

21M.380 MUSIC AND TECHNOLOGY SOUND DESIGN

SPRING 2017

INSTRUCTOR: FLORIAN HOLLERWEGER

COURSE SYLLABUS

Please ensure that you always have access to the latest version of this document. Important information, such as assignment due dates, assigned readings, etc. might be updated throughout the semester.

Description

In this course, you will learn how to build sounds and sound effects from scratch, using the open-source graphical programming environment *Pure Data* (<https://puredata.info/>). You will learn how to analyze and synthesize everyday sounds and encapsulate them in dynamic sound objects that can be embedded into computer games, animations, movies, virtual environments, sound installations, and theater productions. Our work will be guided by Andy Farnell's book *Designing Sound* (Farnell 2010).

Intended learning outcomes

A student who has successfully completed this course will be able to:

1. Reflect upon and analyze everyday sonic experiences and articulate them to others
2. Design and implement computer music applications using essential sound synthesis and programming techniques
3. Identify suitable synthesis techniques to develop a design strategy for a specific sound design problem

Instructor

- Prof. Flo(rian Hollerweger)
- Email: [REDACTED]
- Public GPG key: 0XE725 7AF0FE 29DE7A
- Office phone: [REDACTED]

Office hours

- [REDACTED]
- Room [REDACTED]
- Sign up online at [REDACTED] (or just drop by)

If you can, please sign up for a time slot on the above website – even if it’s just minutes before you attend – which will help me to distribute my attention more evenly among students. That being said, you should *always* feel free to drop by during the above times without any prior arrangement and regardless of how full the schedule might already be. If you cannot make the above hours, please contact me with one or two suggestions for alternative meeting times. Try to prepare something that helps me understand what you are working on (e.g., a specific assignment that you are struggling with).

Locations of interest

- [REDACTED]: Class meetings
- [REDACTED]: Instructor’s office
- [REDACTED]: Office hours
- [REDACTED]: Lewis Music Library

Required hardware and software

You will require reliable access to additional audio editing hard- and software to work on your assignments. *Please ensure you have access to the following hard- and software by Thursday, February 16, 2017!* By that date, you should also have completed and tested the installation of all software packages.

Desktop or laptop computer

You will need reliable access to a desktop or laptop computer for working on your assignments. Besides your personal device, it is possible to work on the four iMacs upstairs at the Lewis Music Library, which are equipped with suitable software. Let me know if you’re interested!

Studio headphones (or nearfield monitor loudspeakers)

It is strongly recommended that you invest in a pair of studio headphones. If you have to work in an environment that is not well acoustically isolated, opt for closed-back headphones. If you have a silent space to work in, you can opt for semi-closed or semi-open headphones, which are more comfortable to wear. See table 1 for recommendations. Completely open headphones tend to be expensive, but can yield great results in sufficiently quiet environments.¹ Don’t even think about using in-ear phones (like they come with your smartphone), mixing on which is the acoustic equivalent of blindfolded graphic design.

If you plan to work on your assignments in the Lewis Music Library, you can borrow a pair of the AKG K240 Studio (55 Ω) headphones available from the library’s front desk. If you already happen to have a pair of studio headphones or nearfield monitor loudspeakers, or if you are planning to acquire a pair of the latter, feel free to consult me regarding their suitability for this class.






¹The video at <https://www.youtube.com/watch?v=oqsyaH1Z6ro> explains the differences between open and closed-back headphones in detail.

Manufacturer and model	Price	Back	Description
Beyerdynamic DT770 Pro 80 Ω	\$175	closed	use on laptop headph. out
Beyerdynamic DT770 Pro 250 Ω	\$175	closed	use on separate amp
Audio-Technica ATH-M series	\$50–\$170	closed	M20x, M30x, M40x, M50x
Sennheiser HD 25-1 II	\$170	closed	
Sennheiser HD 25-SP II	\$120	closed	
Sennheiser HD280 Pro	\$90	closed	
Shure SRH440	\$100	closed	
AKG K240 MKII	\$150	semi-open	
AKG K240 Studio	\$85	semi-open	at Lewis Music Library
AKG K99	\$80	semi-open	
AKG K77	\$50	semi-closed	
AKG K44	\$30	closed	Phasing out of production

TABLE 1. Some headphones suitable for use in this course

Pure Data (Pd)

Our main software tool will be *Pure Data* (also known as *Pd*), a free (as in beer *and* speech) graphical multimedia programming environment. Please install the current version (0.47.1) of *Pd vanilla*.

- If you work on Linux, install Pd through your package manager (e. g., on Debian-based systems via `sudo apt-get install puredata`). On Ubuntu you can also install it through the Software Center.
- For Mac OS X, <http://puredata.info/downloads/pure-data> provides a .tar.gz tarball that contains Pd as an .app directory, which you can put straight into your  Macintosh HD  Applications folder.
- Under Windows, download Pd as a .zip archive from <http://puredata.info/downloads/pure-data>. Inside that archive, you will find the actual executable program under  pd  bin  pd.exe.

In later stages of the course, we might also use *Pd extended*, a version that includes a collection of popular external libraries.

Audacity (or other audio editing software)

You will also require a digital audio editor, such as one of the software packages listed in table 2. The open-source *Audacity* editor (Linux, Mac, Windows) is a perfectly reasonable choice, which is also installed on the four upstairs iMacs in the Lewis Music Library. A multichannel digital audio workstation (DAW) such as Reaper, Logic Pro, Pro Tools, or Ardour is beyond our needs, but if you already have access to one of these, you are welcome to use it for your editing.

Sonic Visualiser

Please install the latest version (2.5) of the *Sonic Visualiser* package for your operating system. The program is free (as in beer *and* speech) for Linux, Mac OS X, and Windows.

Software package	Linux	Mac	Win	Price	Description
Audacity	✓	✓	✓	\$0	Open-source
Hairersoft Amadeus Lite		✓		\$25	Single-track
Hairersoft Amadeus Pro		✓		\$60	Multitrack
Sony Sound Forge Audio Studio		✓	✓	\$60	
snd	✓	(✓)		\$0	For the adventurous
Steinberg WaveLab Elements		✓	✓	\$100	1-mth trial w/ dongle
Adobe Audition CC		✓	✓	\$20 / mth	1 year subscription

TABLE 2. Some audio editors suitable for use in this course

Handheld recorders at the Lewis Music Library

Although this course's primary focus is the synthesis rather than the recording of sound,² we will occasionally need to record sounds in order to analyze and model them. For this purpose, you can borrow one of five Zoom H4n portable audio recorders from the Lewis Music Library's front desk over night.

Practice drumstick

You might find it beneficial to get a practice drumstick with a plastic-coated tip, so you can test the sound of various objects without breaking them. This is not mandatory, but it is little money well spent. Find another student in the class to share a pair of Vic Firth 5BCO with (which can be found online for \$10)!

Required textbook

Farnell, Andy (2010). *Designing Sound*. Cambridge, MA and London: MIT Press. 688 pp. ISBN: 978-0-262-01441-0. MIT LIBRARY: 001782567. Hardcopy and electronic resource.

Online versions of this title are available through the MIT Library, either from Books24x7 and from the MIT Press. The former is recommended, since the latter only serves a limited number of concurrent readers. In addition, the MIT COOP offers hard copies for rent and for purchase under this course's number (21M.380). I strongly recommend that you invest in a printed copy of this fantastic book, which you will most likely enjoy long after the end of this course. Chapters 1 and 9–14, which provide a practical introduction to Pd, are also available from the author's website at http://aspress.co.uk/ds/pdf/pd_intro.pdf. Please note that the chapter numbers in that document differ from those in the full textbook, and that the latter will be used in all reading assignment instructions!

Lecture notes

Lecture notes will be made available online solely at the instructor's discretion and pace. You should not rely on their availability and are expected to take your own notes in class. However, I will do my best to keep the following documents available and updated on the Athena course locker (see below).

²If you are interested in sound recording, you might want to enroll for the fall edition of 21M.380 on *Recording Techniques and Audio Production* (t.b.c. for next fall semester). Note that you can repeat 21M.380 in the fall for credit.

21m380_syllabus.pdf is what you are reading right now. You should rely primarily on the latest version of this document to get up-to-date information about upcoming readings, quizzes, and assignment due dates.

21m380_slides_screen.pdf is an adopted version of the slides shown in class that is optimized for screen reading. It contains clickable play buttons (▶) to run audio, video, and other examples,³ together with instructions on how to download some examples that can only be played from your local hard drive.

21m380_slides_print.pdf is a printer-friendly version of the slides scaled to letter format. Use this document if you prefer to study from printed paper. The file does not contain any hyperlinks and is therefore less convenient for screen reading.

21m380_class_201*-**-*.pdf are class-meeting specific handouts that include announcements, reviews, etc. and will sometimes be distributed in printed form in class. Consult these first to catch up on a missed class or otherwise get a quick overview of what we have covered that day.

All these documents will be regularly updated throughout the semester (including content from previous lectures), so it pays off to synchronize your local copies frequently, especially as you prepare for upcoming quizzes.

Online resources

Learning Modules (LMO; formerly Stellar)

The LMO site at

<https://learning-modules.mit.edu/class/index.html?uuid=/course/21M/sp17/21M.380>

will be used for:

- Copyrighted readings and listenings not available online elsewhere
- Assignment instructions
- Submission of assignments
- Grade communication for individual assignments

Athena course locker

The Athena course locker at <https://web.mit.edu/course/21/21m.380/> is accessible only via https (not http), only from a browser that has your MIT browser certificates installed, and only after I have set your access permissions sometime during the first two weeks of classes. It will be used for:

- Lecture notes and syllabus (regularly updated)
- Sound and video examples not available online elsewhere

³Some examples that cannot be published due to copyright restrictions might be indicated through grayed-out play buttons (▶) that do not link anywhere.

Description	Code	Contribution to final grade				Σ				
2 In-class quizzes	QZ1+QZ2	10%	+	10%	=	20%				
10 Reading assignments	RDO1–RD10	10	×	1%	=	10%				
3 Sound design exercises	EX1–EX3	5%	+	5%	+	10%	=	20%		
3 Pd assignments	PD1–PD3	5%	+	5%	+	5%	=	15%		
1 Written assignment	WR							5%		
1 Recording & editing assignment	ED							5%		
4 Final project assignments	FP1–FP4	5%	+	5%	+	5%	+	10%	=	25%

TABLE 3. Assessment items and final grade contributions

OpenCourseWare archive

The spring 2016 edition of this course is archived at <https://ocw.mit.edu/courses/music-and-theater-arts/21m-380-music-and-technology-sound-design-spring-2016/>. It is an excellent resource for slides, lecture handouts, sample quizzes, and other materials relating to this course.

Assignments, quizzes, and grading

Table 3 lists all assessment items that will count towards your final grade.

- Detailed instructions will be posted for each assignment on the LMOD site. For the reading (RD) assignments, these will include specific questions relating to the respective reading, which you will need to respond to in writing.
- Assignments will be submitted via LMOD. *Email submissions will not be accepted under any circumstances*, even if LMOD is down.
- You need to complete *all* assignments and quizzes in order to pass this course, and you are expected to submit all assignments on time. Late submissions will initially incur a penalty of one letter grade per 24 hours. Repeat offenders will eventually receive zero scores until the situation improves.
- Your responses to reading assignments will be checked for completeness, but they will not be graded. All other assignments will receive letter grades (without + and – modifiers) according to the scheme outlined in table 4. This grading scheme also applies to your final grade for the course, except that your internal grade report might include a + or – modifier with an A, B, or C letter grade. Corrected quizzes will be returned with the numeric score in addition to the letter grade.

Letter grade	Numeric score
A	90%–100%
B	80%–89%
C	70%–79%
D	60%–69%
F	0%–59%

TABLE 4. Grading scheme

- Grading will be conducted in accordance with the Academic Procedures and Institute Regulations at <http://catalog.mit.edu/mit/procedures/academic-performance-grades/#gradestext>
- There is no final exam for this course.

Assignment submission format

You can help me make the grading process much more efficient by sticking closely to the submission guidelines specified in the assignment instructions. For example, I might ask you to submit an assignment in the following format, whose correct interpretation is explained below.

```

submission.zip
├── writeup.pdf (2000 words max.)
└── audio_example.[wav|aif] (44.1 kHz, 24 bit)

```

- Submit a .zip archive named `submission.zip` (and *only* `submission.zip`).
 - Please stick meticulously to all suggested file names.
 - Note that file names use exclusively small letters and underscores instead of spaces.
- The .zip file should contain two (and *only* two) files.
 - Please make sure the .zip archive does not contain an extra subdirectory which its contents unpack into. In Mac os x, you can achieve this by selecting the *files* rather than their parent folder before right-clicking to `Compress N Items`.
 - Extra points (well, not really...) for .zip files that do not contain mysterious `__MACOSX` folders or `.DS_Store` files. ☺
- The first file should be named `writeup.pdf` (and *only* `writeup.pdf`) and be max. 2000 words long.
- The other file should be named either `audio_example.wav` or `audio_example.aif`, meaning that you have two audio file formats to choose from, and should be submitted (only) in 44.1 kHz and 24 bit.

Attendance

You are expected to attend *all* class meetings in this course.

- Any absences have to be communicated to and approved by the instructor ahead of time, so please email me as soon as you know about any scheduling conflicts. If you will miss an in-class quiz, you need to simultaneously arrange an in-lieu oral exam with the instructor.
- *Unexcused absences from any in-class presentations will not be tolerated and result in a fail grade for the course.* In all other class meetings, you are entitled to a single unexcused absence without penalty, but any further unexcused absences will negatively affect your final grade.
- In-class quizzes missed due to an unexcused absence cannot be repeated and will receive a zero score.

It is your own responsibility to keep track of your attendance and make up for any missed work. Assignment deadlines are not affected by absences, unless specific arrangements are made with the instructor.

Use of electronic devices in class

If you have a laptop, please bring it along to all class meetings that are marked accordingly in the schedule. Keep an eye on syllabus updates before deciding whether to bring your laptop to class, as last-minute changes might occur. The use of laptops is only permitted where necessary for actual coursework, and I will announce when this is the case. The use of cellphones in class is not permitted.

Workload

This is a 12-unit class, which means you should expect to invest about 9 hours of work per week beyond the 3 class hours.

Academic integrity

Please make sure you are familiar with MIT's policies on academic integrity (<https://integrity.mit.edu>). The guidelines that this handbook provides with regards to plagiarism and proper citation apply to this course.

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Date	Time	Where	Content	Bring laptop	Assignments out	due	Quizzes
Tue, 2/7	11am-12:30pm	4-364	Why and how to design sound?		RDO1		
Thu, 2/9	11am-12:30pm	4-364	The sound design process		EX1, RDO2	RDO1	
Tue, 2/14	11am-12:30pm	4-364	Everyday sound objects		RDO3	EX1, RDO2	
Thu, 2/16	11am-12:30pm	4-364	Introduction to Pure Data (Pd)	✓	RDO4	RDO3	
Tue, 2/21			No class (Monday schedule held on Tuesday)		PD1		
Thu, 2/23	11am-12:30pm	4-364	Physics of sound		RDO5	RDO4	
Tue, 2/28	11am-12:30pm	4-364	Pd programming concepts	✓	PD2	PD1	
Thu, 3/2	11am-12:30pm	4-364	Perception of sound		RDO6	RDO5	
Tue, 3/7	11am-12:30pm	4-364	Soundwalk		WR	PD2	
Thu, 3/9	11am-12:30pm	4-364	Shaping sound with Pd	✓	PD3	WR	
Tue, 3/14	11am-12:30pm	4-364	Digital audio theory		RDO7	RDO6	
Thu, 3/16	11am-12:30pm	4-364	Sound recording & editing techniques	✓	ED	PD3	
Tue, 3/21	11am-12:30pm	4-364	Quiz, review, preview		FP1		QZ1
Thu, 3/23	11am-12:30pm	4-364	Analysis & requirements specification	✓	EX2	ED	
Tue, 3/28			No class (spring vacation)				
Thu, 3/30			No class (spring vacation)				
Tue, 4/4	11am-12:30pm	4-364	Additive synthesis	✓	RDO8	RDO7	
Thu, 4/6	11am-12:30pm	4-364	Research & model making	✓	FP2	EX2	
Tue, 4/11	11am-12:30pm	4-364	Waveshaping & wavetable synthesis	✓	RDO9	RDO8	
Thu, 4/13	11am-12:30pm	4-364	Student presentations	✓		FP1	
Tue, 4/18			No class (Patriots Day)			RDO9	
Thu, 4/20	11am-12:30pm	4-364	Modulation synthesis (AM & FM)	✓	EX3	FP2	
Tue, 4/25	11am-12:30pm	4-364	Method selection & implementation	✓	FP3		
Thu, 4/27	11am-12:30pm	4-364	Steam train drive-by	✓	RD10	EX3	
Tue, 5/2	11am-12:30pm	4-364	Granular synthesis	✓		RD10	
Thu, 5/4	11am-12:30pm	4-364	Student presentations	✓	FP4	FP3	
Tue, 5/9	11am-12:30pm	4-364	Quiz & student presentations	✓			QZ2
Thu, 5/11	11am-12:30pm	4-364	Thunder	✓			
Tue, 5/16	11am-12:30pm	4-364	Music synthesizers	✓			
Thu, 5/18	11am-12:30pm	4-364	Final project presentations	✓		FP4	