

Homework #6: Audio Effects

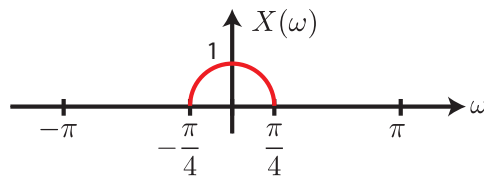
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Questions

Please print this out and answer the following questions in the space provided below. Please add additional sheets if necessary or use the backs of sheets. For full points, please provide explanations and reasoning in your solutions.

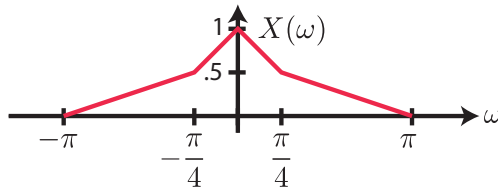
1. *Flanging*.
 - a. Is flanging a linear process? Please explain. You may do a proof showing or not showing that superposition holds.
 - b. Is flanging a time-invariant process? Please explain.

2. *Decimation.* Consider a signal $x(n]$ with the following spectrum $X(\omega)$:



- Draw the spectrum of the decimated signal for $D=3$.
- For what range of D will the decimator make use of the anti-aliasing filter to avoid aliasing?

3. *Interpolation.* Consider a signal $x(n)$ with the following spectrum $X(\omega)$:



Draw the spectrum of the interpolated signal for $I=5$.

4. *Upsampling and Downsampling.* Consider the following two systems. The first conducts downsampling first and then upsampling both by the same factor D . The second conducts upsampling first and then downsampling both by factor D . Are these systems equivalent (i.e., do they always have the same outputs for the same inputs)?

