

Scilab Manual for
Radio Frequency Circuit Design
by Prof Nandini Ammangi
Electronics Engineering
VESIT¹

Solutions provided by
Nandan Hegde
Electronics Engineering
V.E.S.I.T./Mumbai

March 10, 2025

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Scilab Manual and Scilab codes written in it can be downloaded from the "Migrated Labs" section at the website <http://scilab.in>

Contents

List of Scilab Solutions	3
1 To plot frequency response of high frequency resistor	5
2 To plot frequency response of high frequency capacitor	9
3 To plot frequency response of high frequency inductor	13
4 To plot SWR circle for an impedance	17
5 To plot efficiency of different types of amplifiers	21

List of Experiments

Solution 1.1	To plot frequency response of high frequency resistor	5
Solution 2.1	To plot frequency response of high frequency capacitor	9
Solution 3.1	To plot frequency response of high frequency inductor	13
Solution 4.1	To plot SWR circle for an impedance	17
Solution 5.1	To plot efficiency of different types of amplifiers .	21

List of Figures

1.1	To plot frequency response of high frequency resistor	6
1.2	To plot frequency response of high frequency resistor	7
2.1	To plot frequency response of high frequency capacitor	10
2.2	To plot frequency response of high frequency capacitor	11
3.1	To plot frequency response of high frequency inductor	14
3.2	To plot frequency response of high frequency inductor	15
4.1	To plot SWR circle for an impedance	18
4.2	To plot SWR circle for an impedance	19
5.1	To plot efficiency of different types of amplifiers	22
5.2	To plot efficiency of different types of amplifiers	23

Experiment: 1

To plot frequency response of high frequency resistor

Scilab code Solution 1.1 To plot frequency response of high frequency resistor

```
1 //To plot the frequency response of high frequency
  Resistor
2 //Scilab 5.4.1;64 bit (windows 8)
3 f=10^4:10^5:10^10;
4 w=2*%pi.*f;
5 mu0=4*%pi*10^-7;
6 l=2*2.5*10^-2;
7 a=2.032*10^-4;
8 temp=log(2*l/a)/log(%e);
9 lex=mu0*l*(temp-1)/(2*%pi); //external inductance
10 r=2*10^3; // resistance
11 c=5*10^-12; //capacitance
12 z=w*lex*%i+1 ./ (w*c*%i+1/r); //impedance
13 plot2d("gll",f,abs(z));
```

