APPENDIX E:
MATLAB CODE TO DETERMINE THE RLC VALUES FOR THE CIRCUIT MODEL

In this appendix, the MATLAB code that was used to calculate the RLC values from the S_{11} values measured by the network analyzer is provided. The calculations used by the code are described in Chapter 5.

Main Program

```
%This is a script that will determine the proper frequency
%to use as the normalization value in the linear
%extrapolation.  The frequency selected is the frequency
%corresponding to the maximum value of Real(1/Zout) of the
%transducer.  The S11 parameter for each transducer were
%measured using a Network Analyzer.  The program also
%determines the RLC equivalent circuit for each transducer.

clear all;
close all;

j=sqrt(-1);

%Enter the data file to be read in
dat='/dunn/bigelow/Transducer_impedance/DATA06num.txt'

Zo=50; %Impedance of line used by NA to find S11.

N=7; %Set number of points on either side of peak to find
     %fit.

%Read in the data
[S11_re,S11_im,freq]=read_S11(dat);

S11=S11_re + j*S11_im;

freq=freq*1e-8; %Adjust to improve fit calculation

%Determine the Input Impedance at each frequency
Zin=Zo*(1+S11)./(1-S11);
Yin=1./Zin;

%Find the maximum in real(Yin)
```

```
[m,n]=max(real(Yin));

%Determine polynomial coefficients (degree = 8)
P=polyfit(freq(n-N:n+N),(Yin(n-N:n+N)),8);

%Extract region over which extrapolation will be done.
f=freq(n-N):((freq(n+N)-freq(n-N))/200):freq(n+N);

y=polyval(P,f);

ye=100*abs(polyval(P,freq(n-N:n+N)) - …
                    Yin(n-N:n+N))./abs(Yin(n-N:n+N));
max(ye)

%Plot the Real(Yin)
figure(1)
clf
plot(freq*100,real(Yin))
hold
plot(f*100,real(y),'r-.')
grid
xlabel('Frequency (MHz)')
ylabel('Real(Yin) (Mhos)')

%Determine Resonance Frequency
[m2,n2]=max(real(y));
freq_res=f(n2)*100

%Determine R1
R1=1/m2

%Determine Co
Co=imag(y(n2))/(2*pi*f(n2)*1e8)

%Find X1
w=1e8*f*2*pi;
wo=2*pi*1e8*f(n2);
X1=imag(1./(y-j*w*Co));

%Determine C1
C1=0;
cnt=0;

for wi=1:length(X1)
   if abs(X1(wi))>1e-9
      val=((w(wi)/wo)^2 - 1)/(w(wi)*X1(wi));
```

```
      C1=C1+val;

      cnt=cnt+1;
   end
end

C1=C1/cnt

%Determine L1
L1=1/(C1*wo^2)


file =  input('Enter  a  filename  to  save  the  transducer
information: ','s');

if ~isempty(file)
   save(file,'freq_res','R1','Co','L1','C1');
   'Saved Resonance Frequency, R1, Co, L1, and C1 !!!!!'
end
```

Read in S_{11} Values

```
function [S11_re,S11_im,f]=read_S11(dat);
%This  is  a  MATLAB  function  that  reads  in  the  S11  values
from
%the Network Analyzer.

%Inputs
%    dat = data file
%Output
%    S11_re = real part of S11
%    S11_im = imag part of S11
%    f = frequency of measurement point

%*******************************************************
*


fid  = fopen(dat, 'r');
fstart=fscanf(fid,'%f',[1,1]);
fend=fscanf(fid,'%f',[1,1]);
fnum=fscanf(fid,'%i',[1,1]);

for si=1:fnum
   S11_re(si)=fscanf(fid,'%f',[1,1]);
   hld=fscanf(fid,'%c',[1,1]);
   S11_im(si)=fscanf(fid,'%f',[1,1]);
   f(si)=fstart+(si-1)*(fend-fstart)/(fnum-1);
end
```

```
fclose(fid);
```