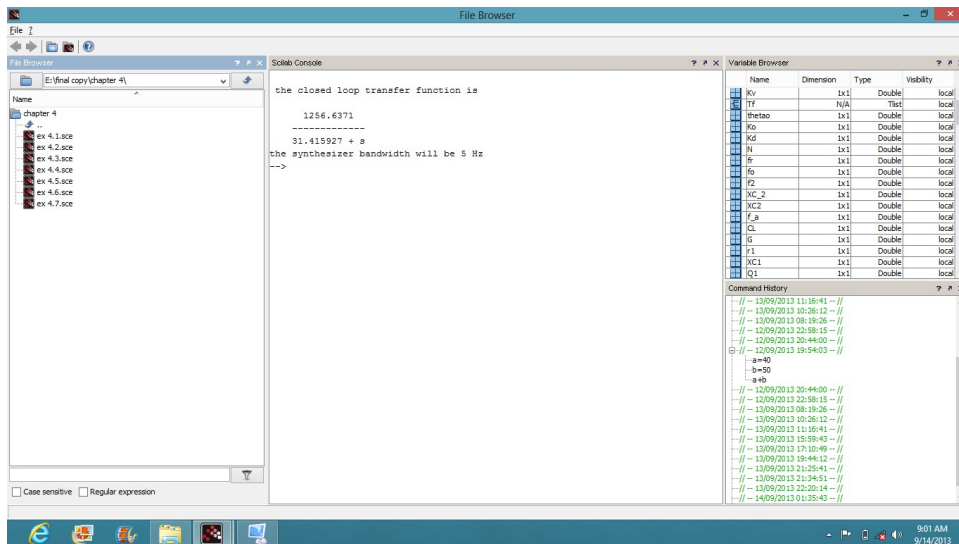


Figure 8.1: PLL Ex 8 1

### Scilab code Exa 8.2 PLL Ex 8 2

```

1  clc
2  //Chapter 8:Linear model of phase locked loop
3  //example 8.2 page no 316
4  //given
5  zeta=0.707//damping ratio for butterworth filter
6  Kv=10*%pi//bandwidth
7  wL=Kv*(2*zeta)^2//low pass filter bandwidth
8  wn=sqrt(Kv*wL)//bandwidth of closed loop system
9  tr=2.2/wn//rise time
10 mprintf('low pass filter bandwidth is %f rad/s \n
    bandwidth of closed loop system is %f rad/s \n
    the system rise time is %3.2e s',wL,wn,tr)

```

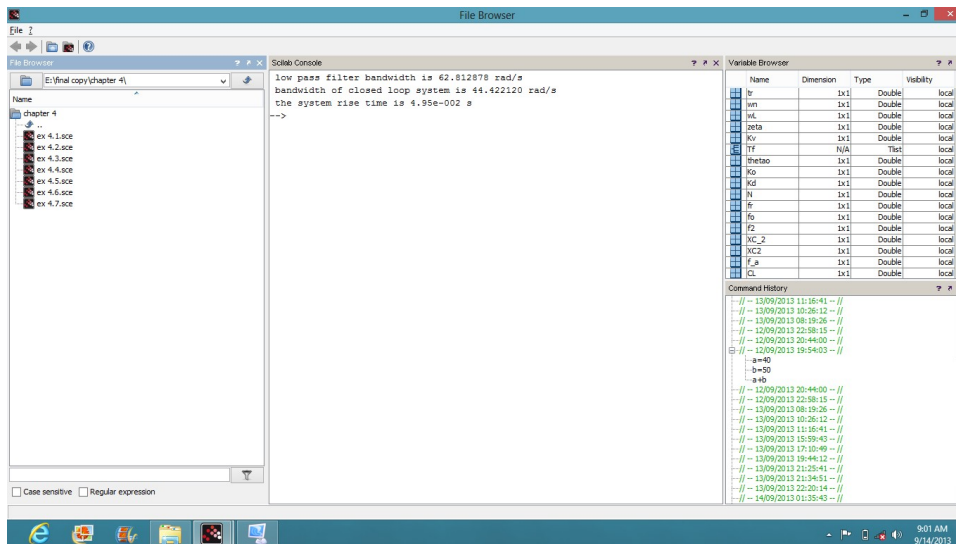


Figure 8.2: PLL Ex 8 2

#### Scilab code Exa 8.4 PLL Ex 8 4

```

1  clc
2  //Chapter 8:Linear model of phase locked loop
3  //example 8.6 page no 349
4  //given
5  //The VCO is designed to oscillate at 100kHz
6  R1=10.8*10^3
7  R2=10.8*10^3
8  C=1*10^-9
9  N=2//order of filter
10 fmin=(R2*(C+32*10^-12))^-1//minimum frequency
11 fmax=fmin+(R1*(C+32*10^-12))^-1//maximum frequency
12 VDD=9//regulated power supply
13 Kvco=(2*%pi*(fmax-fmin))/(VDD-2)
14 Kv=Kvco*(VDD/%pi)/N
15 zeta=0.707//damping ratio for butterworth filter

```

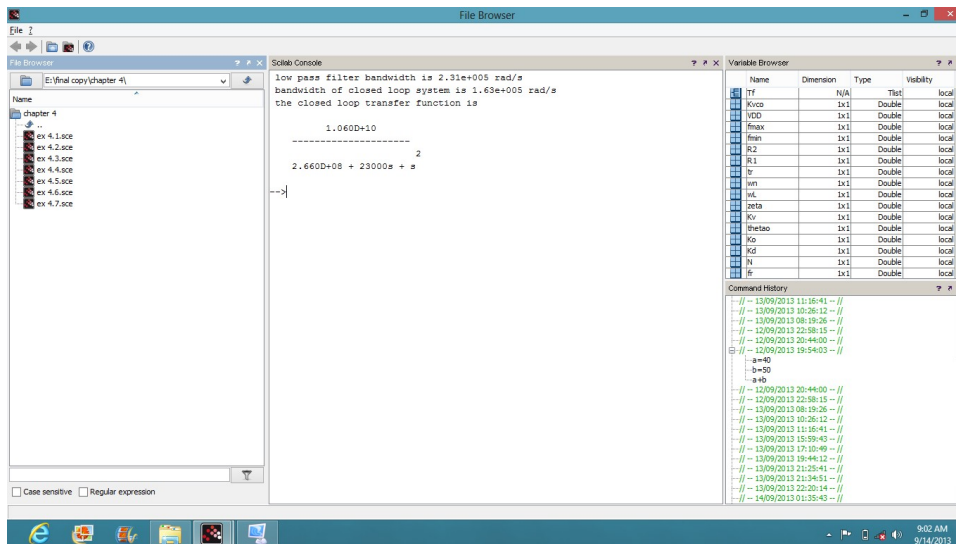


Figure 8.3: PLL Ex 8 4

```

16 wL=Kv*(2*zeta)^2//low pass filter bandwidth
17 wn=sqrt(Kv*wL)//bandwidth of closed loop system
18 mprintf('low pass filter bandwidth is %3.2e rad/s \n
           bandwidth of closed loop system is %3.2e rad/s',
           wL,wn)
19 thetao=(10.6*10^9)//output phase
20 s=poly(0,"s")
21 thetar=s^2+s*2.3*10^4+2.66*10^8//input phase
22 Tf=thetao/thetar
23 disp(Tf,'the closed loop transfer function is ')

```

# Chapter 9

## Phase Locked Loop Analysis

Scilab code Exa 9.1 PLLA Ex 9 1

```
1 clc
2 //chapter 9: Stability Analysis
3 //Example 9.1 page no 357
4 //given
5 Kv=50//DC gain
6 wL=100//corner frequency
7 disp('The system crossover frequency is
      approximately 50 rad/s')
8 PhaseMargin=90-(atan(50/wL)*180/%pi)//phase margin
      of system
9 disp('At this frequency the phase shift of the open
      loop transfer function is -112.5')
10 disp(PhaseMargin,'The phase margin is ')
```

