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:	Detection and Estimation - Theory and Applications in Communications
Course Code:	EE6617
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	EE3210 Signals and Systems; or EE3008 Principles of Communications; or Courses in Signal Processing and Communications
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

The course provides students with principles in three areas of Estimation and Detection:

- Estimation and Detection theory
- Statistical signal processing and optimization
- Applications in Communications.

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 frameworks in detection and estimation.		✓	✓	
2.	Recognize the detection and estimation problems and apply mathematical formulations, skills in statistical signal processing, and tools in optimization to the problems.		✓	✓	
3.	Apply the general detection and estimation techniques to practical problems arising in communications and signal processing.		✓	✓	✓
		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				
Lecture	Lecture delivers fundamentals of estimation and detection, skills in statistical signal processing, tools in optimization, and applications of them in communications.	✓	✓	✓				3 hrs/wk for 12 weeks
Mini project	Mini-projects provide Matlab coding and learning experience in applied estimation and detection problems.		✓	✓				
Case study	Case studies are designed to expose students to the latest R & D front of detection and estimation technologies and its applications to other emerging field		✓	✓				3 hrs/wk for 1 week

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					
Continuous Assessment: 50%								
Assignment I, II, and III	✓	✓	✓				20%	
Mid-term test	✓	✓					20%	
Mini projects and case studies		✓	✓				10%	
Examination: 50% (duration: 2hrs , if applicable)								
							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	Substantial	Satisfactory	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	Substantial	Satisfactory	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1-4	The course exposes students to various estimation and detection problems arising in the field of communications and/or information engineering. The learning experience will be enriched by mini-projects and case studies.
2,3,4	Students are required to complete assignments designed to corroborate fundamental understanding of the theory. Mini-projects are designed for students to gain practical experience and coding skills in real applications of the estimation and detection technologies.

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

1. Keyword Syllabus

Fundamentals

Vector spaces, linear subspaces, random variables, probability density function, cumulative distribution function, statistical signal representation.

Detection and estimation theory

Hypothesis testing, Neyman-Pearson detector, minimum probability error detector, matched filters, Bayes detector, Minimum variance estimation, Cramer-Rao bound, maximum likelihood estimation, least squares, Bayesian estimator

Applications to communications and signal processing

The case studies and laboratories are designed to supplement the lecture aspects of the course, and will provide practical learning experience on how various detection and estimation techniques are applied to design communication and signal processing systems.

Typical topics for the laboratory sessions in the form of mini-projects and case studies are

- Inference methods for information decoding (single stream vs. multiple streams)
- Maximum likelihood decoder design using Viterbi algorithm
- Iterative equalizer and decoder design
- Channel estimator design for WiFi OFDM (orthogonal frequency division multiplexing) systems
- Spatial filter design for 3GPP LTE transceivers
- Radar array beamforming algorithms

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.	Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory by Steven M. Kay, Prentice Hall, ISBN: 0133457117, 1993.

2.2 Additional Readings

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

1.	Fundamentals of Statistical Signal Processing, Volume II: Detection Theory by Steven M. Kay, Prentice Hall, ISBN: 013504135X, 1998.
2.	Statistical Signal Processing: Detection, Estimation, and Time Series Analysis by Louis L. Scharf, Addison Wesley, ISBN: 0201190389, 1991.
3.	Matlab tutorial: http://www.youtube.com/playlist?list=PL1D547802F5F38A94