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CSU11031 Assignment 4 IT

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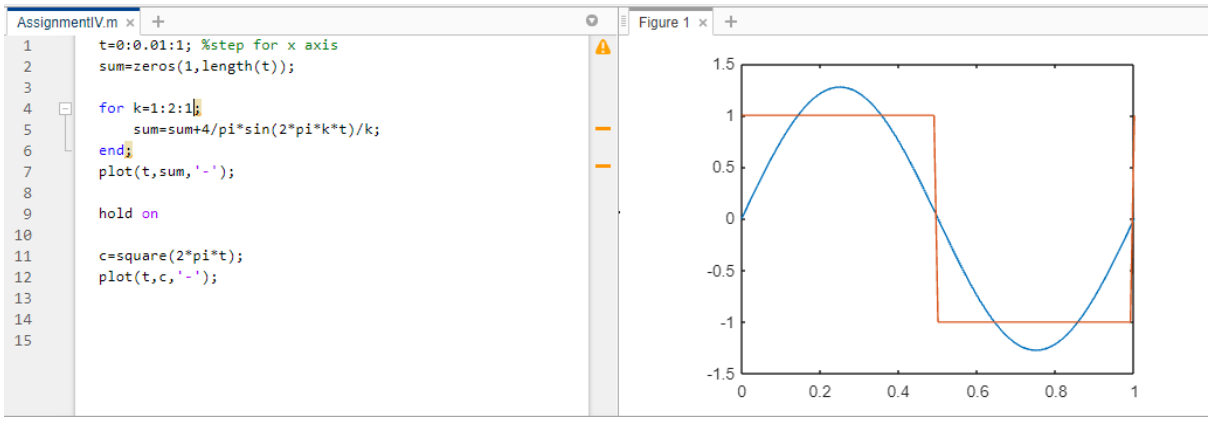
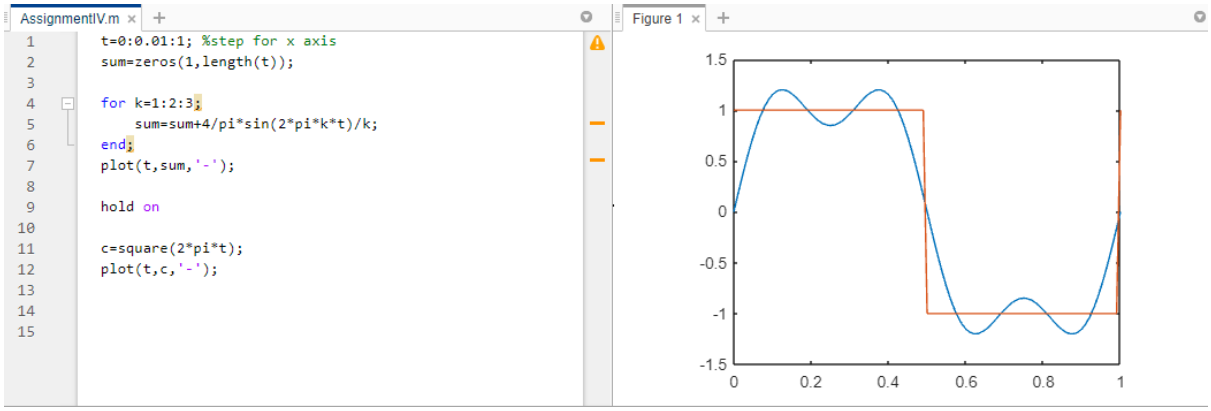
1. The plots below represent composite periodic signals generated by summing up the sine wave $4/\pi * \sum_{k=1,k=odd}^{n} \sin \frac{2\pi kt}{k}$ a certain number of times. The fundamental frequency of the wave is k, all higher frequency components are called harmonics. t is our time domain and displays the square wave approximation in time. We can see the spectrum of a periodic signal in the time domain as a series of waves. We see that as we increase the frequency of the summation, we get closer to our square wave that is because in order to be a perfectly square wave we would need to sum an infinite number of sine waves. As we can see our variable c below represents our perfect square wave in red with respect to time domain t. This is because the equation for c square $(2 * pi * t)$ does not depend on frequency k hence it sums an infinite number of sine waves resulting in a perfect square wave.

