Assignment 5

Course: DSAA, Monsoon 2017 @IIITS

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I. Analysis and Synthesis

MATLAB CODES:

1.

```
clc
clear all
close all
%%
t = -0.5: 0.01: 0.49;
xt = t.^ 2;
M = 10000;
T = 2;
for i = 1:M
        k = 1;
        for t = -0.5: 0.01: 0.49
                graph(k) = (t ^ 2) * exp(-j * i * 2 * pi / T * t);
                k = k + 1;
        end;
        c(i) = 1 / T.*trapz(graph);
end;
for t = -0.5: 0.01: 0.49
        s = 0;
        m = int16(t * 100 + 51);
        for k = 1: M
                s = s + c(k) * exp(j * k * 2 * pi / T * t);
        end;
        d(m) = abs(s) / M * T;
        m = m + 1;
end;
t = -0.5: 0.01: 1.49;
xt(numel(t)) = 0;
d(numel(t)) = 0;
figure;
t = -0.5: 0.01: 5.49;
xt = repmat(xt, 1, 3);
plot(t, xt, 'Linewidth', 2);
hold on;
d = repmat(d, 1, 3);
plot(t, d, 'Linewidth', 2);
xlabel('t');
ylabel('x[t]');
legend('Original', 'Reconstructed');
xlim([-0.5, 4.5]);
figure;
plot(real(c));
xlabel('index');
ylabel('Real part');
figure;
plot(imag(c));
xlabel('index');
ylabel('Imaginary part');
```

2.

```
clc
clear all
close all
%%
t = -0.5: 0.01: 0.49;
xt = abs(t);
M = 10000;
T = 2;
for i = 1:M
        k = 1;
        for t = -0.5: 0.01: 0.49
                graph(k) = abs(t) * exp(-j * i * 2 * pi / T * t);
                k = k + 1;
        end;
        c(i) = 1 / T.*trapz(graph);
end;
for t = -0.5: 0.01: 0.49
        s = 0;
        m = int16(t * 100 + 51);
        for k = 1: M
                s = s + c(k) * exp(j * k * 2 * pi / T * t);
        end;
        d(m) = abs(s) / M * T;
        m = m + 1;
end;
t = -0.5: 0.01: 1.49;
xt(numel(t)) = 0;
d(numel(t)) = 0;
figure;
t = -0.5: 0.01: 5.49;
xt = repmat(xt, 1, 3);
plot(t, xt, 'Linewidth', 2);
hold on;
d = repmat(d, 1, 3);
plot(t, d, 'Linewidth', 2);
xlabel('t');
ylabel('x[t]');
legend('Original', 'Reconstructed');
xlim([-0.5, 4.5]);
figure;
plot(real(c));
xlabel('index');
ylabel('Real part');
figure;
plot(imag(c));
xlabel('index');
ylabel('Imaginary part');
```

3.

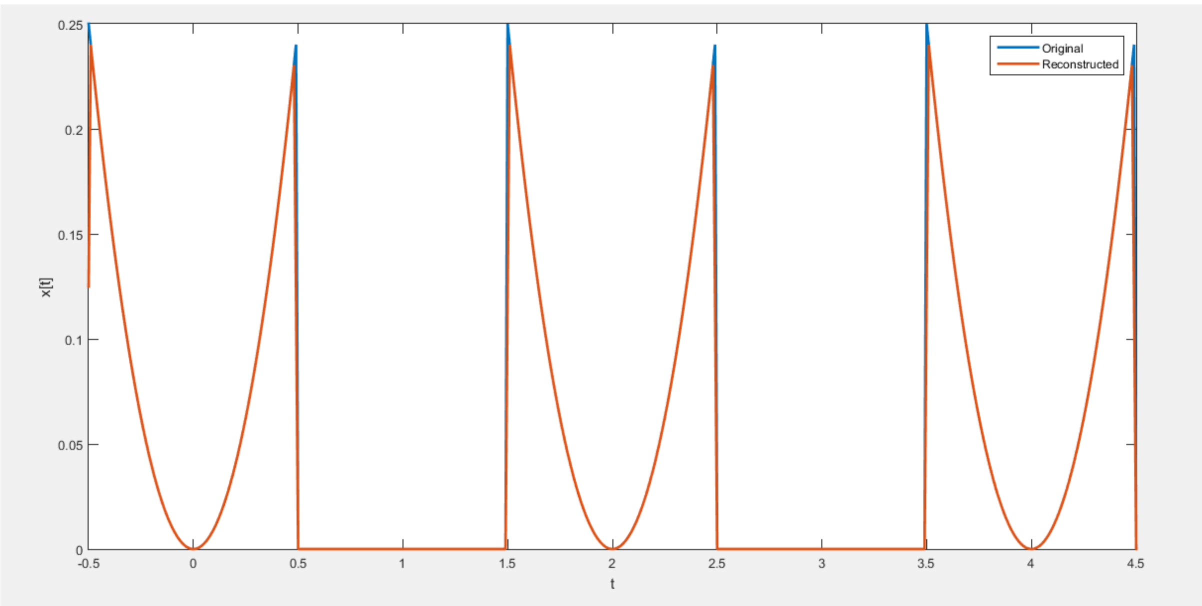
```
clc
clear all
close all
%%
t = -0.5: 0.01: 0.49;
xt = exp(-abs(t));
M = 10000;
T = 2;
for i = 1:M
        k = 1;
        for t = -0.5: 0.01: 0.49
                graph(k) = exp(-abs(t)) * exp(-j * i * 2 * pi / T * t);
```

```
            k = k + 1;
        end;
        c(i) = 1 / T.*trapz(graph);
end;
for t = -0.5: 0.01: 0.49
        s = 0;
        m = int16(t * 100 + 51);
        for k = 1: M
            s = s + c(k) * exp(j * k * 2 * pi / T * t);
        end;
        d(m) = abs(s) / M * T;
        m = m + 1;
end;
t = -0.5: 0.01: 1.49;
xt(numel(t)) = 0;
d(numel(t)) = 0;
figure;
t = -0.5: 0.01: 5.49;
xt = repmat(xt, 1, 3);
plot(t, xt, 'Linewidth', 2);
hold on;
d = repmat(d, 1, 3);
plot(t, d, 'Linewidth', 2);
xlabel('t');
ylabel('x[t]');
legend('Original', 'Reconstructed');
xlim([-0.5, 4.5]);
figure;
plot(real(c));
xlabel('index');
ylabel('Real part');
figure;
plot(imag(c));
xlabel('index');
ylabel('Imaginary part');
```

