ECE 113 HW 1

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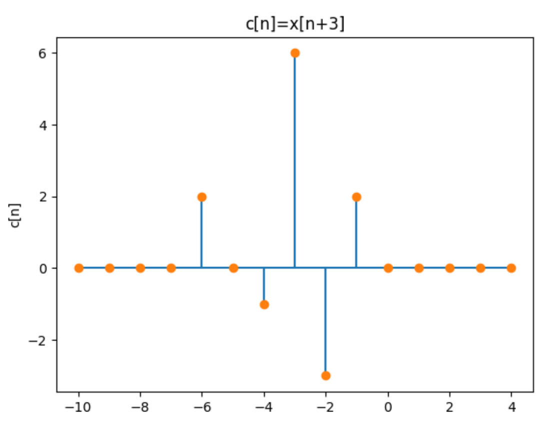
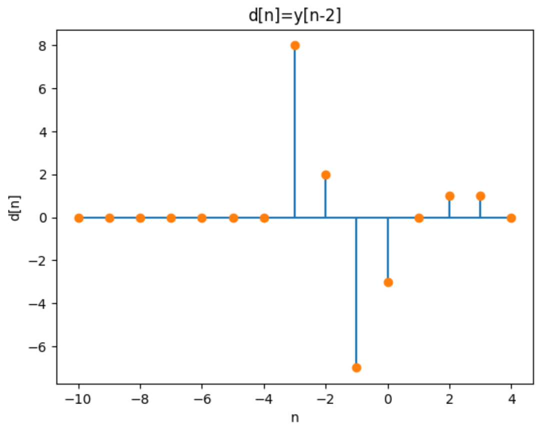
Problem 1

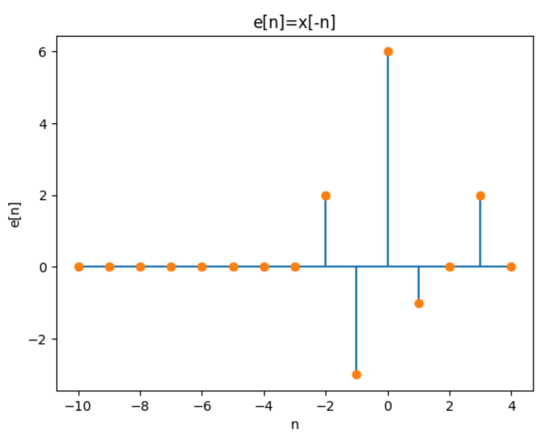
(a)



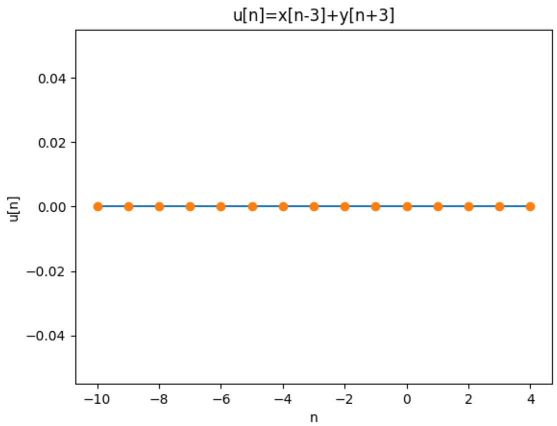
(b)



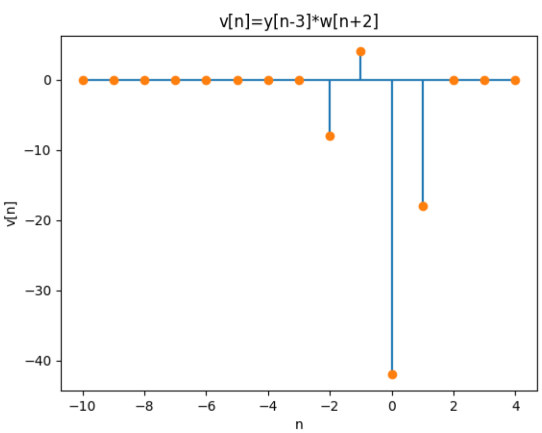
(c)



