**ECE 2045: Statistical Signal Processing**

**Lab 3: Performance of the Periodogram**

Consider the following sequence of 100 samples:

```
randn('state',0)
fs = 1000;            % Sampling frequency
t = (0:fs/10)/fs;     % One-tenth of a second worth of samples
A = [1 2];            % Sinusoid amplitudes
f = [150;140];        % Sinusoid frequencies
xn = A*sin(2*pi*f*t) + 0.1*randn(size(t));
Hs = spectrum.periodogram;
psd(Hs,xn,'Fs',fs,'NFFT',1024)
```

Consider a case where this criterion is not met, as for the sequence of 67 samples below:

```
randn('state',0)
fs = 1000;               % Sampling frequency
t = (0:fs/15)./fs;       % 67 samples
A = [1 2];               % Sinusoid amplitudes
f = [150;140];           % Sinusoid frequencies
xn = A*sin(2*pi*f*t) + 0.1*randn(size(t));
Hs=spectrum.periodogram;
psd(Hs,xn,'Fs',fs,'NFFT',1024)
```

The above discussion about resolution did not consider the effects of noise since the signal-to-noise ratio (SNR) has been relatively high thus far. When the SNR is low, true spectral features are much harder to distinguish, and noise artifacts appear in spectral estimates based on the periodogram. The example below illustrates this:

```
randn('state',0)
fs = 1000;            % Sampling frequency
t = (0:fs/10)./fs;    % One-tenth of a second worth of samples
A = [1 2];            % Sinusoid amplitudes
f = [150;140];        % Sinusoid frequencies
xn = A*sin(2*pi*f*t) + 2*randn(size(t));
Hs=spectrum.periodogram;
psd(Hs,xn,'Fs',fs,'NFFT',1024)
```

The periodogram function allows you to compute a modified periodogram by specifying the window to be used on the data. For example, compare a default rectangular window and a Hamming window:

```
randn('state',0)
```

```
fs = 1000;            % Sampling frequency
t = (0:fs/10)./fs;    % One-tenth of a second worth of samples
A = [1 2];            % Sinusoid amplitudes
f = [150;140];        % Sinusoid frequencies
xn = A*sin(2*pi*f*t) + 0.1*randn(size(t));
Hrect = spectrum.periodogram;
psd(Hrect,xn,'Fs',fs,'NFFT',1024);
```

```
Hhamm = spectrum.periodogram('Hamming');
psd(Hhamm,xn,'Fs',fs,'NFFT',1024);
```