Lab 3

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Regarding:	Lab 3
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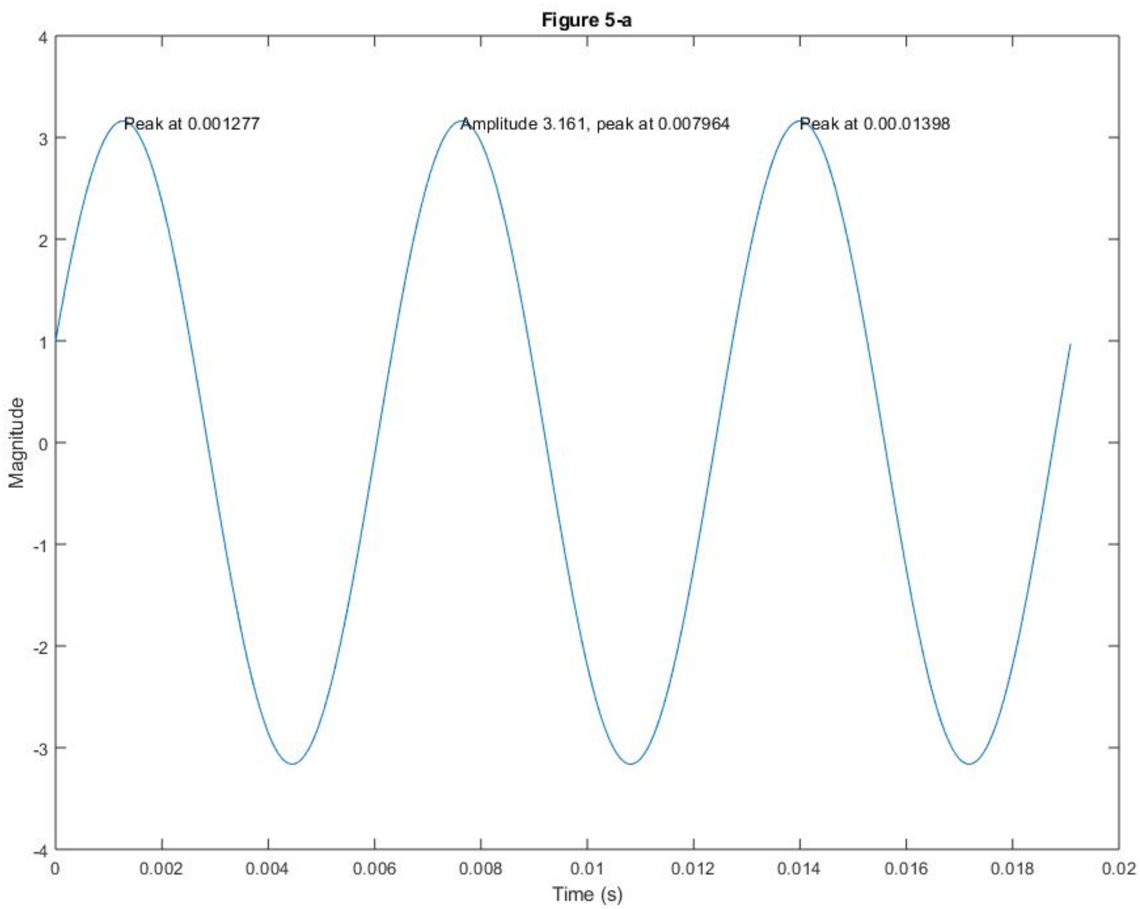
Summary

In this lab the representation of sinusoids through complex exponentials was explored. In addition I revisited a similar problem from lab 2 when analyzing the direction a signal is receives from when it arrives at two separate receivers after unique time delays.

