Review

Go over HW1

Prob 1 - Period + shift

Problem 5 - Phasor Addition

CH2

P10 Let $x(t) = 10\cos[2\pi(440)t - 0.4\pi]$

FIND SHIFT in Time and Period T_0

$$2\pi(440)t_{shift} - 0.4\pi = 0$$

To write $\cos[\omega_0(t - t_{shift})] = x(t)$

1. THINK

shift is to right $0.4\pi = \frac{4}{10}\pi$.

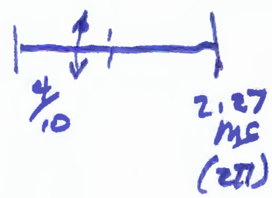
which is $\frac{2}{10}$ of 2π or $\frac{2}{10}$ of Period!

$$t_{shift} = \frac{0.4\pi}{2\pi(440)} = \frac{0.4\pi}{2\pi/T_0} = \underline{\underline{T_0 \times 0.2}}$$

2. $T_0 = \frac{1}{f_0} = \frac{1}{\omega_0/2\pi} = \frac{1}{440} = \frac{1000}{440}10^{-3}s$

$$\doteq 2.27\,ms$$

So shift is $0.2 \times 2.27\,ms$



3. $10\cos[\omega_0(t - t_{shift})] =$

$$10\cos\left[\omega_0\left(t - \frac{0.4\pi}{\omega_0}\right)\right] =$$

$$10\cos[\omega_0(t - 4.55\times10^{-4})]$$

$$4.55\times10^{-4} = (4.55\times10^{-3})\times10^{-1}$$

$$= 0.455\,ms$$

Check $\omega_0 t_{shift}/\pi = -0.4$ ✓

Consider Euler

$$\cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$$

$$\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$$

note $\frac{1}{j} = \frac{j}{j} \cdot \frac{1}{j} = \frac{j}{-1} = -j = \underline{\underline{e^{-j\pi/2}}}$

so expect

pg 27 $A\cos(\omega_0 t + \phi) \Rightarrow$

$\left[\frac{1}{2} A e^{j\phi} + \frac{1}{2} A e^{-j\phi}\right]$ ~~A~~s PHASOR

OR

$$\frac{1}{2} A e^{j\phi} e^{j\omega_0 t} + \frac{1}{2} A e^{-j\phi} e^{-j\omega_0 t}$$

pg 28 WATCH SINE! $1/j$

$$A\sin(\omega_0 t + \phi) =$$

$$\frac{1}{j}\left[\frac{1}{2} A e^{j\phi} e^{j\omega t} - \frac{1}{2} A e^{-j\phi} e^{-j\omega_0 t}\right]$$

$$= \frac{1}{2} A e^{j\phi} e^{-j\pi/2} e^{j\omega_0 t} + \frac{1}{2} A e^{-j\phi} \underline{e^{j\pi/2}} e^{-j\omega_0 t}$$

Go over HW 2

problem 1 Periodic waves

Problem 3 complex Exponentials

CHAPTER 3

Periodic waveforms

$$x(t+T_0) = x(t) \quad \text{for all } t$$

T_0 is the period in seconds

$$x(t) = 20\cos\left(2\pi(40)t + \phi\right)$$

Then

$$x(t+T_0) = 20\cos\left(2\pi(40)[t+T_0] + \phi\right)$$

$$= 20\cos\left[2\pi(40)t + 2\pi(40)T_0 + \phi\right]$$

$$= 20\cos\left\{2\pi(40)t + 2\pi f_0 T_0 + \phi\right\}$$

but $f_0 T_0 = 1$ so

$$= 20\cos\left\{2\pi(40)t + \phi + 2\pi\right\}$$

Repeats

Pg 67 $\quad f_0 = 40\text{ Hz} \quad T_0 = \frac{1}{40}$ sec

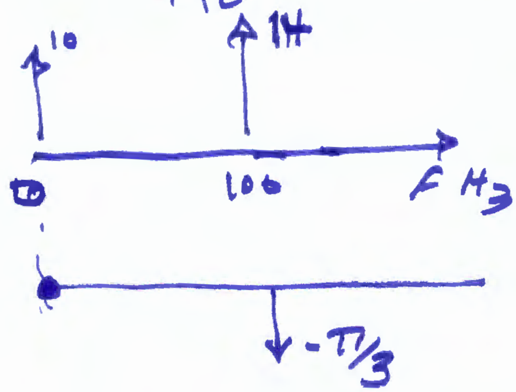
SPECTRUM

pg 50 1 SIDED OR 2 SIDED ?.

