→Developing convolution algorithm for digital signal and filter kernel using Arduino IDE:

→CODES:-

```
#define SIG_LENGTH 70  //taking 70 samples from 320 input samples due to
//inablility of Arduino UNO's memory capabilities
#define IMP_RSP_LENGTH 15    //taking 15 out of 29 samples
#define OFFSET 5   //used to shift signal along y axis
extern double InputSignal_1kHz_15kHz[];
extern double  Impulse_response[];

double output_signal_arr[SIG_LENGTH+IMP_RSP_LENGTH];

void plot_signal(double *sig_src_arr, uint32_t signal_length);
void plot_both(void);

void convolution(double *sig_src_arr,
                 double *sig_dest_arr,
                 double *imp_response_arr,
                 uint32_t sig_src_length,
                 uint32_t imp_response_length
                 );


void setup() {
  Serial.begin(9600);

     convolution((double *)&InputSignal_1kHz_15kHz[0],
                 (double *)&output_signal_arr[0],
                 (double *)&Impulse_response[0],
                 (uint32_t) SIG_LENGTH,
                 (uint32_t) IMP_RSP_LENGTH
                 );

 plot_both();

}

void loop() {

}



void plot_both(void) //plotting function
{
  uint32_t i;
  for(i=0;i<SIG_LENGTH;i++){
  Serial.print(InputSignal_1kHz_15kHz[i]+OFFSET,8);
```

```
  Serial.print(",");
  Serial.println(output_signal_arr[i],8);
  delay(5);

  }
}



void convolution(double *sig_src_arr,
                 double *sig_dest_arr,
                 double *imp_response_arr,
                 uint32_t sig_src_length,
                 uint32_t imp_response_length
                 )//convolution function
 {
   uint32_t i,j;
   for (i=0;i<(sig_src_length+ imp_response_length);i++)
   {
    sig_dest_arr[i]=0;
   }
    for(i=0;i<sig_src_length;i++)
    {
      for(j=0;j<imp_response_length;j++)
      {
        sig_dest_arr[i+j] = sig_dest_arr[i+j]+
sig_src_arr[i]*imp_response_arr[j];
      }

    }
 }
```

→Convolution response kernel and input digital signal:-

```
 double Impulse_response[] = {  //Filter kernel
  -0.0018225230f, -0.0015879294f, +0.0000000000f, +0.0036977508f,
+0.0080754303f, +0.0085302217f, -0.0000000000f, -0.0173976984f,
  -0.0341458607f, -0.0333591565f, +0.0000000000f, +0.0676308395f,
+0.1522061835f, +0.2229246956f, +0.2504960933f, +0.2229246956f,
  +0.1522061835f, +0.0676308395f, +0.0000000000f, -0.0333591565f, -
0.0341458607f, -0.0173976984f, -0.0000000000f, +0.0085302217f,
  +0.0080754303f, +0.0036977508f, +0.0000000000f, -0.0015879294f, -
0.0018225230f
};
```

```
double InputSignal_1kHz_15kHz[] = //Input signal
{
+0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
-0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
+0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
+0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
+0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
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+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
+0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
-0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
-0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
```
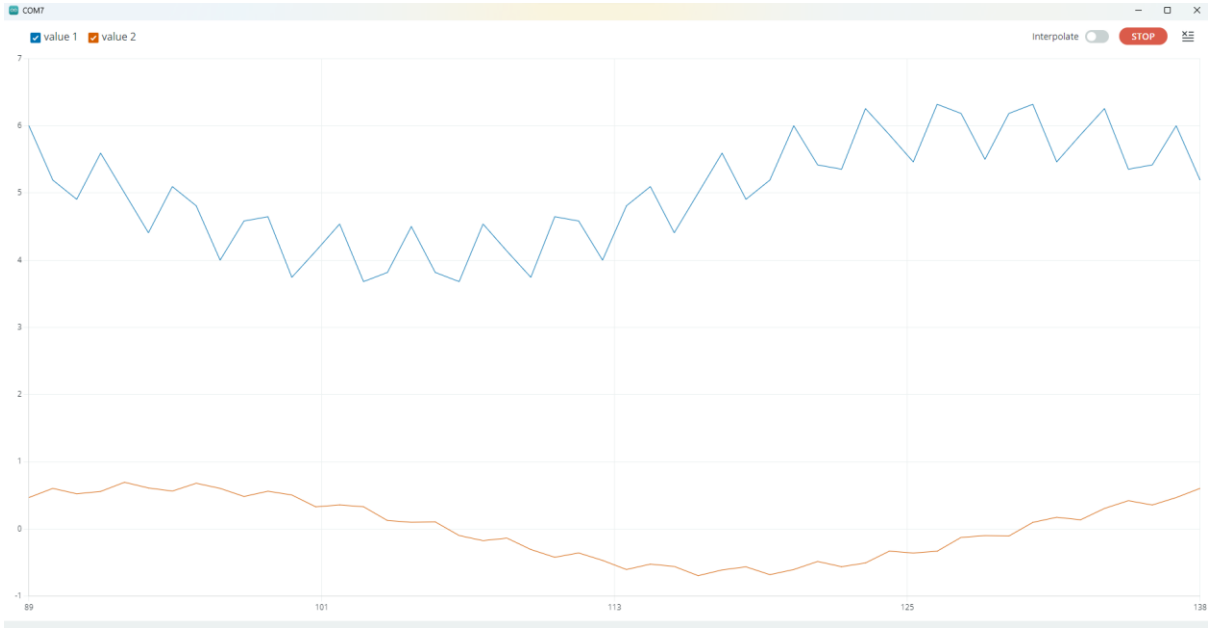

```
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
+0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
+0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
-0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
+0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f,
-0.8660254038f, -0.4619397663f, -1.3194792169f, -1.1827865776f, -
0.5000000000f, -1.1827865776f, -1.3194792169f, -0.4619397663f,
-0.8660254038f, -1.2552931065f, -0.3535533906f, -0.4174197128f, -
1.0000000000f, -0.1913417162f, +0.0947343455f, -0.5924659585f,
-0.0000000000f, +0.5924659585f, -0.0947343455f, +0.1913417162f,
+1.0000000000f, +0.4174197128f, +0.3535533906f, +1.2552931065f,
+0.8660254038f, +0.4619397663f, +1.3194792169f, +1.1827865776f,
+0.5000000000f, +1.1827865776f, +1.3194792169f, +0.4619397663f,
+0.8660254038f, +1.2552931065f, +0.3535533906f, +0.4174197128f,
+1.0000000000f, +0.1913417162f, -0.0947343455f, +0.5924659585f,
+0.0000000000f, -0.5924659585f, +0.0947343455f, -0.1913417162f, -
1.0000000000f, -0.4174197128f, -0.3535533906f, -1.2552931065f, };
```

