3.1

$f_s = 1$ MHz

$c_s = 343$ m/s

If $v(t)$ is transmitted by speaker, microphone signals:

$$y_1(t) = G_{1,v}\, v(t-\tau_1) + \sum_{k=1}^{K} G_{1,k}\, v(t-\tau_{1,k}) + w_1(t)$$

$$y_2(t) = \underbrace{G_{2,v}\, v(t-\tau_1)}_{\text{direct path}} + \underbrace{\sum_{k=1}^{K} G_{2,k}\, v(t-\tau_{1,k})}_{\text{echoes / multipath}} + \underbrace{w_2(t)}_{\text{noise}}$$

lets ignore multipath

$$y_1(t) = s(t-\tau_1)$$

$$y_2(t) = s(t-\tau_2)$$

Use $B = 200$ m and $L = 100$ m

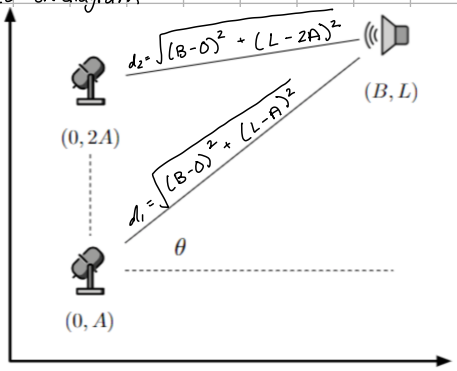
a) Calculate formulas for delays τ_1 and τ_2. Answer should be in terms of A, B, L

$$\tau = \frac{d}{c}$$

where d is distance

c = speed of sound

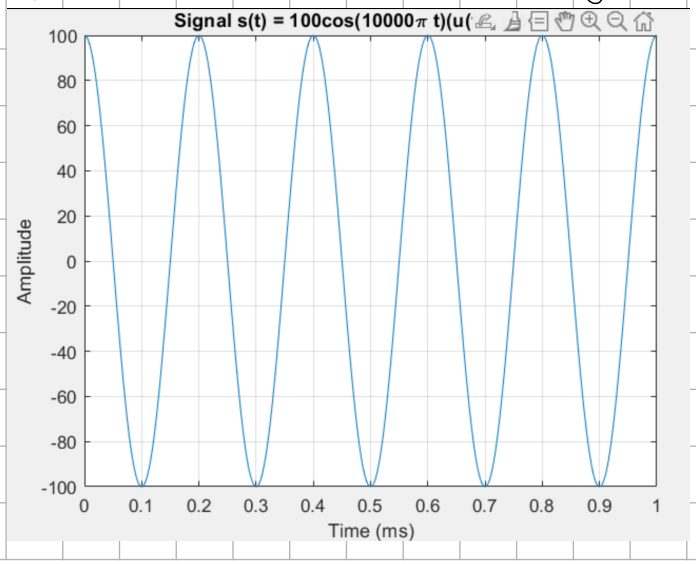
Based on diagram



$$\frac{d_1}{c} = \frac{\sqrt{B^2 + (L-A)^2}}{c} = \tau_1$$

$$\frac{d_2}{c} = \frac{\sqrt{B^2 + (L-2A)^2}}{c} = \tau_2$$

b) Suppose signal $s(t) = 100\cos(1000\pi t)(u(t) - u(t-1))$. Using the sig=@(



c) find frequency & wavelength. What is null separation?

$s(t) = 100 \cos(10000\pi t)(u(t) - u(t-1))$

$\omega = 10000\pi$

$\omega = 2\pi f$

$f = \frac{\omega}{2\pi} = \frac{10000\pi}{2\pi} = 5000\ Hz$

$\lambda = \frac{c}{f} = \frac{343\ m/s}{5000\ Hz} = 0.0686\ m$

null separation $= \frac{1}{2} = \frac{0.0686}{2} = 0.0343\ m$