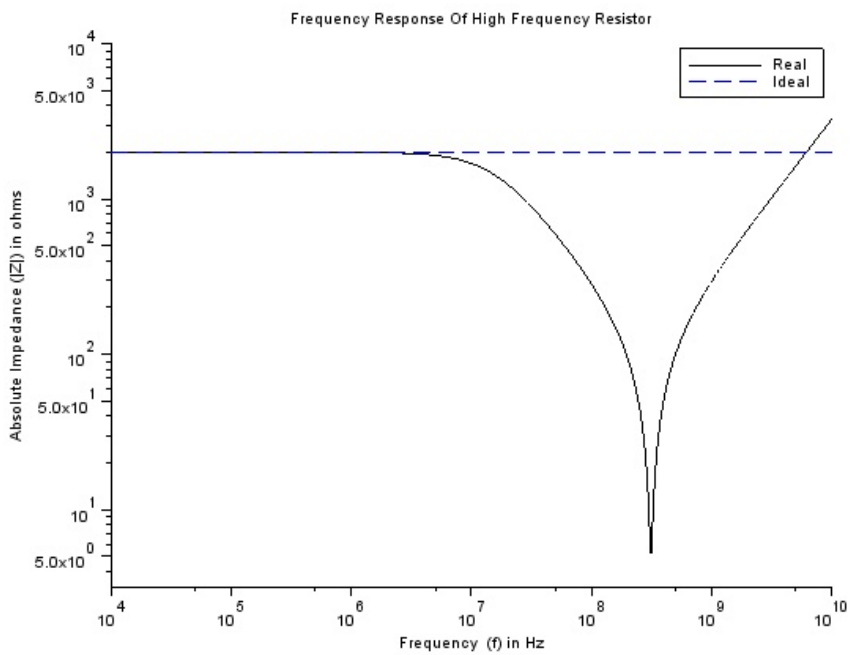


Figure 1.1: To plot frequency response of high frequency resistor

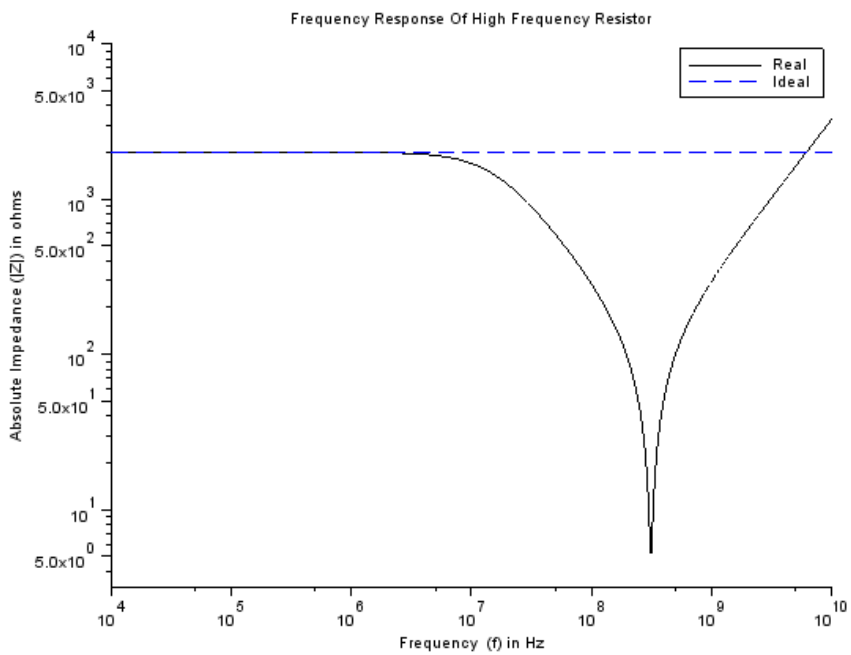


Figure 1.2: To plot frequency response of high frequency resistor


```
14 plot(f,r,"—");
15 title("Frequency Response Of High Frequency Resistor
      ");
16 xlabel('Frequency (f) in Hz');
17 ylabel('Absolute Impedance (|Z|) in ohms');
18 legend(["Real "; "Ideal"]);
```

Experiment: 2

To plot frequency response of high frequency capacitor

Scilab code Solution 2.1 To plot frequency response of high frequency capacitor

```
1 //To plot frequency response of high frequency
   Capacitor
2 //Scilab 5.4.1;64 bit (windows 8)
3 f=10^6:10^7:10^10;
4 rs=(4.8*10^-6).*sqrt(f);
5 re=(33.9*10^12) ./f;
6 mu0=4*%pi*10^-7;
7 c=47*10^-12;
8 w=2*%pi.*f;
9 l=2*1.25*10^-2;
10 a=2.032*10^-4;
11 temp=log(2*l/a)/log(%e);
12 lex=mu0*l*(temp-1)/(2*%pi);           //external
   inductance
```