---

Scilab code Exa 9.2 PLLA Ex 9 2

```
1 clc
```

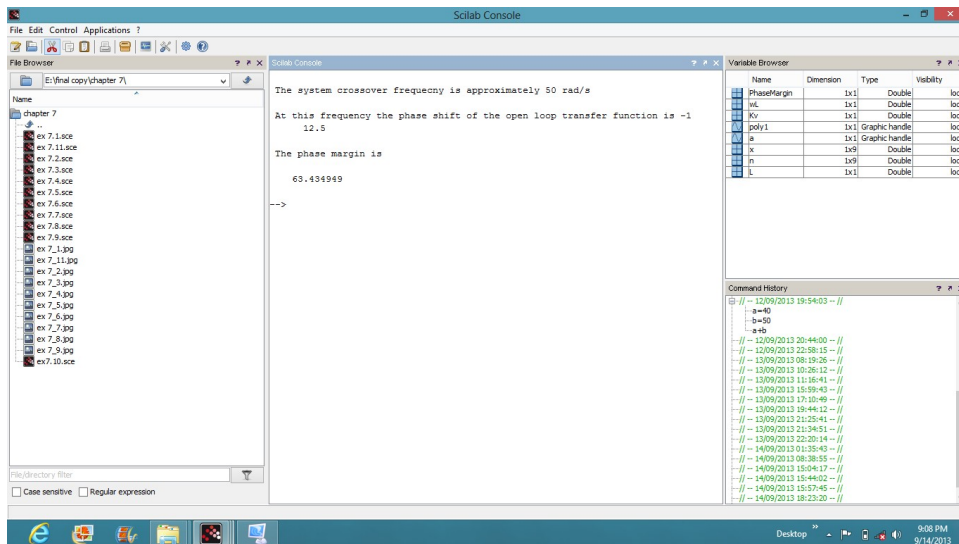


Figure 9.1: PLLA Ex 9 1

```

2 //chapter 9: Stability Analysis
3 //Example 9.2 page no 357
4 //given
5 Kv=50 //DC gain
6 wL=10 //corner frequency
7 disp('The system crossover frequency is
      approximately 22 rad/s')
8 PhaseMargin=90-(atan(22/wL)*180/%pi) //phase margin
      of system
9 disp(PhaseMargin,'The phase margin is ')

```

### Scilab code Exa 9.3 PLLA Ex 9 3

```

1 clc
2 close
3 //chapter 9: Stability Analysis

```

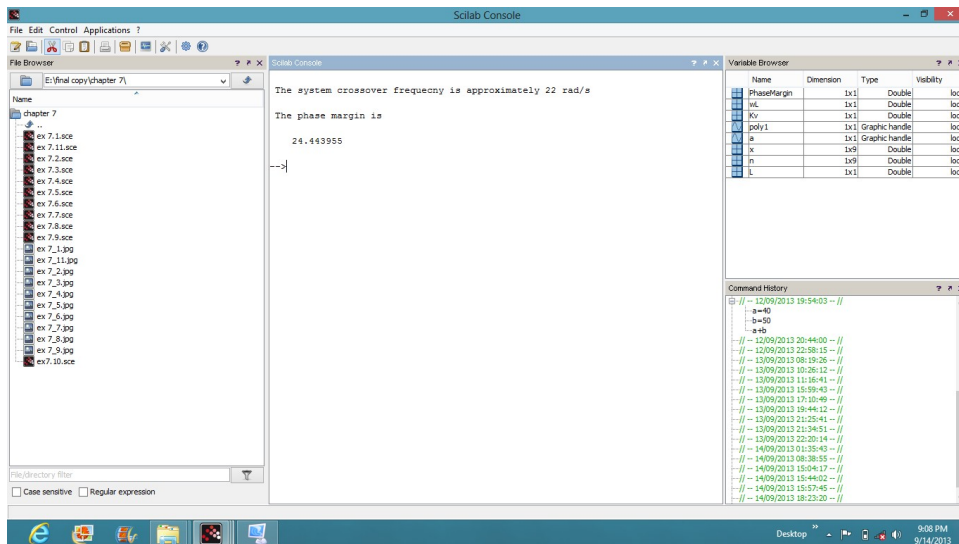


Figure 9.2: PLLA Ex 9 2

```

4 //Example 9.3 page no 361
5 //given
6 clear
7 wL=258
8 s=poly(0, 's')
9 h=syslin('c', (100/(s*(s/wL+1)^2)))
10 clf(); bode(h,1,1000);
11 disp('The open loop gain and the phase plots are
    given .It is seen that the crossover frequency is
    15Hz, and the phase margin is 50degree')
12 disp('We know that the overshoot can be increased by
    decreasing the phase margin. In fact, in this case
    selecting wL=233 rad/s corresponding to phase
    margin of 43.5degree gives an overshoot of 20
    percent')

```

---

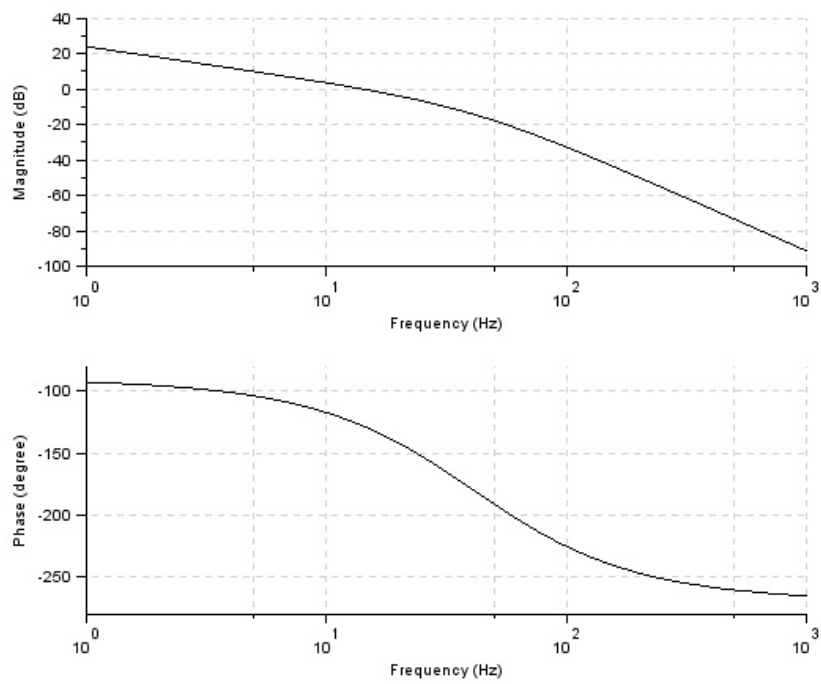


Figure 9.3: PLLA Ex 9 3



#### Scilab code Exa 9.4 PLLA Ex 9 4

```
1 clc
2 close
3 //chapter 9: Stability Analysis
4 //Example 9.4 page no 363
5 //given
6 clear
7 N=2
8 Kv=0.83*10^3//DC gain
9 B=1250//closed loop bandwidth
10 wn=1.27*10^3
11 wL=wn^2/Kv//corner frequency
12 s=poly(0, 's')
13 h=syslin('c', (1/((s^2/wn^2)+0.9*s/wn+1)))
14 clf();bode(h,1,1000);
```

---

#### Scilab code Exa 9.5 PLLA Ex 9 5

```
1 clc
2 close
3 //chapter 9: Stability Analysis
4 //Example 9.5 page no 368
5 //given
6 clear
7 Ka=(2.2e3)^2
8 wz=(2*%pi)/(2.2/sqrt((2.2e3)^2))
9 s=poly(0, 's')
10 h=syslin('c', (1000*(s/(wz+1))/(s^2/Ka +(s/wz) +1)))
11 clf();bode(h,1,1000);
```

