1. Write an autofocus program to implement the sub-aperture shift algorithm.

Use a 1-D image for ease of implementation. Assume the signal is a single chirp waveform with the following parameters:

Chirp slope:	10^{12} Hz/s
Pulse length:	10 µs
Sample rate fs:	100 Mhz

Correlate this chirp with reference chirps of slope $1 \cdot 10^{12}$ Hz/s, $1.01 \cdot 10^{12}$ Hz/s, $1.03 \cdot 10^{12}$ Hz/s, and $0.98 \cdot 10^{12}$ Hz/s. In each case analyze the resulting complex image and calculate

(a) the offset in pixels of the subaperture images
(b) the implied Δs for each case

2. Download the data file "simlband.dat" from the web page. This file represents signal data in ***complex floating point*** format, 2048 lines of 2048 complex samples each. Display the file and note the range migration present. (You may have to byte-swap the file if your machine is big-endian.)

(a) Range compress the data and examine the migration as a function of time. Chirp parameters are:

Chirp slope:	10^{12} Hz/s
Pulse length:	10 µs
Sample rate fs:	24 Mhz

(b) Transform the compressed data in azimuth and display, again noting the migration path. Other radar parameters are:

PRF:	250 Hz
Velocity:	250 m/s
Antenna length:	2 m
Wavelength:	0.25 m
Range to first bin:	4653 m

(c) Estimate the Doppler centroid of the data. List at least three possible f_{DC}'s consistent with the ambiguous measurement of f_{DC}.

(d) Process these data using the original (non-migrating) algorithm. Examine and plot the impulse response and describe the blurring. Process 80% of the azimuth bandwidth.

(e) Apply the cut and paste algorithm assuming each f_{DC} found in (c) above. Which gives the best impulse response? Again use 80% bandwidth.

3. In class we showed that for a satellite passing directly overhead, the effective velocity for SAR processing was

$$v_{eff} = v\sqrt{\frac{r_e}{h + r_e}}$$

Show that for a point not directly under the satellite,

$$v_{eff} = v\sqrt{\frac{r_e \cos\beta}{h + r_e}}$$

where β is the angle from the point, to the center of the Earth, to the satellite at its point of closest approach.