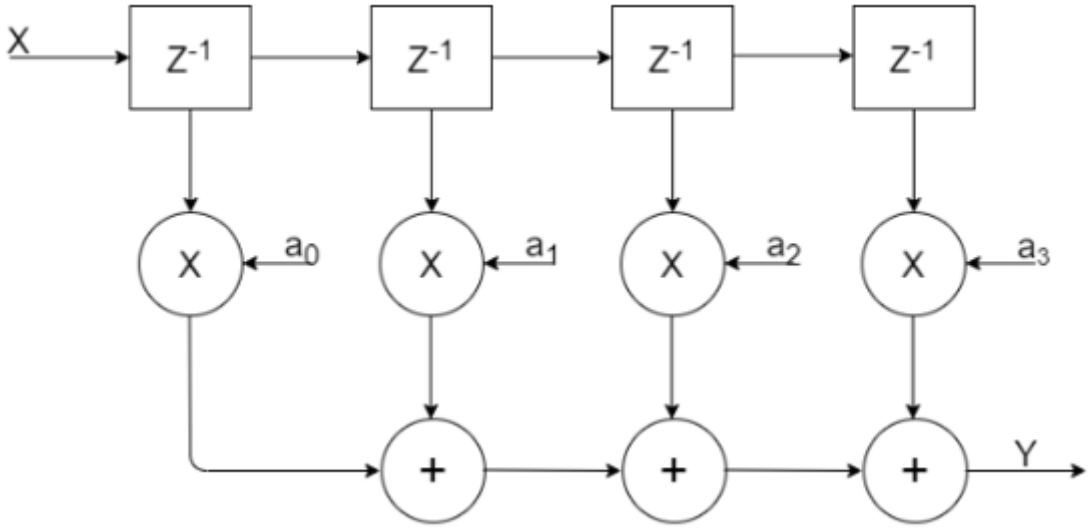
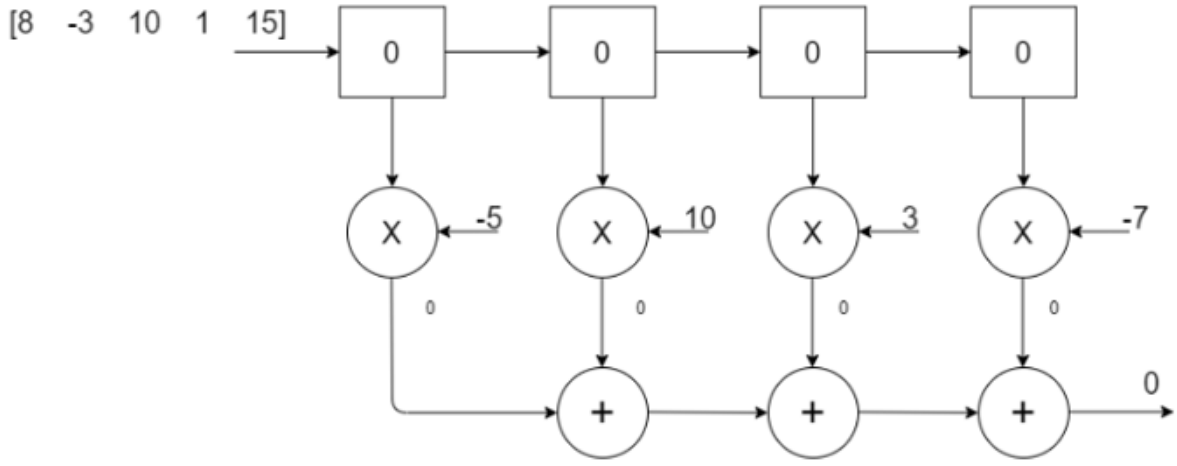
An FIR (finite impulse response) filter, takes the digital input date, manipulates it, and outputs the digital data. In this example, a simple convolution operation course between the input data (X), the FIR filter coefficients (a) to give an output (Y) which is the convolution between X and a.

Shown below is a generic design of a 4 tap FIR filter. As we can see, a FIR filter tap consists of delay block (z^{-1}), a multiplication block (ⓧ), and the addition block (⊕). A similar principle can be applied for an n tap FIR filter.

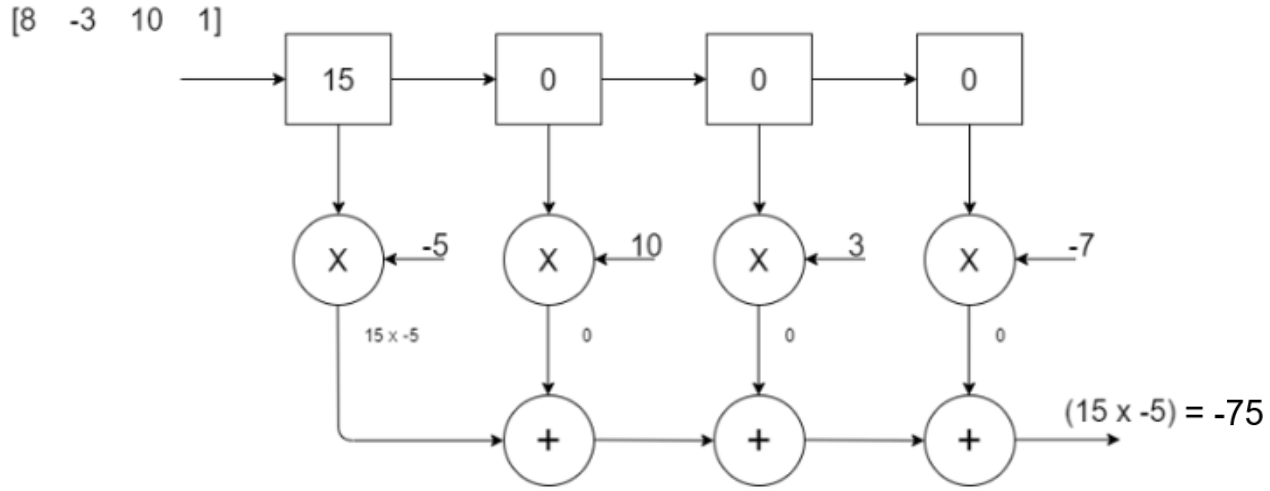


Shown below is a step by step process of the convolution operation between the input [8 -3 10 1 15] and the coefficients [-5 10 3 -7]. It should be noted, all the steps shown below, will occur at the positive edge of the system clock signal.

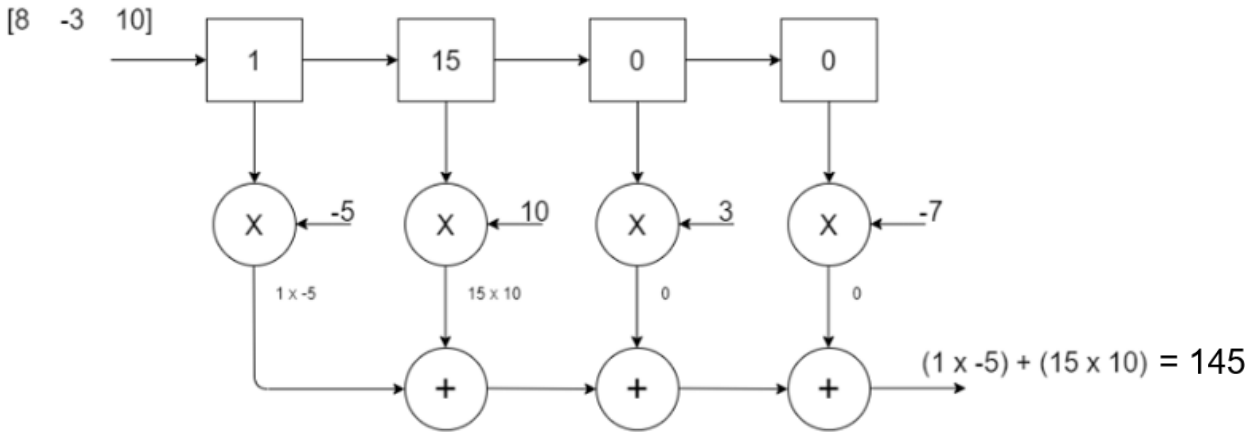
1)



