<u>ECEN220 Tutorial 3 Questions</u>

Block 3: Fourier Series

Q1. Obtain the Fourier Series representation for the waveform shown in Figure 1, where the signal is given by

$$x(t) = \begin{cases} 5t & \text{for } -2 \le t \le 0, \\ 10 - 5t & \text{for } 0 \le t \le 2. \end{cases}$$

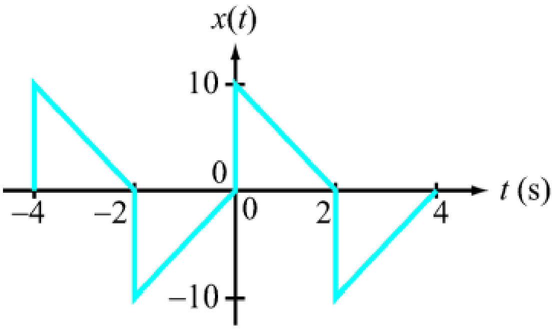


Figure 1.

Q2. Obtain the line spectra associated with the periodic function as shown in Q1 above.

Q3. a) Does the waveform x(t) shown in Figure 2 exhibit either even or odd symmetry?

b) What is the value of a_0?

c) Does the function $y(t) = x(t) - a_0$ exhibit either even or odd symmetry?

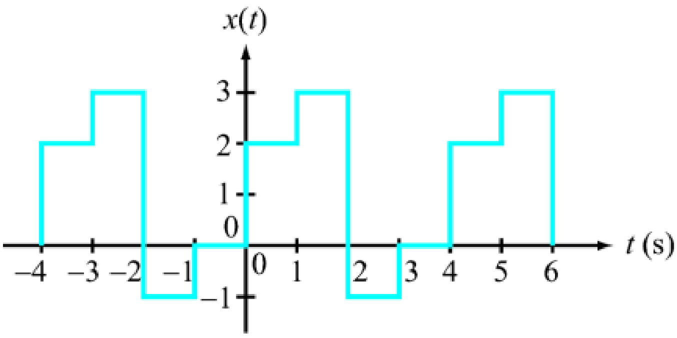


Figure 2.

Q4. The Fourier Series technique can be applied to analyse circuits excited by what type of functions/signals?

Q5. How is the angular frequency of the *n*-th harmonic related to the fundamental frequency ω_0? How is ω_0 related to the period T of the periodic function?

Q6. What steps can be used to apply Fourier Series to determine the response of a circuit to an input function?

Q7. For the cosine/sine and amplitude/phase Fourier Series representations, the summation extends from n = 1 to n = ∞. What are the limits on the summation for the complex exponential representation?

Q8. What purpose is served by the symmetry properties of a periodic function in Fourier Series representation?

Q9. What is the Gibbs phenomenon?

Q10.

We call a set of signals $\{\Psi_n(t)\}$ *orthogonal* on an interval (a, b) if any two signals $\Psi_m(t)$ and $\Psi_k(t)$ in the set satisfy the condition

$$\int_a^b \Psi_m(t)\,\Psi_k^*(t)\,dt = \begin{cases} 0 & m \neq k \\ \alpha & m = k \end{cases}$$

where $*$ denotes the complex conjugate and $\alpha \neq 0$. Show that the set of complex exponentials $\{e^{jk\omega_0 t}: k = 0, \pm 1, \pm 2, \ldots\}$ is orthogonal on any interval over a period T_0, where $T_0 = 2\pi/\omega_0$.

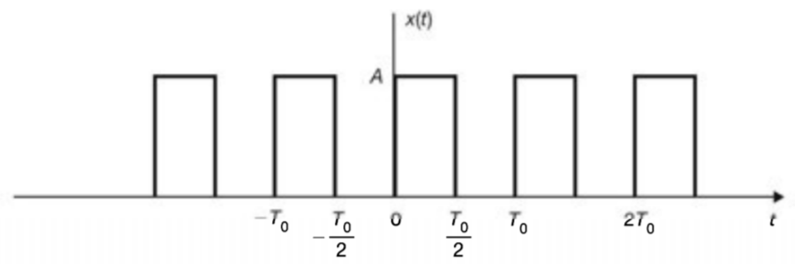
Q11. Determine the complex exponential Fourier series representation for each of the following signals:

(*a*) $x(t) = \cos \omega_0 t$

(*b*) $x(t) = \sin \omega_0 t$

(*c*) $x(t) = \cos\left(2t + \frac{\pi}{4}\right)$

Q12. Consider the periodic square wave x(t) shown here. Determine the complex exponential Fourier series of x(t).



Q13. Compute the DTFS of 4 cos(0.15πn+1).

Q14. Confirm Parseval's rule for the above exercise in Q13, i.e. compute and compare the time-domain and frequency-domain average power of the signal 4 cos(0.15πn+1).