Main Body

Section 5:

5-a)



A sum of three equal frequency sine waves graphed using the syn_sin function

```
[xx1,tt1] =
syn_sin([50*pi,50*pi,50*pi],[-2,-1*exp(50*pi*-0.02*j),(2-j*3)],50*pi*
2,3*(1/(50*pi)))

hold off;

plot(tt1,real(xx1)),text(0.007599,3.161,"Amplitude 3.161, peak at
0.007964"),
text(0.01398,3.161,"Peak at 0.00.01398"),text(0.001277,3.161,"Peak at
0.001277"),
title("Figure 5-a"),xlabel("Time (s)"), ylabel("Magnitude"), hold off
```

5-b)

Hand calculations

5c) $-2e^{j50\pi T} - e^{j50\pi T - 0.02\cdot 50\pi j} + (2-3j)e^{j50\pi T}$

$-(2\angle 0^\circ) - (e^{\pi j}\angle 0^\circ) + (2-3j)\angle 0^\circ$

$-(2\angle 0^\circ) - (-1\angle 0^\circ) + (2-3j)\angle 0^\circ$

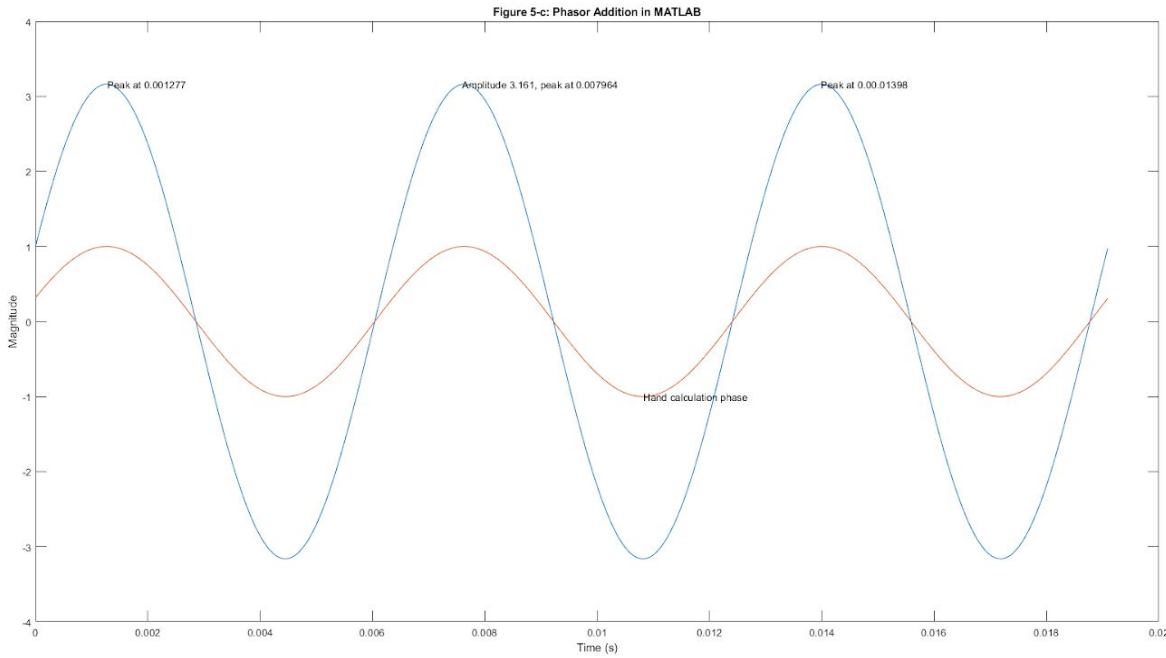
$\cancel{-2} + 1 \cancel{+2} - 3j$

$1-3j$

Amp $=\sqrt{(1)^2+(3)^2} = \sqrt{10} \approx 3.1622$

Phase $= \arctan\left(\frac{-3}{1}\right) = -1.249$

5-c)



Blue: Phasor Addition Full Wave, Orange: Phasor Addition Frq/Phase Verification

The amplitude, phase shift, and frequency calculated by hand via the phasor addition theorem match the plots produced in MATLAB.