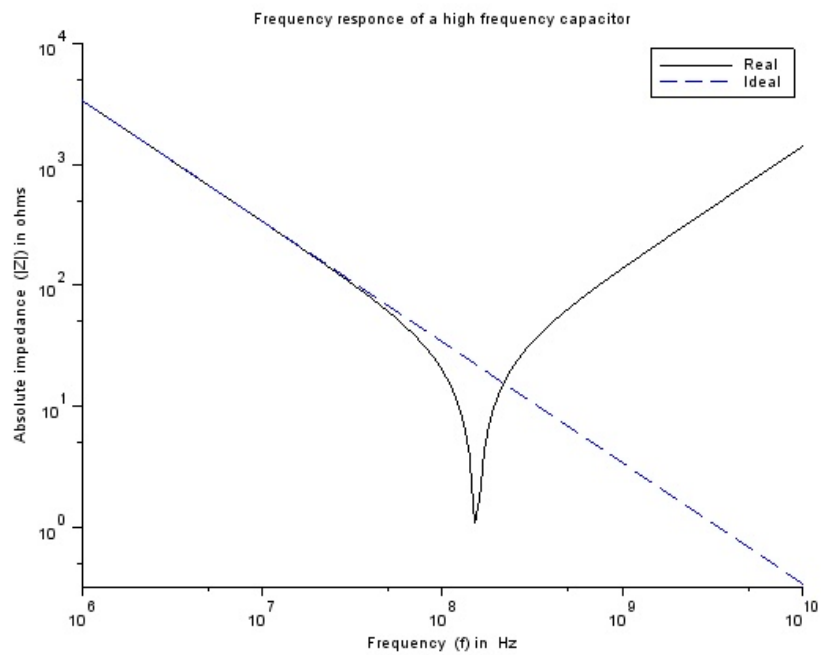


Figure 2.1: To plot frequency response of high frequency capacitor

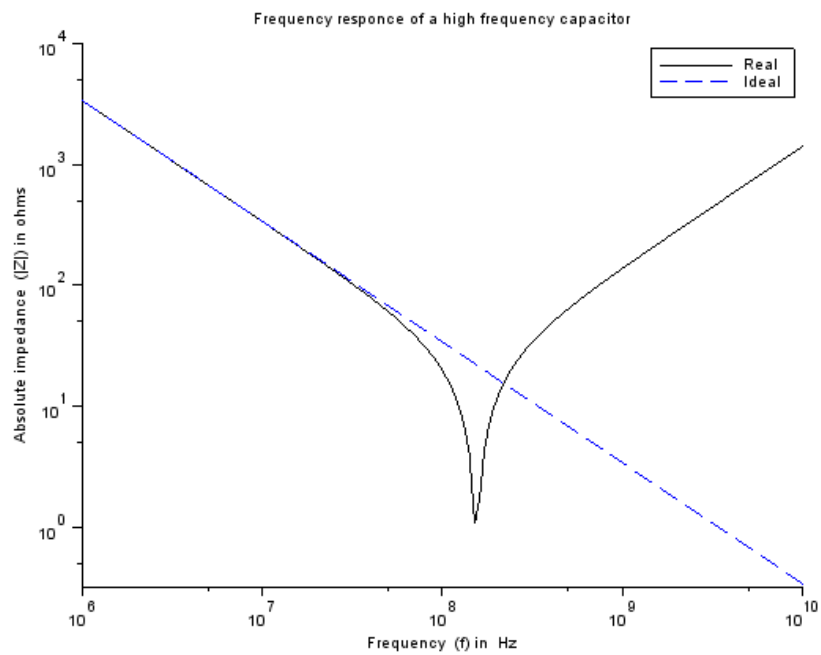


Figure 2.2: To plot frequency response of high frequency capacitor

```
13 z=1 ./(1 ./re +w*c*i)+rs+w.*lex*i; // impedance of
    frequency dependent capacitor
14 zideal=1 ./(w*c*i); //impedance of an ideal
    capacitor
15 plot2d("gll",f,abs(z));
16 plot(f,abs(zideal),"—");
17 title("Frequency responce of a high frequency
    capacitor");
18 xlabel('Frequency (f) in Hz');
19 ylabel('Absolute impedance (|Z|) in ohms');
20 legend(["Real "; "Ideal"]);
```

Experiment: 3

To plot frequency response of high frequency inductor

Scilab code Solution 3.1 To plot frequency response of high frequency inductor

```
1 //To plot frequency response of high frequency
   Inductor
2 //Scilab 5.4.1;64 bit (windows 8)
3 f=10^7:10^8:10^10;
4 w=2*%pi.*f;
5 N=3.5;           //number of turns
6 rad=0.05*0.0254;
7 len=0.05*0.0254; //length of wire
8 a=(5*0.0254*10^-3)/2;
9 u0=4*%pi*10^-7;
10 sig_cu=64.516*10^6;
11 e0=8.854*10^-12;
12 l=(%pi*rad^2*u0*(N^2))/len;
13 c=(e0*4*%pi*rad*(N^2)*a)/len;
```

