ECE 278C **IMAGING SYSTEMS** **Winter 2019**

ASSIGNMENT 5: Resolution Analysis

Due: Tuesday, March 5, 6 pm

Name: _____

In the time domain, the chirp waveform for range estimation is in the form of

$$p(t) = A \exp(j\pi B t^2/T) \qquad -T/2 < t < T/2$$

where T is the chirp period and B is the bandwidth.

In the space domain, suppose there is an active coherent point source centered at $(x, z) = (0, 0)$. At a distance, a centered linear receiver aperture has a span of L, from $x = -L/2$ to $x = +L/2$. The center of the linear aperture is at $(x, z) = (0, z_o)$. The received wavefield over the aperture is in the form of

$$g(x) = (1/j\lambda r)^{1/2} \exp(j2\pi r/\lambda) \qquad -L/2 < x < L/2$$

$$\approx C \exp(j2\pi r/\lambda)$$

where $r = (x^2 + z_o^2)^{½}$.

1. Observe the spectrum of $p(t)$ as a function of T.
2. Observe the autocorrelation function of $p(t)$ as a function of T.
3. Calculate and observe the spectrum of $p(t - \Delta t)\, p^*(t)$ as a function of Δt and T.
4. Observe the spatial-frequency spectrum of $g(x)$ as a function of L and z_o.
5. Observe the autocorrelation function of $g(x)$ as a function of L and z_o.
6. Calculate and observe the spectrum of $g(x - \Delta x)\, g^*(x)$ as a function of Δx, L and z_o.
7. Establish the similarity and equivalence between $p(t)$ and $g(x)$.

Hint:

If Part (1) of the homework assignment seems confusing, you can modify it into the form of

$$p(t) = A \exp(j\pi S t^2) \qquad -T/2 < t < T/2$$

where T is the chirp period and S is the *slope* of the chirp. Set the slope S to constant. Then variation of the chirp period T will give you different bandwidth and subsequently different autocorrelation function.