Section 6:

6-1a) Mathematical Expression for Receiver 1

```
function[t1] = delay_one(xv)

    dist = (xv - 0)^2 + (100-0)^2;
    d = sqrt(dist);
    t1 = d/(333 + 1/3);

end
```

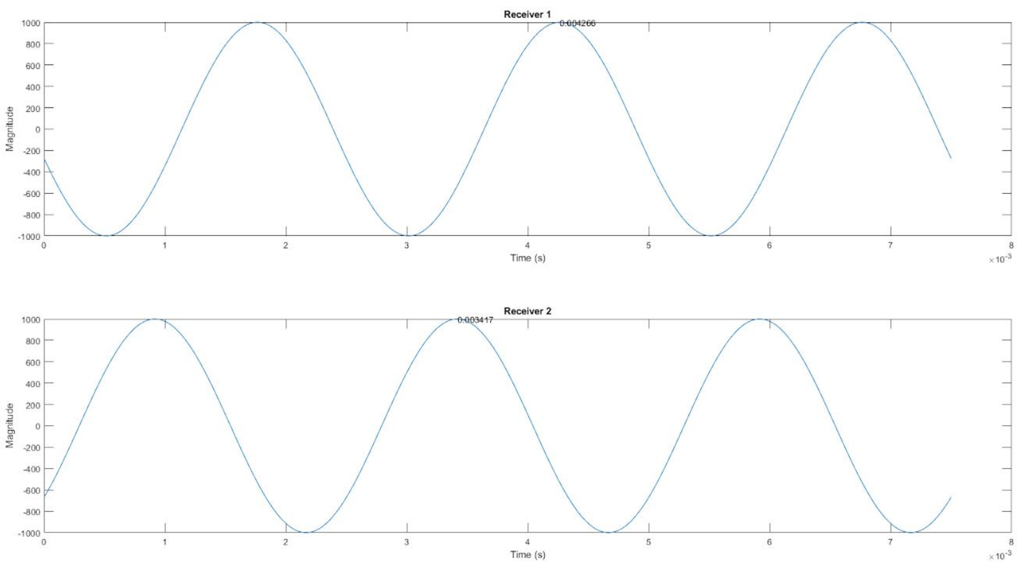
6-1b) Mathematical Expression for Receiver 2

```
function[t2] = delay_two(xv)

    dist2 = (xv - 0.4)^2 + (100-0)^2;
    d2 = sqrt(dist2);
    t2 = d2/(333 + 1/3);

end
```

6-1c)



Time delay between signals: -8.49e-4

6-1d)

-8.49e-4 * 400 * 2 * pi = -2.1337 radians

Phase Difference = -2.1337 radians
Verified in section 6-1f)

6-1e)

