APPENDIX B
MATLAB CODE TO COMPUTE THE ACOUSTIC RESPONSE

B.1 Code to Compute the Response at Radial Slices within the Cylinder

```
%This function computes the acoustic response of the cylinder
%along radial slices of the cylinder
clear
global l R to h Rac lac

%The following structural response loads the variables:_____
%l R to h Rac lac A fre (r/s)
%Calculate the structural response using the impedance model (variables cleared here)
inphase
%clearin
%Calculate the single mode symmetric structural response
%symmeta
%load the structural response from the experiment on 9/10/98

cylexstr

%_____
_______

start=clock;
pref=20e-6;
%Need to calculate the acoustic response along radial slices of the
%cylinder in the z-plane
radac=Rac*[0 .4 .8 1.0];
angac=(pi/180)*[0:15:360];
for ii=1:1:length(radac),
  for jj=1:1:length(angac),
    %Now calculate the response within the cylinder
    %using the calculated radius and angle
    if ii>1
     if angac(jj)==2*pi  %values at 0 and 360 are the same
      [pre0(ii,jj)]=pre0(ii,1);
      [pre1(ii,jj)]=pre1(ii,1);
      [pre2(ii,jj)]=pre2(ii,1);
      %[pre3(ii,jj)]=pre3(ii,1);
      %[pre4(ii,jj)]=pre4(ii,1);
      %[pre5(ii,jj)]=pre5(ii,1);
      %[pre6(ii,jj)]=pre6(ii,1);
      %[pre7(ii,jj)]=pre7(ii,1);
      %[pre8(ii,jj)]=pre8(ii,1);
```

```
    %[pre9(ii,jj)]=pre9(ii,1);
    %[pre10(ii,jj)]=pre10(ii,1);
   else
    [pre0(ii,jj)]=prespnt5((0.75/15.42)*lac,radac(ii),angac(jj),A,fre);
    [pre1(ii,jj)]=prespnt5((5.14/15.42)*lac,radac(ii),angac(jj),A,fre);
    [pre2(ii,jj)]=prespnt5((7.71/15.42)*lac,radac(ii),angac(jj),A,fre);
    %[pre3(ii,jj)]=prespnt5(.3*lac,radac(ii),angac(jj),A,fre);
    %[pre4(ii,jj)]=prespnt5(.4*lac,radac(ii),angac(jj),A,fre);
    %[pre5(ii,jj)]=prespnt5(.5*lac,radac(ii),angac(jj),A,fre);
    %[pre6(ii,jj)]=prespnt5(.6*lac,radac(ii),angac(jj),A,fre);
    %[pre7(ii,jj)]=prespnt5(.7*lac,radac(ii),angac(jj),A,fre);
    %[pre8(ii,jj)]=prespnt5(.8*lac,radac(ii),angac(jj),A,fre);
    %[pre9(ii,jj)]=prespnt5(.9*lac,radac(ii),angac(jj),A,fre);
    %[pre10(ii,jj)]=prespnt5(1*lac,radac(ii),angac(jj),A,fre);
   end
  elseif jj==1  %ii=1
    [pre0(ii,jj)]=prespnt5((0.75/15.42)*lac,radac(ii),angac(jj),A,fre);
    [pre1(ii,jj)]=prespnt5((5.14/15.42)*lac,radac(ii),angac(jj),A,fre);
    [pre2(ii,jj)]=prespnt5((7.71/15.42)*lac,radac(ii),angac(jj),A,fre);
    %[pre3(ii,jj)]=prespnt5(.3*lac,radac(ii),angac(jj),A,fre);
    %[pre4(ii,jj)]=prespnt5(.4*lac,radac(ii),angac(jj),A,fre);
    %[pre5(ii,jj)]=prespnt5(.5*lac,radac(ii),angac(jj),A,fre);
    %[pre6(ii,jj)]=prespnt5(.6*lac,radac(ii),angac(jj),A,fre);
    %[pre7(ii,jj)]=prespnt5(.7*lac,radac(ii),angac(jj),A,fre);
    %[pre8(ii,jj)]=prespnt5(.8*lac,radac(ii),angac(jj),A,fre);
    %[pre9(ii,jj)]=prespnt5(.9*lac,radac(ii),angac(jj),A,fre);
    %[pre10(ii,jj)]=prespnt5(1*lac,radac(ii),angac(jj),A,fre);
  else   % ii=1, jj>1, radac=0