Let $x(t) = 14\cos(200\pi t - \pi/3)$ Ex 3.1

$+10$

Plot



Angle

So 10 dc

$14\angle{-\pi/3}$ 100 Hz

2 sided - Euler (Divide by 2)

$$10 + 7e^{-j\pi/3}e^{j2\pi(100)t} + 7e^{j\pi/3}e^{-j2\pi(100)t}$$

Fig 3.1
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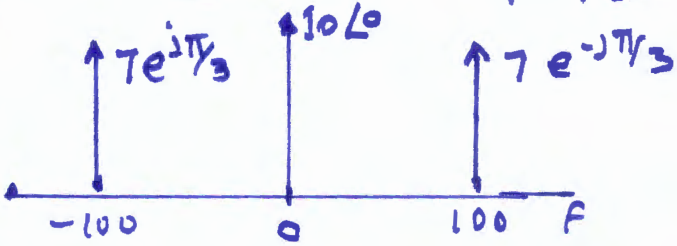


NOTE: MUST HAVE AMPLITUDE

AND PHASE !

Note 2: The Exponential terms are COMPLEX CONJUGATES !

CH 3

ADDING SIGNALS

Pg 67 FIND greatest common divisor of the frequencies

OR

Look at time relationship

K+H Pg 6 / Problem 3-2 Pg 91

$$10\cos(800\pi t + \phi_1) + 7\cos(1200\pi t + \phi_2)$$

note $GCD(400, 600) = \underline{\underline{200\ Hz}}$

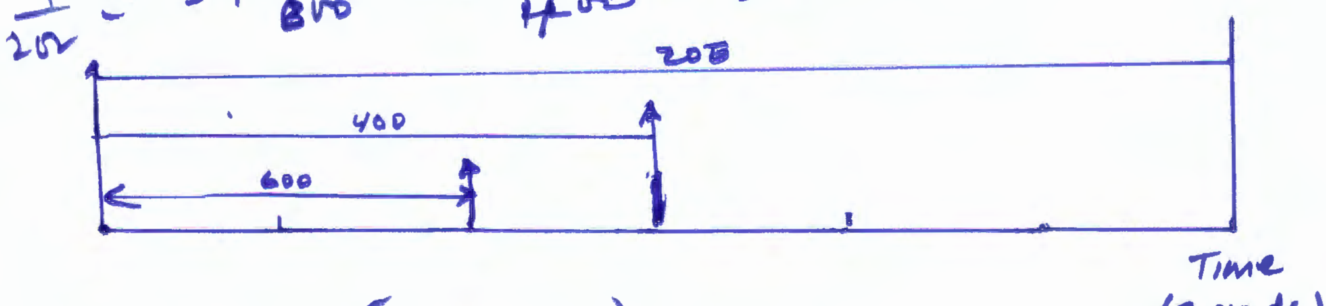
Period $= \frac{1}{200}$ sec $= .005$ sec

<u>OR</u> $mT_1 = nT_2$

$$\frac{T_1}{T_2} = \frac{m}{n} = \frac{\frac{1}{400}}{\frac{1}{600}} = \frac{600}{400} = 3/2$$

Expect ~~2 × 1200~~

$$\frac{1}{200} = 3 \times \frac{1}{600} = \frac{2}{400} = \frac{1}{200}$$



$GCD(f_0, kf_0) = \underline{f_0}$

FOURIER

Given the period To, the

Sum

$$x(t) = a_0^* + \sum a_k^* \cos(k\omega_0 t) + b_k^* \sin(k\omega_0 t)$$

contains frequencies kf_0 where $f_0 = \omega_0/2\pi$

start here

but $f_0 = \frac{1}{T_0}$ so we have

f_0 $2f_0$ $3f_0$ . . . .   Big $N \times f_0$

$\frac{1}{T_0}$ $\frac{2}{T_0}$ $\frac{3}{T_0}$ $\frac{BigN}{T_0}$ . . .

OR

p 74 $$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{j(2\pi/T_0)kt}$$

so $k = 0, \pm 1, \pm 2$ ... $\pm$ BigN ...

Note: In many texts this a_k is written c_k!

CH3 FOURIER

HW2 #4

SHOW SPECTRUM ANALY~~ZER~~
HW3 Problem 5 - Also Aliasing

Remember could write as

$$\sum_{k=-\infty}^{\infty} c_k \, e^{j(2\pi/T_0)kt} \qquad k=0, \pm 1, \cdots$$

OR

$$a_0 + 2\sum_{k=1}^{\infty} a_k^* \cos(2\pi k t/T_0)$$

CHAPTER 4 SAMPLING

HW 3

A few Examples:

K+H p 246

speech Assum $f_{max} = 10$ KHz

$$f_s > 2 f_{max} = 20{,}000 \text{ s/sec}$$

$$T_s = \frac{1}{f_s} = \underline{50\,\mu s}$$

NOT TOO fast

For the phone (old time) $f_{max} = 4$ kHz

$$T_s = \frac{1}{8000} = \frac{1000}{8000} \times 10^{-3} = 0.125 \text{ ms}$$

much slower

Go over HW3 Problem 5 for Aliasing!

Sampling

$$x[n] = x[nT_s] = A\cos(\omega n T_s + \varphi)$$

$$= A\cos(\hat{\omega} n + \phi)$$

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So $\boxed{\hat{\omega} \equiv \omega T_s = \frac{\omega}{f_s}}$!!