

# ECE 113 HW 1

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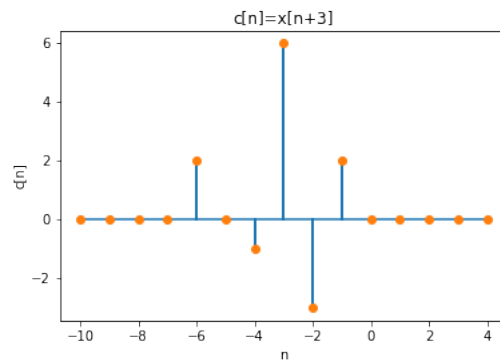
October 7, 2022

## Problem 1

(a)

$$c[n] = \{2, 0, -1, 6, -3, 2\}, -6 \leq n \leq -1$$

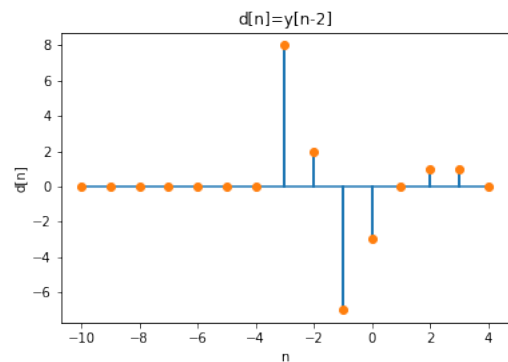
the sample values for the sequence outside of the range specified is 0.



(b)

$$d[n] = \{8, 2, -7, -3, 0, 1, 1\}, -3 \leq n \leq 3$$

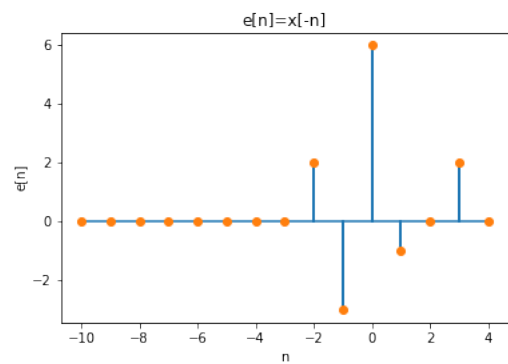
the sample values for the sequence outside of the range specified is 0.



(c)

$$e[n] = \{2, -3, 6, -1, 0, 2\}, -2 \leq n \leq 3$$

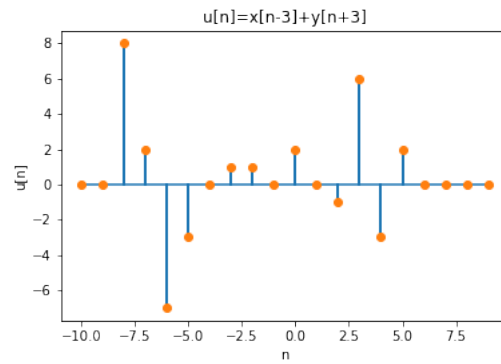
the sample values for the sequence outside of the range specified is 0.



(d)

$$u[n] = \{8, 2, -7, -3, 0, 1, 1, 0, 2, 0, -1, 6, -3, 2\}, -8 \leq n \leq 5$$

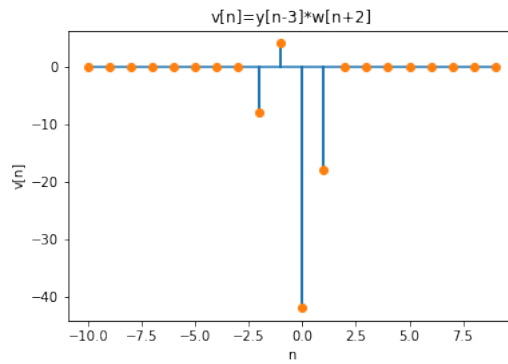
the sample values for the sequence outside of the range specified is 0.



(e)

$$v[n] = \{-8, 4, -42, -18\}, -2 \leq n \leq 1$$

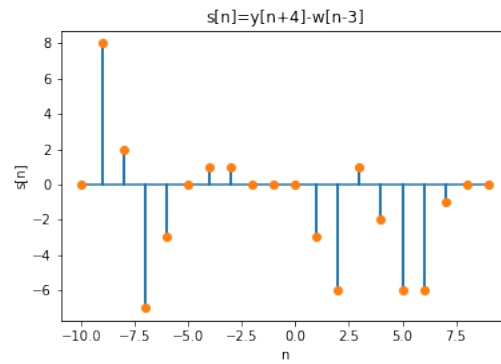
the sample values for the sequence outside of the range specified is 0.