    [pre0(ii,jj)]=pre0(1,1);
    [pre1(ii,jj)]=pre1(1,1);
    [pre2(ii,jj)]=pre2(1,1);
    %[pre3(ii,jj)]=pre3(1,1);
    %[pre4(ii,jj)]=pre4(1,1);
    %[pre5(ii,jj)]=pre5(1,1);
    %[pre6(ii,jj)]=pre6(1,1);
    %[pre7(ii,jj)]=pre7(1,1);
    %[pre8(ii,jj)]=pre8(1,1);
    %[pre9(ii,jj)]=pre9(1,1);
    %[pre10(ii,jj)]=pre10(1,1);
  end  %if

 end %jj
length(radac)-ii
end %ii

%Calculate the rms pressure and the SPL
```

```
prms0=.7071*abs(pre0);
prms1=.7071*abs(pre1);
prms2=.7071*abs(pre2);
%prms3=.7071*abs(pre3);
%prms4=.7071*abs(pre4);
%prms5=.7071*abs(pre5);
%prms6=.7071*abs(pre6);
%prms7=.7071*abs(pre7);
%prms8=.7071*abs(pre8);
%prms9=.7071*abs(pre9);
%prms10=.7071*abs(pre10);


pdB0=20*log10(prms0./pref);
pdB1=20*log10(prms1./pref);
pdB2=20*log10(prms2./pref);
%pdB3=20*log10(prms3./pref);
%pdB4=20*log10(prms4./pref);
%pdB5=20*log10(prms5./pref);
%pdB6=20*log10(prms6./pref);
%pdB7=20*log10(prms7./pref);
%pdB8=20*log10(prms8./pref);
%pdB9=20*log10(prms9./pref);
%pdB10=20*log10(prms10./pref);

stop=clock;
time=60*(stop(5)-start(5))+stop(6)-start(6);
time=time+24*3600*(stop(3)-start(3))+3600*(stop(4)-start(4));

%rescale bottom so zero pressure is not negative infinity
for ii=1:1:length(radac),
  for jj=1:1:length(angac),
   if pdB0(ii,jj)<0
    pdB0(ii,jj)=10;
   end
   if pdB1(ii,jj)<0
    pdB1(ii,jj)=10;
   end
   if pdB2(ii,jj)<0
    pdB2(ii,jj)=10;
   end
 end %jj
end  %ii

[RADAC,ANGAC]=meshgrid(radac,angac);
```

```
ZX=RADAC.*cos(ANGAC);
ZY=RADAC.*sin(ANGAC);

figure(4)
surf(ZY,ZX,pdB0'),grid
title('Radial Acoustic Response at x=0.75"')
ylabel('Right Hand Side [90 deg.]')
xlabel('Bottom [180 deg.]')
zlabel('SPL [dB] ref: 20e-6 Pa')
axis([-Rac Rac -Rac Rac min(min(pdB0)) max(max(pdB0))])
view([0,90])
shading interp
colorbar

figure(5)
surf(ZY,ZX,pdB1'),grid
title('Radial Acoustic Response at x=5.14"')
ylabel('Right Hand Side [90 deg.]')
xlabel('Bottom [180 deg.]')
zlabel('SPL [dB] ref: 20e-6 Pa')
axis([-Rac Rac -Rac Rac min(min(pdB1)) max(max(pdB1))])
view([0,90])
shading interp
colorbar

figure(6)
surf(ZY,ZX,pdB2'),grid
title('Radial Acoustic Response at x=7.71"')
ylabel('Right Hand Side [90 deg.]')
xlabel('Bottom [180 deg.]')
zlabel('SPL [dB] ref: 20e-6 Pa')
axis([-Rac Rac -Rac Rac min(min(pdB2)) max(max(pdB2))])
view([0,90])
shading interp
colorbar
```

B.2 Code to Compute the Response at a Point within the Cylinder

```
function[pamp]=prespnt5(x,r,theta,A,freq)
%this function is different than prespnt4.m because it sorts
%the acoustic natural frequencies and only uses the lowest
%modes in the calculation of the Green's function
global l R to h Rac lac
xelem=size(A,1)-1;
telem=size(A,2)-1;
```

```
c=343*(1+i*0.001);
rhoair=1.2;
cro=1;
cylvolum=pi*Rac^2*lac;
numbmds=80; %Number of modes in the Green's function summation
wavnum=freq/c;
alpha=[0 1.8412 3.0542 4.2012 5.3176 6.4156 7.5013 8.5778 9.6474;...