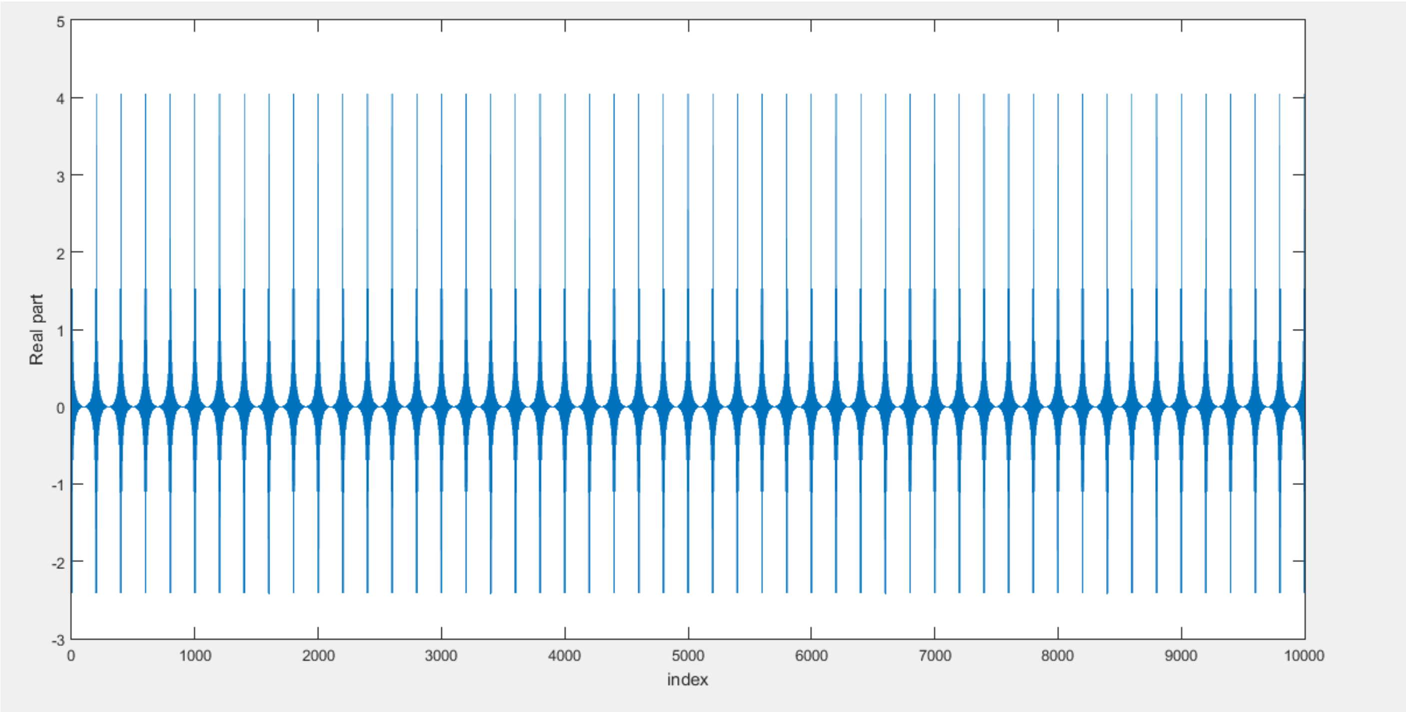
RESULTS:

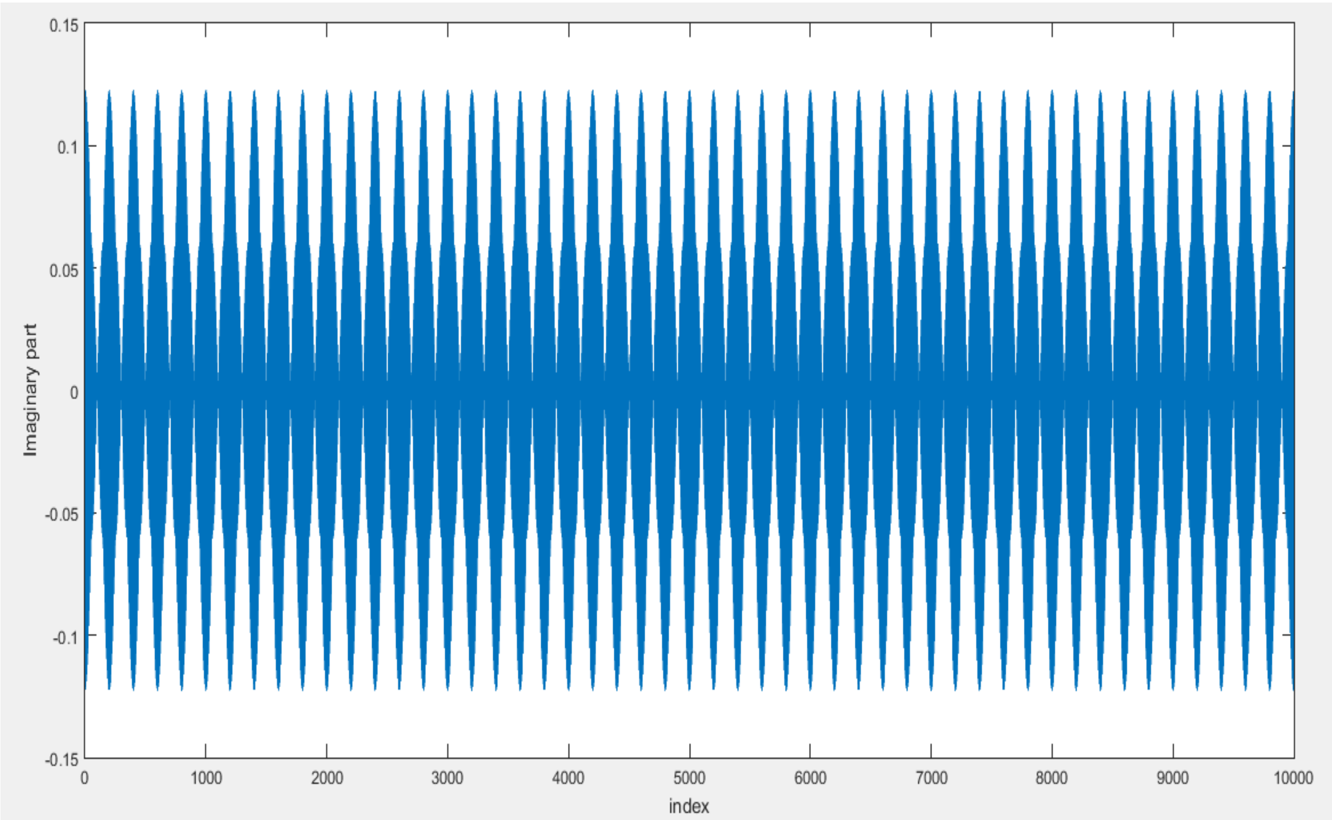
1.

The original and the reconstructed signal:



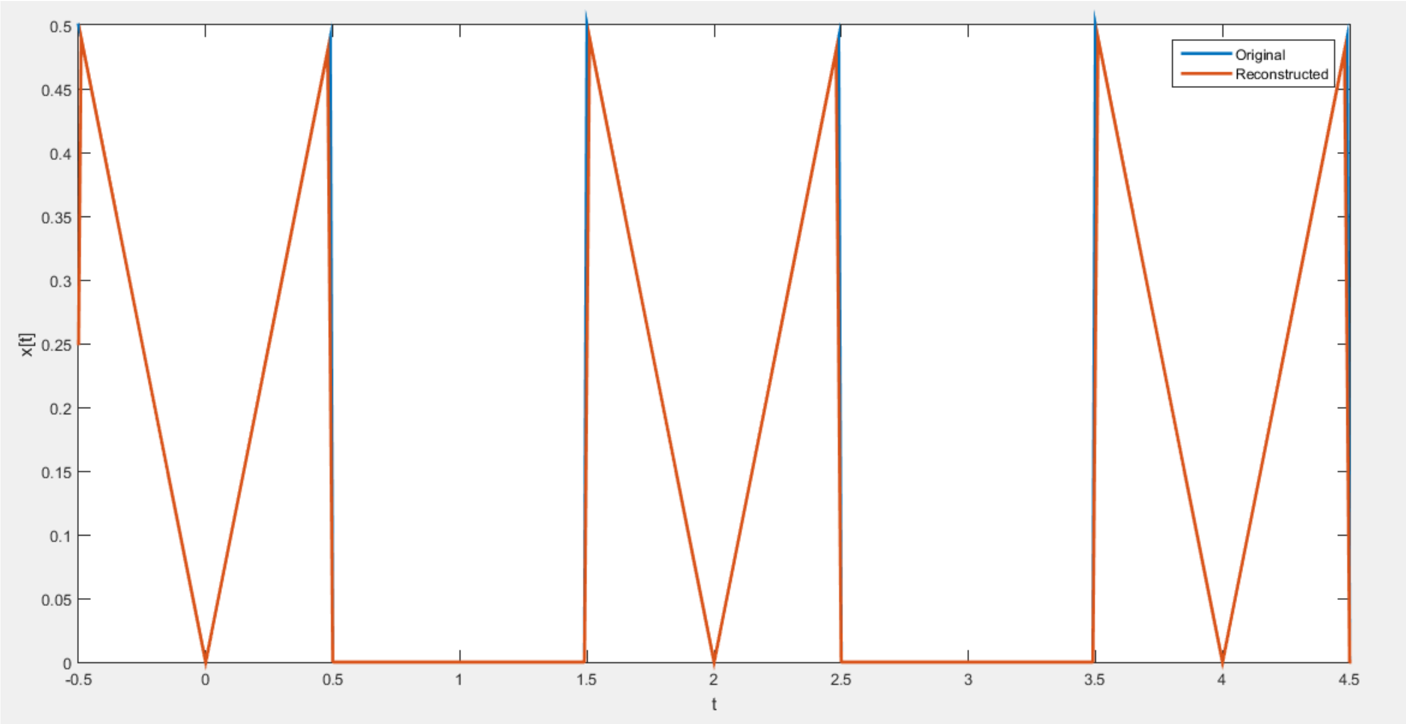
The real and imaginary parts of the Fourier coefficients obtained:



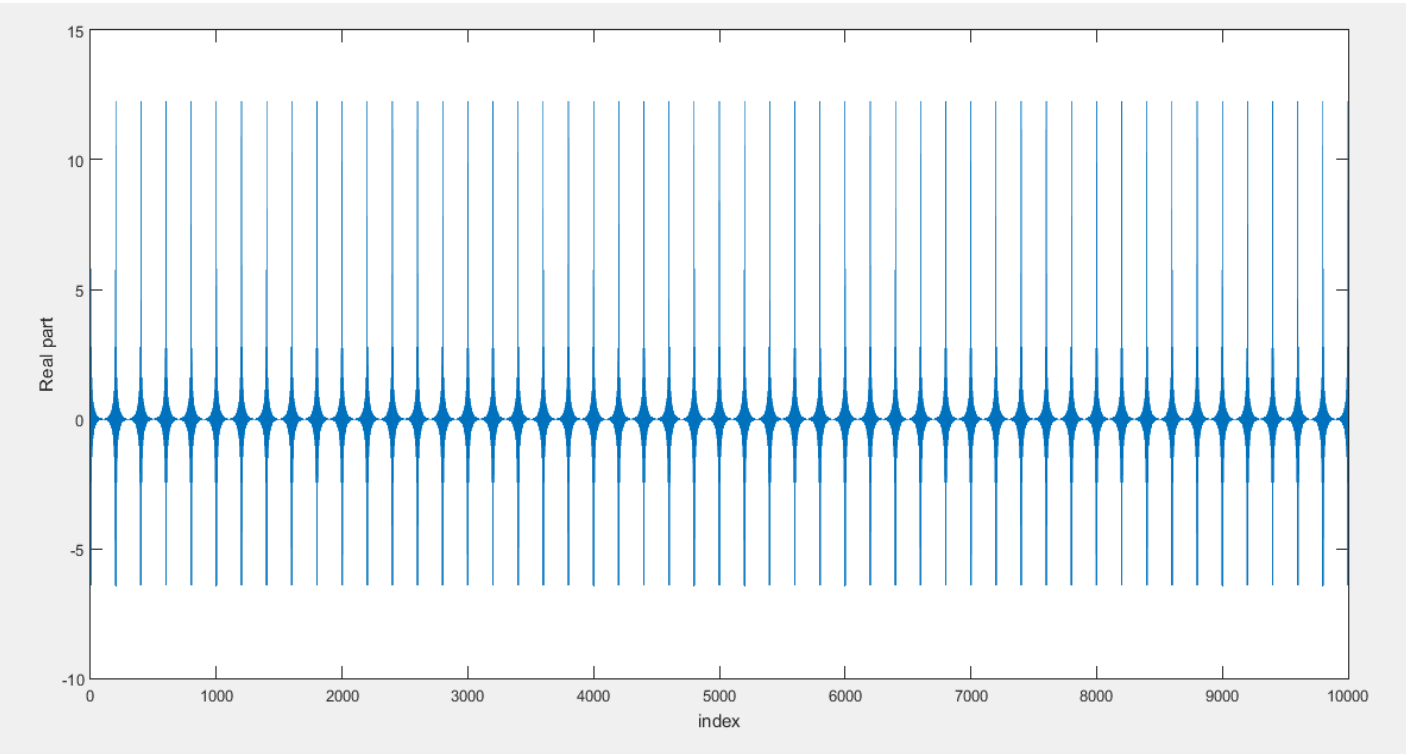


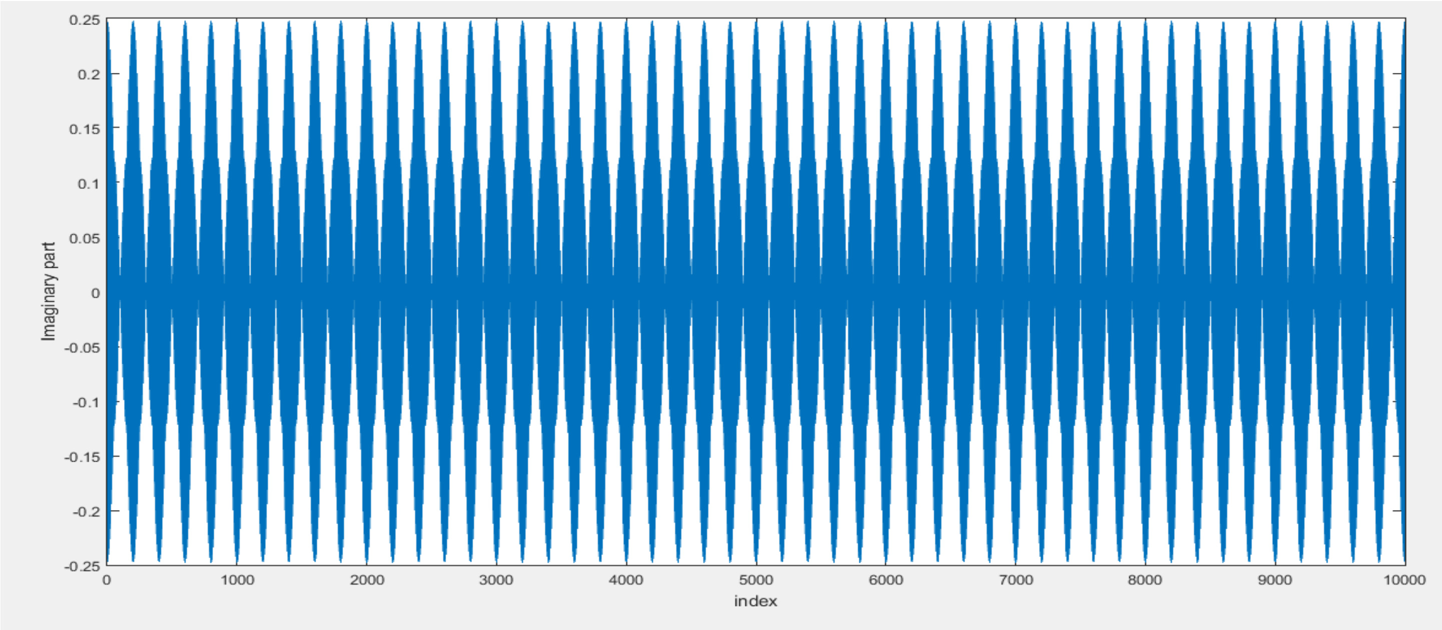
2.

The original and the reconstructed signals.



