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:	Video and Speech Compression
Course Code:	EE6805
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	EE5410 Signal Processing or EE3202 Digital Signal Processing or EE3210 Signals & Systems or equivalent
Precursors: *(Course Code and Title)*	Nil
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 theoretical and technical knowledge in video and speech compression technologies and to simulate students' interest in learning the internal functioning of modern-day speech and video compression systems.

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 general characteristics and modelling of speech and video signals, and devise modelling techniques for the analysis of these signals.		✓		
2.	Apply lossless entropy coding algorithms and analyse the relationship between compressibility and source probability distribution.		✓	✓	✓
3.	Apply the skills for compression of speech signals and analyse the trade off in speech quality, compression ratio and coding complexity.		✓	✓	✓
4.	Apply the skills for compression of images and videos and analyse the trade off in quality, compression ratio and coding complexity.		✓	✓	✓
5.	Apply ITU/MPEG standard compression algorithms for coding of speech and video signals and evaluate the performance of these standard coding algorithms.		✓		
		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 speech and video signal compression are described and illustrated	✓	✓	✓	✓	✓		2 hrs/wk
Tutorials	Key concepts are worked out based on questions and problem solving	✓	✓	✓	✓			1hr/wk (*Some of the tutorials will be conducted in the laboratory)*
Case study	Demonstrate the working principles and apply key concepts of coding problems	✓	✓	✓	✓			
Assignment (mini project) for implementing a simple speech or image encoder/decoder	Mini-projects to encourage students to discover the inter-relationship between various coding strategies in time/frequency domains and to evaluate the practicality of applying compression under real-world situations		✓	✓	✓			
Coder evaluation assignment including group discussion	Presentation and group discussion of various coding methodologies					✓		

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: <u>40%</u>								
Test	✓	✓	✓	✓			15%	
At least 3 assignments (assignments, mini project etc.)		✓	✓	✓			15%	
Tutorial and quizzes	✓	✓	✓	✓	✓		10%	
Examination: <u>60%</u> (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 new coding technologies, and also the applications of mathematics and engineering problem solving skills which are central to the aims of this program.
4, 5	Students are required to complete an assignment designed to gain practical experience in implementing a workable speech coding/decoding system. The analytical and research skills developed 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

Principles of Source Compression
Digital representation, source entropy, compression ratio, lossy and lossless compression, Huffman, arithmetic coding

Fundamental concepts in speech
Basic speech representation: speech production, source-filter model for speech generation, human auditory perception. Digitization: sampling and quantization, SNQR and speech quality.

Speech Compression
Linear prediction, LPC parameter representation; PARCOR and LSP, vector quantization, code excited linear predictive (CELP) coding. Issues of rate-distortion, coding complexity and latency, error concealment.
Speech compression standards: G.723/G.729, GSM-AMR, MPEG-4.

Fundamental concepts in video
Video signal representation: PAL/NTSC, digitization, colour models; YUV, YIQ, YCbCr.

Video Compression
Basic video compression techniques: chroma subsampling, transform coding; DCT, wavelet, scaled quantization, forward/backward prediction, motion compensation, entropy coding, rate-distortion issues, scalable coding.
Video compression standards: H.261, H.263, H.264, MPEG-1,2,4.

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.	Murat A Tekalp : Digital Video Processing, (Prentice Hall, 1996, ISBN 0-13-190075-7).
2.	John R Deller, JR John G Proakis and John H L Hansen : Discrete-Time Processing of Speech Signals, (MacMillan, 1993, ISBN 0-02-328301-7).

2.2 Additional Readings

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

1.	Jerry D. Gibson, et al, " Digital Compression for Multimedia : Principles and Standards," Morgan Kaufmann Publishers, January 1998.
2.	Ze-Nian Li and Mark S. Drew : Fundamentals of Multimedia, Prentice Hall, 2004.
3.	K. R. Rao and J. J. Hwang : Techniques & Standards For Image, Video & Audio Coding, Prentice Hall, 1996.
4.	B. Furht, S. W. Smoliar, and H. J. Zhang: Video and Image Processing in Multimedia Systems, Kluwer Academic Publishers, 1995.
5.	Jorg Wilberg, " Codesign for Real-Time Video Applications," Kluwer, November 1997.
6.	Ralf Steinmetz and Klara Nahrstedt : Multimedia Fundamentals: Media Coding and Content Processing, Prentice Hall, 2002.
7.	Bishnu S Atal, Vladimir Cuperman, Allen Gersho : Advances in Speech Coding, (Kluwer Academic Publishers, 1991, ISBN 0-7923-9091-1).
8.	W B Kleijn : Speech Coding and Synthesis, (Kluwer Academic Publishers, 1995).
9.	Thomas Barnwell, Kambiz Nayebi and Craig Richardson, "Speech Coding: A Computer Laboratory Textbook", John Wiley & Sons Inc., 1996. ISBN 0-471-51692-9.
10.	ITU Standards, G.723, G.728 speech coders.
11.	ISO MPEG Audiovisual coding standards.