CS-215: Experiment 8B

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1. Find system response from frequency response

Aim

Find the time-domain system response from given frequency response.

Theoretical Background

In the frequency domain, the system response (convolution) is

$$Y(e^{jw}) = H(e^{jw}) \cdot X(e^{jw})$$

The time domain counterpart can be found by applying discrete-time inverse Fourier transform.

Methodology

- The real part of inverse fourier transform of H is plotted.
- The frequency domain of x is computed and multiplied elementwise with H.
- The inverse fourier transform of $Y = X \cdot H$ (only real part) are computed and plotted.

Code

```
clearvars
clc
%%
N = 128;
k = 0:N-1;
n = k;

x = triangularPulse((n-8)/8);
X = fft(x);

H = exp(1i*2*pi*k/N) ./ (exp(1i*2*pi*k/N) - 0.7);
h = real(ifft(H));

```

```
Y = H .* X;
y = real(ifft(Y));
%%
excitPlt = subplot(1, 1, 1);
stem(n, x, 'k', "Marker","none");
grid on;
excitPlt.XLim = [0 30];
excitPlt.PlotBoxAspectRatio = [2 1 1];
xlabel('\itn'); ylabel('x [{\itn}]');

print(gcf, 'x[n].eps', '-depsc');
%%
impulsePlt = subplot(1, 1, 1);
stem(n, h, 'k', "Marker","none");
grid on;
impulsePlt.XLim = [0 30];
impulsePlt.PlotBoxAspectRatio = [2 1 1];
xlabel('\itn'); ylabel('h [{\itn}]');

print(gcf, 'h[n].eps', '-depsc');
%%
respPlt = subplot(1, 1, 1);
stem(n, y, 'k', "Marker","none");
grid on;
respPlt.XLim = [0 30];
respPlt.YLim = [0 3];
respPlt.PlotBoxAspectRatio = [2 1 1];
xlabel('\itn'); ylabel('y [{\itn}]');

print(gcf, 'y[n].eps', '-depsc');
```

Input Description

The excitation signal is

$$x[n] = tri\left(\frac{n-8}{8}\right)$$

where

$$tri(n) = \begin{cases} 1-|n| & |n|<1 \\ 0 & else \end{cases}$$

The frequency response is

$$H\left(e^{jw}\right) = \frac{e^{jw}}{e^{jw}-0.7}$$

The number of samples taken is N = 128.

Result

Note that only the 1st 30 samples have been plotted.

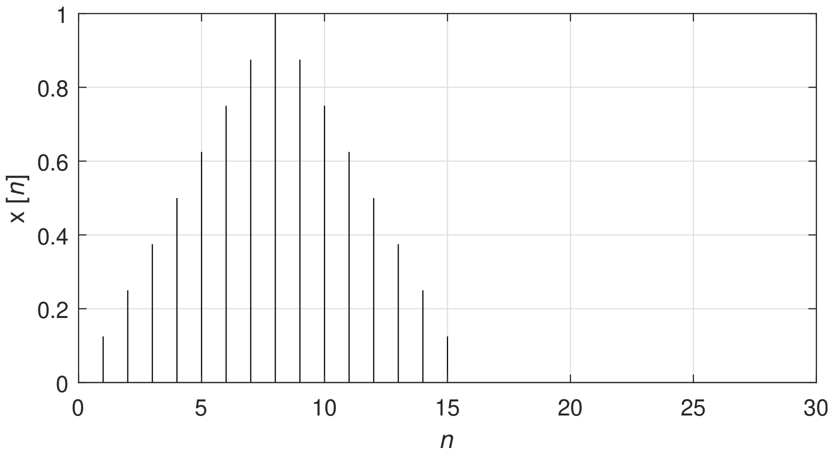

Figure 1.1: *Excitation signal*

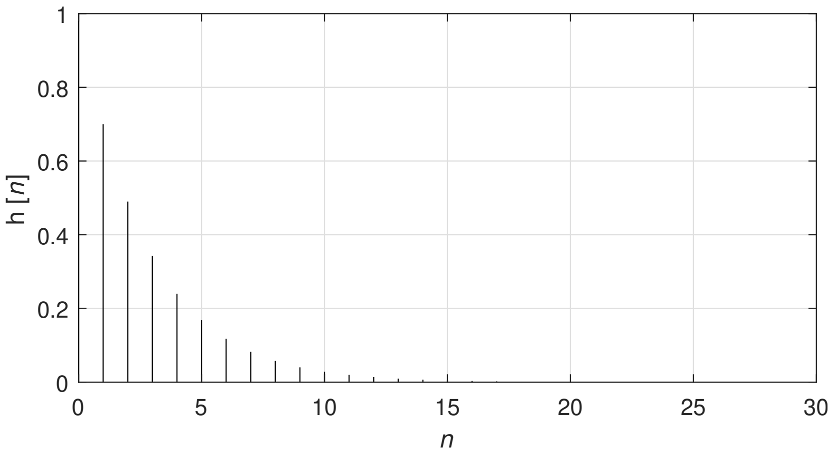

Figure 1.2: *Impulse Response*

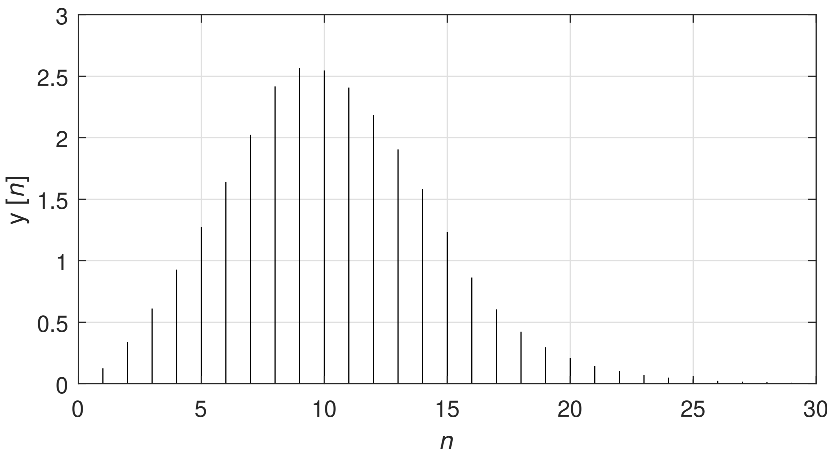

Figure 1.3: *System Response*

Conclusion and Discussion

Hence, the convolution is performed in the frequency domain by simnply multiplying the discrete-time fourier transforms of excitation and impulse response.