(f)

$$s[n] = \{8, 2, -7, -3, 0, 1, 1, 0, 0, 0, -3, -6, 1, -2, -6, -6, -1\}, -9 \leq n \leq 7$$

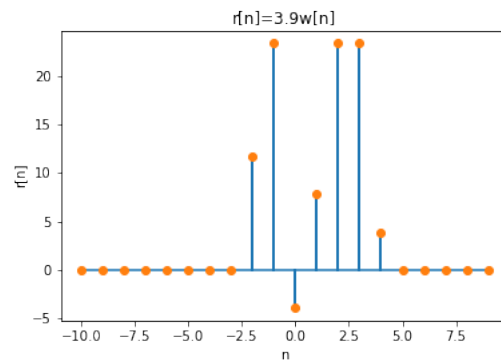
the sample values for the sequence outside of the range specified is 0.



(g)

$$u[n] = \{11.7, 23.4, -3.9, 7.8, 23.4, 23.4, 3.9\}, -2 \leq n \leq 4$$

the sample values for the sequence outside of the range specified is 0.



## Problem 2

(a)

20

(b)

25

(c)

40

(d)

80

(e)

20

(f)

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 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 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 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 200.

(e)

The period of  $\sin(0.1\pi n + 0.75\pi)$  is 20 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  $\boxed{\text{periodic}}$ , since  $(-1)^{n+N} = (-1)^n$ , therefore the period would be  $\boxed{N}$  if  $N$  is even, and  $(-1)^{n+2N} = (-1)^n$ , and thus the period would be  $\boxed{2N}$  if  $N$  is odd.

## Problem 5

With the following matlab code:

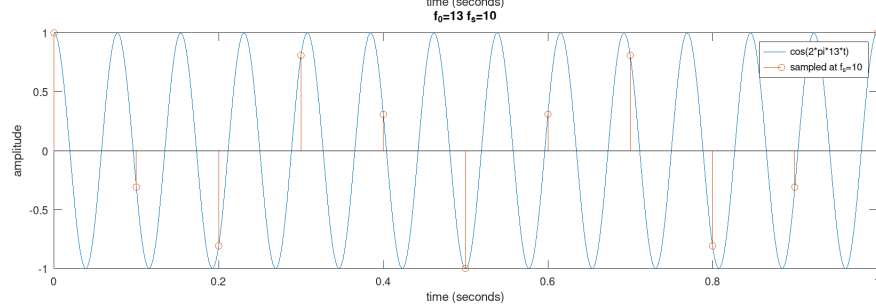
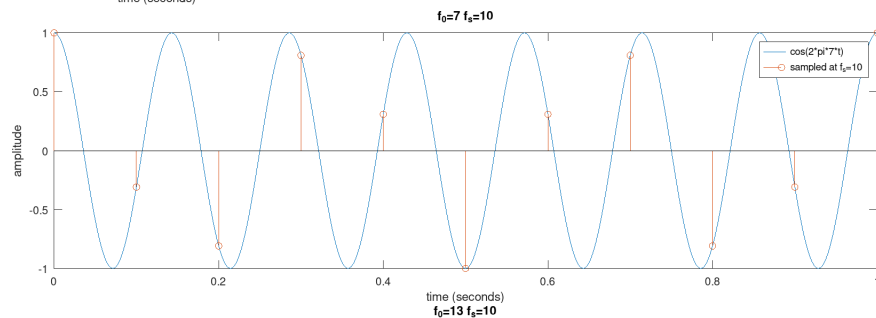
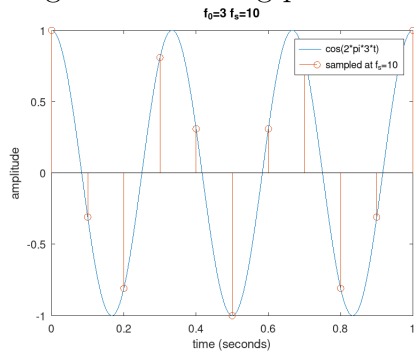
```
t=0:0.001:1;
f_s=10;
for f_0=[3 7 13]
    y=cos(2*pi*f_0*t);
    n=0:1/f_s:1;
    y_sampled=cos(2*pi*f_0*n);
    plot(t,y)
    hold on;
    stem(n,y_sampled)
    title(strcat("f_0=",int2str(f_0)," f_s=",int2str(f_s)))
```

```

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 continuous 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 frequency is less than the Nyquist sampling frequency.