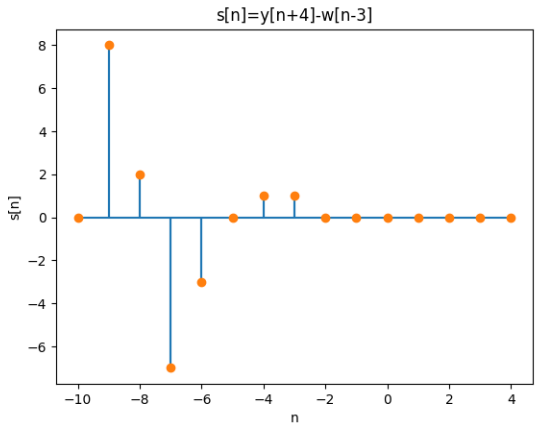
(d)


u[n]=x[n-3]+y[n+3]
0.04
0.02
0.00
−0.02
−0.04
u[n]
−10
−8
−6
−4
−2
0
2
4
n

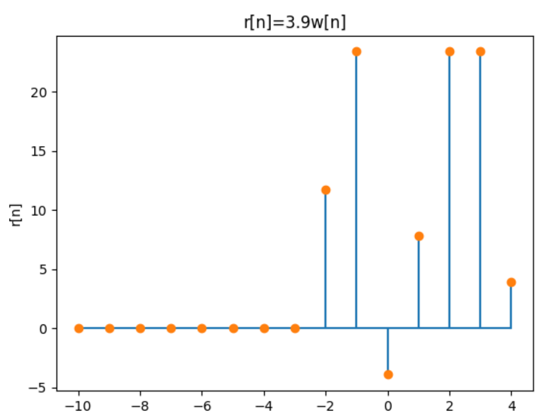
(e)


v[n]=y[n-3]*w[n+2]
0
−10
−20
−30
−40
v[n]
−10
−8
−6
−4
−2
0
2
4
n

(f)


s[n]=y[n+4]-w[n-3]
s[n]
n
8
6
4
2
0
−2
−4
−6
−10
−8
−6
−4
−2
0
2
4

(g)


r[n]=3.9w[n]
r[n]
n
20
15
10
5
0
−5
−10
−8
−6
−4
−2
0
2
4

Problem 2

(a)

$$\boxed{20}$$

(b)

$$\boxed{25}$$

(c)

$$\boxed{40}$$

(d)

$$\boxed{80}$$

(e)

$$\boxed{20}$$

(f)

$$\boxed{8}$$

Problem 3

(a)

Since $e^{j\theta} = \cos(\theta) + j\sin(\theta)$, we have that the fundamental period of $\hat{x}_a[n]$ is $\boxed{8}$

(b)

We have that $F_0 = 0.3$, therefore we have that the period of the sequence is $\frac{k}{0.3}$. The minimum k such that this evaluates to a positive integer is $k = 3$. Therefore, the fundamental period of the sequence is $\boxed{10}$.

(c)

The period of $e^{j\pi n/8}$ is 16 and the period of $e^{j\pi n/5}$ is 10. Therefore, the period of the sequence is the least common multiple of these two, which is $\boxed{80}$.

(d)

The period of $\sin(0.15\pi n)$ is 40 and the period of $\cos(0.12\pi n + 0.1\pi)$ is 50. Therefore, the period of the sequence is the least common multiple of these two, which is $\boxed{200}$.

(e)

The period of $\sin(0.15\pi n + 0.75\pi)$ is 10 and the period of $\cos(0.8\pi n + 0.2\pi)$ is 5, and the period of $\cos(1.3\pi n)$ is 20. Therefore, the period of the sequence is the least common multiple of these three, which is $\boxed{20}$.

