

EE321 Fourier Transform Sample Problems

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Instructions: You are permitted to use a self-prepared study-guide limited to two ($8\frac{1}{2}'' \times 11''$) page (both sides). Show all the intermediate steps for credits.

- Given a 200MHz TTL (5 V) computer clock (50% duty cycle) signal $v(t)$ as shown in following figure,
 - find its exponential Fourier series representation and sketch the magnitude and phase spectrum up to its 5th harmonic frequencies.
 - find the partial power of the signal up to 5th harmonic frequencies and calculate the percentage of the partial power out of the total average power of the signal.
 - Write down the expression using the signal components up to 5th harmonic frequencies. Find the error energy of the approximation and find the percentage of error out of the total average power of the signal.

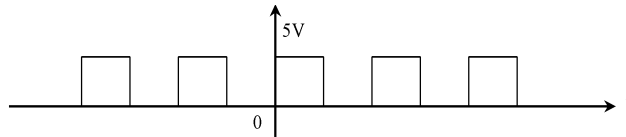


Figure 1:

- For a periodic signal $f(t) = 2 + 4 \cos(20\pi t - 2) + \sin(60\pi t) + \frac{1}{4} \cos(80\pi t)$, find all the exponential Fourier series coefficients C_n 's. (Hint: using Fourier series recognition).
- Show that if the following pairs of periodic signals, $x(t)$ and $f(t)$ are orthogonal or not.

$$x(t) = e^{jk\omega_0 t} \text{ and } f(t) = e^{jn\omega_0 t} \text{ where } n \neq k$$

- Find the Fourier transform and inverse Fourier transform (show your steps of derivations):
 - Given the Fourier transform pairs $e^{-at}u(t) \iff \frac{1}{a+j\omega}$ (Table 4.1(1)), find Fourier transform of
 - $f(t) = 3e^{-3t}u(t-2)$ using time shift property
 - $x(t) = f(t) * \cos(4t)$ using frequency shift property
 - Given the Fourier transform pairs $\text{rect}(\frac{t}{\tau}) \iff \tau \text{sinc}(\frac{\omega\tau}{2})$ (Table 4.1(17)), find inverse Fourier transform of $Y(\omega) = \text{rect}(\frac{3\omega-9\pi}{6})$ using duality (symmetry) property. And sketch functions $y(t)$ and $Y(\omega)$.
- Given the following sets of exponential Fourier coefficients of real signals, find the signal expression in time domain and plot the signals in Matlab.

$$\omega_0 = 10\pi \text{ rad./sec.}, C_0 = 1, C_2 = -2j, C_{-5} = 1 + j\sqrt{3}$$