Lab 8

Ex 8.2

Trignometric Fouries Series:

6.2

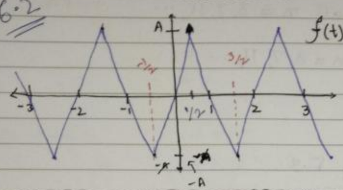
* we take → $\frac{-1}{2}$ to $\frac{3}{2}$ (2 piece wise function)

* if we take 0 → 2 (we have three piece wise functions)

↓

* so we prefer $\frac{-1}{2}$ to $\frac{3}{2}$

* complete signal Repeated $\{T_0\}$

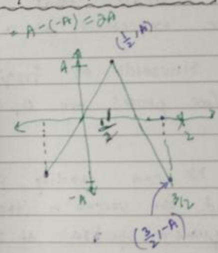


* {Find the compact / trig. Fouries Series} for triangular periodic signal f(t) shown}

{Sketch Amplitude & Phase spectra of f(t).}

$T_0 = \frac{3}{2} - (-\frac{1}{2}) = \frac{4}{2} = 2$

$T_0 = 2$; $\omega_0 = \frac{2\pi}{T_0}$; $\omega_0 = \pi$



$$f(t) = a_0 + \sum_{n=1}^{\infty} \{a_n \cos n\pi t + b_n \sin n\pi t\}$$

Where;

$$f(t) = \begin{cases} 2At & |t| \le \frac{1}{2} \\ 2A(1-t) & \frac{1}{2} < t \le \frac{3}{2} \end{cases}$$

Average value (dc) of f(t) is zero.

$$a_0 = 0$$

$$a_n = \frac{2}{2} \int_{-1/2}^{3/2} f(t) \cos n\pi t \, dt$$

$$= \int_{-1/2}^{1/2} 2At \cos n\pi t + \int_{1/2}^{3/2} 2A(1-t) \cos n\pi t \, dt$$

Solving the integrals: both integrals evalute to zero.

Date:

$a_n = 0$

$$b_n = \int_{-1/2}^{1/2} 2At \sin n\pi t \, dt + \int_{1/2}^{3/2} 2A(1-t) \sin n\pi t \, dt$$

the detailed evaluation of the integral yield:

$$b_n = \frac{8A}{n^2\pi^2} \sin\left(\frac{n\pi}{2}\right) = \begin{cases} 0 & n \text{ even} \\ \frac{8A}{n^2\pi^2} & n = 1, 5, 9, 13, \ldots \\ -\frac{8A}{n^2\pi^2} & n = 3, 7, 11, 15, \ldots \end{cases}$$

Therefore

$$f(t) = \frac{8A}{\pi^2} \sum_{n=1,3,5\ldots}^{\infty} \left\{ \frac{\sin\left(\frac{n\pi}{2}\right)}{\pi} \times \sin n\pi t \right\}$$

$$= \frac{8A}{\pi^2} \left[\sin \pi t - \frac{1}{9} \sin 3\pi t + \frac{1}{25} \sin 5\pi t - \frac{1}{49} \sin 7\pi t + \cdots \right] \rightarrow (A)$$

Identities:

$$\sin kt = \cos(kt - 90^\circ)$$
$$-\sin kt = \cos(kt + 90^\circ)$$

By using these identities, Eq (A) can be expressed as

$$f(t) = \frac{8A}{\pi^2} \left[\cos(\pi t - 90^\circ) + \frac{1}{9} \cos(3\pi t + 90^\circ) + \frac{1}{25} \cos(5\pi t - 90^\circ) + \ldots \right] \text{ — (B)}$$