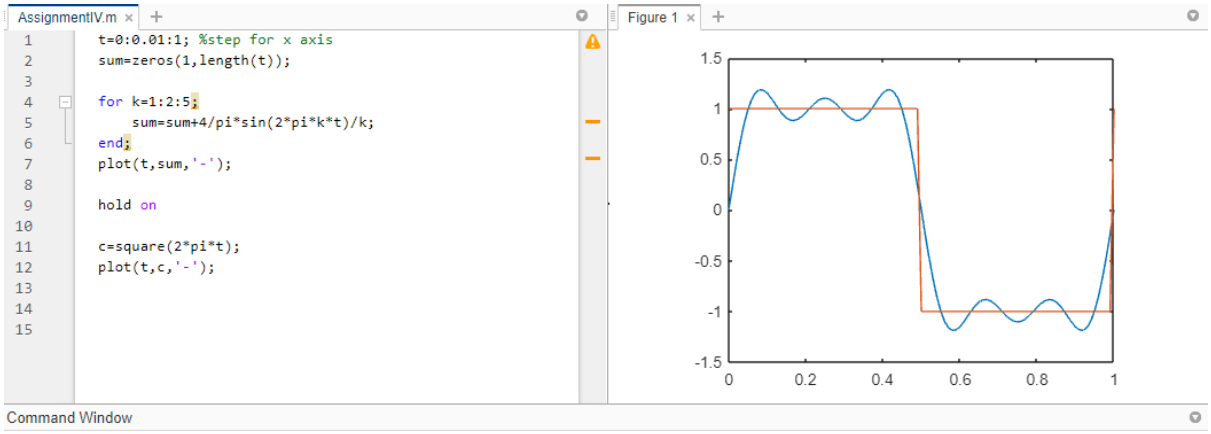
   This plot shows the sine wave summed once.



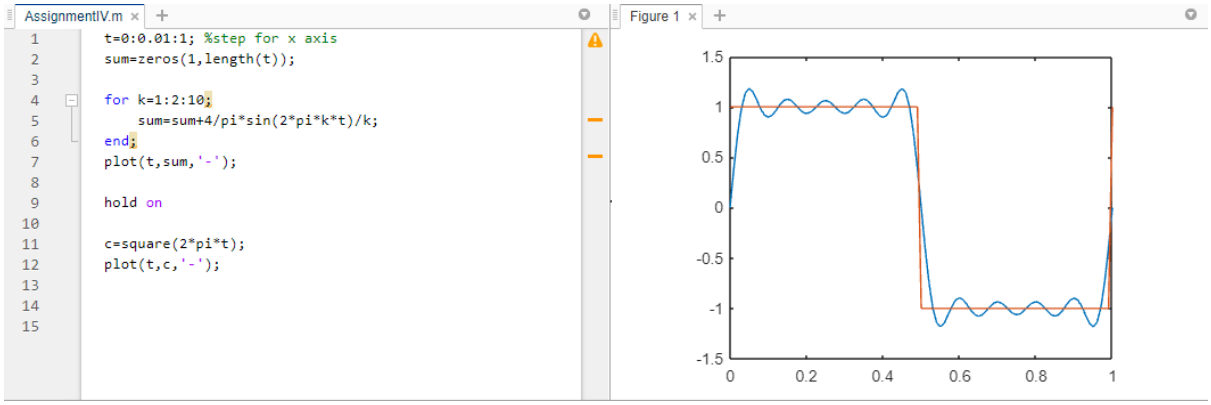
   This plot shows the sine wave summed 3 times.