---

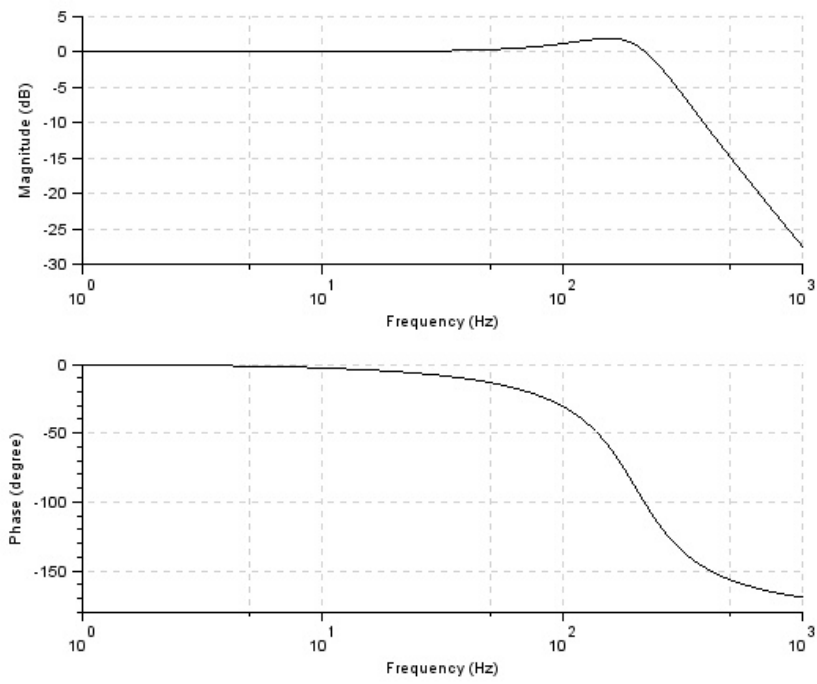


Figure 9.4: PLLA Ex 9 4

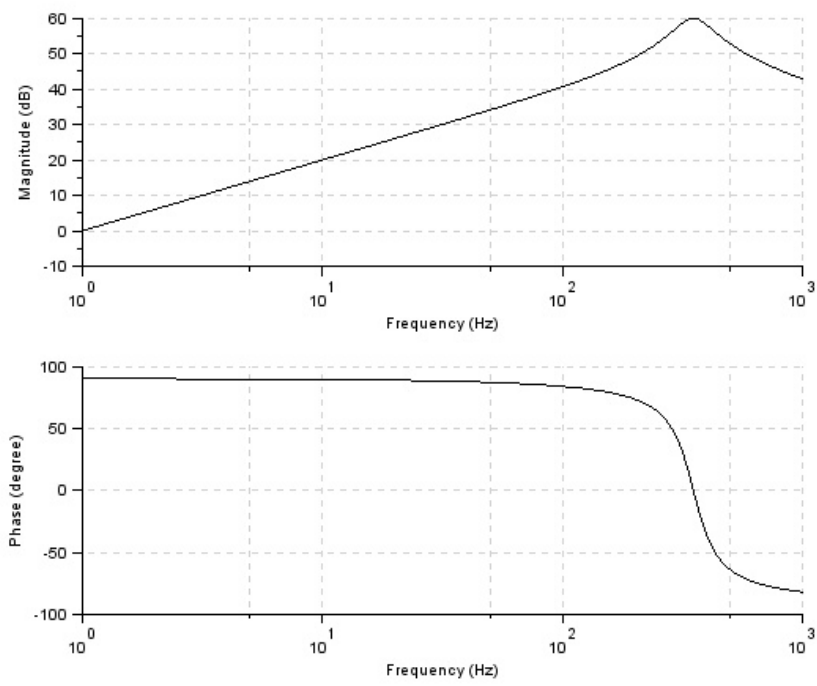


Figure 9.5: PLLA Ex 9 5

### Scilab code Exa 9.6 PLLA Ex 9 6

```
1 clc
2 //Chapter 9:Stability Analysis
3 //example 8.6 page no 373
4 //given
5 zeta=0.8//damping ratio
6 B=10^3//closed loop bandwidth
7 X=sqrt(1+2*zeta^2+sqrt(2+4*zeta^2+4*zeta^4))
8 Ka=(B/X)^2//loop gain
9 wn=sqrt(Ka)//
10 wz=wn/(2*zeta)//the system zero
11 mprintf('the closed loop gain is %3.2e (rad/s)^2 \n
           wn = %f rad/s \n the system has zero at %d rad/s'
           ,Ka ,wn ,wz)
```

---

### Scilab code Exa 9.7 PLLA Ex 9 7

```
1 clc
2 //Chapter 9:Phase locked loop Analysis
3 //Example 9.7 page no 376
4 a=28//taking alpha as a
5 Ka=0.21*10^6
6 GF=20*log10(a)^1/2
7 disp(GF,'The value of gain is ')
8 disp('so we must determine where the uncompensated
       frequency response is -14.5dB ')
9 Wc=a^(1/4)*Ka^(1/2)
10 disp('The 28:1 lead ratio will increase the
       crossover frequency by a factor 2.3 The factor
```

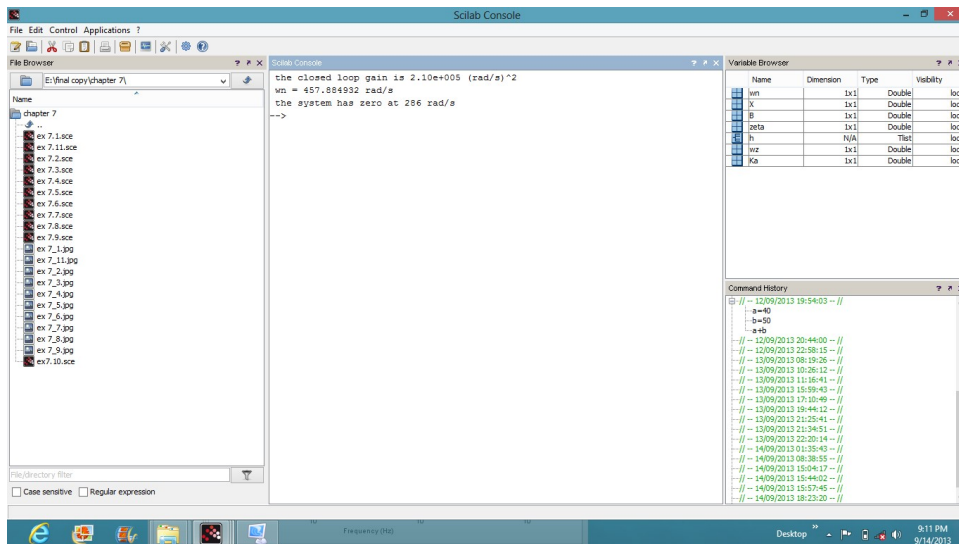


Figure 9.6: PLLA Ex 9 6

```

    zero is placed at ')
11 Wz=Wc/sqrt(a)//systems zero
12 Wp=a*Wz//systems pole
13 mprintf('The crossover frequency is %3.2e rad/s \n
    The zero is placed at %d rad/s \n The pole is
    placed at %d rad/s ',Wc,Wz,Wp)

```

#### Scilab code Exa 9.9 PLLA Ex 9 9

```

1 clc
2 //Chapter 9:Phase locked loop Analysis
3 //Example 9.9 page no 380
4 disp('since the phase margin without time delay is
    50 degree , a 10 degree phase lag can be
    introduced by the time delay at the crossover
    frequency. That is ,')

