# City University of Hong Kong

## Information on a Course offered by Department of _Electronic Engineering with effect from Summer 2015

**Part I**

| | |
|---|---|
| Course Title: | Detection and Estimation - Theory and Applications in Communications |
| Course Code: | EE6617 |
| Course Duration: | One Semester (13 weeks) |
| No. of credits: | 3 |
| Level: | 6 |
| Medium of Instruction: | English |
| Prerequisites *(Course Code and Title)*: | Nil |
| Precursors *(Course Code and Title)*: | EE3210 Signals and Systems; or<br>EE3008 Principles of Communications; or<br>Courses in Signal Processing and Communications |
| Equivalent Course *(Course Code and Title)* : | Nil |
| Exclusive Courses: *(Course Code and Title)*: | Nil |

**Part II**

**1. Course Aims:**

The course aims at providing students with fundamental in the field of Detection and Estimation with the emphasis on the real-life applications to Wireless Communications and Digital Signal Processing.

**2. Course Intended Learning Outcomes (CILOs)**

*Upon successful completion of this course, students should be able to:*

| No. | CILOs |
|---|---|
| 1. | Describe the general frameworks in detection and estimation. |
| 2. | Recognise the detection and estimation problems and apply mathematical formulations and basic tools to the problems. |
| 3. | Apply the general detection and estimation techniques to practical wireless communications and signal processing. |

## 3. Teaching and Learning Activities (TLAs)

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|---|---|
| CILO 1, 2 | Lecture |
| CILO 2, 3 | Lecture, mini project, case study |

*Mini-projects aim to provide students with learning experience in applied problems. Materials for case studies are designed to expose students to the latest applied R & D front of detection and estimation technologies and its applications to other engineering fields.*

Timetabling Information

| **Pattern** | **Hours** |
|---|---|
| Lecture: | 39* |
| Tutorials: | |
| Laboratory: | |
| Other activities: | 0 |

**Some of the lectures (about 5-6 weeks) will be conducted in the laboratory as mini-projects and case studies.*

## 4. Assessment Tasks/Activities

| | ***Type of assessment tasks*** | ***Weighting (if applicable)*** |
|---|---|---|
| Continuous Assessment | *Assignment, test mini project, and case study* | *50%* |
| Examination | *Written exam* | *50% 2 hours* |

Remarks: To pass the course, students are required to achieve at least 35% in course work and 35% in the examination.

## 5. Grading of Student Achievement:

| **Letter Grade** | **Grade Point** | **Grade Definitions** |
|---|---|---|
| A+<br>A<br>A- | 4.3<br>4.0<br>3.7 | Excellent: |
| B+<br>B<br>B- | 3.3<br>3.0<br>2.7 | Good: |
| C+<br>C<br>C- | 2.3<br>2.0<br>1.7 | Adequate: |
| D | 1.0 | Marginal: |
| F | 0.0 | Failure: |

## 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 enhanced by mini-projects and case studies. |
| 2,3,4 | Students are required to complete assignments designed to corroborate basic understanding of the theory. Mini-projects are designed for students to gain practical experience in real applications of the estimation and detection technologies. |

**Part III**

**Keyword Syllabus:**

Fundamentals
Vector spaces, linear subspaces, probability density function, random variables, 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 complement 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

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

*Fundamentals of Statistical Signal Processing, Volume II: Detection Theory* by Steven M. Kay, Prentice Hall, ISBN: 013504135X, 1998

*Statistical Signal Processing: Detection, Estimation, and Time Series Analysis* by Louis L. Scharf, Addison Wesley, ISBN: 0201190389, 1991

**Online Resources (if any)**
Matlab tutorial: http://www.youtube.com/playlist?list=PL1D547802F5F38A94
Estimation theory tutorial: http://www.youtube.com/watch?v=WKPDZLus8Fo
Detection theory tutorial: http://www.youtube.com/watch?v=ODDqE7BwCfE