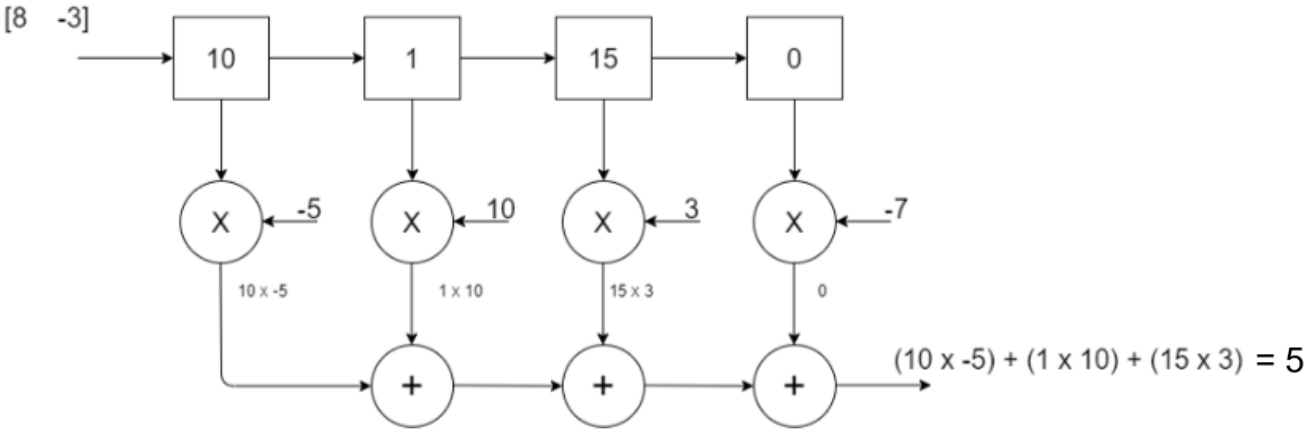
2)


[8 -3 10 1]
15
0
0
0
X
-5
10
3
-7
15 x -5
0
0
0
+
(15 x -5) = -75

3)

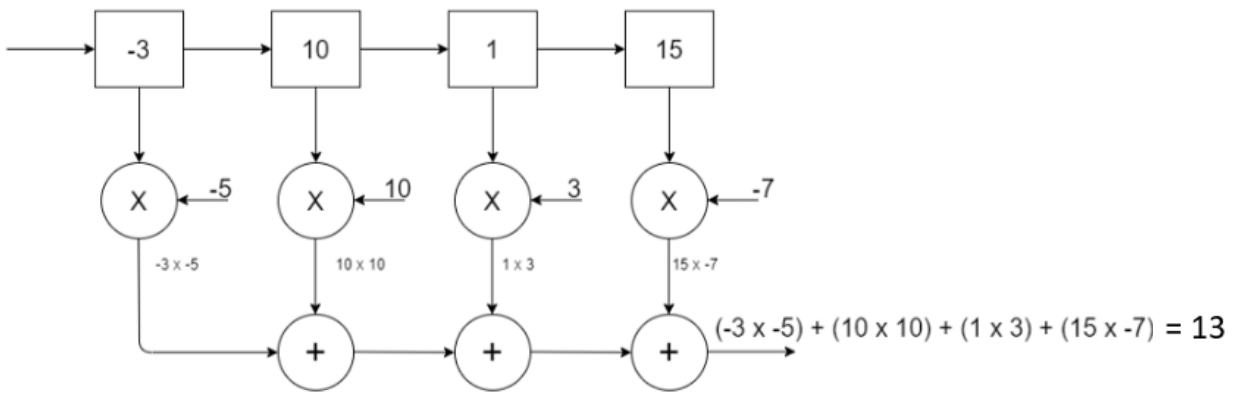

[8 -3 10]
1
15
0
0
X
-5
10
3
-7
1 x -5
15 x 10
0
0
+
(1 x -5) + (15 x 10) = 145

4)


[8 -3]
10
1
15
0
X
-5
10
3
-7
10 x -5
1 x 10
15 x 3
0
+
(10 x -5) + (1 x 10) + (15 x 3) = 5