```

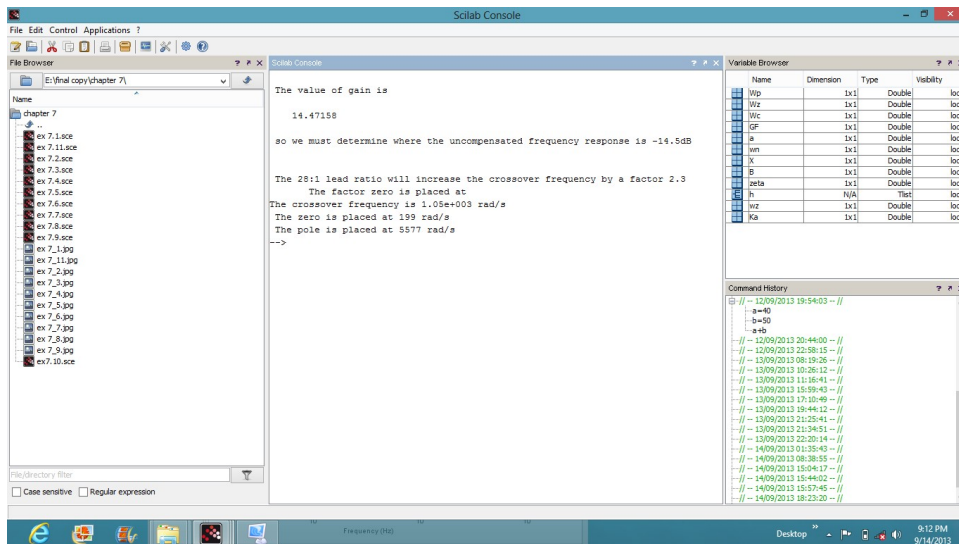


Figure 9.7: PLLA Ex 9 7

```

5 Wc=1000//crossover frequency
6 thetaT=-0.174
7 T=thetaT/Wc//time delay
8 mprintf('The time delay is %3.2e ',T)

```

---

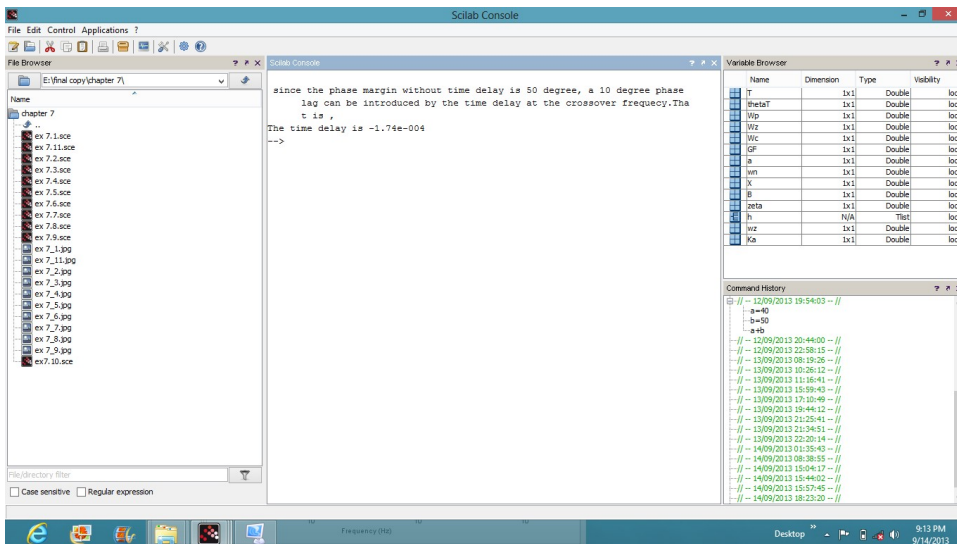


Figure 9.8: PLLA Ex 9 9

# Chapter 10

## Frequency Synthesizers

Scilab code Exa 10.3 FS Ex 10 3

```
1 clc
2 //Chapter 10:Frequency Synthesizers
3 //Example 10.3 page no 416
4 fr=1*106//reference frequency
5 f=100*106//given frequency
6 fi=1*106//increment in frequency
7 Dmin=fr*f/fi
8 mprintf('The value of Dmin is %d Hz ',Dmin)
```

---

Scilab code Exa 10.4 FS Ex 10 4

```
1 clc
2 //Chapter 10:Frequency Synthesizers
3 //Example 10.4 page no 417
4 fo=185.6*106//required output frequency
5 fr=31.25*103//reference frequency
6 P=64
```



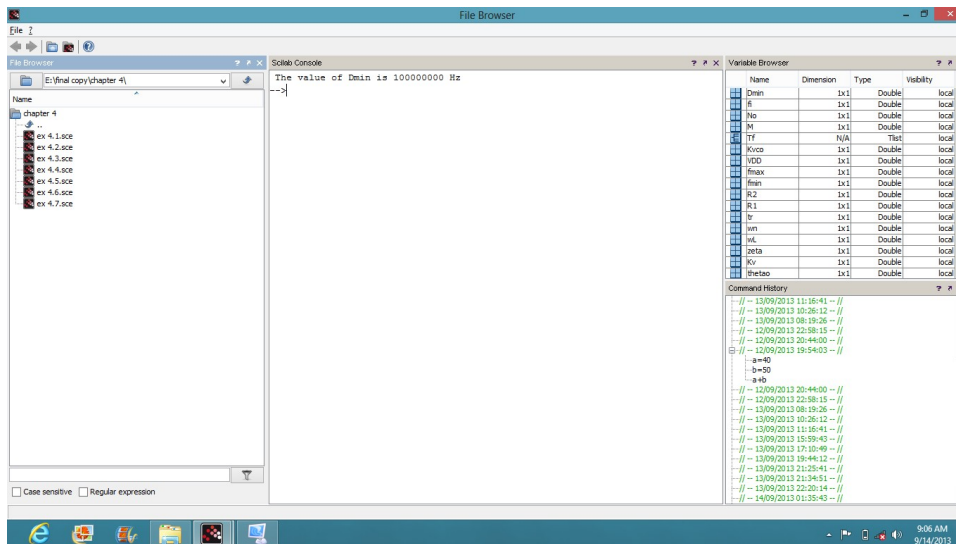


Figure 10.1: FS Ex 10 3

```

7 disp('To begin with the hopping bin channel spacing
  requirement of at least 20KHz, a 2MHz crystal is
  connected to the MC14512-2 with the reference
  address inputs(pins 4,5,6) connected such that
  the crystal is divided by 64(RA2=0,RA1=0,RA0=1)
  This gives a reference frequency of 31.25KHz; and
  the maximum number of hops is 5.2MHz/31.25KHz
  =166.4hops FOr 185.6MHZ the values of N and A are
  found as follows:')
8 N=(fo/fr)/P//finding N for A=0
9 disp('For this value of N,find A by ')
10 A=(fo/fr)-92*P
11 mprintf('N = %d \n A = %d ',N,A)

```

---

Scilab code Exa 10.5 FS Ex 10 5

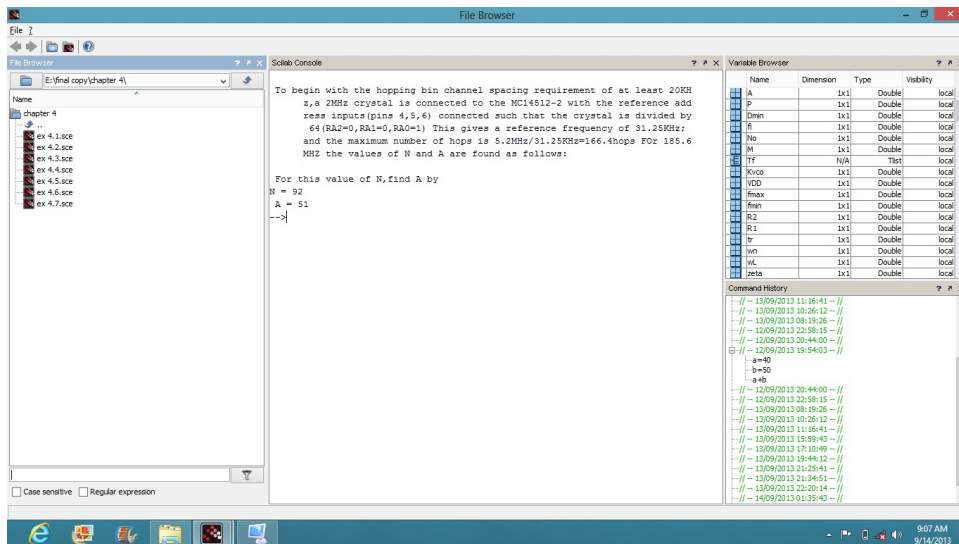


Figure 10.2: FS Ex 10 4

```
1 clc
2 //Chapter 10:Frequency Synthesizers
3 //Example 10.5 page no 426
4 fr=100*10^3//reference frequency
5 f=10*10^6//given frequency
6 fi=1*10^3//increment in frequency
7 fo=fr*f/fi//required VCO operating frequency
8 mprintf('The value of VCO operating frequency is %3
    .2e Hz',fo)
```

