Mohammet Fikret Atar CSE 351-Final

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" I hereby pledge that I will strictly adhere to academic integrity codes and the work done on this examination is solely my own and I will not receive/give any help from/to anybody or source during this examination!"

(1)

a) $f(t) = 3\cos(t) + \sin(5t - \pi/6) - 2\cos(8t - \pi/3)$

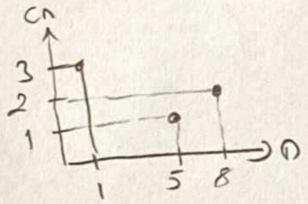
$\Rightarrow$ Compact trigonometric

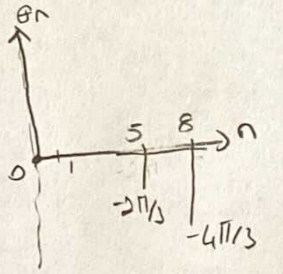
* All terms needs to be cosine form
* Amplitudes needs to be positive

$f(t) = 3\cos t + \cos(5t - \pi/6 - \pi/2) + 2\cos(8t - \pi/3 - \pi)$

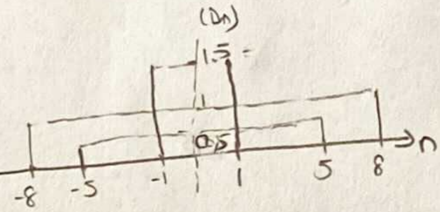
$= 3\cos(t) + \cos(5t - 2\pi/3) + 2\cos(8t - 4\pi/3)$

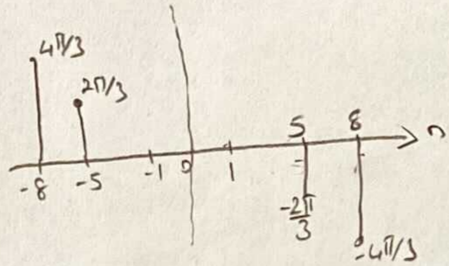
in below shows the amplitude and phase spector





b) In above figure by inspection of the trigonometric spectra we can plot the exponential spectra.





Turn back

c) we obtain using last figure

$f(t) = 3/2\ (e^{it} + e^{-it}) + 1/2\left[e^{i(5t-2\pi/3)} + e^{-i(5t-2\pi/3)}\right] + \left[e^{i(8t-4\pi/3)} + e^{-i(8t-4\pi/3)}\right]$

$= 3e^{it} + (1/2\, e^{-i2\pi/3})\, e^{i5t} + (e^{-i4\pi/3})\, e^{i8t} + 3/2\, e^{-it} + (1/2\, e^{+i2\pi/3})\, e^{-i5t} + (e^{+i4\pi/3})\, e^{-i8t}$ — ①

$f(t) = 3\cos t + \cos(5t - 2\pi/3) + 2\cos(8t - 4\pi/3)$

$= 3\cos t + \sin(5t - \pi/6) - 2\cos(8t - \pi/3)$

② a) $g(t+T) + g(t-T) \Leftrightarrow 2G(\omega)\cos(T\omega)$

use this

$g(t+T) + g(t-T) = G(\omega)e^{+j\omega T} + G(\omega)e^{-j\omega T}$

$= G(\omega)(e^{+j\omega T} + e^{-j\omega T})$

$= 2G(\omega)\cos(T\omega)$

b) $G(t) = \Pi(t/2) \Leftrightarrow 2\,\mathrm{sinc}(t\omega)$

$T{-}3 \Rightarrow$ the signal $G(t+3) + G(t-3)$

$G(t+3) + G(t-3) \Leftrightarrow 4\,\mathrm{sinc}(\omega) + \cos(3\omega)$

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(3) a) Nyquist sampling ⇒ $2 \times$ Bandwidth rate

$= 2 \times 15kHz = \boxed{30kHz}$

b) $L = 65536$, $L = 2^n$

$65536 = 2^n \Rightarrow n = \log_2 65536$

$\Downarrow$

$\boxed{n = 16}$ → binary digits we needed to encode the audio signal.

c) Determine the number of binary digits/sec (bit/second)

sampling rate $\times n = 3 \times 10^4 \times 16 = 48 \times 10^4$ bits/sec

$= \boxed{480 \text{ kbps}}$

d) Practical CDs use 44100 samples/second

if $L = 65536 \Rightarrow 16$ binary digits

$\Downarrow n$

Transmission rate $= f_s . n$

$= 44100 \times 16 = 705600$

705.6 kbps

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4-) Find the Z-transform of $x(n) = \cos(w_0 n) . u(n)$

$$Z.T[\cos(nw_0)u[n]] = \sum_{n=-\infty}^{\infty} \cos(nw_0)u[n]z^{-n}$$

$$= \sum_{n=0}^{\infty} \cos(w_0 n) z^{-n}$$

$$x(n) = \sum_{n=0}^{\infty} \frac{e^{-jnw_0} + e^{-jnw_0}}{2} . z^{-n}$$

$$= \frac{1}{2}\left[\sum_{n=0}^{\infty}(e^{jw_0}z^{-1})^n + \sum_{n=0}^{\infty}(e^{-jw_0}z^{-1})^n\right]$$

$$= \frac{1}{2}\left[\frac{1}{1-e^{jw_0}z^{-1}} + \frac{1}{1-e^{-jw_0}z^{-1}}\right]$$

$$= \frac{1}{2}\left[\frac{z}{z-e^{jw}} + \frac{z}{z-e^{-jw}}\right]$$

$$= \frac{1}{2}\left[\frac{z(z-e^{-jw}) + z(z-e^{jw})}{z^2 - ze^{-jw} - z^{jw} + 1}\right]$$

$$= \frac{1}{2}\left[\frac{2z^2 - 2z\left[\frac{e^{jw}+e^{-jw}}{2}\right]}{z^2 + 1 - 2z\left[\frac{e^{-jw}+e^{jw}}{2}\right]}\right]$$

$$= \frac{z^2 - z\cos(w_0)}{z^2 - 2z\cos(w_0) + 1} = \boxed{\frac{1-\cos(w_0)z^{-1}}{1-2\cos(w_0)z^{-1} + z^{-2}}}$$