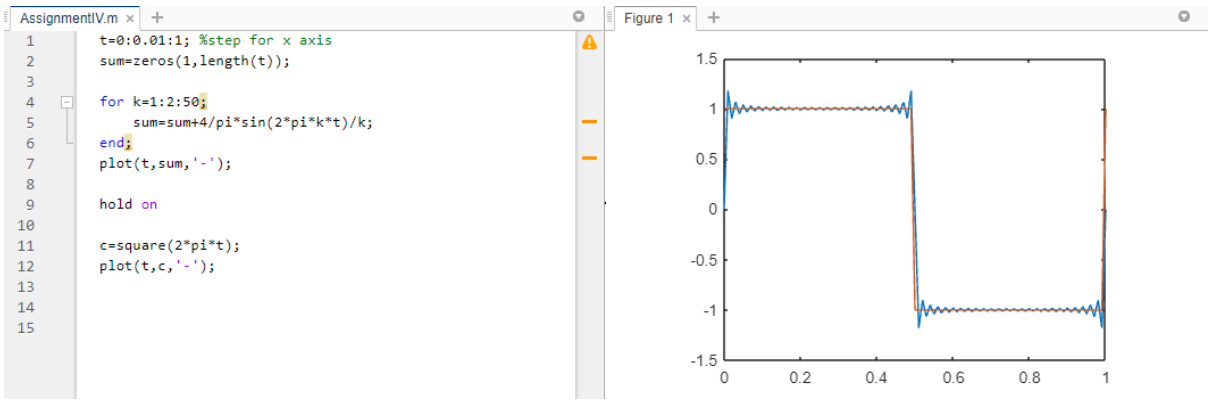
This plot shows the sine wave summed 5 times.



This plot shows the sine wave summed 10 times.



This plot shows the sine wave summed 50 times.



This plot shows the sine wave summed 500 times.

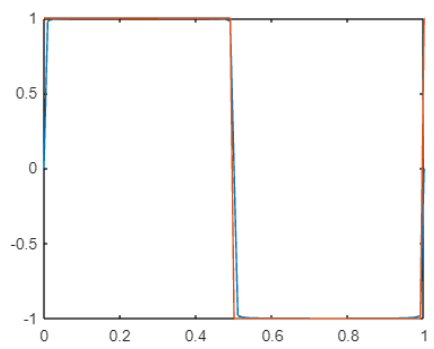
AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));

for k=1:2:500;
    sum=sum+4/pi*sin(2*pi*k*t)/k;
end;
plot(t,sum,'-');

