City University of Hong Kong
Course Syllabus

offered by Department of Electronic Engineering
with effect from Semester B in 2017/2018

Part I Course Overview

Course Title:	Digital Audio Processing and Applications
Course Code:	EE5809
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	EE3210 Signals and Systems or EE3118 Linear Systems and Signal Analysis
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

The aim of this course is to provide students with a solid foundation in digital audio processing and applications, and to stimulate student's interest in developing the necessary skills for audio engineering profession.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe the characteristics of audio signals and explain the principles of over-sampling analogue to digital conversion and analyse the relationship between quantization noise and signal precision.		✓		
2.	Develop basic skills for coding audio signals digitally in time and frequency domains and evaluate their performance thereof.		✓	✓	✓
3.	Describe the concept and internal functioning of modern audio coding standards and evaluate the suitability of these standards for real-world applications.		✓	✓	
4.	Develop basic skills on the processing and synthesis of music signals.		✓	✓	✓
5.	Describe the design parameters for multi-channel home audio systems and evaluate their performance thereof.		✓	✓	
		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lecture	Key concepts of digital audio signal processing described and illustrated	✓	✓	✓	✓	✓		2 hrs/wk
Tutorials	Key concepts are worked out based on questions and problem solving	✓	✓	✓	✓	✓		1 hr/wk
Case study	To encourage students to apply the knowledge learn from the course to build a real-world application.	✓	✓	✓	✓	✓		
Mini project	To encourage students to apply the knowledge learn from the course to build a real-world application.		✓		✓			

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 30%								
At least 3 assignments (mini projects, case study and presentation etc.)		✓		✓			15%	
Quizzes	✓	✓	✓	✓	✓		5%	
Tests	✓	✓	✓	✓	✓		10%	
Examination: 70% (duration: 2hrs)								
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1, 2, 3	The course provides students with amble opportunities in acquiring knowledge of and evaluation of digital audio technologies, and also the applications of mathematics and engineering problem solving skills which are central to the aims of this program.
4, 5, 6	Students are required to complete an assignment designed to gain practical experience in implementing a workable digital audio coding/decoding system. They need to write a report and present their work accordingly. These practical training and presentation skills are central to the aims of this program.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Introduction
Characteristics of audio and music signals; digitization of audio signal; bandwidth; precision, and signal-to-quantization noise ratio ; over-sampling A/D conversion; sigma-delta A/D, digital processing of audio signals; digital filtering; microphone and loudspeaker characteristics; sound propagation in different environments; human auditory perception; loudness and frequency masking; critical band.

Audio coding
Fundamental of data compression: lossy and lossless compression, Huffman and arithmetic coding, model-based predictive coding, time- and frequency-domain approaches.

Audio coding formats: WAV coding formats for CD; Digital Audio Broadcast (DAB).

Waveform coding: PCM, Delta Modulation, ADPCM, Dolby DTS.

Pyschoacoustic coding: Transform coding, QMF and MDCT, MPEG I, II, IV Audio, Advanced audio coding and MP3. Perceptual audio quality measurement; PEAQ

Lossless coding: Meridean Lossless Packing coding for DVD-Audio, Direct Stream Digital for Sony/Philips Super Audio CD, Blu-Ray audio.

Music synthesis
Musical acoustic; Time- and frequency-domain representation of sound; sinusoidal and harmonic signal; additive synthesis and non-linear synthesis; FM synthesis and Chebyshev techniques; physical modelling; wavetable synthesis; MIDI format; instrument and sequencing.

Sound effects and audio production
Concert hall, studio and home listening room acoustics; absorption, reverberation time and Sabin calculations; room design for good acoustics; Sound effects: reverberation, depth perception, Sound localization/spatialization, 3D sound synthesis; HRTF modelling, Surround sound; Compression and expansion; Digital mixing; filtering; Dolby ProLogic; THX; Dynamic EQ; Common DSP techniques for audio processing.

Multimedia applications
Internet audio broadcast; music jukebox

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Ken C. Pohlmann, Ken C. Pohlman: Principles of Digital Audio, McGraw Hill Text; 3rd edition (September 1995), ASIN: 0070504695.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Marina Bosi, Richard E. Goldberg, Leonardo Chiariglione: Introduction to Digital Audio Coding and Standards, Kluwer Academic Publishers; (December 2002), ISBN: 1402073577.
2.	John Watkinson: Introduction to Digital Audio, Focal Press; 2nd edition (November 13, 2002), ISBN: 0240516435.
3.	F. Alton Everest: Master Handbook of Acoustics, McGraw-Hill/TAB Electronics; 4th edition (September 22, 2000), ISBN: 0071360972.
4.	John Watkinson: Art of Digital Audio, Third Edition, Focal Press; 3rd edition (December 2000), ISBN: 0240515870.
5.	Jerry Whitaker and Blair Benson: Standard Handbook of Audio and Radio Engineering, McGraw-Hill Professional, ISBN: 0070067171.
6.	John Watkinson: MPEG Handbook, Focal Press; 1st edition (September 2001), ISBN: 0240516567.
7.	Eberhard Zwicker, H. Fastl, and H. Frater: Psychoacoustics: Facts and Models, Springer Verlag; 2nd edition (April 1999), ISBN: 3540650636.
8.	David Howard and James Angus: Acoustics and Psychoacoustics (Music Technology), Focal Press; 2nd edition (January 3, 2001), ISBN: 0240516095.