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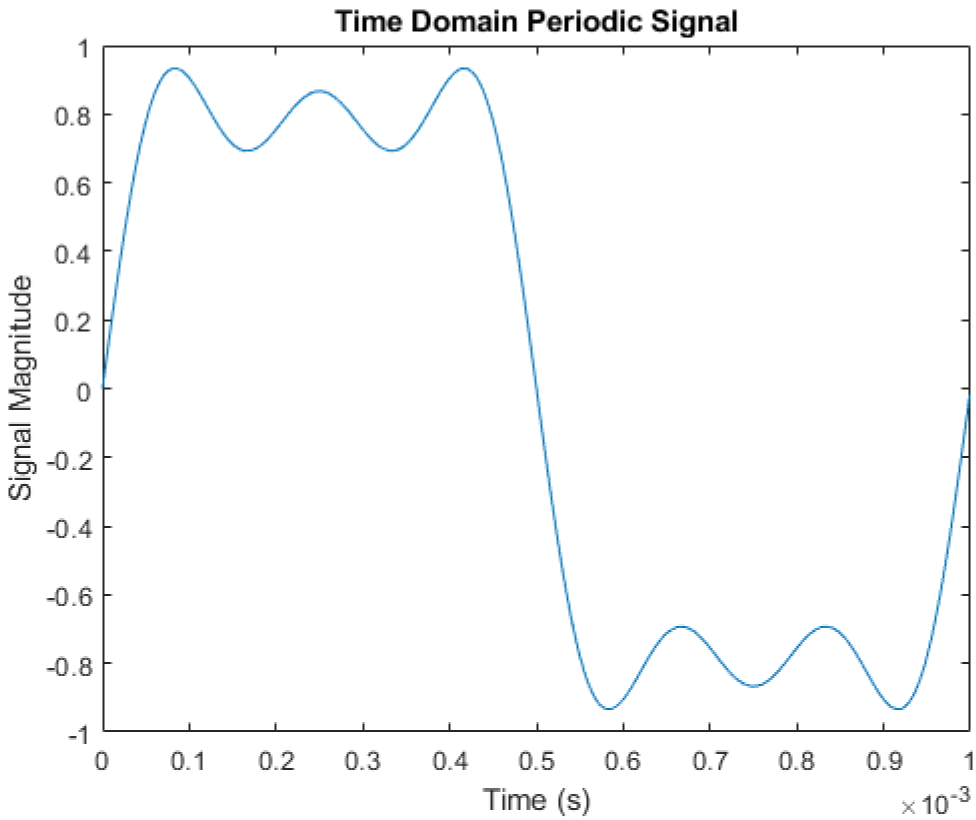
Thursday October 4, 2018