hold on

c=square(2*pi*t);
plot(t,c,'-');
```



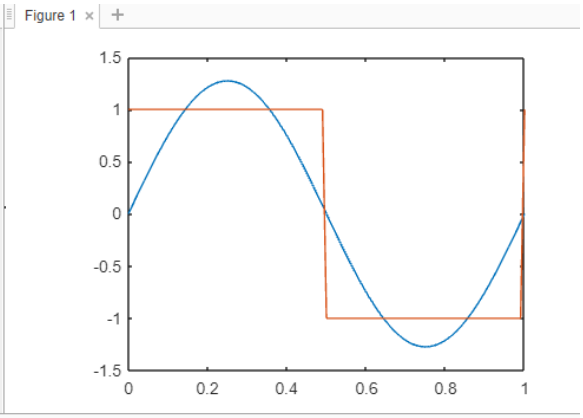
2. The plots below represent the decomposition of a composite periodic signal in the time domain. The amplitude of the sine wave with frequency k is almost the same as the peak amplitude of the original composite signal. The amplitude of the sine wave with frequency 3k is one-third of that of the first harmonic, and the amplitude of the sine wave with frequency 9k is one-ninth of the first harmonic. This logic applies for all our frequency values The frequency decomposition of the signal is discrete and value k represents frequency

AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=1;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

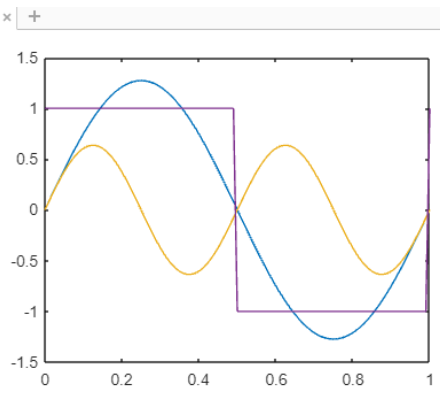


AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=2;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```



Command Window

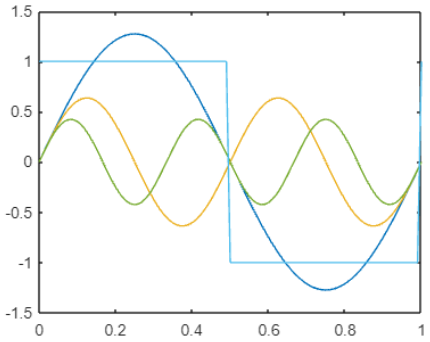
AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=3;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

Figure 1



Command Window

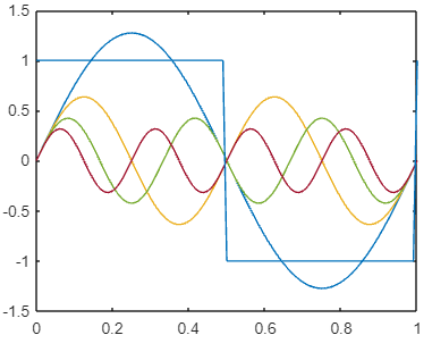
AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=4;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

Figure 1



Command Window

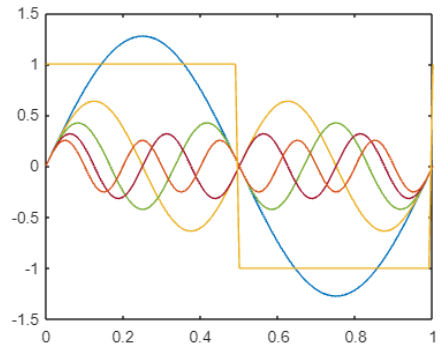
AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=5;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

Figure 1



Command Window

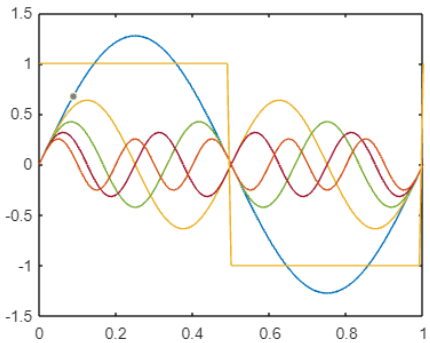
AssignmentIV.m *

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=6;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

Figure 1



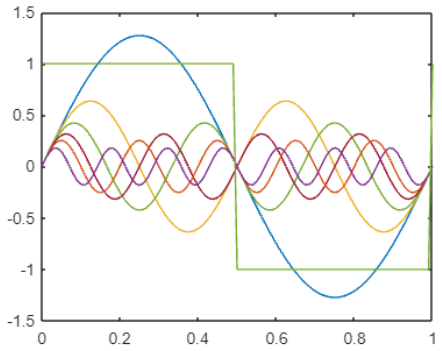
Command Window

AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=7;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```



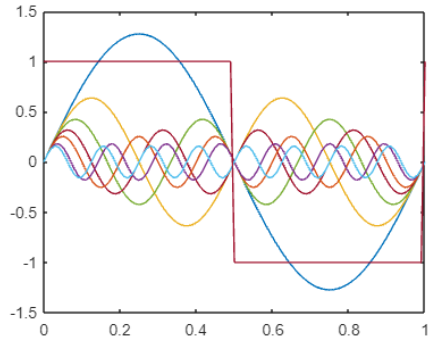
Command Window

AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=8;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```



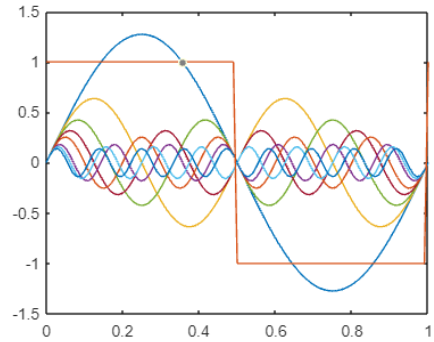
Command Window

AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=9;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```



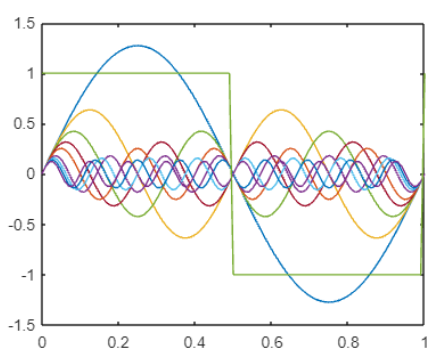
Command Window

AssignmentIV.m