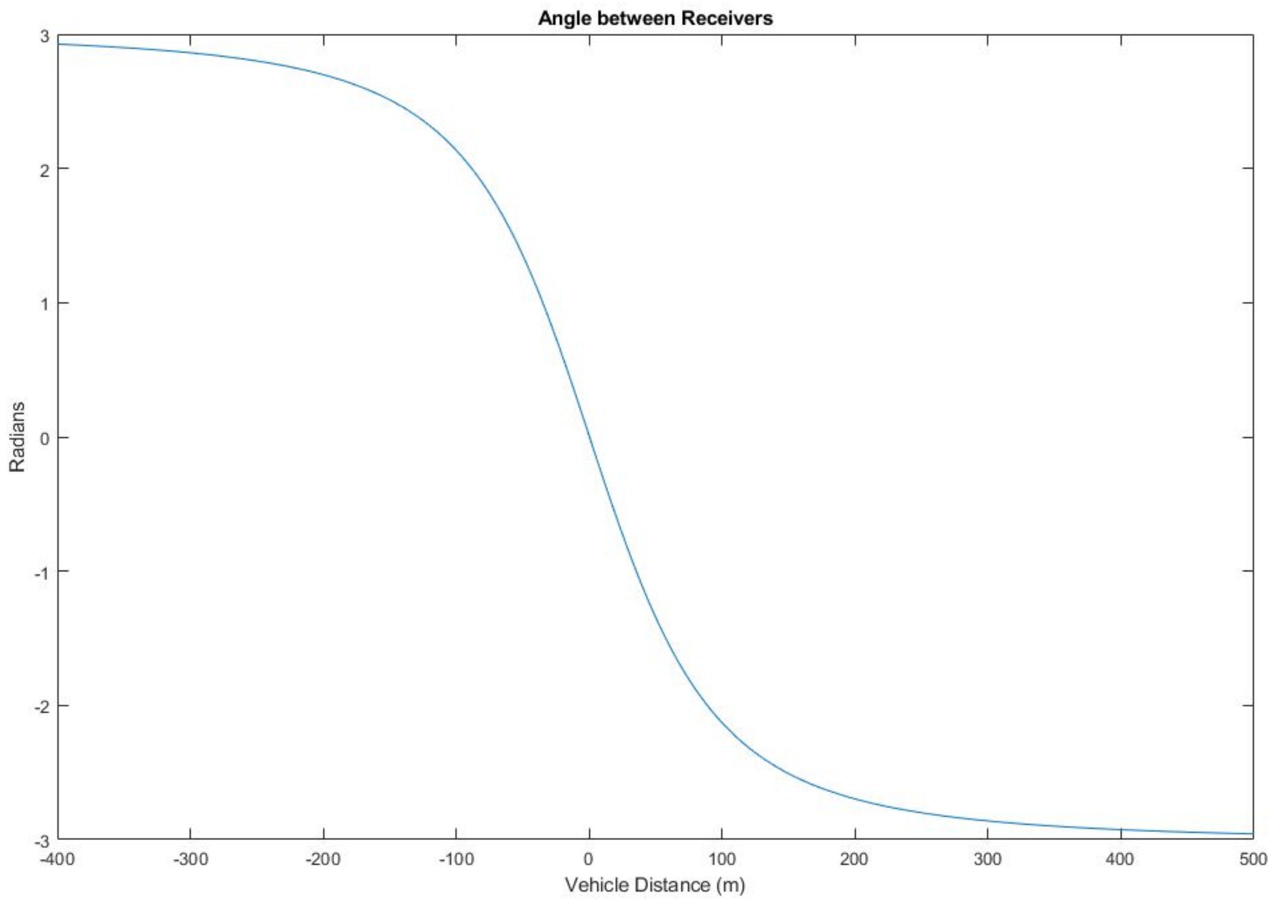
```
function[theta] = direction_finding(xv)

    dist1 = (xv - 0).^2 + (100-0)^2;
```

```
    dist2 = (xv - 0.4).^2 + (100-0)^2;
    d1 = sqrt(dist1);
    d2 = sqrt(dist2);
    t1 = d1/(333 + 1/3);
    t2 = d2/(333 + 1/3);

    t3 = t2 - t1;
    theta = t3*400 * 2 *pi;

end
```

