L22: class exercises – Try to implement/solve the following problems in MATLAB.

Time series

In this step you will create your own time series that contains multiple periodic components, a linear trend and noise. Create a time vector from 0:1000 with a time step of dt=1.

Now create a periodic signal (x_p) composed of three sine functions with 1) A1=2, f1=1/50; 2) A2=1, f2=1/15, and 3) A3=0.5, f3=1/5 summed together. For example, sine wave one would be A1*sin(2*pi*f1*t). Plot this wave and label the axes.

Next, create a linear trend (x_tr) that has a slope of 0.005 and y-intercept at 0. Add this to the x_p curve and plot on top of the individual x_p curve. Do you notice a linear trend?

Finally, generate zero-mean random Gaussian noise with **randn()**. The noise should have a standard deviation of one. *Note: Prior to calling **randn()**, make sure to set **rng(0)** so that everyone in class has the same random noise.* Add this noise to the periodic and trend data so that you have a time series with all three components. Plot this data on top of the periodic only signal.

You should now have three signals.

1. $x_p(t)$ = periodic signal composed of three sine curves
2. $x_1(t) = x_p(t) + x_{tr}(t)$ = periodic plus linear trend
3. $x_2(t) = x_p(t) + x_{tr}(t) + x_n(t)$ = periodic plus linear trend plus noise

1 Periodogram

Use **nextpow()** to find the next power of two of the number of data points. Set **nfft=**$2^{nextpow(N)}$, where N is the number of data. Then call **[Pxx,f]=periodogram(x_p,[],nfft,fs)**, where *nfft* is the number of points in the fft (an *even* number of points makes the fft symmetric and using powers of two enables this to be done easily). x_p is the periodic only signal; *fs* is the sampling frequency 1/dt. Then plot the output with the y-limits set from 0:1000;

```
nfft = 2^nextpow2(N);
[Pxx,f] = periodogram(x_p,[],nfft,fs);

figure;
plot(f,Pxx); grid on;
xlabel('Frequency [Hz]' ylim([0 1000]););
ylabel('Power');
title('Auto-Spectrum');
ylim([0 1000]);
```

Describe the output. What do you notice about the upper frequency limit?

Repeat the periodogram computation and plotting using 1) the periodic + trend signal and 2) the periodic, trend and noise signal. Describe the differences in the plots.

Now vary the noise from a standard deviation of 1 to 2 to 3 to 4. What happens to you plots?