Exercises for **Digital Audio Signal Processing**, 2nd Edition
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Chapter N°3: **AD/DA Conversion**

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1. Oversampling

1. How do we define the power spectral density $S_{XX}(e^{j\Omega})$ of a signal $x(n)$?
2. What is the relationship between signal power σ_X^2 (variance) and power spectral density $S_{XX}(e^{j\Omega})$?
3. Why do we need to oversample a time-domain signal?
4. Explain why an oversampled PCM A/D converter has lower quantization noise power in the base-band than a Nyquist rate sampled PCM A/D converter.
5. How do we perform oversampling by a factor of L in the time domain?
6. Explain the frequency domain interpretation of the oversampling operation.
7. What is the passband and stopband frequency of the analog anti-aliasing filter?
8. What is the passband and stopband frequency of the digital anti-aliasing filter before downsampling?
9. How is the downsampling operation performed (time-domain and frequency-domain explanation)?

2. Delta-Sigma Conversion

1. Why can we apply noise shaping in an oversampled AD converter?
2. Show how the delta-sigma converter (DSC) has a lower quantization error power in the base-band than an oversampled PCM A/D converter.
3. How do the power spectral density and variance change in relation to the order of the DSC?
4. How is noise shaping achieved in an oversampled delta-sigma AD converter?
5. Show the noise shaping effect (with Matlab plots) of a delta sigma modulator and how the improvement of the signal-to-noise for pure oversampling and delta-sigma modulator is achieved.
6. Using the previous plots specify which order and oversampling factor L will be needed for our 1-bit Delta sigma conveter if we need a gain of 100 dB.
7. What is the difference between the delta-sigma modulator in the delta-sigma AD converter and the delta-sigma DA converter?

8. How do we achieve a w-bit signal representation at Nyquist sampling frequency from an oversampled 1-bit signal?
9. Why do we need to oversample a w-bit signal for a delta-sigma DA converter?