

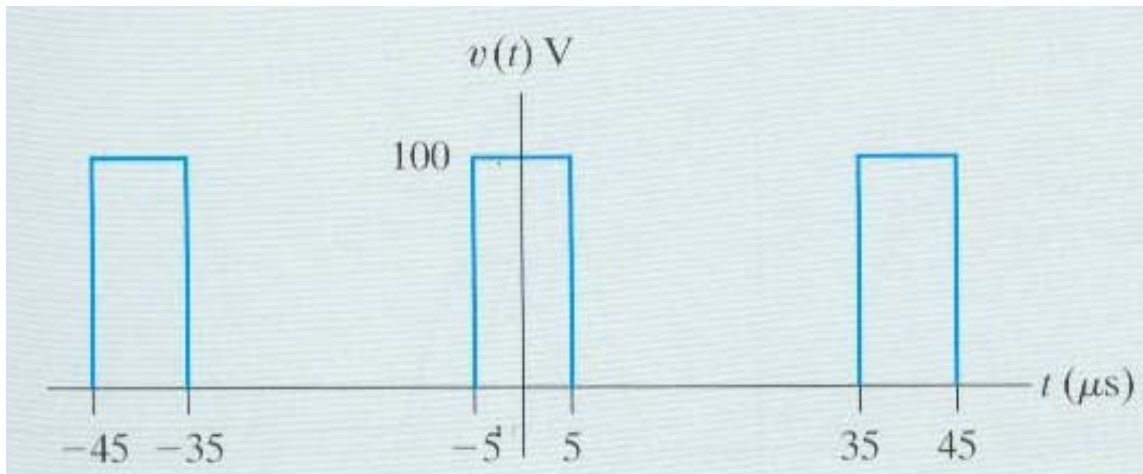
Homework Assignment #7 – Fourier Series

Reading Assignment:

Chapter 16 in Electric Circuits, 9th Edition by Nilsson

Problem Assignment:

- 1) Work the following Ch. 16 problems: 1(a and c only), 3 (a only), 12, 28, 35 (Note: for problems 28 and 35 do not derive the Fourier series – use expressions shown in the text).
- 2) Graph the Fourier series for the waveform of below using Excel, MathCAD, or MatLab. Note that the Fourier series has already been provided below. In particular, form 5 graphs:
 - DC only
 - DC + 1st harmonic
 - DC + 1st through 2nd harmonics
 - DC + 1st through 3rd harmonics
 - DC + 1st through 4th harmonics



$$v(t) = 25 + \frac{200}{\pi} \sum_{n=1}^{\infty} \left[\frac{1}{n} \sin\left(\frac{n\pi}{4}\right) \cos(n\omega_0 t) \right] \text{ V}$$

Selected Answers:

16.28) Partial solution

$$v_i = 60 \sum_{n=1,3,5,\dots}^{\infty} \left(\frac{1}{n} \sin \frac{n\pi}{2} \right) \cos 500nt \text{ V} \quad \mathbf{V}_o = \frac{\mathbf{V}_i}{R + j\omega L} \cdot j\omega L = \frac{j\omega}{R/L + j\omega} \mathbf{V}_i = \frac{j\omega}{1000 + j\omega} \mathbf{V}_i$$

$$\mathbf{V}_{i1} = 60 \angle 0^\circ \text{ V}; \quad \omega = 500 \text{ rad/s} \quad \mathbf{V}_{o1} = \frac{j500}{1000 + j500} (60 \angle 0^\circ) = 26.83 \angle 63.43^\circ \text{ V}$$

$$v_o = 26.83 \cos(500t + 63.43^\circ) + 16.64 \cos(1500t - 146.31^\circ)$$

$$+ 11.14 \cos(2500t + 21.80^\circ) + \dots \text{ V}$$

16.35) Partial solution

$$v_g = 10 - \frac{80}{\pi^2} \cos 500t - \frac{80}{9\pi^2} \cos 1500t + \dots$$

$$H(s) = \frac{10^6}{s^2 + 1000\sqrt{2}s + 10^6}$$

$$H(j\omega) = \frac{10^6}{10^6 - \omega^2 + j1000\omega\sqrt{2}}$$

$$H(j0) = 1$$

$$H(j500) = 0.9701 \angle -43.31^\circ$$

$$v_o = 10 + 7.86 \cos(500t - 43.31^\circ) + 0.3658 \cos(1500t - 120.51^\circ) + \dots$$

$$V_{\text{rms}} \cong \sqrt{10^2 + \left(\frac{7.86}{\sqrt{2}} \right)^2 + \left(\frac{0.3658}{\sqrt{2}} \right)^2} = 11.44 \text{ V}$$

$$P \cong \frac{V_{\text{rms}}^2}{50\sqrt{2}} = 1.85 \text{ W}$$