#### Scilab code Exa 10.7 FS Ex 10 7

```
1 clc
2 //Chapter 10:Frequency Synthesizers
3 //Example 10.7 page no 429
4 N=4
```

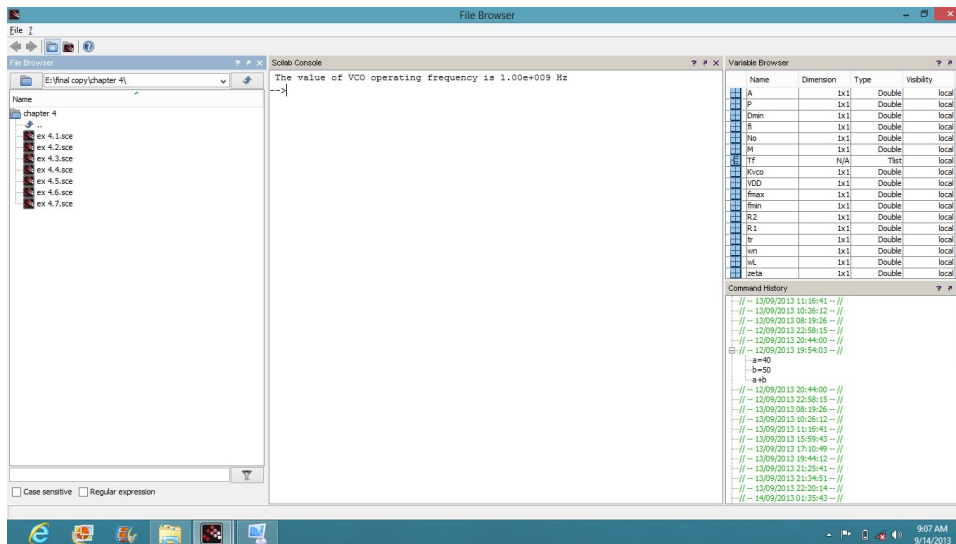


Figure 10.3: FS Ex 10 5

```

5 M=1.8//count
6 fr=100*10^3//reference frequency
7 fo=fr*(N+M^-1)//output frequency
8 mprintf('The value of output frequency is %3.2e Hz',
          fo)

```

---

#### Scilab code Exa 10.8 FS Ex 10 8

```

1 clc
2 //Chapter 10:Frequency Synthesizers
3 //Example 10.8 page no 429
4 N=100
5 M=10//count
6 fr=10*10^3//reference frequency
7 fo=fr*(N+M^-1)//output frequency
8 mprintf('The value of output frequency is %f Hz',fo)

```

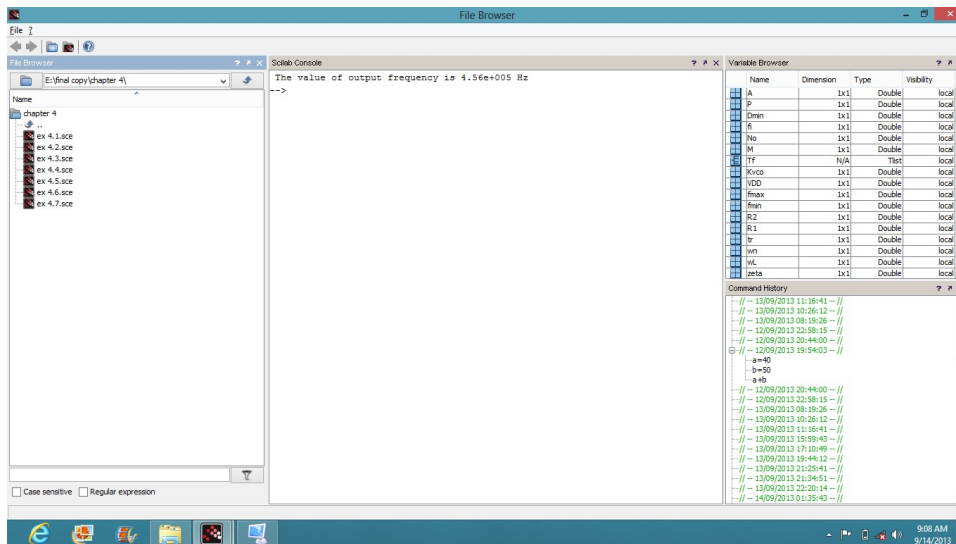


Figure 10.4: FS Ex 10 7

---

### Scilab code Exa 10.11 FS Ex 10 11

```

1  clc
2  //Chapter 10:Frequency Synthesizers
3  //Example 10.11 page no 446
4  disp('A signal sideband power is -140dB/Hz ')
5  N=5*10^6//frequency of reference oscillator
6  M=5*10^3//count
7  No=-140+10*log10((N/M)^2)//the output noise power
   due to the reference oscillator
8  mprintf('The single sideband noise power at a
   frequency offset of 0.5KHz is %d dB/Hz ',No)