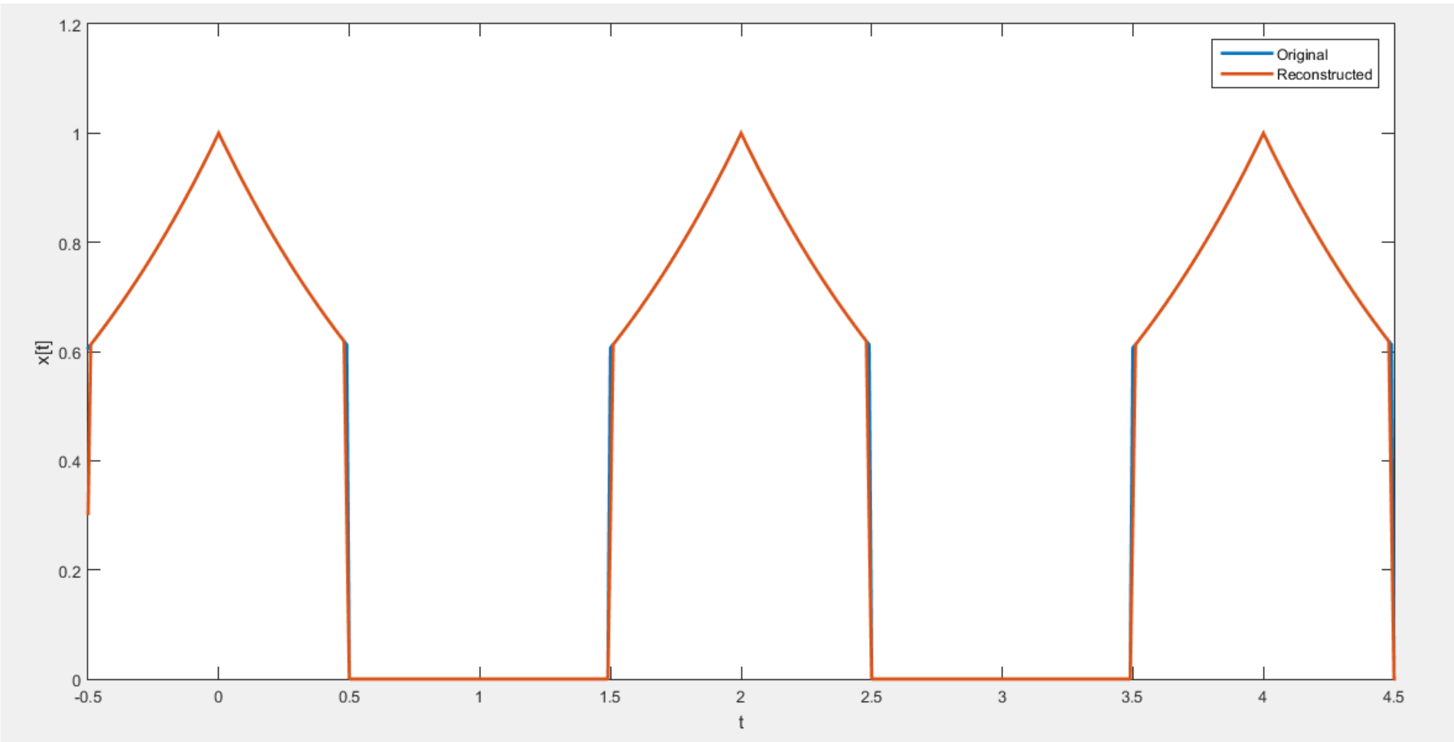
The real and imaginary parts of the Fourier Coefficients obtained:



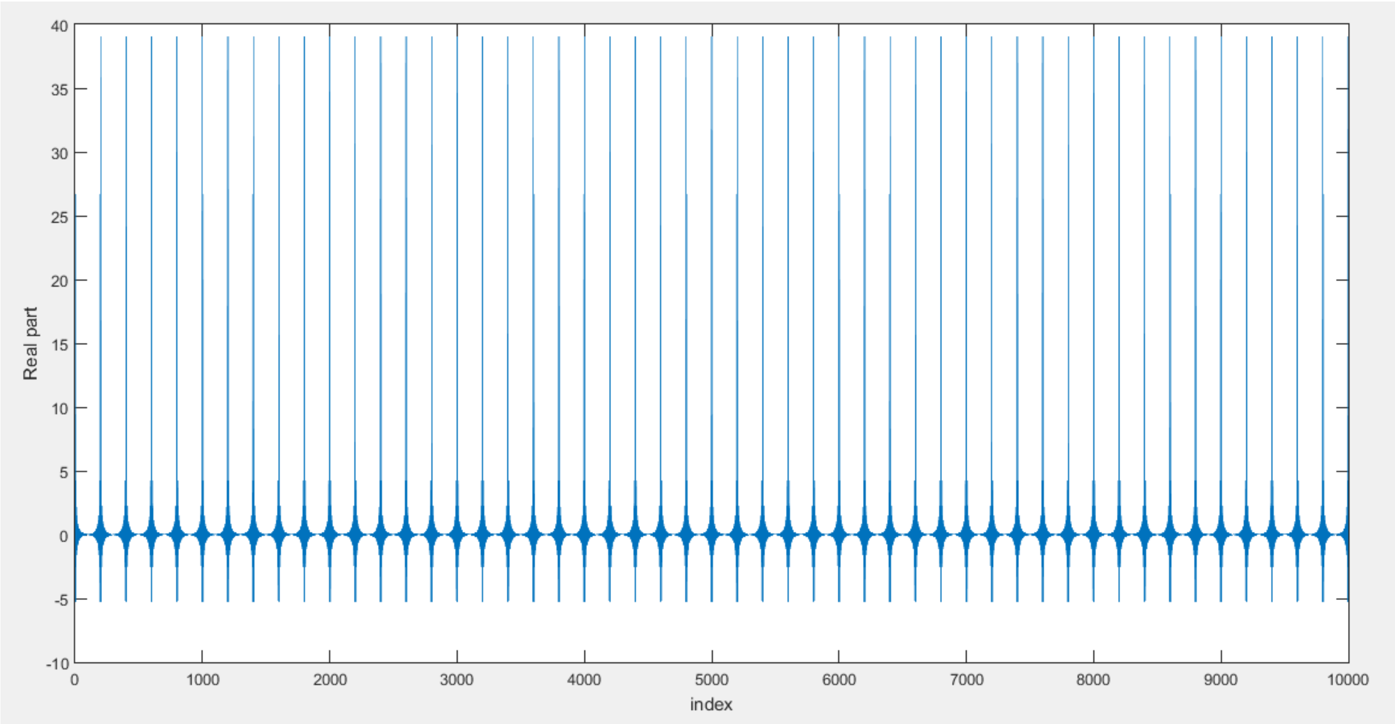


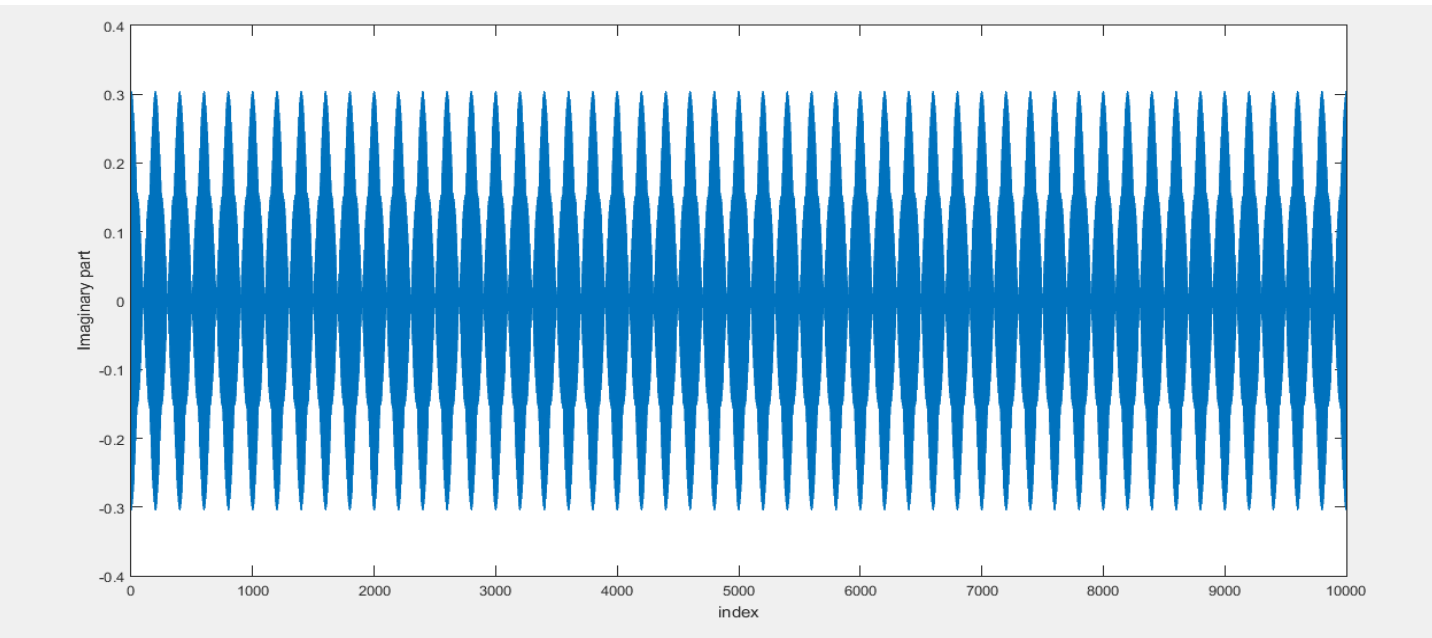
3.