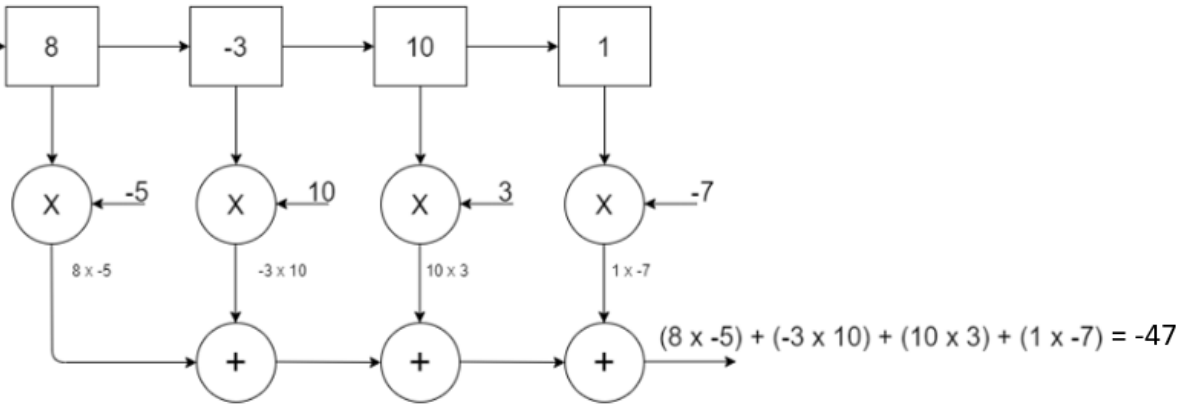
5)

[8]


-3
10
1
15
X
-5
X
10
X
3
X
-7
-3 x -5
10 x 10
1 x 3
15 x -7
+
+
+
(-3 x -5) + (10 x 10) + (1 x 3) + (15 x -7) = 13

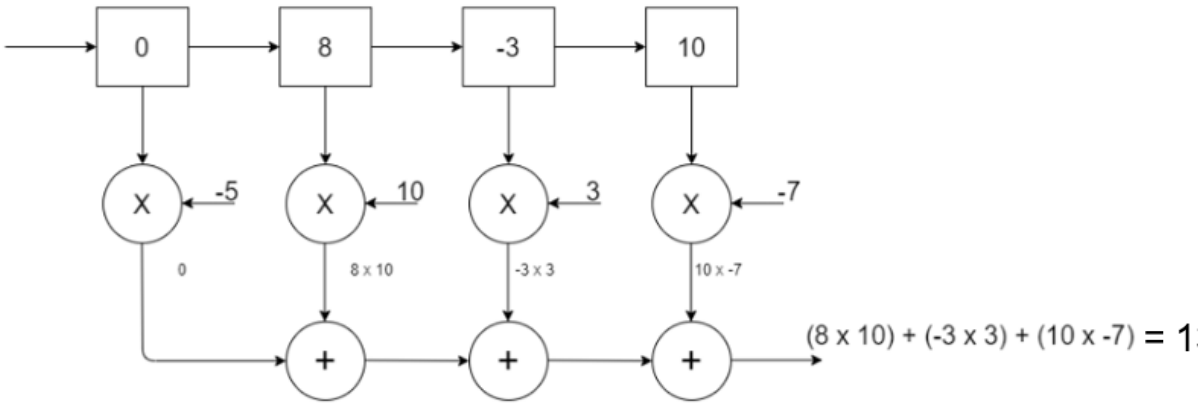
6)

[]

