4.33 Consider the following pair of signals.

$$\begin{aligned} x &= [1, 2, 4, 8, 16, 8, 4, 2, 1]^T \\ y &= [2, -1, -4, -4, -1, 2]^T \end{aligned}$$

Verify that linear cross-correlation can be achieved by zero-padding and circular cross-correlation by writing a MATLAB script that pads these signals with an appropriate number of zeros, and uses the FDSP toolbox function *f_corr* to compute the linear cross-correlation $r_{xy}(k)$ and the circular cross-correlation $c_{x_z y_z}(k)$. Plot the following.

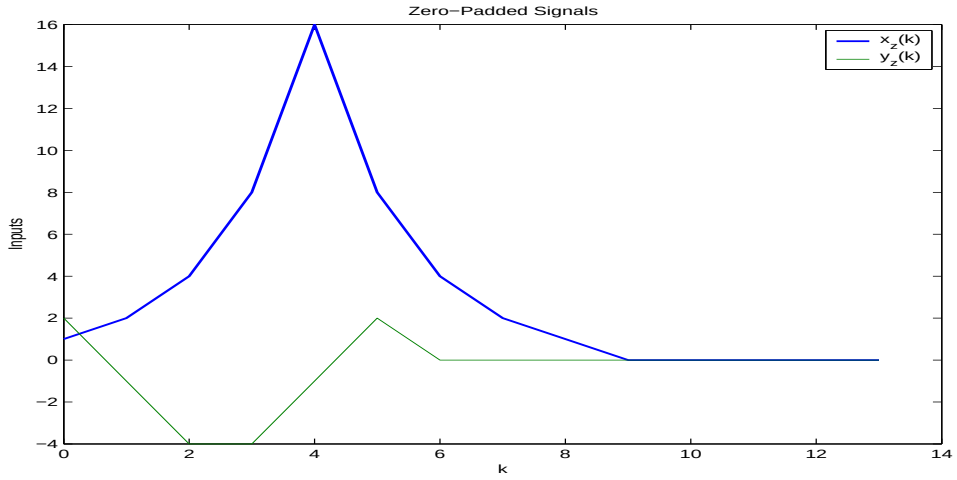
(a) The zero-padded signals $x_z(k)$ and $y_z(k)$ on the same graph using a legend.

(b) The linear cross-correlation $r_{xy}(k)$ and the scaled zero-padded circular cross-correlation $(N/L)c_{x_z y_z}(k)$ on the same graph using a legend.

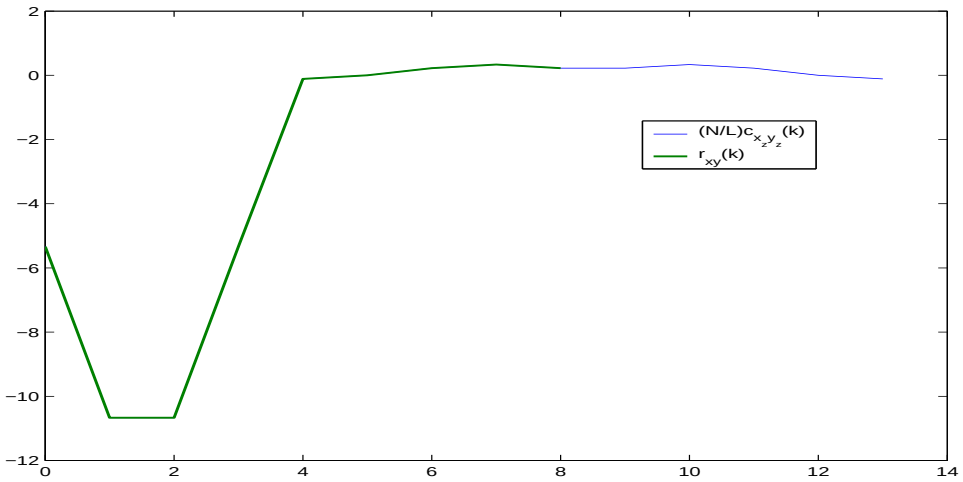
Solution

```
% Problem 4.33

% Iniitialize

clc
clear
x = [1 2 4 8 16 8 4 2 1]
y = [2 -1 -4 -4 -1 2]

% Construct and plot zero-padded signals

L = length(x);
M = length(y);
x_z = [x, zeros(1,M-1)];
y_z = [y, zeros(1,L-1)];
figure
N = length(x_z);
k = 0 : N-1;
hp = plot (k,x_z,k,y_z);
set (hp(1),'LineWidth',1.5)
f_labels ('Zero-Padded Signals','k','Inputs')
legend ('x_z(k)','y_z(k)')
f_wait

% Compute and plot cross-correlations

r_xy = f_corr (x,y,0,0);
R_xy = (N/L)*f_corr (x_z,y_z,1,0);
```

```
kr = 0 : length(r_xy)-1;
kR = 0 : length(R_xy)-1;
figure
h = plot (kR,R_xy,kr,r_xy);
set (h(2),'LineWidth',1.5)
legend ('(N/L)c_{x_zy_z}(k)', 'r_{xy}(k)')
f_wait
```



(a) Zero-Padded Signals



(b) Cross-Correlations