```

---

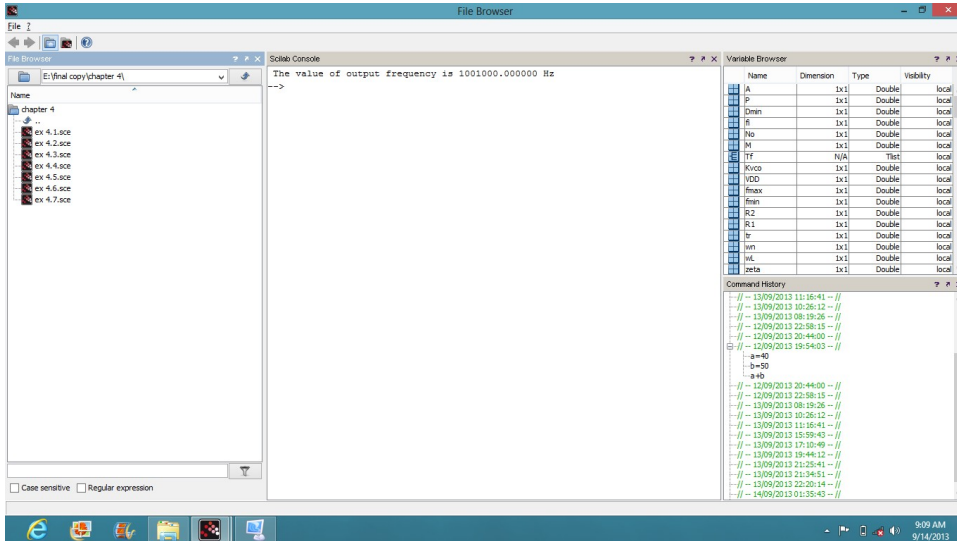


Figure 10.5: FS Ex 10 8

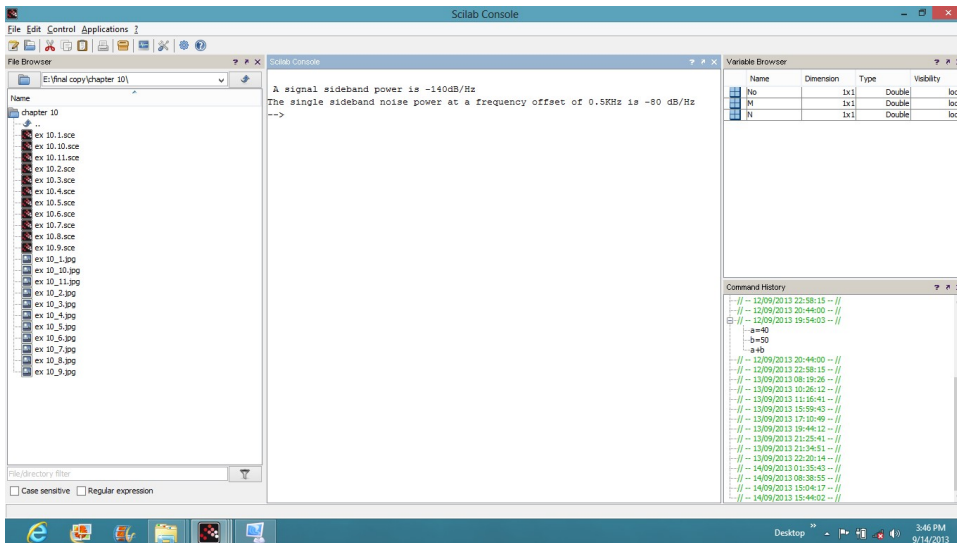


Figure 10.6: FS Ex 10 11

# Chapter 11

## Power Amplifiers

Scilab code Exa 11.1 PA Ex 11 1

```
1  clc
2  //Chapter 11:Power amplifiers
3  //example 11.1 page no 456
4  //given
5  Po=5//max power in watts
6  Rl=50//load resistance in ohm
7  Vp=sqrt(2*5*50)//peak voltage across Rl
8  Vcc=24//supply voltage
9  Ip=Vp/Rl//peak current corresponding to Vp
10 Iq=Vcc/50//Q point current value
11 Pcc=Vcc*Iq//power supplied
12 Eff=(Po/Pcc)*100//efficiency
13 mprintf('peak voltage across Rl is %f V \n the peak
           current is %f A \n the power supplied is %f W \n
           the efficiency is %f ',Vp,Ip,Pcc,Eff)
14 disp('the transistor that is selected must be able
        to dissipate 11.52W in case the input power drops
        to zero and the transistor Vce breakdown voltage
        must be at least 48V(2*Vcc)')
```

---

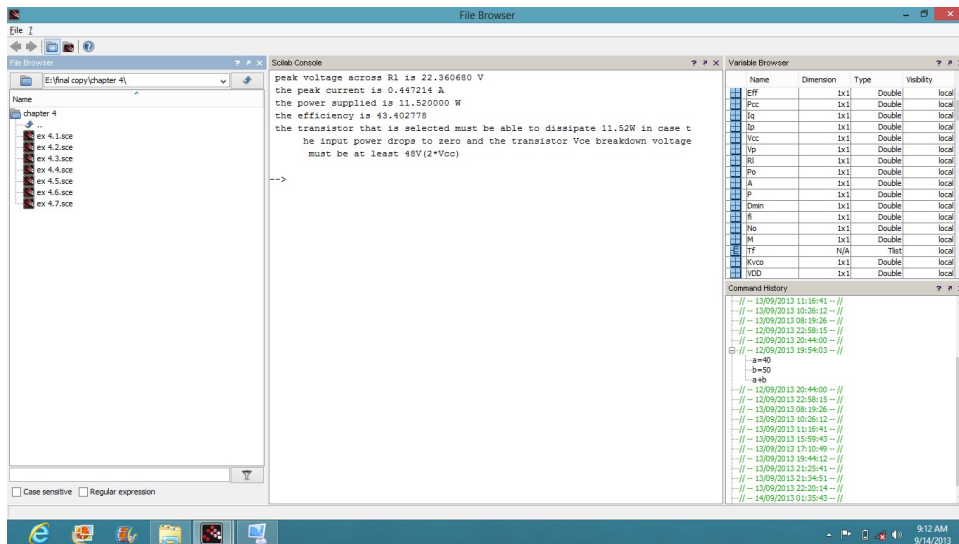


Figure 11.1: PA Ex 11 1

### Scilab code Exa 11.2 PA Ex 11 2

```

1  clc
2  //Chapter 11:Power amplifiers
3  //example 11.2 page no 466
4  //given
5  Po=5//max power in watts
6  Rl=50//load resistance in ohm
7  //assume'1:1 truns ratio transformer coupled push
   pull amplifier each suplling 2.5 watt'
8  disp('since a push pull amplifier is used, each
   class B amplifier will supply 2.5W')
9  Pomax=2.5
10 Vcc=sqrt(4*Rl*Po)//supply voltage
11 Ptmax=Pomax*(4/%pi^2)//maximum power handling

```

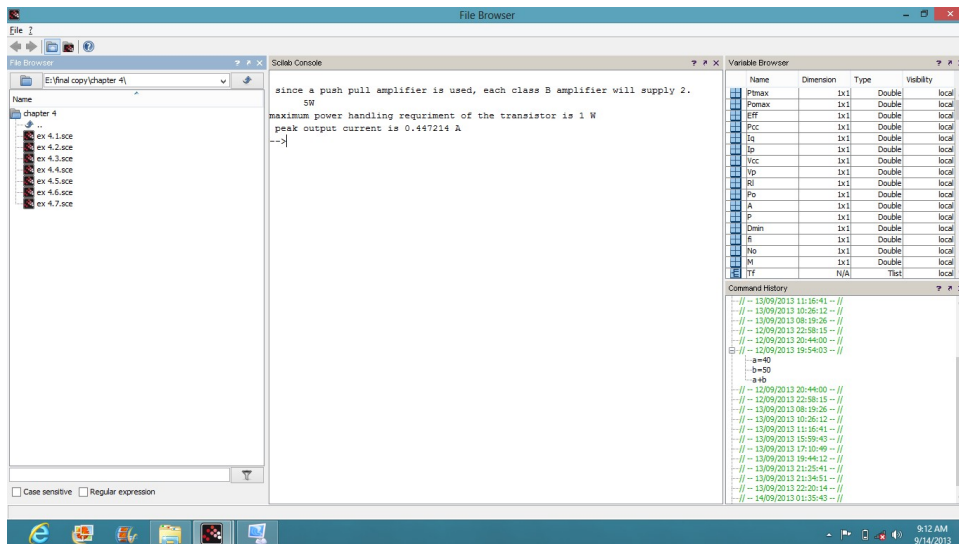


Figure 11.2: PA Ex 11 2

```

    requirment of the transistor
12 I=sqrt((4*Pomax)/Rl) //peak output current
13 mprintf('maximum power handling requirment of the
    transistor is %d W \n peak output current is %f A
    ',Ptmax,I)

```

### Scilab code Exa 11.3 PA Ex 11 3

```

1 clc
2 //Chapter 11:Power amplifiers
3 //example 11.2 page no 474
4 //given
5 Po=5 //max power in watts
6 Rl=50 //load resistance in ohm
7 f=1e6 //operating frequency in hertz
8 Vcc=sqrt(2*Rl*Po)

