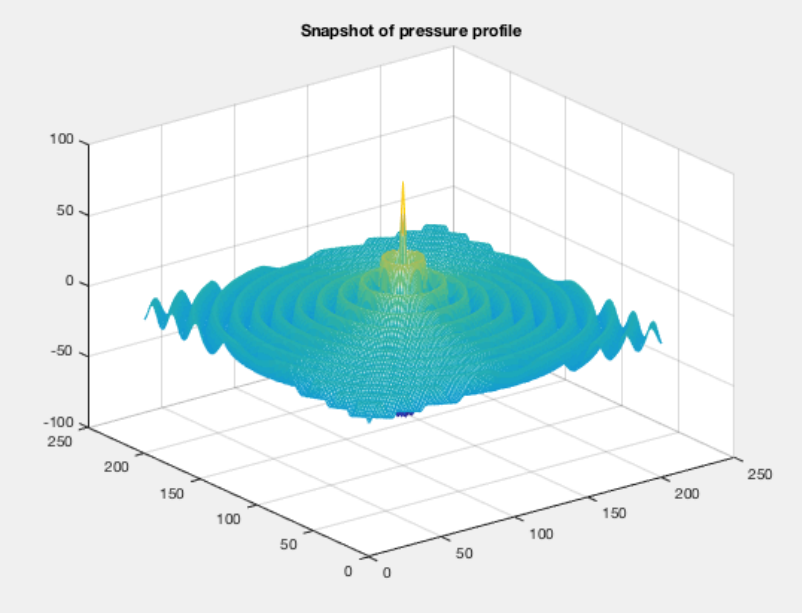
1. A 300 Hz sinusoidal acoustical point source is operating continuously in free space (no reflections.) The pressure at the source is 100 mPa.
a. Write the equation of the wave pressure function using complex exponential notation for two-dimensional space, p(x, y, t), assuming that the pressure amplitude is inversely proportional to distance. Write a Matlab script that generates the pressure wave as function of location on the x-y plane, and time (e.g., moving wave ripples on the water surface.) You may use functions meshgrid, surf and view in Matlab to generate a snapshot of the pressure profile as function of the distance, for - 10 < x < 10 m for -10 < y < 10 m. (You need to deal with pressure at x = 0 so that it does not become inf.)

```
%% ECE 502 Q1 %%
T = 0.02; %Time specification (seconds)
L = 10; % Distance specification (meters)

a = 1; % amplitude
Fs = 8000; % sampling rate in Hz
f = 300;  % Hz
c = 341;  % speed of sound in m/s
p0 = 100; % Pa
d = 100;

w = 2*pi*f; % radians
k = w/c;
[x,y]=meshgrid(-L:L/d:L, -L:L/d:L);
r = sqrt(x.^2 + y.^2);
p = p0./(a+sqrt(x.^2 + y.^2)).*real(exp(-j*k.*sqrt(x.^2 + y.^2)));
figure(1)
mesh(p)
title('Snapshot of pressure profile')
for t = 0:1/Fs:T/4
    figure(2)
    p = p0./(a+sqrt(x.^2 + y.^2)).*real(exp(-j*k.*sqrt(x.^2 +
y.^2))*exp(j*w*t));
    mesh(x,y,p)
    axis([-10 10 -10 10 -100 100])
    title('Pressure wave on x-y plane')
    view(45, 60)
    pause(0.1)
end
```



2. Determine the orientation, length, gain (acoustic velocity) profile and control strategy for a one-dimensional loudspeaker array, which, at 200 Hz exhibits a mainlobe width of 20 degrees in the elevation plane and the sidelobes are suppressed by at least 10 dB.

```
%% Question 2 %%

c = 341; % speed of sound (m/s)

orientation = 'vertical';
gainProfile = 'rectangular window';
length = c/(200*sind(20/2));

fprintf('Orientation: %s\n', orientation)
fprintf('Gain Profile: %s\n', gainProfile)
fprintf('Length: %f\n', length)
```