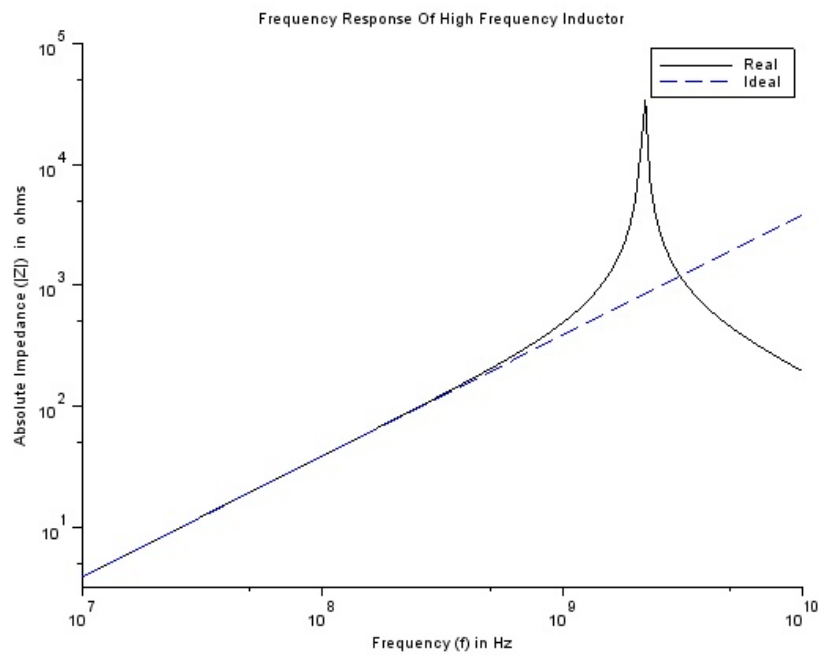


Figure 3.1: To plot frequency response of high frequency inductor

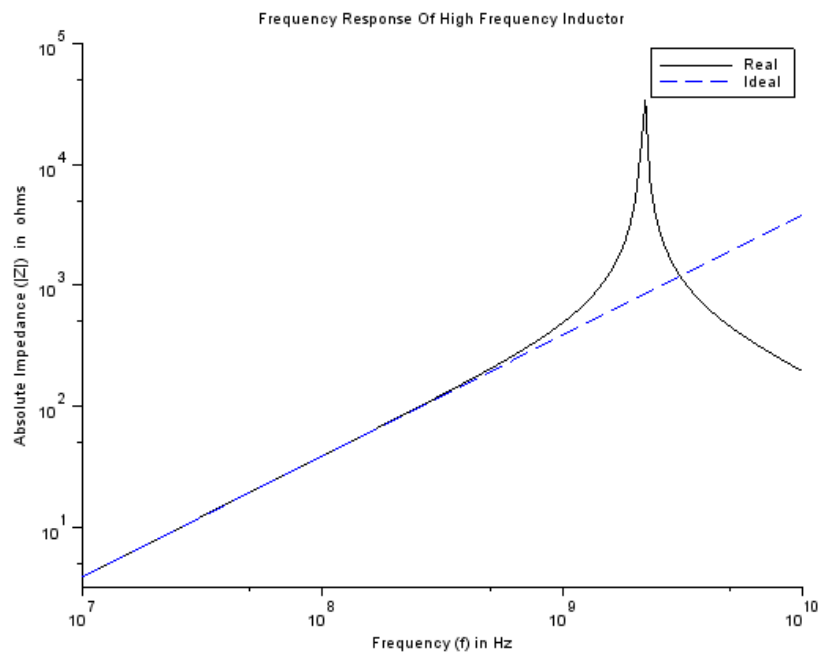


Figure 3.2: To plot frequency response of high frequency inductor


```

14 r=(2*rad*N)/(sig_cu*(a^2));
15 z=1 ./((1 ./(r+w*i*l))+w*i*c); //impedance
16 zideal=w*i.*l; //impedance of an
    ideal inductor
17 plot2d("gll",f,abs(z));
18 plot(f,abs(zideal),"—");
19 title("Frequency Response Of High Frequency Inductor
    ");
20 xlabel('Frequency (f) in Hz');
21 ylabel('Absolute Impedance (|Z|) in ohms');
22 legend(["Real "; "Ideal"]);

