City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A in 2024/2025

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.	Engage in exploring and discussing the general frameworks in detection and estimation through interactive learning activities, enhancing conceptual understanding.		✓	✓	
2.	Collaboratively identify detection and estimation problems, applying mathematical formulations, statistical signal processing skills, and optimization tools in group problem-solving scenarios.		✓	✓	
3.	Apply detection and estimation techniques to practical problems in communications and signal processing through hands-on applications, fostering critical thinking and practical skills.		✓	✓	✓
		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 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.

3. Learning and Teaching Activities (LTAs)

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

LTA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3				
Lecture	Interactive lectures where fundamentals of estimation and detection, skills in statistical signal processing, tools in optimization, and their applications in communications are explored through active discussions, real-time problem-solving, and multimedia resources, encouraging student engagement and participation.	✓	✓	✓				3 hrs/wk for 12 weeks
Mini project	Mini-projects where students apply Matlab coding to solve real-world estimation and detection problems, enhancing practical skills and active learning experiences.		✓	✓				
Case study	Case studies designed for students to investigate the latest R&D advancements in detection and estimation technologies and their applications to emerging fields, promoting critical analysis and connection to real-world developments.		✓	✓				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 %								
Tests (min.: 2)	✓	✓	✓				30 %	
#Assignments (min.: 3)	✓	✓	✓				20 %	
Examination: 50 % (duration: 2 hrs , if applicable)								
Examination	✓	✓	✓				50 %	
							100%	

Remark:

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

5. Assessment Rubrics

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

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

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

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	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 criterion, minimum probability error detector, non-coherent detection, parameter estimation, minimum variance estimation, Cramer-Rao bound, maximum likelihood estimation, least squares, Bayesian estimator

Applications to communications and signal processing

The mini-projects 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.

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.	Detection and Estimation for Communication and Radar Systems by Kung Yao, Flavio Lorenzelli, Chiao-En Chen, Cambridge University Press, ISBC: 978-0-521-76639-5, 2013.

2.2 Additional Readings

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

1.	Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory by Steven M. Kay, Prentice Hall, ISBN: 0133457117, 1993.
2.	Fundamentals of Statistical Signal Processing, Volume II: Detection Theory by Steven M. Kay, Prentice Hall, ISBN: 013504135X, 1998
3.	Statistical Signal Processing: Detection, Estimation, and Time Series Analysis by Louis L. Scharf, Addison Wesley, ISBN: 0201190389, 1991.
4.	Matlab tutorial: http://www.youtube.com/playlist?list=PL1D547802F5F38A94