→Serial Plotter output:-



→Serial Monitor output:-

Serial Monitor × Output

Message (Enter to send message to 'Arduino Uno' o

```
5.00000000,0.00000000
5.59246587,-0.00107978
4.90526580,-0.00076814
5.19134187,-0.00019829
6.00000000,0.00006443
5.41741991,0.00208543
5.35355329,0.00368919
6.25529289,0.00158559
5.86602544,-0.00262808
5.46193981,-0.00759077
6.31947898,-0.01193905
6.18278646,-0.00866660
5.50000000,0.00889812
6.18278646,0.04305392
6.31947898,0.09744688
5.46193981,0.17404054
5.86602544,0.13606636
6.25529289,0.30571365
5.35355329,0.42103161
5.41741991,0.35677430
6.00000000,0.46743826
5.19134187,0.60392446
4.90526580,0.52316665
5.59246587,0.55799965
5.00000000,0.69487514
4.40753412,0.60991163
5.09473419,0.56361060
4.80865812,0.68003749
4.00000000,0.60380306
4.58258008,0.48341708
4.64644670,0.56167030
3.74470686,0.50577092
4.13397455,0.32962765
4.53806018,0.35779390
3.68052077,0.33073973
3.81721353,0.12565529
4.50000000,0.09944659
3.81721353,0.10535647
3.68052077,-0.09744688
4.53806018,-0.17404054
4.13397455,-0.13606636
3.74470686,-0.30571365
4.64644670,-0.42103161
4.58258008,-0.35677430
```

Serial Monitor × Output

Message (Enter to send message to 'Arduino Uno' on 'COM

```
4.80865812,0.68003749
4.00000000,0.60380306
4.58258008,0.48341708
4.64644670,0.56167030
3.74470686,0.50577092
4.13397455,0.32962765
4.53806018,0.35779390
3.68052077,0.33073973
3.81721353,0.12565529
4.50000000,0.09944659
3.81721353,0.10535647
3.68052077,-0.09744688
4.53806018,-0.17404054
4.13397455,-0.13606636
3.74470686,-0.30571365
4.64644670,-0.42103161
4.58258008,-0.35677430
4.00000000,-0.46743826
4.80865812,-0.60392446
5.09473419,-0.52316665
4.40753412,-0.55799965
5.00000000,-0.69487514
5.59246587,-0.60991163
4.90526580,-0.56361060
5.19134187,-0.68003749
6.00000000,-0.60380306
5.41741991,-0.48341708
5.35355329,-0.56167030
6.25529289,-0.50577092
5.86602544,-0.32962765
5.46193981,-0.35779390
6.31947898,-0.33073973
6.18278646,-0.12565529
5.50000000,-0.09944659
6.18278646,-0.10535647
6.31947898,0.09744688
5.46193981,0.17404054
5.86602544,0.13606636
6.25529289,0.30571365
5.35355329,0.42103161
5.41741991,0.35677430
6.00000000,0.46743826
5.19134187,0.60392446
```

→Combined screenshot:-