Problem 4

(i)

In order for the sequence to be periodic, we must have that

$$x(1-2(n+N_2)) = x(1-2n)$$

for some period N_2, since the signal is periodic for period of N we have that

$$x(1-2n) = x(1-2n-N) = x(1-2n-2N)$$

Therefore we have that $x(1-2(n))$ is periodic with period of $N_2 = N$.

(ii)

If N is an integer then the signal is periodic, since $(-1)^{n+N} = (-1)^n$ if N is even, and $(-1)^{n+2N} = (-1)^n$ if N is odd. But if N is not an integer, then the signal is not periodic.

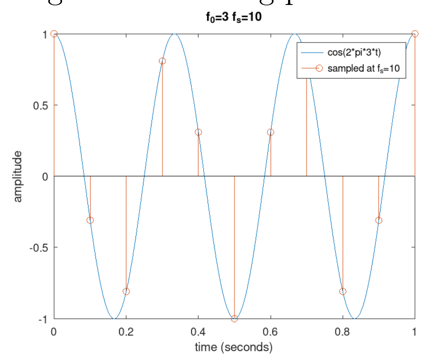
Problem 5

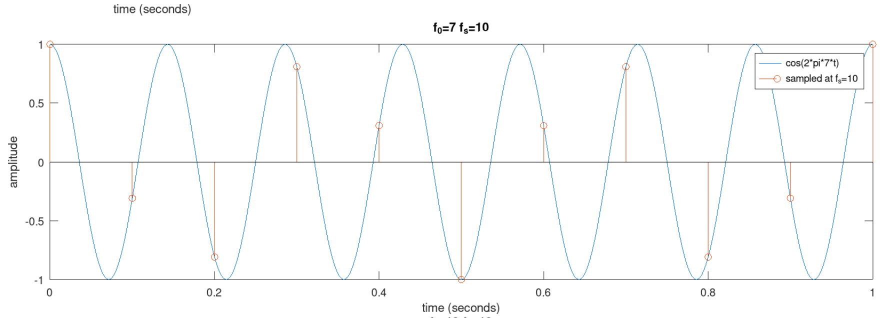
With the following matlab code:

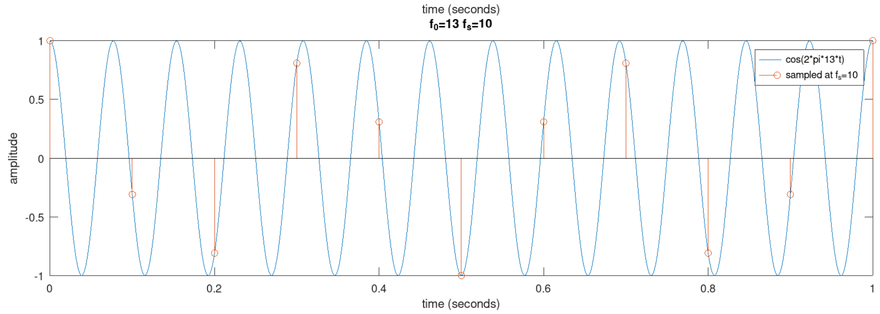
```
t=0:0.001:1;
f_s=10;
for f_0=[3 7 13]
        y=cos(2*pi*f_0*t);
        n=0:1/f_s:1;
        y_sampled=cos(2*pi*f_0*n);
        plot(t,y)
        hold on;
        stem(n,y_sampled)
        title(strcat("f_0=",int2str(f_0)," f_s=",int2str(f_s)))
        xlabel("time (seconds)")
```

```
        ylabel("amplitude")
        legend(strcat("cos(2*pi*",int2str(f_0),"*t)"),
                strcat("sampled at f_s=",int2str(f_s)))
        saveas(gcf,strcat("f_0",int2str(f_0),".png"))
        hold off;
end
```

We get the following plots







As one can see, we can reconstruct the original conitnous time function from the first sample, since the sampling rate is greater than the nyquist sampling frequency, but not for the other two, since the sampling frequncy is less than the nyquist sampling frequency.