```



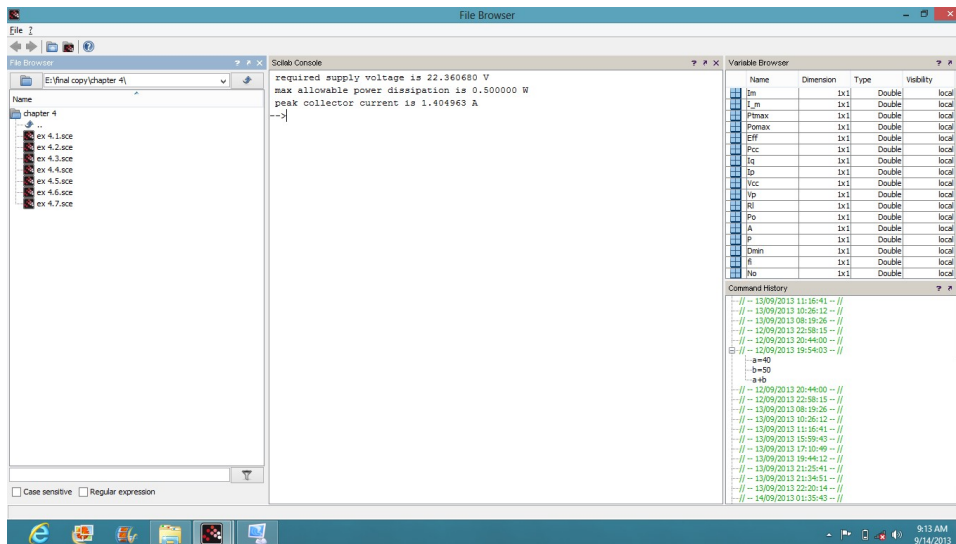


Figure 11.3: PA Ex 11 3

```

9 Ptmax=0.1*Po//allowable power dissipation
10 Im=0.5
11 Im=(2*%pi*Vcc*Im)/Rl//peak collector current
12 mprintf('required supply voltage is %f V \n max
    allowable power dissipation is %f W \n peak
    collector current is %f A',Vcc,Ptmax,Im)

```

#### Scilab code Exa 11.4 PA Ex 11 4

```

1 clc
2 //Chapter 11:Power amplifiers
3 //example 11.4 page no 475
4 //given
5 Pt=4//max power dissipation in watt
6 Idmax=1.5//max drain current in amp
7 Vcc=48//supply voltage

```

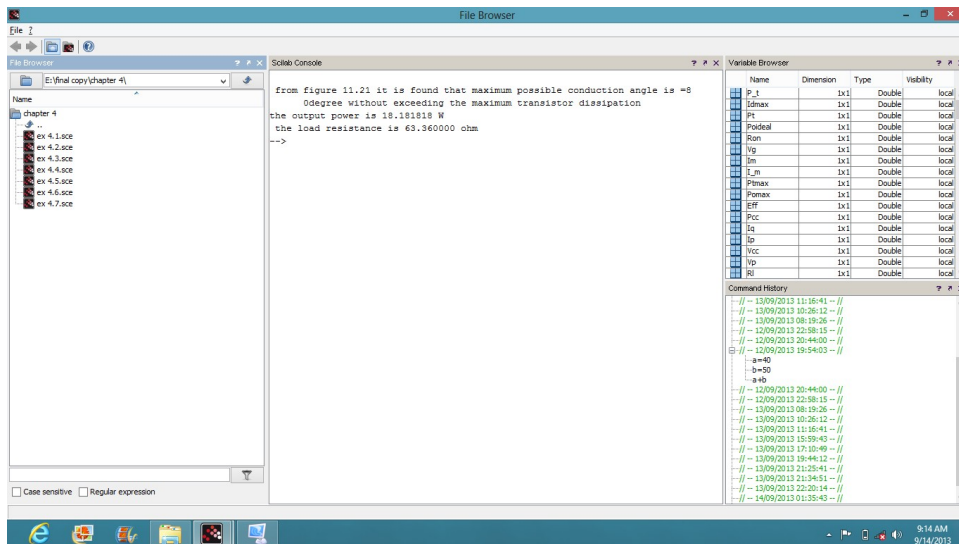


Figure 11.4: PA Ex 11 4

```

8 P_t=(4*%pi*Pt)/(Vcc*Idmax)//the normalised max
  transistor dissipation
9 disp('from figure 11.21 it is found that maximum
  possible conduction angle is =80degree without
  exceeding the maximum transistor dissipation')
10 Po=Pt/0.22//output power
11 Rl=Vcc^2/(2*Po)//load resistance
12 mprintf('the output power is %f W \n the load
  resistance is %f ohm ',Po,Rl)

```

---

#### Scilab code Exa 11.5 PA Ex 11 5

```

1 clc
2 //Chapter 11:Power amplifiers
3 //example 11.5 page no 477
4 //given

```

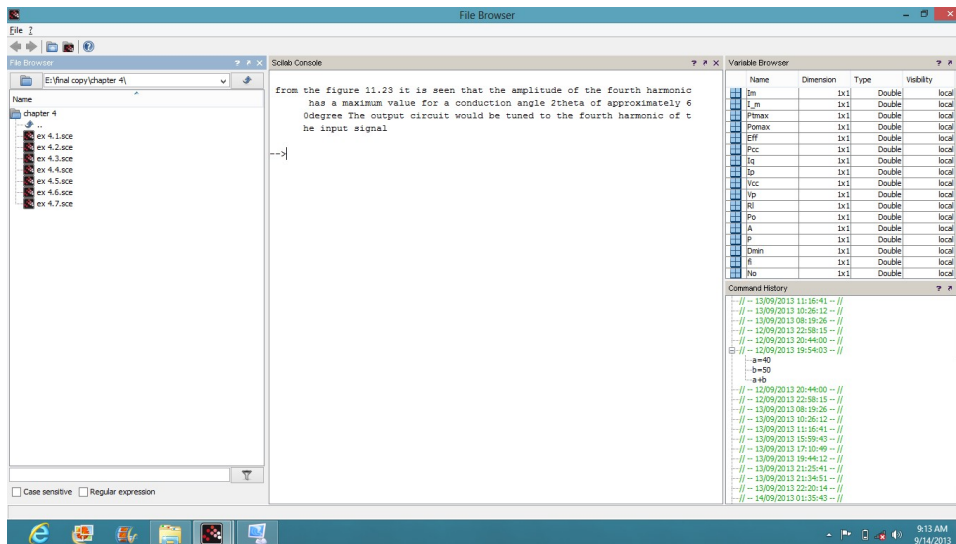


Figure 11.5: PA Ex 11 5

- 5 `disp('from the figure 11.23 it is seen that the amplitude of the fourth harmonic has a maximum value for a conduction angle 2theta of approximately 60degree The output circuit would be tuned to the fourth harmonic of the input signal')`

#### Scilab code Exa 11.6 PA Ex 11 6

```

1 clc
2 //Chapter 11:Power amplifiers
3 //example 11.6 page no 479
4 //given
5 Po=20//power delivered in watt
6 Rl=50//load resistance
7 Vcc=sqrt(%pi^2*Rl*Po/8)//suppy volatage

```

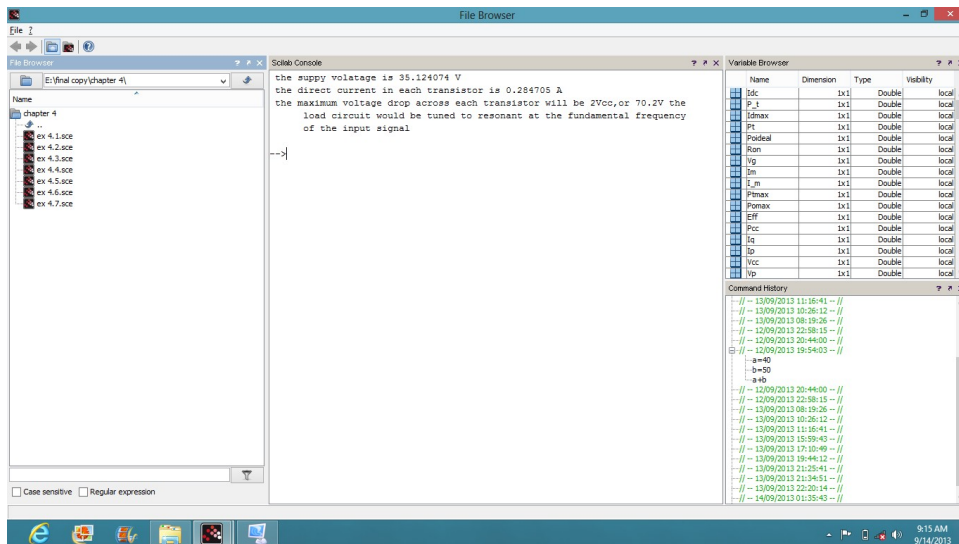


Figure 11.6: PA Ex 11 6

```

8 Idc=4*Vcc/(Rl*%pi^2)//direct current in each
  transistor
9 mprintf('the suppy volatage is %f V \n the direct
  current in each transistor is %f A',Vcc,Idc)
10 disp('the maximum voltage drop across each
  transistor will be 2Vcc, or 70.2V the load circuit
  would be tuned to resonant at the fundamental
  frequency of the input signal')

