Feedback — Fourier Series Exercises

You submitted this homework on **Wed 3 Apr 2013 2:07 PM CDT -0500**. You got a score of **3.00** out of **28.00**. You can attempt again, if you'd like.

Question 1

The signal $\cos(2\pi t)$ is, of course periodic. What is its period? Enter a numeric value.

You entered:

Your Answer		Score	Explanation
	✘	0.00	
Total		0.00 / 1.00	

Question Explanation

Since $\cos(2\pi(t+1)) = \cos(2\pi t + 2\pi) = \cos(2\pi t)$, the period is 1.

Question 2

What are the Fourier series coefficients c_0 , c_1 , c_2 for $\cos(2\pi t)$ *without* explicitly calculating integrals. Use Euler's formula, Fourier series properties and any appropriate mathematical "tricks."

Express your answer numerically, typing the real and imaginary parts for each answer separated by spaces. So, an answer of $c_0 = 0$, $c_1 = 1 + j$, $c_2 = -j$, $c_3 = 0$ would be typed as 0 0 1 1 0 -1 0 0.

You entered:

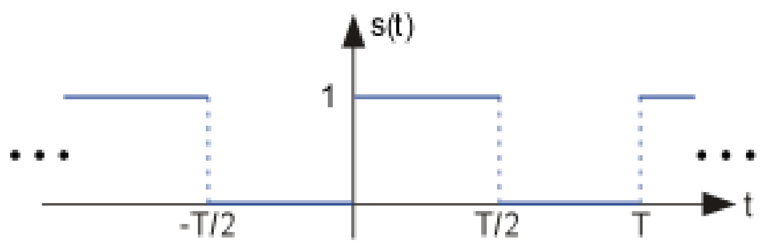
Your Answer		Score	Explanation
	✘	0.00	
Total		0.00 / 6.00	

Question Explanation

Since Euler's formula says $\cos(2\pi t) = \frac{1}{2}\left(e^{j2\pi t} + e^{-j2\pi t}\right)$, we have a direct expression of the Fourier series! $c_0 = 0$, $c_1 = 1/2$, and $c_2 = 0$.

Question 3

What are the Fourier series coefficients c_0, c_1, c_2 for the depicted waveform?



You could evaluate the coefficients by evaluating the integral, but there is a simpler way. See if you can figure out the simple approach.

Express your answer numerically, typing the real and imaginary parts for each answer separated by spaces. So, an answer of $c_0 = 0$, $c_1 = 1 + j$, $c_2 = -j$, $c_3 = 0$ would be typed as 0 0 1 1 0 -1 0 0.

You entered:

Your Answer		Score	Explanation
	✘	0.00	

Total	0.00 / 6.00

Question Explanation

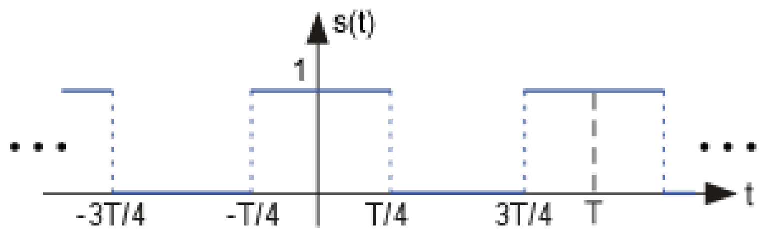
This is a square wave with a constant, what electrical engineers call a DC offset, added. Just like we did early in the course, we are decomposing a signal as a sum simpler signals.

$$s(t) = \frac{1}{2} + \frac{1}{2}\,\mathrm{sq}_T(t)$$

The offset equals $1/2$, making $c_0 = 1/2$. So, $c_1 = \frac{1}{j\pi} = -0.318j$ and $c_2 = 0$ (square wave only has odd harmonics). The Fourier series of the square wave adds to that of the constant; in other words, superposition applies.

Question 4

What are the Fourier series coefficients c_0 , c_1 , c_2 for the depicted waveform?



You could evaluate the coefficients by evaluating the integral, but there is a simpler way. See if you can figure out the simple approach.

Express your answer numerically, typing the real and imaginary parts for each answer separated by spaces. So, an answer of $c_0 = 0$, $c_1 = 1 + j$, $c_2 = -j$, $c_3 = 0$ would be typed as 0 0 1 1 0 -1 0 0.