```
t=0:0.01:1; %step for x axis
sum=zeros(1,length(t));
k=10;

    sum=sum+4/pi*sin(2*pi*k*t)/k;

    plot(t,sum,'-');
    hold on;
    c=square(2*pi*t);
    plot(t,c,'-');
```

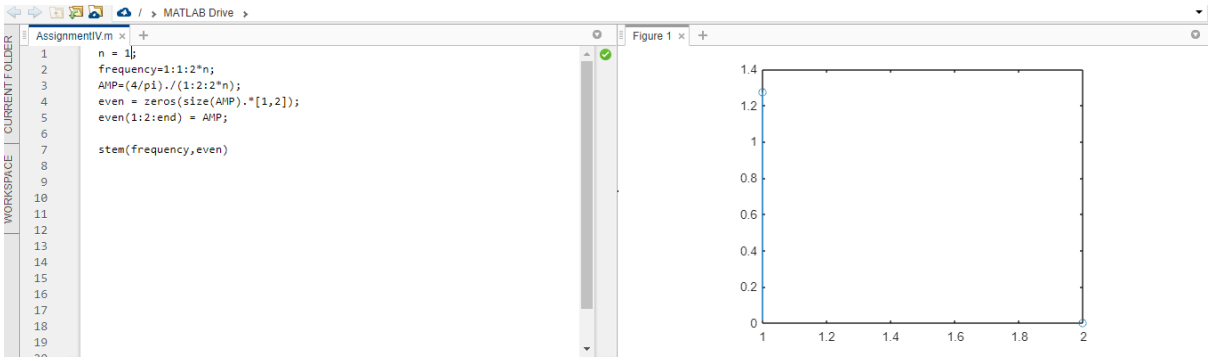


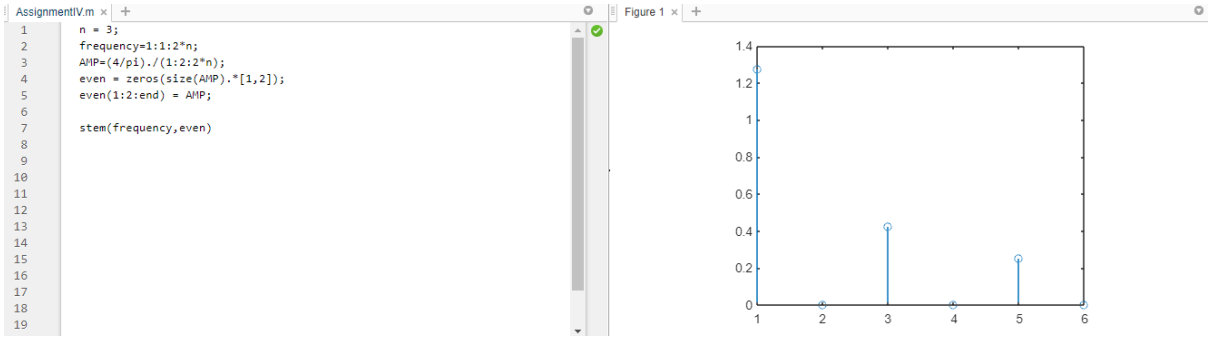
Command Window

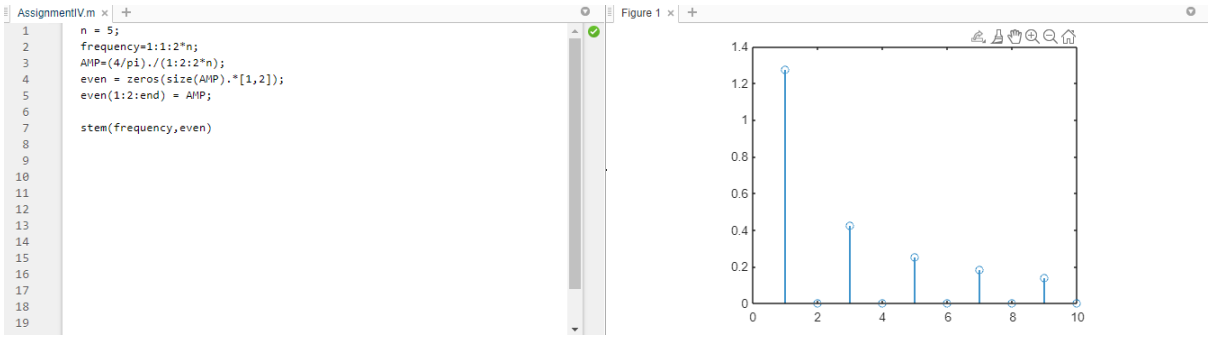
3. The below plots show the representation in the frequency domain of the square wave approximation in part 1. Each line represents the amplitude of each sine wave on the sum. The plot shows all such amplitudes, in sequence. Even figures are plotted with a height of zero.