```

#### Scilab code Exa 11.7 PA Ex 11 7

```

1 clc
2 //Chapter 11:Power amplifiers
3 //example 11.7 page no 480
4 //given
5 Vg=8//get signal level for VMOS 2N6659

```

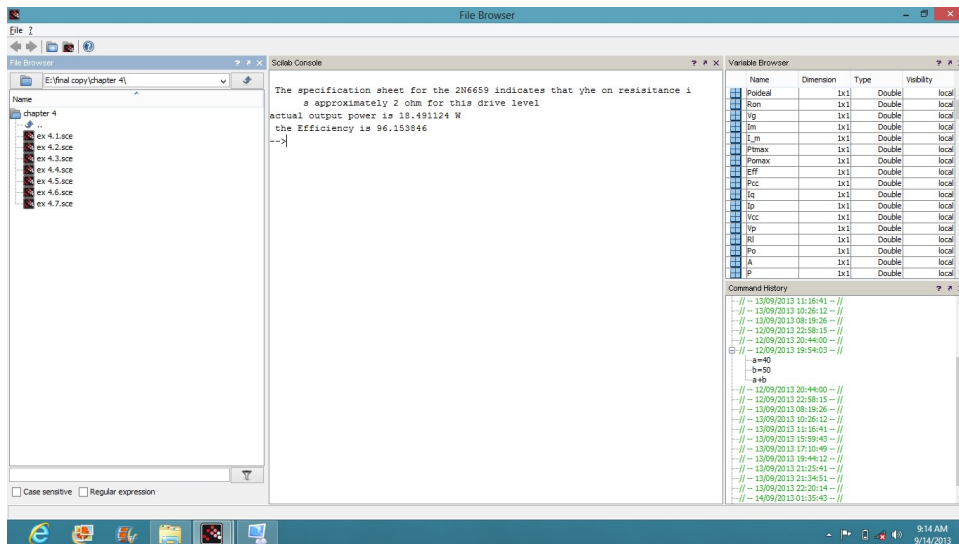


Figure 11.7: PA Ex 11 7

```

6 R1=50 //load resistance in ohms(it should have been
   given in the problem but its missing)
7 disp('The specification sheet for the 2N6659
   indicates that yhe on resistance is
   approximately 2 ohm for this drive level')
8 Ron=2
9 Poideal=20
10 Po=Poideal*((R1/(R1+Ron))^2) //actual output power
11 Eff=R1*100/(R1+Ron) //Efficiency
12 mprintf('actual output power is %f W \n the
   Efficiency is %f ',Po,Eff)

```

---

# Chapter 12

## Modulators and Demodulators

Scilab code Exa 12.2 MD Ex 12 2

```
1 clc
2 //Chapter 12:Frequency mixers
3 //example 12.2 page no 504
4 //given
5 gm=14*10-3//tranconductance
6 IDSS=40*10-3
7 RL=50//load resistance
8 Vgs=0
9 Vp=2*IDSS/gm//pinch off voltage
10 gc=IDSS/(2*Vp)//conversion tranconductance
11 Av=gc*RL//voltage gain
12 mprintf('the conversion voltage gain is %f ',Av)
```

---

Scilab code Exa 12.4 MD Ex 12 4

```
1 clc
2 //Chapter 12:Frequency mixers
```

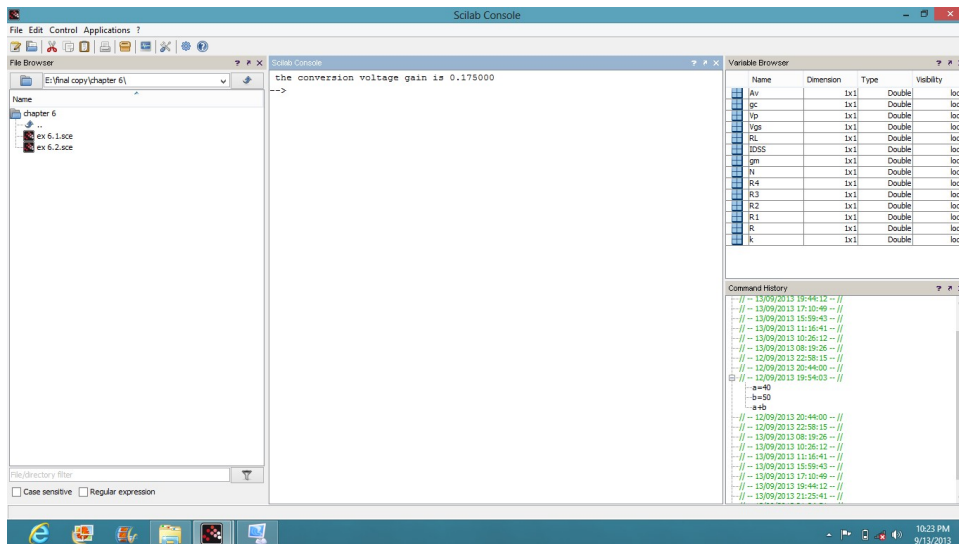


Figure 12.1: MD Ex 12 2

```

3 //example 12.4
4 //given
5 f=1*10^3//maximum frequency of unknown signal
6 df=1//maximum error in signal
7 fs=f^2/df//sampling frequency
8 disp(fs,'the required sampling frequency is ')

```

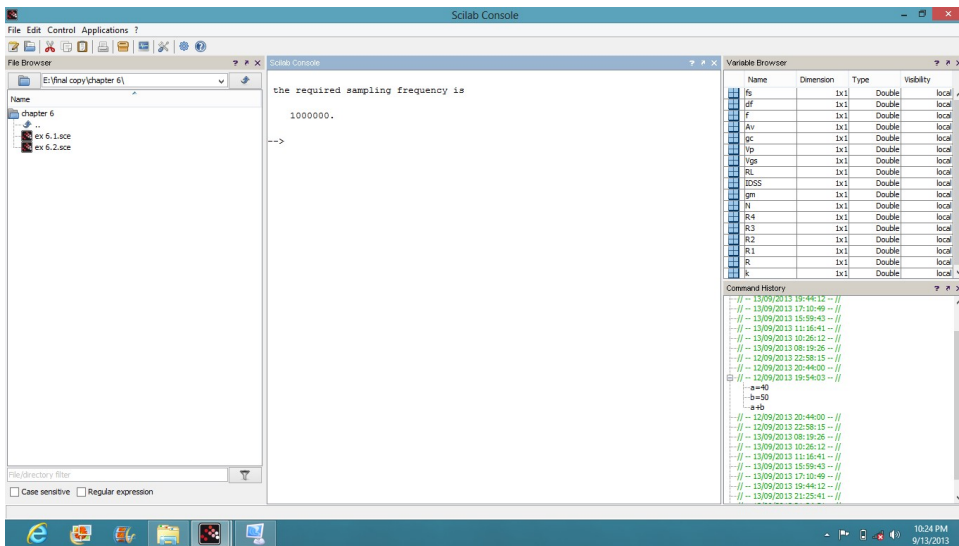


Figure 12.2: MD Ex 12 4