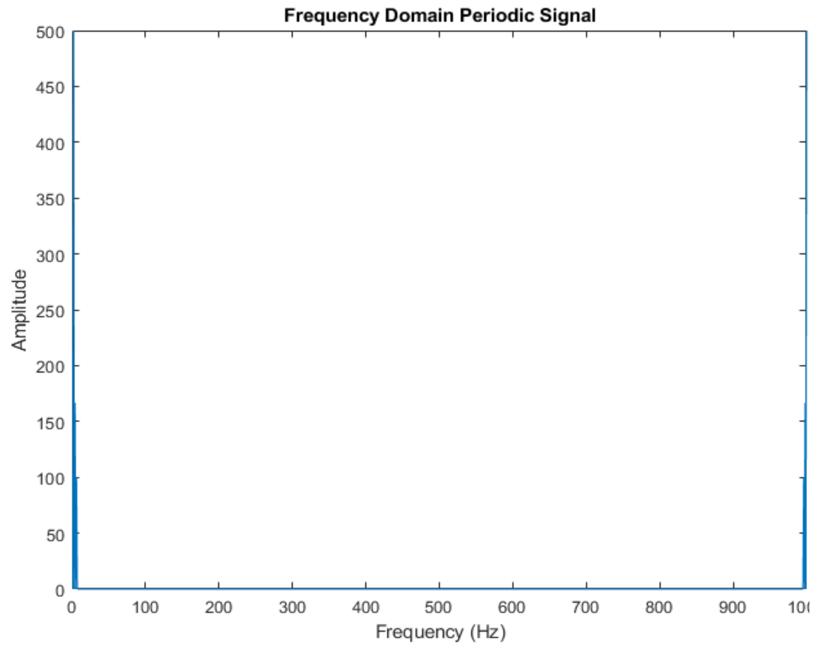
EECS 4214: Digital Communications

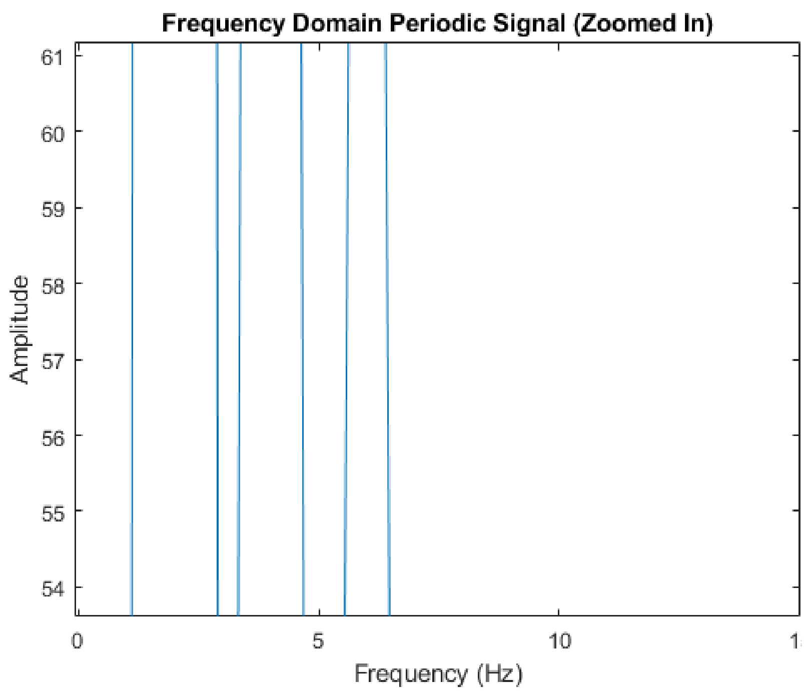
Assignment 2: Deterministic and Random Signals

1.




```
% t = 0:0.000001:0.000999;
% f = 1000;
% x = sin(2*pi*f*t) + (1/3)*sin(2*pi*3*f*t) + (1/5)*sin(2*pi*5*f*t);
% plot(t,x);
% title('Time Domain Periodic Signal');
% xlabel('Time (s)');
% ylabel('Signal Magnitude');
```