You entered:

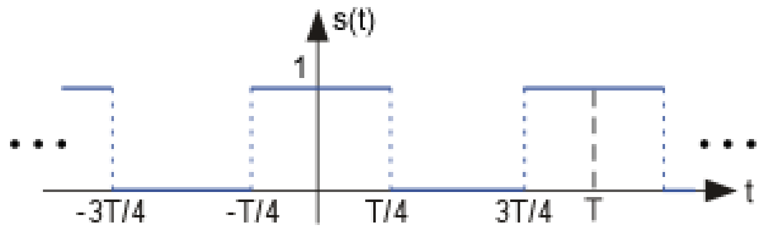
Your Answer		Score	Explanation
	✘	0.00	
Total		0.00 / 6.00	

Question Explanation

This signal is the *same* square-wave-like signal in the previous problem, but advanced in time by $T/4$. Consequently, the Fourier series coefficients of the previous problem can be multiplied by $e^{+j2\pi k\tau/T}$, $\tau = T/4$, which equals $e^{jk\pi/2}$. For k=1, $e^{jk\pi/2} = j$, which means that the coefficient $c_1 = \frac{1}{\pi} = 0.318$. The others are unchanged.

Question 5

What kind of signal is this? Select all the properties that this signal possesses.



Your Answer		Score	Explanation
Odd symmetry	✔	1.00	
A superposition of pulses having width $T/2$.	✘	0.00	
Periodic	✘	0.00	
Even symmetry	✘	0.00	
Total		1.00 / 4.00	

Question Explanation

This is an even, periodic signal, which makes its Fourier series coefficients real-valued. We have viewed it as a square wave, the most convenient decomposition for Fourier series calculation (in other words, as a sum of periodic signals). It can be viewed as a superposition of pulses, but this does not help with Fourier series calculations.

Question 6

A square wave of period T and amplitude 1 serves as the input to an RC lowpass filter. What are the Fourier series coefficients for the filter's output? Since the square wave consists only of odd harmonics, enter your answer for the output's Fourier series coefficients d_k, k odd, as an expression involving T, R and C.

d_k =?, k odd.

You entered:

Preview Help

Your Answer	Score	Explanation
✘	0.00	Could not parse student submission
Total	0.00 / 1.00	

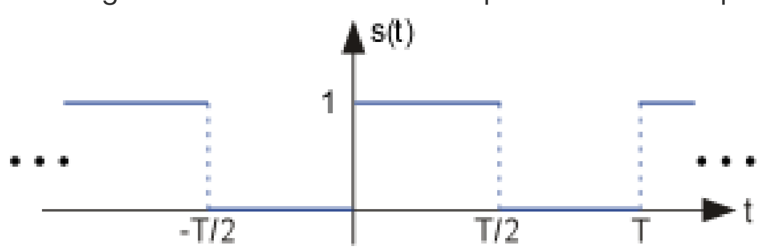
Question Explanation

The filter's transfer function is $\frac{1}{1+j2\pi fRC}$. The harmonics of the square wave occur at the frequencies $f = k/T$. Consequently, the output Fourier series coefficients equal the square wave coefficients $\frac{2}{j\pi k}$ times the transfer function evaluated at the associated harmonic frequency.

$$d_k = \frac{2}{j\pi k} \cdot \frac{1}{1 + j2\pi RCk/T}$$

Question 7

Suppose the following waveform serves as the input to our RC lowpass filter.



How does the Fourier series coefficients for the output compare to those when a square-wave was the input? Select *all* that apply.

Your Answer		Score	Explanation
d_0 is now non-zero and equals $1/2$.	✘	0.00	
The values for the coefficients for $k \geq 1$ are unchanged.	✔	1.00	
The two are the same.	✔	1.00	
The values for the coefficients for $k \geq 1$ are half the value of those resulting from the square-wave input.	✘	0.00	
Total		2.00 / 4.00	

Question Explanation

As $s(t) = \frac{1}{2} + \frac{1}{2}\,\mathrm{sq}_T(t)$, use superposition. The constant passes through without changing amplitude since the filter's gain at $f = 0$ is one. The coefficients for the square wave are scaled by $1/2$ since the square-wave portion of the input is scaled by half.