Solution

We will plot its actual impulse response and then the approximation to it using cross-correlation between the output and the input noise. We do that using MATLAB.

```
N=500;
nr=0:499;
ny=nr;
r=randn(1,N);
y=zeros(size(r)); % output initialized to zeros
for n = 2: 500
  y(n)=r(n)-0.5*y(n-1);
end
rr=fliplr(r);
nrr=-fliplr(nr);
Ryr=conv(y, rr);
%k=-(N-1):(N-1);
kmin=ny(1)+nrr(1);
kmax=ny(length(ny))+nrr(length(nrr));
k=kmin:kmax;
subplot(2,1,1);
stem(k,Ryr/Ryr(N));axis([-1 15 -1 1.2]);
title('Approximation of impulse response using cross-
 correlation');
num = [1 0]; den=[ 1 0.5];
n=0: 500;
x=zeros(size(n)); x(1)=1;
[y,v]=dlsim(num,den,x);
yy=conv(y,x);
n=0:1000;
subplot(2,1,2);stem(n,yy); title('Actual impulse response');
axis([-1 15 -1 1.2]);
```

The plots are shown in Figure 2.49.

2.21 End of Chapter Problems

EOCP 2.1

Consider the following systems

1. $y(n) = nx(n)$

   $n \geq 0$

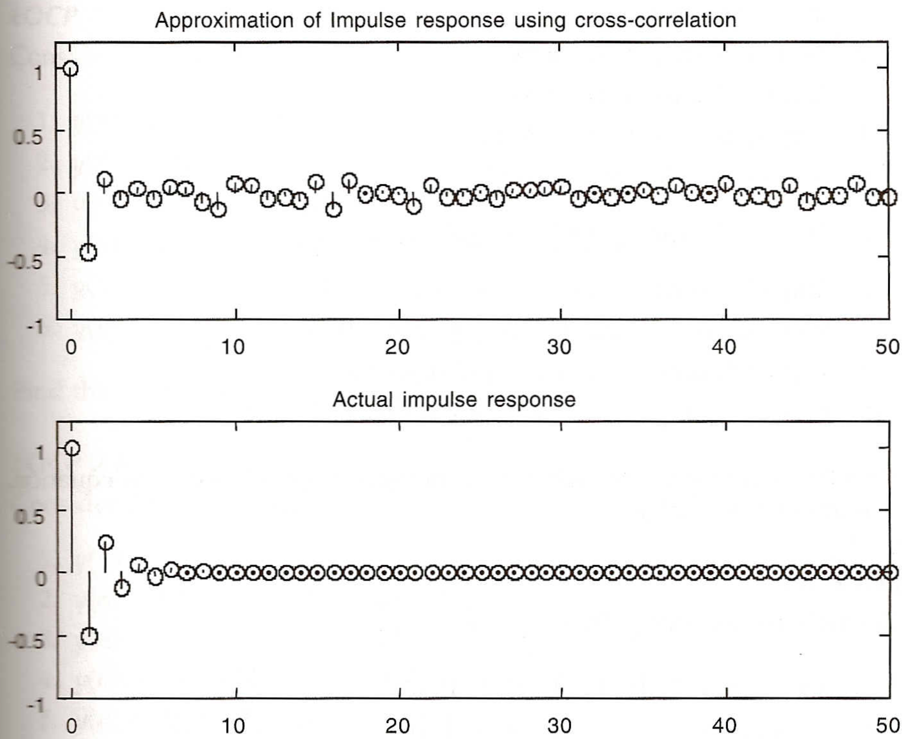

FIGURE 2.49 Plots for EOCE 2.16.

2. $y(n) = \cos(x(n)) + u(n)$

   $n \geq 0$
3. $y(n) = \sqrt{n}x(n)$
4. $y(n) = (4)^n \sin(n)$
5. $y(n) = \cos\left(n\dfrac{\pi}{2} - 1\right)$
6. $y(n) = \dfrac{\sin(nx(n))}{n}$
7. $y(n) = \sin(n)\cos(x(n))$
8. $y(n) = y(n-1) + x(n)$
9. $y(n) = ny(n-1) + x(n)$
10. $y(n) = y(n-1) + y(n-2) + x(n)$

Are the above systems linear? Are they time-invariant systems? Show work.

EOCP 2.2

Consider the following systems

1. $h(n) = u(n),\ \ x(n) = u(n)$
2. $h(n) = (.2)^n u(n),\ \ x(n) = \delta(n)$
3. $h(n) = (.3)^n u(n),\ \ x(n) = u(n)$
4. $h(n) = (.3)^n u(n),\ \ x(n) = (.2)^n u(n)$
5. $h(n) = (.3)^n nu(n),\ \ x(n) = \delta(n)$
6. $h(n) = n(.5)^n \cos\left(\frac{\pi n}{2} + 1\right) u(n),\ \ x(n) = \delta(n)$
7. $h(n) = (.4)^n u(n),\ \ x(n) = u(n) - u(n-2)$
8. $h(n) = u(n) - u(n-2),\ \ x(n) = u(n) - u(n-2)$
9. $h(n) = (.4)^n u(n),\ \ x(n) = (.5)^n [u(n) - u(n-1)]$
10. $h(n) = (.1)^n u(n),\ \ x(n) = (.5)^n [u(n) - u(n-5)]$

Find the output $y(n)$ for each system using the convolution sum equation. Are the systems stable?

EOCP 2.3

Consider the following finite signals:

1. $x_1(n) = \{\underset{\uparrow}{1}\ \ 1\ \ 1\ \ 1\}\ \ x_2(n) = \{\underset{\uparrow}{1}\ \ 1\ \ 1\ \ 1\}$
2. $x_1(n) = \{1\ \ 1\ \ \underset{\uparrow}{1}\ \ 1\}\ \ x_2(n) = \{1\ \ 1\ \ \underset{\uparrow}{1}\ \ 1\}$
3. $x_1(n) = \{-1\ \ 2\ \ 1\ \ \underset{\uparrow}{3}\}\ \ x_2(n) = \{\underset{\uparrow}{1}\ \ 2\}$
4. $x_1(n) = \{-1\ \ -2\ \ \underset{\uparrow}{-3}\ \ -4\}\ \ x_2(n) = \{\underset{\uparrow}{1}\ \ 2\}$
5. $x_1(n) = \{1\ \ -1\ \ 2\ \ \underset{\uparrow}{-2}\ \ 3\ \ -3\}\ \ x_2(n) = \{1\ \ \underset{\uparrow}{2}\ \ 3\}$

Find $x(n) = x_1(n) * x_2(n)$ for each case above.

EOCP 2.4

Consider the following systems with the initial conditions.

1. $y(n) - .6\, y(n-1) = 0,\ \ y(-1) = 1$
2. $y\,(n) - .6\, y(n-2) = 0,\ \ y(-1) = 0,\ y(-2) = 1$
3. $y\,(n) - .6\, y(n-1) + .6\, y(n-2) = 0,\ \ y(-1) = 0,\ y(-2) = -1$
4. $y\,(n) - .1\, y(n-3) = 0,\ \ y(-1) = y\,(-2) = 0,\ y(-3) = 1$
5. $y\,(n) + .1\, y(n-1) + y(n-3) = 0,\ y(-1) = 0,\ \ y(-2) = 1,\ y(-3) = 0$
6. $y(n) + .6y(n-2) = 0,\ \ y(-1) = y(-2) = 1$

Are the above systems stable? What is the output due to the given initial conditions?