Ve 216: Introduction to Signals and Systems Quiz

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Quiz 8

16:00-16:45

Quiz Rules (1)

- Your entire face must be visible at all times throughout the duration of the quiz.
- Each study group completes the quiz problems collaboratively and submits one solution set.
- Any writing after the time is up is an honor code violation. Write your group number, names and IDs before starting the quiz so that you can stop writing immediately when the time is up.
- Submit your quiz solutions as a pdf file to Canvas by 16:55. The Canvas submission will be closed at 16:55 sharp.
- In the unlikely event of a technical problem with Canvas, email your solutions to me (`yong.long@sjtu.edu.cn`) by the deadline, and then later upload when the system is working.

Quiz Rules (2)

- Your attendance will be taken at 16:10, 16:30, 16:45.
  - If you are not in the ZOOM meeting list by 16:10, your quiz score will be reduced by 30%.
  - If you are not in the ZOOM meeting list by 16:30, your quiz score will be reduced by 80%.
  - If you are not in the ZOOM meeting list by 16:45, your quiz score will be reduced by 100%.

Quiz Rules (2)

- Problems where the number of points are followed by an exclamation point are basic skill problems and will be graded without partial credit.
- Clearly $\boxed{\text{box}}$ your final answer. You will be graded on both the final answer and the steps leading to it. Correct intermediate steps will help earn partial credit.
  For full credit, ~~cross out~~ any incorrect intermediate steps.
  Simplify your answers as much as possible.
- If you need to make any additional assumptions, state them clearly.
- Legible writing will help when it comes to partial credit.

Quiz (1)

Example (10)

A violinist visits an AM radio station to make a "live" performance. The violinist plays a note with a fundamental frequency of 1200Hz. (A violin signal can be modeled as a sawtooth wave with a maximum amplitude of 1). To abide by FCC regulations, the radio station filters the signal to remove all components above 5kHz, and then broadcasts the signal using DSB/WC-AM with $A = 0.5$ at a carrier frequency of 1000kHz. Carefully sketch the magnitude spectrum of the broadcast signal (for positive frequencies only), labeling all relevant components.

Hint: this problem integrates several concepts from the course: Fourier series, Fourier transform filtering, amplitude modulation. Find the spectrum at each step as you work towards the final answer.

Quiz (2)

Example (10)

Considering previous problem again, suppose that the lowpass filter was defective in that all components below 7kHz were retained, rather than only those below 5kHz. The filtered signal is broadcasted using DSB/SC-AM at a carrier frequency of 1000kHz.
Determine the interference signal that would be heard by someone who turned into the AM station centered at 1010kHz.

Hint:

- sketch the broadcast spectrum again with the defective lowpass filter,
- Consider synchronized demodulation with a 1010kHz center frequency (the demodulation signal is $\cos(\omega_c t)$ where $\omega_c = 1010$kHz).
- Assume phases of the carrier and demodulation signal are both 0.
- Assume the receiver's lowpass filter(s) are ideal ($H(\omega) = \text{rect}(\omega/2\omega_M)$ where $\omega_M = 5$kHz).