```

Experiment: 4

To plot SWR circle for an impedance

Scilab code Solution 4.1 To plot SWR circle for an impedance

```
1 //To plot SWR circle for the impedance
2 //Scilab 5.4.1;64 bit(windows 8)
3 Z0=50; //define 50 Ohm characteristic impedance
4 Z=[50 48.5 75+%i*25 10-%i*5]; //define impedances
   for this example
5 Gamma=(Z-Z0)./(Z+Z0) //compute corresponding
   reflection coefficients
6 SWR=(1+abs(Gamma))./(1-abs(Gamma)); //find the SWRs
7 a=0:0.01:2*%pi;
8 for n=1:length(Z)
9
10 plot(abs(Gamma(n))*cos(a),abs(Gamma(n))*sin(a),'b',
   linewidth',2);
11 plot(real(Gamma(n)), imag(Gamma(n)),'ro');
12 end;
```

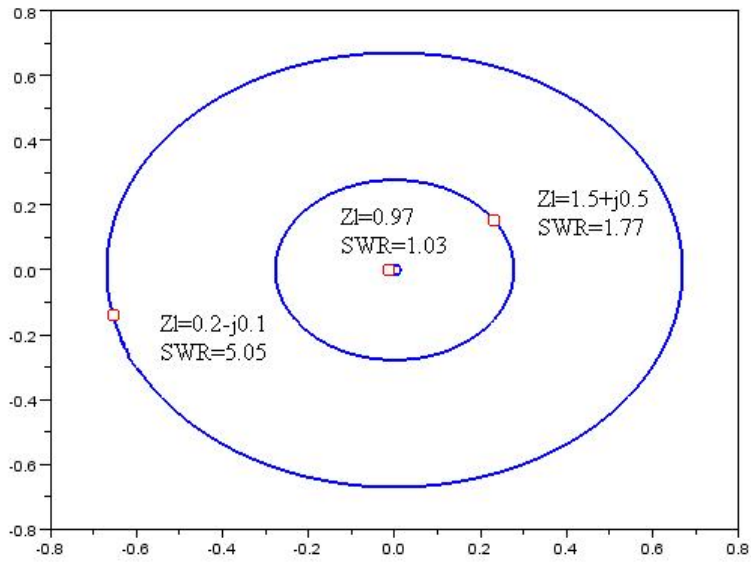


Figure 4.1: To plot SWR circle for an impedance

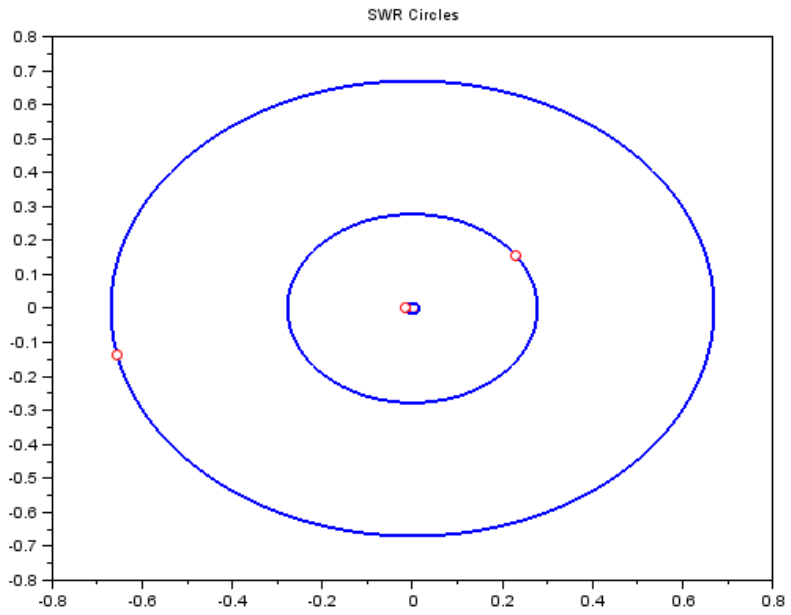


Figure 4.2: To plot SWR circle for an impedance

```
13
14 for n=1:length(Z)
15     if n~=1
16         end;
17 end;
18 title("SWR Circles");
```

