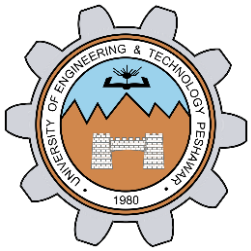
APPLICATION OF FOURIER SERIES

LAB # 09



CSE301L Signals & Systems Lab

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Class Section: **B**

"On my honor, as a student of University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work."

Student Signature: _____

Submitted to: **Engr. Durr-e-Nayab**

Friday, July 31st, 2020

Department of Computer Systems Engineering

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Lab Objectives:

Objectives of this lab are as follows:

- Power of Continuous & Discrete time Signals
- Application of Fourier Series
- Synthesis of Square Wave
- Synthesis of Triangular Wave

Task # 1:

Calculate the power of discrete-time cosine signal with period 20, defined over interval 0:19 using the following formula:

$$P = \frac{1}{N}\sum_{0}^{N-1} |x[n]|^2$$

Problem Analysis:

Choose a cosine signal and put the values in the above formula to find the power of the signal and plot the signal.

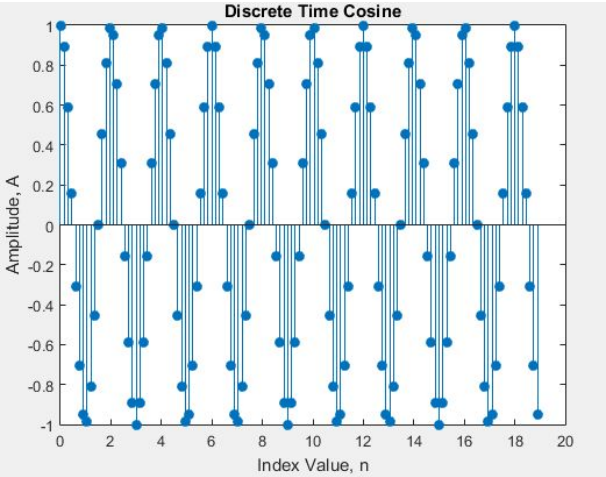
Code:

```
n = 0:0.15:19;                  % time duration of given signal;
x = cos(2*pi*n/2);
stem(n, x,'filled');            % plot signal
xlabel('Index Value, n');
ylabel('Amplitude, A');
title('Discrete Time Cosine');
abs_x_2 = abs(x).^2;            % Absolute square of signal
N = 20;                         % length of interval
delta_n = 0.25;                 % interval duration
px = sum(abs_x_2)*delta_n/N
```

Result:

Power of the signal, px = 0.4775

Output:



Task # 2:

Analyze the effect of Adding 1st to 17th harmonics and the effect of Adding 1st to 27th harmonics in above example.

Code:

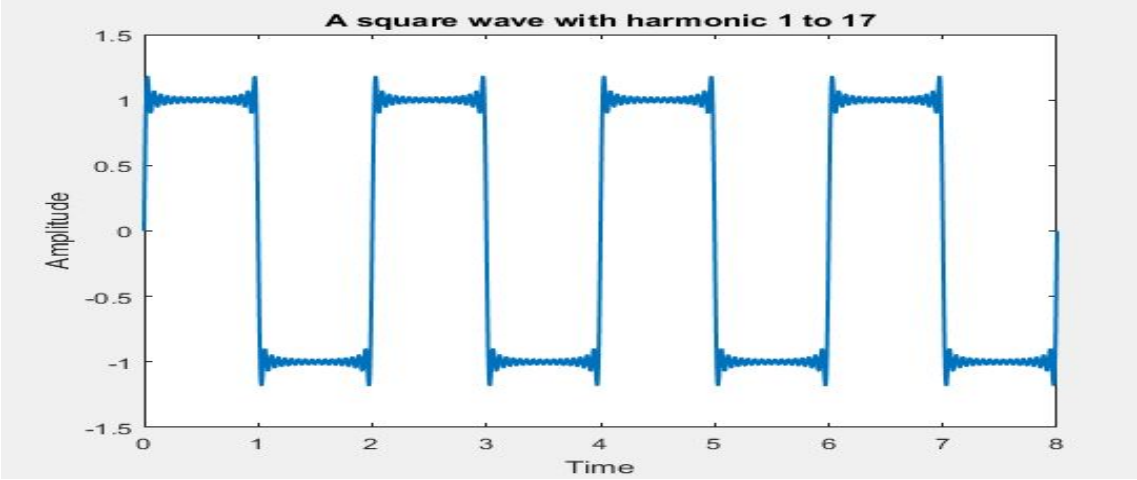
1st to 17th Harmonic:

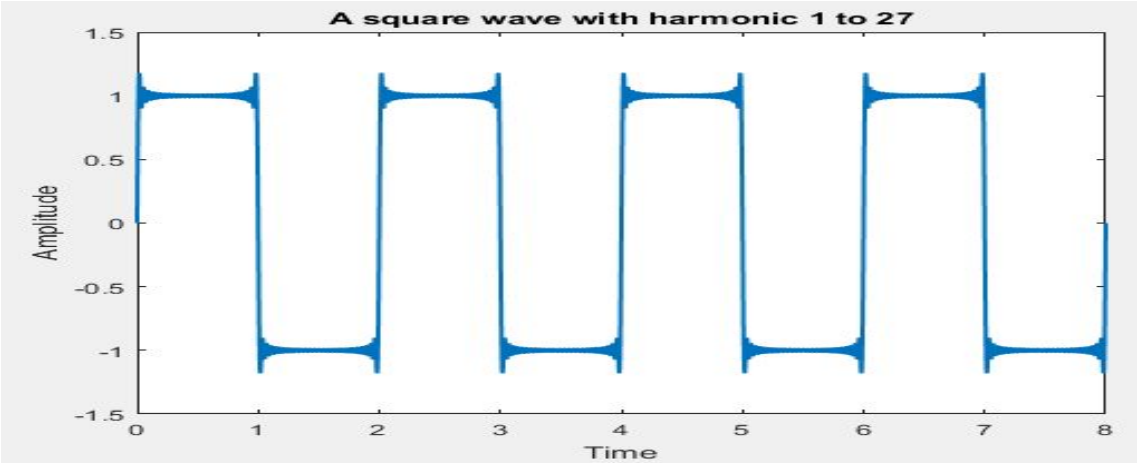
```
clc
clear all
close all
ff=0.5;
fs=1000;
t=0:1/fs:8;
A=4/pi;
har1=A*sin(2*pi*ff*t);
for k=3:2:34
    A=4/(pi*k);
    har2=A*sin(2*pi*ff*t*k);
    har1=har1+har2;
end
plot(t,har1,'linewidth',1.5);
title('A square wave with harmonic 1 to 17');
xlabel('Time');
ylabel('Amplitude');
```

1st to 27th Harmonic:

```
clc
clear all
close all
ff=0.5;
fs=1000;
t=0:1/fs:8;
A=4/pi;
har1=A*sin(2*pi*ff*t);
for k=3:2:55
    A=4/(pi*k);
    har2=A*sin(2*pi*ff*t*k);
    har1=har1+har2;
end
plot(t,har1,'linewidth',1.5);
title('A square wave with harmonic 1 to 27');
xlabel('Time');
ylabel('Amplitude');
```

Output:





Task # 3:

Write a program that plots the signal s(t).

$$s(t) = \sum_{n=1}^{N} \frac{\sin(2\pi nt)}{n}$$ where n = 1, 3, 5, 7, 9 and N = 9 or

$$s(t) = \sin(2\pi * t) + \frac{\sin(6\pi * t)}{3} + \frac{\sin(10\pi * t)}{5} + \frac{\sin(14\pi * t)}{7} + \frac{\sin(18\pi * t)}{9}$$

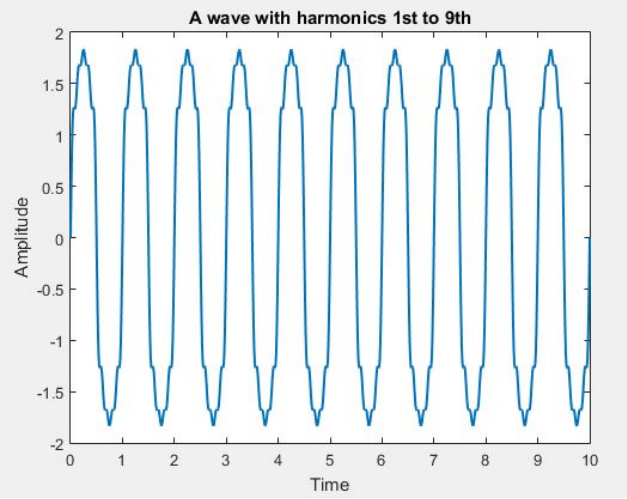
Problem Analysis:

Take the sum of the given sine signal for different values of n and plot the resultant signal.

Code:

```
t=0:0.0001:10;
N=9;
y = sin(2*pi*t);
for n = 1:2:9                    %Odd numbers from 1 to 9
x = sin(2*pi*n*t)/n;
y=y+x;                           %Summation of Signals
end
plot(t,y,'linewidth',1.5);       %Plot signal
title('A wave with harmonics 1st to 9th');
xlabel('Time');
ylabel('Amplitude');
```

Output:



Task # 4:

Generate a triangular wave with N=11.

Code:

```
clc
clear all
close all
t=0:0.01:0.25;
ff=25;
x1=(-8/(pi^2))*exp(i*(2*pi*ff*t));
for k=3:2:21
    fh=ff*k;
    x=(-8/(pi^2*k^2))*exp(i*(2*pi*fh*t));
    y=x1+x;
end
plot(t,real(y),'linewidth',3);
title('Triangular Wave with N=11');
ylabel('Amplitude');
xlabel('Time');
grid;
```

Output: