MUSIC 424/EE 367D, Signal Processing Techniques for Digital Audio Effects

http://ccrma.stanford.edu/courses/424/

Catalog Description

MUSIC 424/EE 367D. Signal Processing Techniques for Digital Audio Effects—Digital signal processing methods for audio effects used in music mixing and mastering. Topics: dynamic range compression, reverberation and room impulse response measurement, equalization and filtering, panning and spatialization; digital emulation of analog processors and implementation of time varying effects. Single-band and multiband compressors, limiters, noise gates, de-essers, convolutional and feedback delay network reverberators, parametric and linear-phase equalizers, wah-wah and envelope-following filters, flanging and phasing, distortion. Students develop effects algorithms of their own design. Prerequisites: MUSIC 320, EE 102B or equivalent; some familiarity with Matlab and C.
3-4 units, Spr (Abel, Berners)

Prerequisites

An exposure to digital signal processing, including familiarity with the sampling theorem, digital filtering and the Fourier Transform at the level of Music 320 or EE 102B is required. An understanding of digital signal processing at the level provided by Music 420 or EE 264 is helpful. Familiarity with the use of audio effects in mixing and mastering, such as presented in Music 192 is also of benefit. Only a modest amount of Matlab or C programming experience is required for the homework and laboratory exercises.

Meeting Time and Place

Tuesdays and Thursdays, 1:15–2:30 PM, Knoll Classroom.

Instructors

Jonathan S. Abel, abel@ccrma.stanford.edu
David P. Berners, dpberner@ccrma.stanford.edu
Office hours after class and by appointment.

Teaching Assistant

Jorge Herrera, jorgeh@ccrma.stanford.edu
Office hours: Wednesdays 4:00—6:00 PM.

Grading and Credit

The course is given for three units credit; students successfully completing an optional project will receive one unit additional credit. Projects may be proposed in the first two weeks of May, and are due the day of the final exam.

Grading is based on performance on problem sets, laboratory exercises and midterm and final exams, weighted as follows:

60% Problem Sets and Labs

40% Final Exam

Collaboration on problem sets and labs is encouraged, but students must write up their submissions individually. Problem set and lab solutions will typically be available at the first class meeting after the due date. The TA will set policy with respect to problem sets and labs, including accepting late problem sets and labs and grading.

Course Materials

Course notes are provided for the photocopying cost, and will be available for purchase at the second lecture. Lecture notes, reading materials and bibliographies will occasionally be provided as handouts and posted to the course web site,

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Schedule

date	*lecture topic*
	Introduction
4-3	Introduction
	Dynamic Range Control (Compression)
4-5	Definitions, terminology, architectures
4-10	Detection and gain computation, feed forward and feedback architectures
4-12	Attack and release, program dependence; analog detectors
4-17	Limiters, De-Essers, multiband compressors
	Equalization
4-19	z-Plane, s-Plane; bilinear transform, parametric filters
4-24	Time-varying filters, LFOs
	Distortion Effects
4-26	Sampling rate conversion and antialiasing, anti–imaging filter design
	Impulse Response Measurement
5-1	LTI Systems, statistics review; Impulse Response (IR) measurement
5-3	Golay codes, allpass chirp IR measurement, Sine sweeps
	Room Acoustics
5-8	Image method, Sabine theory, Room Impulse Response (RIR) statistics
5-10	Normalized echo density, T_{60} estimation, RIR synthesis
5-11	Memorial Church visit for RIR measurement [TENTATIVE]
	Artificial Reverberation
5-15	Reverberation
5-17	Low–latency convolutional reverberation
5-22	Feedback Delay Network (FDN) reverberation
	Delay Effects
5-24	Lagrange interpolation, and echo, chorus and flanger architectures
	Filter Design
5-29	Filter phase, minimum and linear phase, Critical-band smoothing, frequency warping
5-31	IIR filter design and Prony's method; warped filter design
6-5	Canonical cut filter design
	Final Exam
6-12	FINAL EXAM, 7:00–10:00 PM, CCRMA Classroom