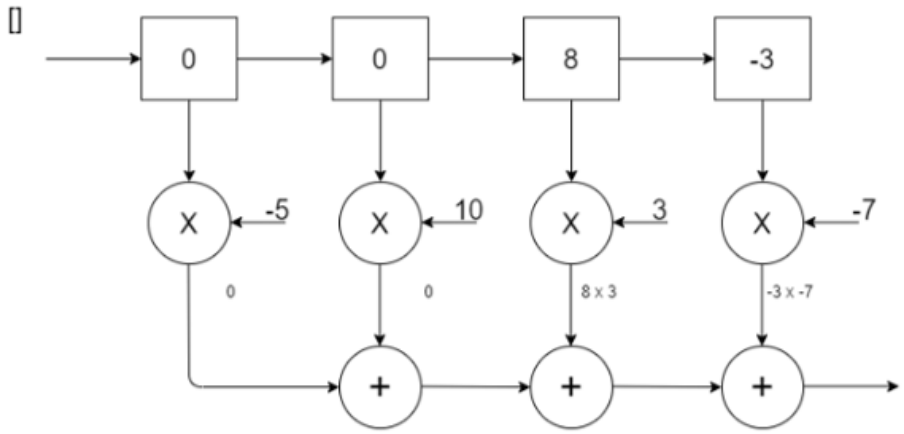

8
-3
10
1
X
-5
X
10
X
3
X
-7
8 x -5
-3 x 10
10 x 3
1 x -7
+
+
+
(8 x -5) + (-3 x 10) + (10 x 3) + (1 x -7) = -47

7)

[]

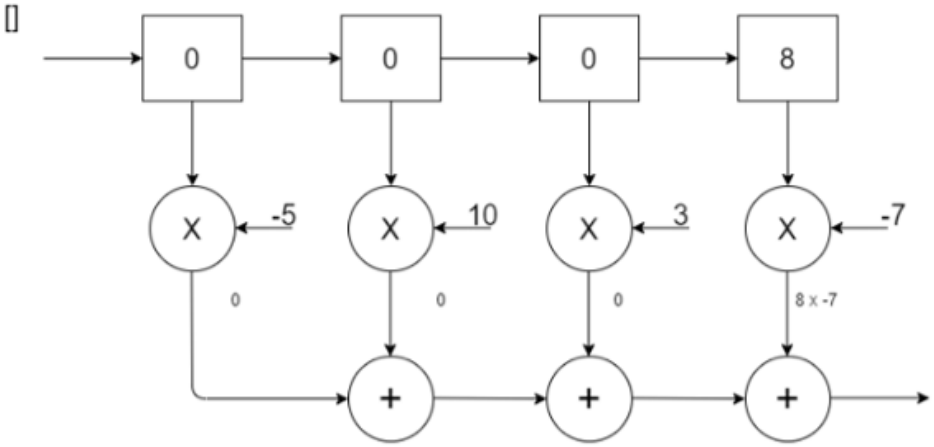

0
8
-3
10
X
-5
X
10
X
3
X
-7
0
8 x 10
-3 x 3
10 x -7
+
+
+
(8 x 10) + (-3 x 3) + (10 x -7) = 1

8)



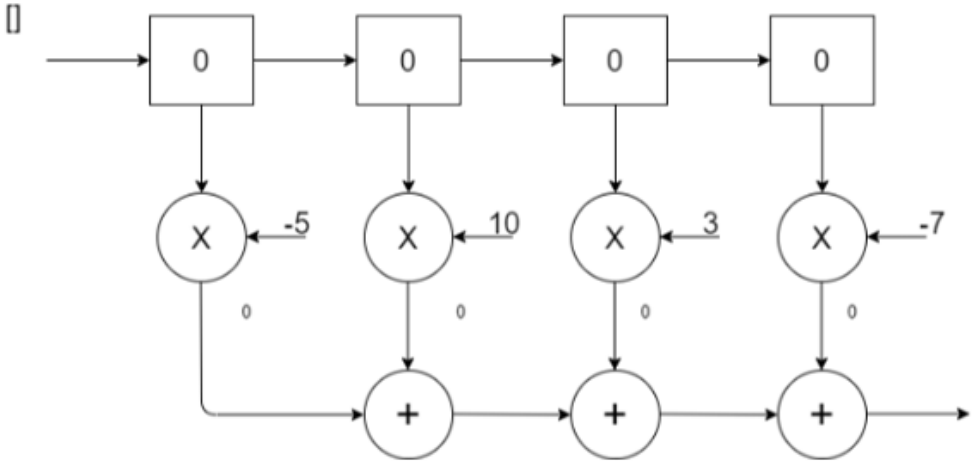
(8 x 3) + (-3 x -7) = 45

9)



(8 x -7) = -56

10)



0

The following convolution process between two complex numbers can be confirmed to be correct through by checking the corresponding operation in MATLAB, as shown below:

```
>> x = [15 1 10 -3 8];
>> a = [-5 10 3 -7];
>> conv(x,a)

ans =

   -75   145     5    13   -47     1    45   -56
```