OUTPUT:
Orientation: vertical
Gain Profile: rectangular window
Length: 9.818704

3. Determine the orientation, length, gain (acoustic velocity) profile and control strategy for a one-dimensional loudspeaker array, which, at 300 Hz exhibits a mainlobe width of 30 degrees in

the azimuth plane and pointing at 20 degrees to its right, and the sidelobes are suppressed by at least 20 dB.

```
%% Question 3 %%
c = 341; % speed of sound (m/s)

% Using gain profile of cos^2 (-32dB), we must half our length
orientation = 'Horizontal';
gainProfile = 'cosine window';
length = 0.5*(c/(300*sind(30/2)));
sweepSpeed = c/sind(20);
T = length/sweepSpeed;
fprintf('Orientation: %s\n', orientation);
fprintf('Gain Profile: %s\n', gainProfile);
fprintf('Length: %f\n',length);
fprintf('Sweeping speed: %f m/s\n', sweepSpeed);
fprintf('Rightmost element delay (in seconds) %f seconds\n', T);

4. %Using gain profile of cos^2 (-32dB), we must double our length
Orientation = 'Vertical';
GainProfile = 'cosine^2 window (-32 dB suppression)';
LengthY = 2*341/(350*sind(5/2));
LengthX = 2*341/(350*sind(10/2));
SweepSpeedY = 341/sind(25);
SweepSpeedX = 341/sind(20);
TY = LengthY/SweepSpeedY;
TX = LengthX/SweepSpeedX;

fprintf('Orientation is %s\n', Orientation);
fprintf('GainProfile is %s\n', GainProfile);
fprintf('Height is %f meters\n',LengthY);
fprintf('Width is %f meters\n',LengthX);
fprintf('Sweeping elevation speed is %f m/s\n', SweepSpeedY);
fprintf('Sweeping azimuth speed is %f m/s\n', SweepSpeedX);
fprintf('The top most elements are delayed by %f seconds\n', TY);
fprintf('the left most elements are delayed by %f seconds\n', TX);
```

Output:

```
Orientation: Horizontal
Gain Profile: cosine window
Length: 2.195871
Sweeping speed: 997.017300 m/s
Rightmost element delay (in seconds) 0.002202 seconds
```

4.

```
%% Question 4%%

%Using gain profile of cos^2 (-32dB), we must double our length
Orientation = 'Vertical';
GainProfile = 'cosine^2 window';
LengthY = 2*341/(350*sind(5/2));
LengthX = 2*341/(350*sind(10/2));
SweepSpeedY = 341/sind(25);
SweepSpeedX = 341/sind(20);
```

```
TY = LengthY/SweepSpeedY;
TX = LengthX/SweepSpeedX;

fprintf('Orientation is %s\n', Orientation);
fprintf('GainProfile is %s\n', GainProfile);
fprintf('Height is %f meters\n',LengthY);
fprintf('Width is %f meters\n',LengthX);
fprintf('Sweeping elevation speed is %f m/s\n', SweepSpeedY);
fprintf('Sweeping azimuth speed is %f m/s\n', SweepSpeedX);
fprintf('The top most elements are delayed by %f seconds\n', TY);
fprintf('the left most elements are delayed by %f seconds\n', TX);
```

Output:

```
%% Question 4%%

%Using gain profile of cos^2 (-32dB), we must double our length
Orientation = 'Vertical';
GainProfile = 'cosine^2 window';
LengthY = 2*341/(350*sind(5/2));
LengthX = 2*341/(350*sind(10/2));
SweepSpeedY = 341/sind(25);
SweepSpeedX = 341/sind(20);
TY = LengthY/SweepSpeedY;
TX = LengthX/SweepSpeedX;

fprintf('Orientation is %s\n', Orientation);
fprintf('GainProfile is %s\n', GainProfile);
```