Experiment: 5

To plot efficiency of different types of amplifiers

Scilab code Solution 5.1 To plot efficiency of different types of amplifiers

```
1 //To plot efficiency of different types of
  amplifiers
2 //Scilab 5.4.1;64 bit(windows 8)
3 theta=(1:1:360)/180*%pi; //define conduction angle
4
5 //compute efficiency
6 nu=-1/2*(theta-sin(theta))./(theta.*cos(theta/2)-2*
  sin(theta/2));
7
8 plot(theta/%pi*180,nu*100,'r','linewidth',2);
9 set(gca(),"auto_clear","off");
10 plot([0 180],[%pi/4*100 %pi/4*100],'b:');
11 plot([180 180],[0 %pi/4*100],'b:');
12 plot(180,%pi/4*100,'bo');
13 plot(360,50,'bo');
```

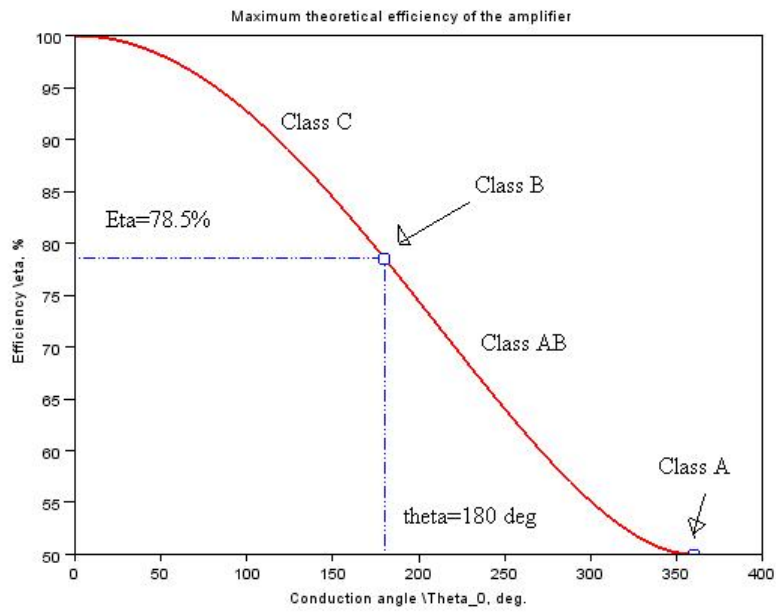


Figure 5.1: To plot efficiency of different types of amplifiers

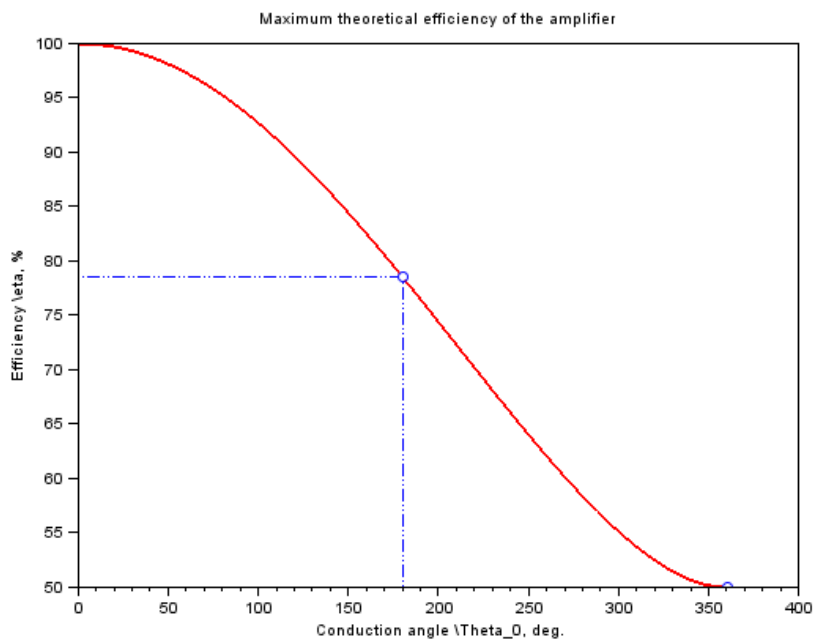


Figure 5.2: To plot efficiency of different types of amplifiers


```
14 mtlb_axis([0 360 50 100]);
15 title('Maximum theoretical efficiency of the
    amplifier ');
16 xlabel('Conduction angle \Theta_0, deg. ');
17 ylabel('Efficiency \eta, %');
```
