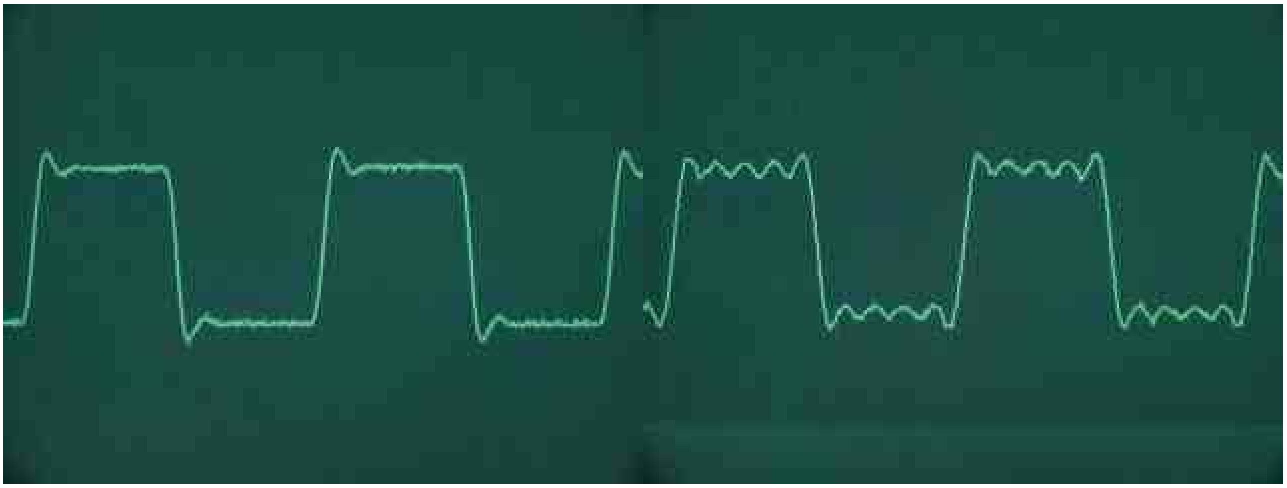
Answer #229

The answer is (d), as seen in the oscilloscope photograph at the left below.



This experiment involves both the action of the filter and *causality*. In particular, as the flat portion of the square wave passes by, the filter takes no action because it sees no variation that it can interpret as a Fourier spectrum. When the square wave changes its level (twice per period) the filter recognizes the change as having a spectrum and removes all frequencies above the ninth, causing the leading edge of the wave to oscillate with a frequency equal to that of the ninth harmonic (the same as the wiggles in the synthesized square wave at the right above).

It is interesting to note that rapid changes in the shape of complex electronic waves limit the accuracy with which such waves can be synthesized. For example, there will always be some high-frequency oscillations at the sharp edges of a square wave. This limitation is known as the Gibbs phenomenon.

Now that you are an expert in these matters, here is the test question: How would the synthesized square wave containing harmonics up to the ninth appear after it is passed through the low-pass filter with its cutoff frequency set to the tenth harmonic of the square wave? Click here to see the answer.

Archive 12

Question of the Week

Outreach Index Page

Lecture-Demonstration Home Page

For questions and comments regarding the *Question of the Week* contact
Dr. Richard E. Berg by e-mail or using phone number or regular mail address

given on the Lecture-Demonstration Home Page.

Filtered Synthesized Square Wave

The photograph at the left below shows the oscilloscope display of a square wave synthesized through the ninth harmonic, filtered by a low-pass filter whose frequency is set to the tenth harmonic of the square wave. The original synthesized square wave is shown at the right for comparison.