### Digital Audio Effects Study Guide

*Note that there may be a little bit more detail here than is necessary. And since there are multiple versions of the exam, some topics in this study guide may not appear in the exam that you receive.*

*In general, be able to look at a block diagram of an audio effect and explain what each element of the diagram does, what the overall effect does and how it is controlled. Be able to write pseudocode to implement a block diagram or the important function within a well-known effect. Be able to distinguish between similar effects.*

Know what the Doppler effect is and its cause. Be able to explain it in terms of a moving source and stationary listener, and the case of a stationary source and moving listener. Given how a sound is changing for a stationary listener, be able to describe the motion of the source. Be able to describe and depict the apparent amplitude, frequency and velocity of a source in different situations (source moves past or moves through the observer, source composed of a single frequency or many frequencies,…).

Be able to give pseudocode to describe an implementation of the Doppler effect, using read and write pointers and a delay line. Know how many delay lines are needed to simulate the Doppler effect with many moving sources and listeners, and why.

Given a general formula for the Doppler Effect, be able to derive the Doppler effect for a particular case (like stationary source or stationary listener). Be able to derive the apparent frequency of a source if the source moves towards the listener at twice the speed of sound. Also explain why in this case the sound is heard backwards.

Know what the main parameters of a compressor do. Know the definition of linearity, and how you can show that the compression operation is a nonlinear system. Describe how a compressor and an expander can be used together to reduce noise in a recording, and know what this process is called. Know the gain curves for compression and expansion, noise gates and limiters. Be able to depict these curves with axes labeled. Be able to give a block diagram for these compression, expansion, noise gates and limiters based on pseudocode, or to write pseudocode for these effects based on a block diagram. Be able to explain, both in words and with a block diagram, how a de-esser works and a ducker works. Also explain each of their relationships to a compressor. Know the side effects of compression, such as pumping and breathing, and the differences between them. Know where each of the compressor and expander are usually placed in the effects chain. Be able to explain why.

Be able to explain why impulse responses are useful for modeling the properties of an acoustic space, and how impulse response is measured with a static sound source and a static mono microphone. Know what a typical impulse response plot looks like for a typical room. Know the difference between the early and late reflections and be able to identify them on an impulse response plot. Be able to describe the types of filters are used to generate the early reflection and late reverberation, and why.

Know what reverse reverberation and gated reverberation are, and how they look like in terms of the impulse response. Be able to define the main difference between an echo and reverberation and explain how they differ, and to explain why a simple delay is not used to implement reverb. Also know what flutter echoes are and how they relate to reverberation.

Be able to distinguish between parametric equalizers, graphic equalizers and tone controls, and know the main controls for each of them. Understand block diagrams or flow diagrams of equalizers. Know which type of filters need to be implemented in series and which type in parallel for graphic equalizer implementations. Understand the frequency spacing of the filters in a graphic equalizer having an octave spacing between filters, and how one can estimate the frequency range of one filter given parameters of another filter in a graphic equalizer with octave spacing. Be able to depict the magnitude response of each band in such an equalizer.

Know how the flanger works. Know the main parameters for the flanger, and the effect of varying their settings. Be able to derive equations for the transfer function and magnitude response of a flanger. Explain whether we hear an echo when the flanger is applied, and why or why not. Understand regeneration, as it applies to this effect, and be able to draw block diagrams of various implementations and of other related effects. For instance, be able to explain the different implementations of phasers and how these implementations can all achieve the desired effect. Know the benefits and drawbacks of the various flanger implementations as well. Be able to describe artifacts that could occur, their cause, and possible solutions.

Know the differences between wah-wah, flanger, phaser and other similar effects. Know which ones typically have feedback, what drives them, whether they typically have multiple delay lines, which filters they might use, and so on. Be able to explain how wah-wah is related to a parametric equalizer.

Understand intermodulation distortion. Be able to derive it using two sinusoids and trigonometric identities, and use this to show the sidebands that result from the intermodulation distortion. Be able to explain why intermodulation distortion is considered to be nonharmonic, and why inharmonic distortions are problematic for nonlinear audio effects. Understand how one can address the problem of aliasing when applying distortion.

Know when ring modulation heard as a sum of sinusoids and when is it heard as a product of sinusoids. Be able to distinguish when it is described as ‘beating,’ or ‘separate tones,’ or ‘roughness’ Know what determines this distinction, and what are the sidebands produced by ring modulation. Be able to find the side bands for given input frequencies into a ring modulator.

Understand the concepts of even and odd symmetry, and know how to show whether a function has even symmetry, or symmetry or neither. Be able to describe and compare nonlinear audio effects such as distortion, overdrive and fuzz.

Be able to depict, and distinguish between, full wave and half wave rectification, and how they affect the resultant sound. Know the various types of clipping covered in class. Be able to depict, and distinguish between, hard and soft clipping, and know which one is often associated with vacuum tubes.