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CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

Quiz No. 9 3/26/04

PUT ANSWERS IN THE SPACE PROVIDED AND SHOW YOUR WORK IF APPROPRIATE
BE SURE TO STATE ALL ASSUMPTIONS

Problem 1 Sinusoidal Waveforms (10 points)

(a) What are the Fourier coefficients of $12\cos(5000t + 30^o)$?

$a = 6\sqrt{3}$ (2 points); $b = -6$ (2 points)

Note: we are looking for numerical answers.

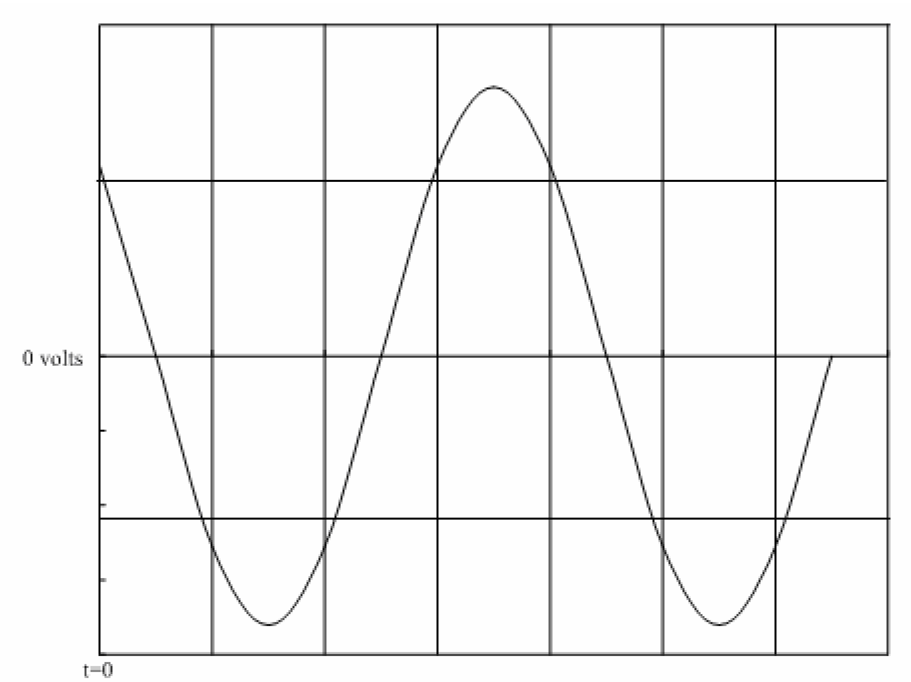
$$v(t) = V_A \cos[\frac{2\pi t}{T_0} + \phi] = 12\cos(5000t + 30^o)$$

So $V_A = 12; \quad \phi = 30^o$

And we know $a = V_A \cos\phi = 12\cos 30^o = 12 \cdot \frac{\sqrt{3}}{2} = 6\sqrt{3}$

$$b = -V_A \sin\phi = -12\sin 30^o = -12 \cdot \frac{1}{2} = -6$$

(b) You are in the laboratory and measure the waveform shown below with your oscilloscope. Assume that t=0 at the left of the screen and that zero volts is in the middle of the screen. The oscilloscope is set to 12 volts/vertical division, and 50 milliseconds per horizontal division. You want to express this waveform mathematically as $v(t) = A\cos[\omega(t - T_s)]$. What are the numerical values of A, ω and T_S?



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$A = 18V$ (2 points);

$\omega = 31.42 rad / s$ (2 points);

$T_s = -25ms$ (2 points);

The maximum amplitude of the waveform is seen to be 1.5 vertical divisions; therefore,

$A = 1.5 * 12 = 18V;$

There are 2 horizontal divisions between successive zero crossings, so the period of the waveform is

$T_0 = 50 * 2 * 2 = 200ms;$

Therefore $f_0 = \frac{1}{T_0} = \frac{1}{200ms} = 5Hz; \omega_0 = 2\pi f_0 = 31.42 rad / s$

The positive peak shown in the display is 3.5 divisions to the right of t=0, so

$T_0 + T_s = 200ms + T_s = 3.5 * 50ms;$

$=> T_s = 3.5 * 50 - 200 = -25ms;$

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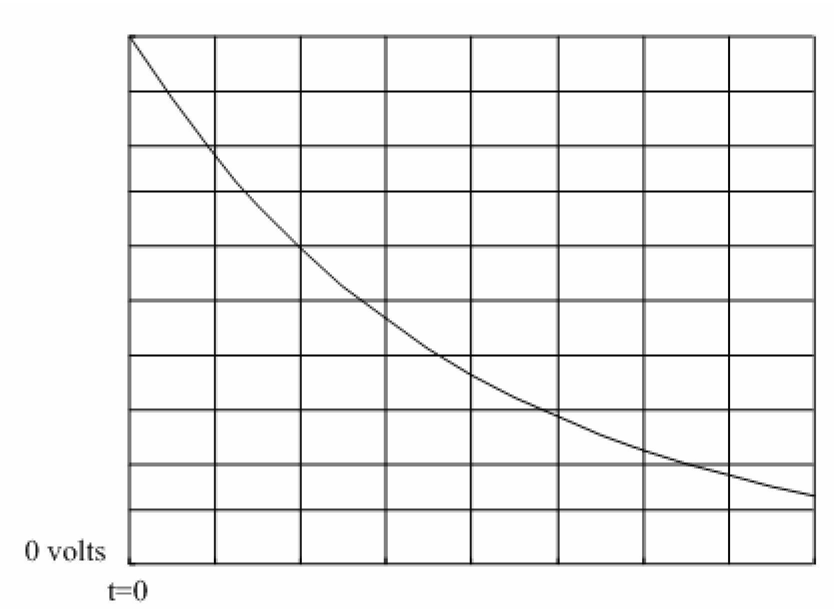
Problem 2 (10 points)



(a) You are in the laboratory measuring an exponential waveform with your oscilloscope. If the units are 20 mS/div horizontal and 8 volts/div vertical determine the numerical value of the time constant T_C for the following waveform.

$T_c = 78.3ms$ (5 points)

$v(t) = V_A e^{-(t-T_s)/T_c}$ and $T_c = \dfrac{\triangle t}{\ln[\dfrac{v(t)}{v(t+\triangle t)}]}$

At t=0, v(t=0)=10 div*8 volts/div=80 volts
At t=40 ms, v(t=40 ms)=6 div*8 volts/div=48 volts

So $T_c = \dfrac{\triangle t}{\ln[\dfrac{v(t)}{v(t+\triangle t)}]} = \dfrac{40ms - 0}{\ln(\dfrac{80}{48})} = 78.3ms$

(b) Write a mathematical expression for the above waveform. Assume that t=0 and v=0 at the lower left of the display.

$v(t) = 80e^{-t/78.3ms}$ (5 points)

From the graph, we can get V_A=80V (v(t=0));
So $v(t) = V_A e^{-(t-T_s)/T_c} = 80e^{-t/78.3ms}$