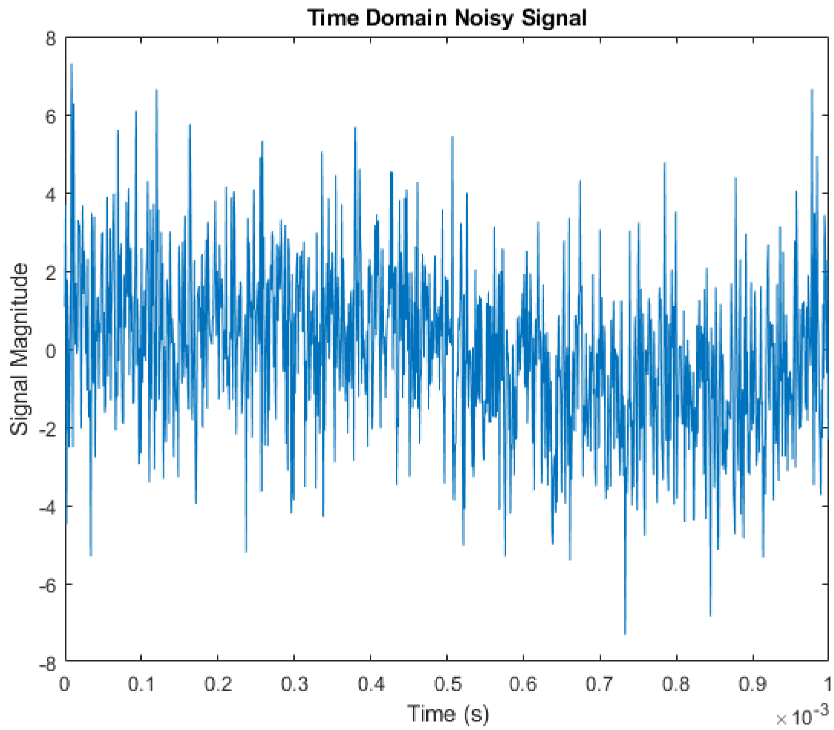


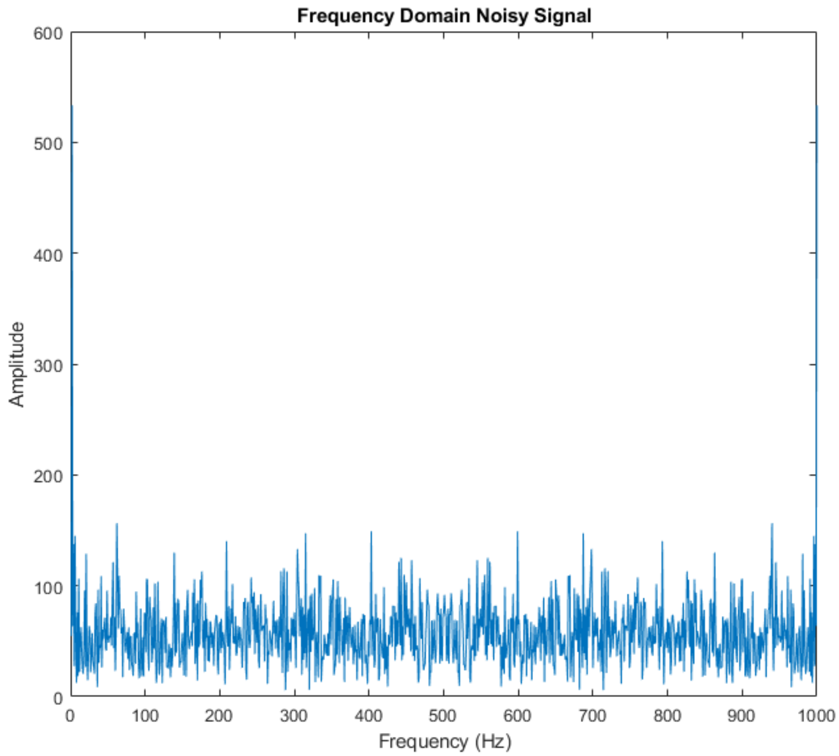

```
% fs = 1000;
% t = 0:0.000001:0.000999;
% x = sin(2*pi*fs*t) + (1/3)*sin(2*pi*3*fs*t) + (1/5)*sin(2*pi*5*fs*t);
% X = fft(x);
% X_mag = abs(X);
% plot(X_mag);
% title('Frequency Domain Periodic Signal');
% xlabel('Frequency (Hz)');
% ylabel('Amplitude');
```

2. The Matlab code for these components is pretty much the same as in question 1 except for this lines

```
% y = x + 2*randn(size(t));
% plot(t,y);
```

Which added the noise to the original signals and plotted the combined signal instead of the original.





3. This signal is ergodic because the time averages equal the ensemble averages. Random waveforms are ergodic in the mean and the autocorrelation function. The statistical properties (DC value, rms value, average power) can be related to the moments of an ergodic random process.

4.

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Assignment 1

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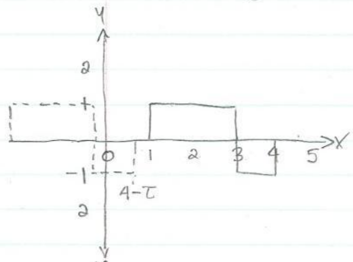
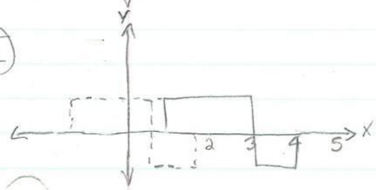
4. $y(t) = \begin{cases} 0 & t < 1s \text{ and } t > 4s \\ 1 & 1s < t < 3s \\ -1 & 3s < t < 4s \end{cases}$

I



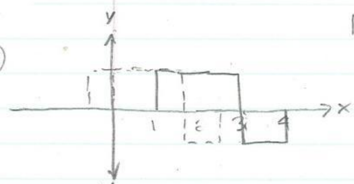
$\tau > 3$, $R_x(\tau) = \int_{-\infty}^{+\infty} x(t)\cdot x(t-\tau)\,dt = 0$

II



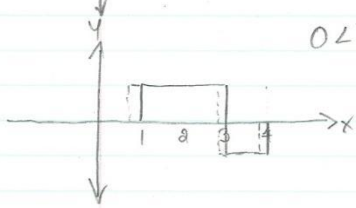
$2 < \tau < 3$ $R_x(\tau) = \int_1^{4-\tau} (1)(-1)\,dt = -t\Big|_1^{4-\tau} = \tau - 4 + 1$
$= \tau - 3$

