

EE5809: DIGITAL AUDIO PROCESSING AND APPLICATIONS

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Digital Audio Processing and Applications

Subject Code

EE - Electrical Engineering

Course Number

5809

Academic Unit

Electrical Engineering (EE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

P5, P6 - Postgraduate Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

EE3210 Signals and Systems or EE3118 Linear Systems and Signal Analysis

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-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.		x		
2	Demonstrate basic skills for coding audio signals digitally in time and frequency domains and evaluate their performance thereof.		x	x	x
3	Describe the concept and internal functioning of modern audio coding standards and evaluate the suitability of these standards for real-world applications.		x	x	
4	Demonstrate basic skills on the processing and synthesis of music signals.		x	x	x
5	Describe the design parameters for multi-channel home audio systems and evaluate their performance thereof.		x	x	

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 real-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.

Learning and Teaching Activities (LTAs)

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

4	Mini project	To encourage students to apply the knowledge learn from the course to build a real-world application.	2, 4	
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Assessment Tasks / Activities (ATs)

ATs		CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	At least 3 assignments (mini projects case study and presentation etc.)	1, 2, 3, 4, 5	15	
2	Quizzes	1, 2, 3, 4, 5	5	
3	Tests	1, 2, 3, 4, 5	10	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Assessment Task

Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Additional Information for AR**Constructive Alignment with Programme Outcomes**

PILO 1, 2, 3 - The course provides students with ample 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.

PILO 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**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.

Psychoacoustic coding: Transform coding, QMF and MDCT, MPEG I, II, IV Audio, Advanced audio coding and MP3.

Perceptual audio quality measurement; PEAQ

Lossless coding: Meridian 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

Reading List**Compulsory Readings**

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

Additional Readings

Title	
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.