The original and reconstructed Signal:



The real and imaginary parts of the Fourier Coefficients obtained:





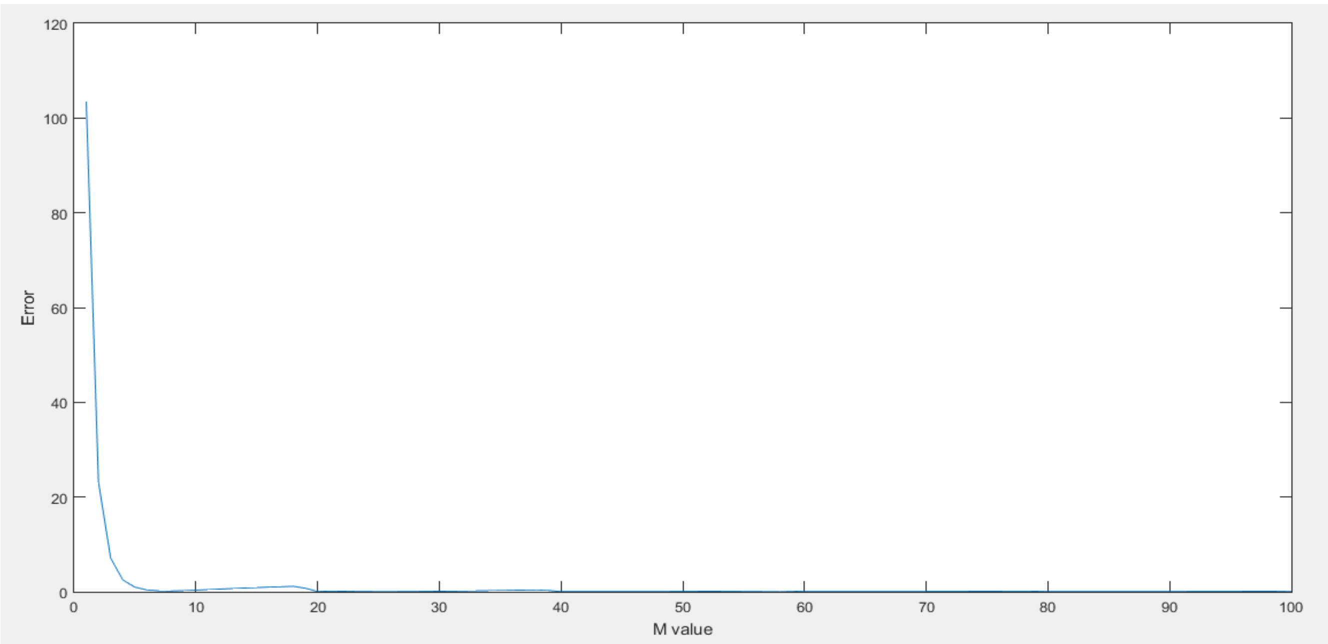
II. Convergence

MATLAB CODE:

```
clc
clear all
close all
%%
t = -0.5: 0.1: 0.5;
xt = exp(-abs(t));
T = 2;
```

```
for M = 1: 100
        for i = 1: M
                k = 1;
                for t = -0.5: 0.1: 0.5
                        graph(k) = exp(-abs(t)) * exp(-j * i * 2 * pi / T * t);
                        k = k + 1;
                end;
                c(i) = 1 / T.*trapz(graph);
        end;
        for t = -0.5: 0.1: 0.5 s = 0;
                m = int16(t * 10 + 6);
                for k = 1: M
                        s = s + c(k) * exp(j * k * 2 * pi / T * t);
                end;
                d(m) = abs(s) / M * T;
                m = m + 1;
        end;
        err(M) = 1 / T * trapz(abs(xt - d). ^ 2);
end;
figure;
plot(err);
xlabel('M value');
ylabel('Error');
```

RESULTS:



DISCUSSION:

1. **We reconstruct the original signal by using the formula**

$$\boldsymbol{y(t)} = \int_{-\infty}^{\infty} c_k e^{-j\omega t} dt\,, where$$

$$c_k = \frac{1}{T}\int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt = \frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} \tilde{x}(t) e^{-j\omega t} dt\,, where$$

$\tilde{x}(t)$ **is the periodic repetitive signal.**

$\boldsymbol{c_k}$ **is the Fourier Coefficient for each index k.**

$\boldsymbol{T}$ **is the time period of the signal.**

$\boldsymbol{y(t)}$ **is the obtained reconstructed signal.**

2. **We plot the obtained reconstructed signal and compare it with the original signal by plotting both the values in a single graph and observe that the values are almost similar in all the three signals given with time period T = 2.**
3. **We also plot the real and imaginary parts of the Fourier Coefficients obtained and plot them separately.**
4. **We can repeat the signals using repmat function in MATLAB.**
5. **We increase the M value to observe convergence in the last problem given. The formula for finding the error is as follows.**

$$err = \frac{1}{T}\int |y(t) - x(t)|^2 dt$$

6. **We observe that with increase of M value the error tends to become close to zero.**
7. **This proves convergence of the reconstructed wave with the original wave.**

********Thanks for Reading********