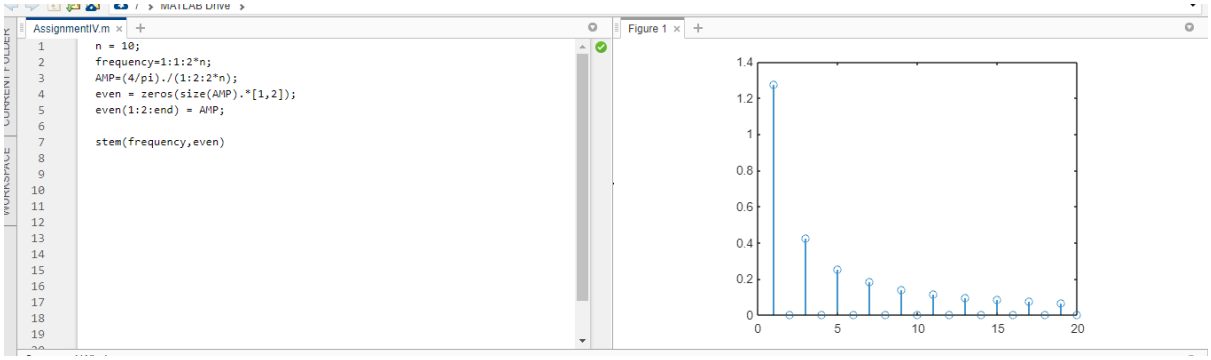
   Thanks to a friend for sharing:

https://uk.mathworks.com/matlabcentral/answers/586724-how-can-i-add-zeros-between-elements-of-a-matrix









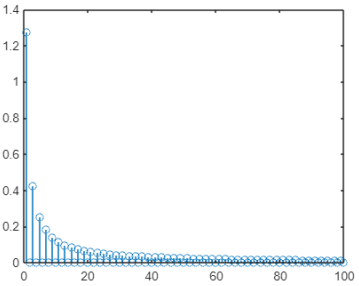
MATLAB Drive

AssignmentIV.m

```
n = 50;
frequency=1:1:2*n;
AMP=(4/pi)./(1:2:2*n);
even = zeros(size(AMP).*[1,2]);
even(1:2:end) = AMP;

stem(frequency,even)
```

Figure 1



MATLAB Drive

AssignmentIV.m

```
n = 500;
frequency=1:1:2*n;
AMP=(4/pi)./(1:2:2*n);
even = zeros(size(AMP).*[1,2]);
even(1:2:end) = AMP;

stem(frequency,even)
```

Figure 1