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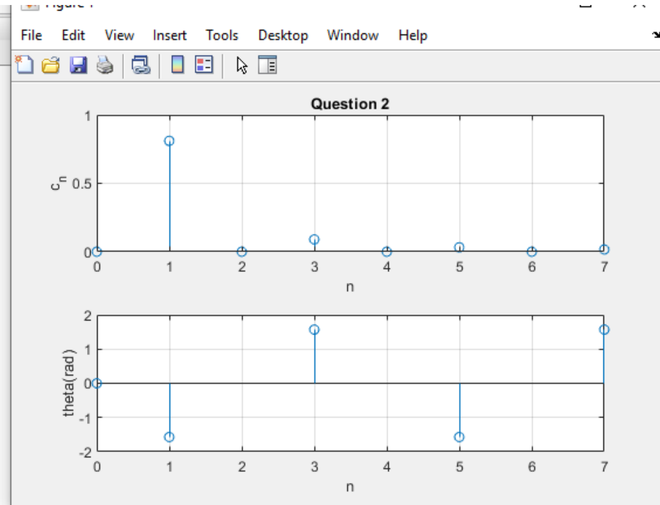
Untitled2.m | Untitled4

```matlab
n=1:7;
a0=0;
b0=0;
Cn=a0;
thetan = 0;

den = (n.^2*pi^2);
N = length(den);

for i=1:N
an(i)=0;
bn(i)=(8./(den(i))).*sind(n(i)*180/2);
cn=sqrt(an(i).^2+bn(i).^2);

Cn=[Cn cn];

theta = atan(-bn(i)/an(i));
thetan = [thetan theta];
end

n=0:7;
subplot(211),stem(n,Cn,'o'),grid,xlabel('n');ylabel('c_n');
title('Question 2');
subplot(212),stem(n,thetan,'o'),grid,xlabel('n'),ylabel('theta(rad)');
```



Ex 8.3

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untitled4.m | untitled3.m

```
n=1:9;
a0=0;
b0=0;
Cn=a0;
thetan = 0;

den = (n.^2*pi^2);
N = length(den);

for i=1:N
an(i)=0;
bn(i)=(4./den(i)).*sind(n(i)*180/2);
cn=sqrt(an(i).^2+bn(i).^2);

Cn=[Cn cn];

theta = atan(-bn(i)/an(i));
thetan = [thetan theta];
end

n=0:9;
subplot(211),stem(n,Cn,'o'),grid,xlabel('n');ylabel('c_n');
title('Question 3');
subplot(212),stem(n,thetan,'o'),grid,xlabel('n'),ylabel('theta(rad)');
```

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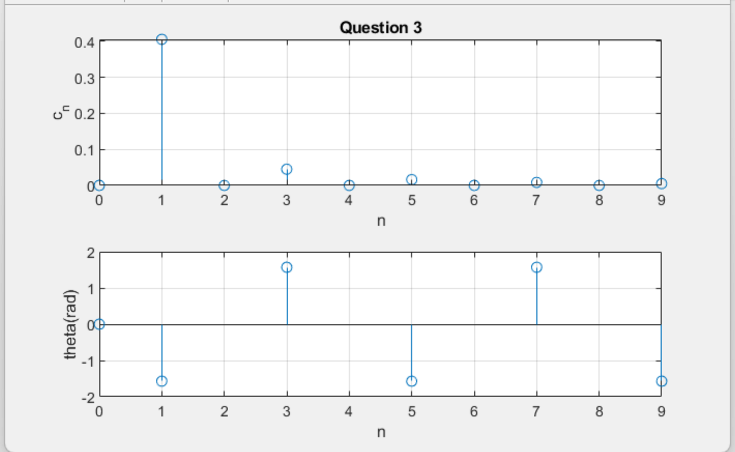

8.3

$T_0 = \pi$

$\omega_0 = \frac{2\pi}{T_0} = 2$

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1-0}{\frac{\pi}{4} - 0} = \frac{4}{\pi}t$

$y = mx + c$

$c = 0$

$b_n = \frac{2}{T_0}\int_{-\pi/4}^{\pi/4} x(t)\sin(n\omega_0 t)\,dt$

$= \frac{2}{\pi}\int_{-\pi/4}^{\pi/4} \frac{4}{\pi}t\sin(2nt)\,dt$

$= \frac{8}{\pi^2}\left[\frac{-t\cos(2nt)}{2n} + \frac{\sin(2nt)}{4n^2}\right]_{-\pi/4}^{\pi/4}$

$= \frac{8}{\pi^2}\left[\frac{\sin(n\pi/2)}{4n^2} - \frac{\sin(-n\pi/4)}{4n^2}\right]$

$= \frac{8}{4n^2\pi}\left[2\sin\left(n\frac{\pi}{2}\right)\right]$

$b_n = \frac{4}{n^2\pi^2}\left[\sin\left(n\frac{\pi}{2}\right)\right] = \begin{cases} 0 & n = \text{even} \\ 4/n^2\pi^2 & n = 1,5,9,13,\dots \\ -4/n^2\pi^2 & n = 3,7,11,15\dots \end{cases}$