III



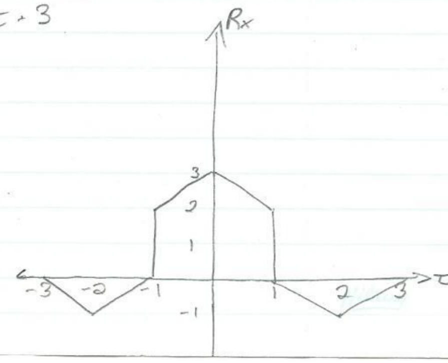
$1 < \tau < 2$ $R_x(\tau) = \int_1^{3-\tau} (1)(1)dt + \int_{3-\tau}^{4-\tau} (1)(-1)dt = t\Big|_1^{3-\tau} - t\Big|_{3-\tau}^{4-\tau}$
$= (3-\tau-1) - (4-\tau-3+\tau)$
$= (-\tau+2) - 1$
$= -\tau + 1$

IV



$0 < \tau < 1$ $R_x(\tau) = \int_{3-\tau}^{3} (-1)(1)\,dt + \int_3^{4-\tau} (-1)(-1)dt + \int_1^{3-\tau} (1)(1)dt$
$= 3 - (3-\tau) + 4 - \tau - (3) + 3 - \tau - 1$
$= \tau \quad - \tau + 1 \quad + 2 - \tau$
$= -\tau + 3$

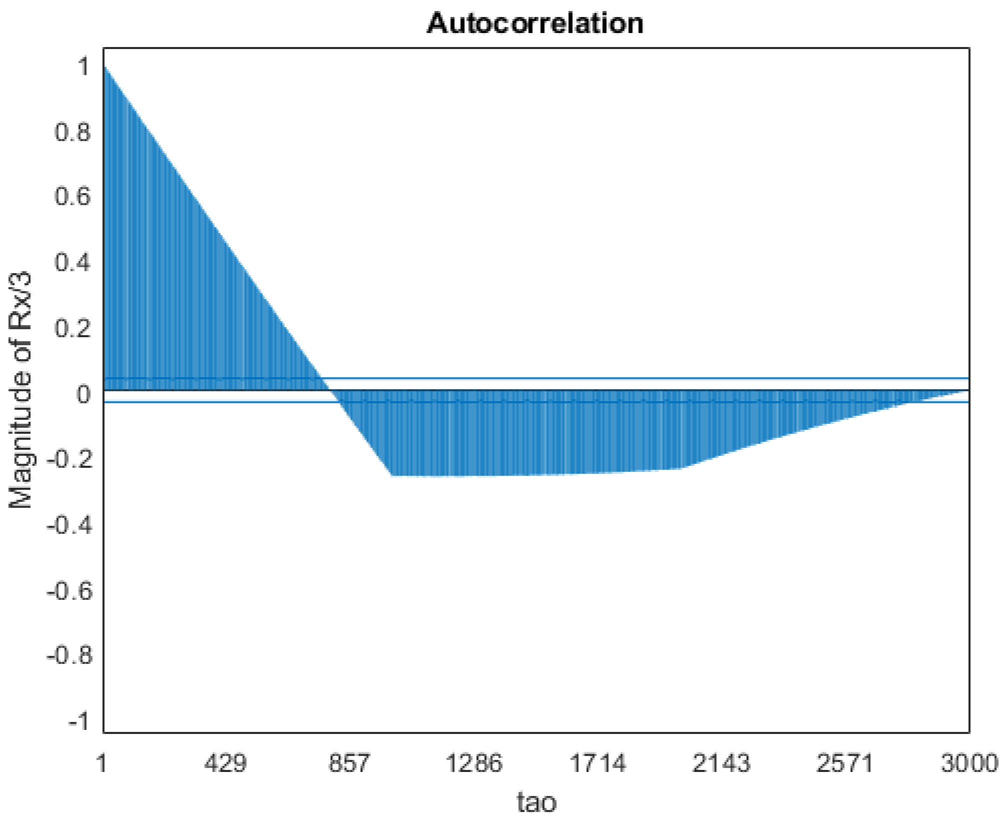
$R_x(\tau) = \begin{cases} 0 & 3 < \tau \\ \tau - 3 & 2 < \tau < 3 \\ -\tau + 1 & 1 < \tau < 2 \\ -\tau + 3 & 0 < \tau < 1 \end{cases}$



4. Continued

```
x1 = 1:0.001:3;

x2 = 3:0.001:4;

x3 = x2*(-1);

y = [x1 x3];
```

```
autocorr(y);

Y = y.';

autocorr(Y); %This is in the econometrics add-on
```



This chart is symmetric about zero.