

# EE4209: DIGITAL AUDIO TECHNOLOGY

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## Effective Term

Semester A 2022/23

## Part I Course Overview

### Course Title

Digital Audio Technology

### Subject Code

EE - Electrical Engineering

### Course Number

4209

### Academic Unit

Electrical Engineering (EE)

### College/School

College of Engineering (EG)

### Course Duration

One Semester

### Credit Units

3

### Level

B1, B2, B3, B4 - Bachelor's Degree

### Medium of Instruction

English

### Medium of Assessment

English

### Prerequisites

EE3210 Signals and Systems

### Precursors

Nil

### Equivalent Courses

EE4207 Digital Speech And Audio Processing

### Exclusive Courses

Nil

## Part II Course Details

### Abstract

The aim of this course is to provide students with a solid foundation in digital audio technology.

**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 |                     | x      | x      |        |
| 2     | Develop basic skills for coding audio signals digitally in time and frequency domains                                    |                     | x      | x      |        |
| 3     | Describe the concept and internal functioning of modern audio coding standards   |                     | x      | x      |        |
| 4     | Develop basic skills on the processing and synthesis of music signals  |                     | x      | x      |        |
| 5     | Describe the design parameters for multi-channel home audio systems  |                     | 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.

**Teaching and Learning Activities (TLAs)**

| TLAs | Brief Description   | CILO No.      | Hours/week (if applicable) |
|------|---|---------------|----------------------------|
| 1    | Lectures<br><br>Key concepts are described and illustrated.<br><br>Key concepts are worked out based on problems. | 1, 2, 3, 4, 5 | 3 hrs/week                 |

**Assessment Tasks / Activities (ATs)**

| ATs | CILO No.               | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|-----|------------------------|---------------|--|
| 1   | Tests (min: 2)         | 1, 2, 3, 4, 5 | 30                                     |
| 2   | # Assignments (min: 3) | 1, 2, 3, 4, 5 | 20                                     |

**Continuous Assessment (%)**

50

**Examination (%)**

50

**Examination Duration (Hours)**

2

**Additional Information for ATs**

Remarks:

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

# may include homework, tutorial exercise, project/mini-project, presentation

**Assessment Rubrics (AR)**

**Assessment Task**

Examination

**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 levels

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**Assessment Task**

Coursework

**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 levels

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## 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; 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.Waveform coding: PCM, ADPCM, Dolby DTS, Linear prediction.

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

Lossless coding: Meridean Lossless Packing coding for DVD-Audio, Direct Stream Digital for Sony/Philips Super Audio CD, MPEG-IV ALS Predictive Lossless Coding.

#### 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.

#### Room Acoustics and 3D Sound

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

#### Multimedia applications

Internet and digital 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     | Dai Tracy Yang, Chris Kyriakakis, and C.-C. Jay Kuo: High-Fidelity Multichannel Audio Coding, EURASIP Book Series on Signal Processing and Communications, Hindawi Publishing Corporation, 2004. ISBN 977-5945-13-5 |
| 2     | Udo Zolzer: Digital Audio Signal Processing 2nd Edition, Wiley (August 2008), ISBN 978-0-470-99785-7  |
| 3     | Marina Bosi, Richard E. Goldberg, Leonardo Chiariglione: Introduction to Digital Audio Coding and Standards, Kluwer Academic Publishers; (December 2002), ISBN: 1402073577  |
| 4     | John Watkinson: Introduction to Digital Audio, Focal Press; 2nd edition (November 13, 2002), ISBN: 0240516435   |
| 5     | F. Alton Everest: Master Handbook of Acoustics, McGraw-Hill/TAB Electronics; 4th edition (September 22, 2000), ISBN: 0071360972   |
| 6     | John Watkinson: Art of Digital Audio, Third Edition, Focal Press; 3rd edition (December 2000), ISBN: 0240515870   |
| 7     | Jerry Whitaker and Blair Benson: Standard Handbook of Audio and Radio Engineering, McGraw-Hill Professional, ISBN: 0070067171   |
| 8     | John Watkinson: MPEG Handbook, Focal Press; 1st edition (September 2001), ISBN: 0240516567  |
| 9     | Eberhard Zwicker, H. Fastl, and H. Frater: Psychoacoustics: Facts and Models, Springer Verlag; 2nd edition (April 1999), ISBN: 3540650636   |

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| 10 | David Howard and James Angus: Acoustics and Psychoacoustics (Music Technology), Focal Press; 2nd edition (January 3, 2001), ISBN: 0240516095 |
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