1. Create 10000 different arrays of 1000 normally-distributed random numbers with a mean of 10 and a standard deviation of 2 (be sure to type a semi-colon at the end of the line or your screen will become cluttered with random numbers), Named as matrix NA. Create another array at the same size, NB, with normally distributed numbers having a mean of 10.5 and a standard deviation of 2. Find the mean and standard deviation of each row in NA and NB (10000 rows in all), named as NAM, NBM, NAstd and NBstd. Plot and send me the histograms of NAM, NBM, NAstd and NBstd. Notice that there is a range of both standard deviations and means. Calculate 10000 t statistics of the difference of means between NA and NB (saved as array tN). Plot and send me the histogram of tN. What is the mean of your experimentally determined tN? What is the standard deviation of tN? Approximately what fraction of the time would your experimentally measured t statistic be greater than 7? (25points)

Hint: Programming with MATLAB.

2. Construct a synthesized magnetic resonance spectroscopy (MRS) time series using the Lorentzian model:

$$y_n = \sum_{k=1}^{K} a_k e^{j\phi_k} e^{(-d_k + j2\pi f_k)t_n} + e_n \quad , \quad n = 0,1,\ldots,\mathrm{N}-1,$$

where y_n is the *n*th measured data point, (a_k, ϕ_k, d_k, f_k) are the amplitude, phase, damping factor and frequency of the *k*th component, t_n = 1s as the data sampling interval, and e_n is the circular complex white Gaussian noise. Here the data length is assumed as N=1024. The metabolite component parameters were assigned as in Table 1:

k	Metabolite	f_k(Hz)	d_k(Hz)	a_k(a.u)	ϕ_k(rad)
1	NAA	0.8285	0.025	10.3	0
2	Cr	0.8925	0.02	4.8	π
3	Cho	0.9053	0.015	3.2	π/2
4	MI	0.9232	0.015	1.5	0
5	Lipid	0.7504	0.01	0.8	π/6

Table 1. Parameters for MRS signal construction

Using various noise level σ^2 = 2 and 5, respectively:
Plot the corresponding absolute value of MRS signal in time domain. Perform a fast Fourier transform (FFT) to obtain the frequency domain representation of MRS signal (i.e. the spectrum). Plot the absolute value, real value and imaginary value of MRS spectrum separately. Send me the codes and plots. (35points)

Hint: Programming with MATLAB. Might use "fft" function for transformation.

3. Given the raw speckle image files in the data folder 'Dat' (80 frames altogether), calculate the spatial LSI (using a 3*3 window) contrast for each frame. By averaging all the contrast frames, draw the final sLASCA image. Implement temporal LSI (using a 20- frame window) too and draw

the final tLASCA image. Apply eLASCA to both images and plot the new figures (2 figures). Send me the codes and plots. All images in gray map. (40 points)

Hint: Programming with MATLAB. Might use "imread" and "imagesc" functions for image loading and plotting. Try to improve the computational efficiency by intelligent matrix manipulation.