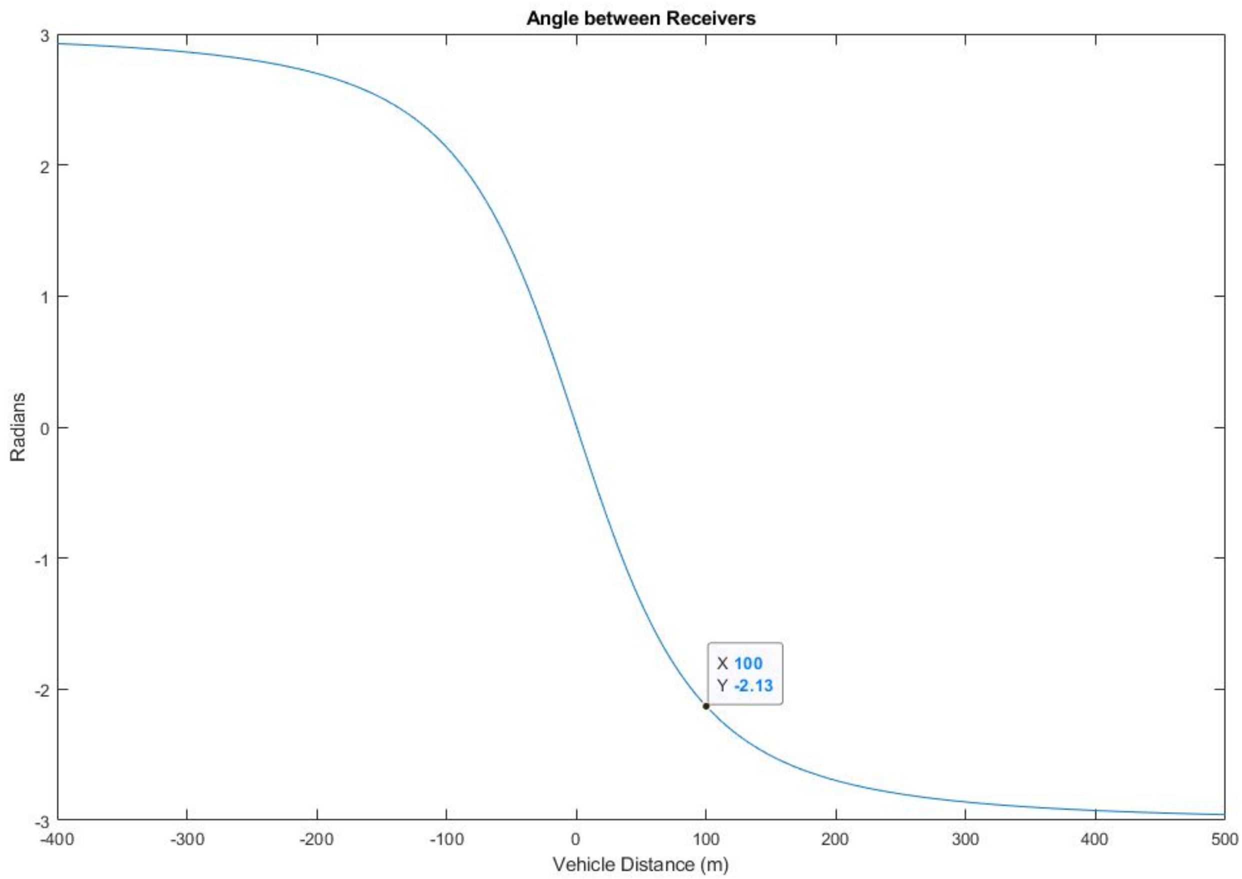


plot of receiver angles from a vehicle going from -400 to 500 meters

6-1f)

From hand calculations at 100m: theta = -2.1337 radians

From function:



Y = -2.13

The function's accuracy is confirmed.

6-1f)

Vectorization used in original function definition and call

```
%% 6-1 theta vector
```

```
xv = -400:1:500;

f = 400;
amp = 1000;

dot = direction_finding(xv)

plot(xv,dot),title("Angle between Receivers"),xlabel("Vehicle
Distance (m)"),ylabel('Radians')

hold off;


%% Function definitions

function[theta] = direction_finding(xv)

    dist1 = (xv - 0).^2 + (100-0)^2;
    dist2 = (xv - 0.4).^2 + (100-0)^2;
    d1 = sqrt(dist1);
    d2 = sqrt(dist2);
    t1 = d1/(333 + 1/3);
    t2 = d2/(333 + 1/3);

    t3 = t2 - t1;
    theta = t3*400 * 2 *pi;

end
```

Conclusion

It is possible to determine the direction a signal is received from across two individual receivers by comparing the difference in time delays and using that information as well as the signal to period to calculate a direct angle. Also, MATLAB functions as well as vectorization can be used to create accurate models and understand real world stimuli.