3.8317 5.3314 6.7061 8.0152 9.2824 10.5199 11.7349 12.9324 14.1155;...
7.0156 8.5363 9.9695 11.3459 12.6819 13.9872 15.2682 16.5294 17.7740;...
10.1735 11.7060 13.1704 14.5859 15.9641 17.3128 18.6374 19.9419 21.2291;...
13.3237 14.8636 16.3475 17.7888 19.1960 20.5755 21.9317 23.2681 24.5872;...
16.4706 18.0155 19.5129 20.9725 22.4010 23.8036 25.1839 26.5450 27.8893;...
19.6159 21.1644 22.6716 24.1449 25.5898 27.0103 28.4098 29.7908 31.1553;...
22.7601 24.3113 25.8260 27.3101 28.7678 30.2029 31.6179 33.0152 34.3966;...
25.9037 27.4571 28.9777 30.4703 31.9385 33.3854 34.8134 36.2244 37.6201]';
B=0;
area=2*pi*Rac*lac/(xelem*telem);

%Calculate the lowest acoustic modes similar to acnfcyl.m
iter=0;
for ii=1:1:9,
 for jj=1:1:9,
  for kk=1:1:9,
          iter=iter+1;
%Convert the input mode number for the table.  For example the (1,0,1)
%mode will correspond to the first column and second row of the jk matrix
          wnat(iter)=c*sqrt( (alpha(jj,kk)/Rac)^2 +((ii-1)*pi/lac)^2);
          iindex(iter)=ii-1;
          jindex(iter)=jj-1;
          kindex(iter)=kk-1;
  end  %kk
 end  %jj
end  %ii
NMD=10;       %Number of modes to be displayed
[wnsort,Indx]=sort(wnat);

for ll=1:1:numbmds,
   ii=iindex(Indx(ll));
   jj=jindex(Indx(ll));
   kk=kindex(Indx(ll));
   lamjk=alpha(jj+1,kk+1);
   WN3D(ll)=c*sqrt( (lamjk/Rac)^2 +((ii)*pi/lac)^2);
   PSYR3D(ll)=besselj(jj,lamjk*r/Rac)*cos((ii)*pi*x/lac)*cos((jj)*(theta-to));
   wavnumn=WN3D(ll)/c;
   if abs(wavnum-wavnumn)<=1e-3
     disp('Warning kn-k is close to zero')
```

```
    disp('    i        j        k        wavnumn')
    [ii jj kk wn]
  end
  bessy(ll)=besselj(jj,lamjk*Rac/Rac);
  if ii==0
    epsiloni=1;
  else
    epsiloni=2;
  end
  if jj==0
    epsilonj=1;
  else
    epsilonj=2;
  end
  if lamjk==0
    temp1=1;
  else
    temp1=1-(jj^2+(B*kk*Rac)^2)/(lamjk^2);
  end
  lamijk=(1/(epsiloni*epsilonj))*temp1*(besselj(jj,lamjk))^2;
  LAMN(ll)=cylvolum*lamijk;

end

areachk=0;
sump=0;
for mm=1:1:(xelem+1),
 for nn=1:1:telem,
  xs=lac*(mm-1)/xelem;
  thetas=2*pi*(nn-1)/telem;
  Grn=0;
  if xs==0
    dA=area/2;
  elseif xs==lac
    dA=area/2;
  else
    dA=area;
    for ll=2:1:numbmds,
      ii=iindex(Indx(ll));
      jj=jindex(Indx(ll));
      kk=kindex(Indx(ll));
      wn=WN3D(ll);
      psyr=PSYR3D(ll);
      psyro=bessy(ll)*cos((ii)*pi*xs/lac)*cos((jj)*(thetas-to));
      Grn=Grn+(psyr*psyro)/( ( (wn/c)^2-wavnum^2)*LAMN(ll)*cro );
    end
```

```
  end
  areachk=areachk+dA;
  sump=sump+A(mm,nn)*Grn*dA;
 end  %nn
end    %mm
if (areachk-2*pi*Rac*lac)>1e-10
  ('WARNING!!! Areas do not match!')
end
pamp=cro*rhoair*sump;
```