**City University of Hong Kong**
**Course Syllabus**

**offered by Department of Systems Engineering**
**with effect from Semester A 2024 / 25**

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**Part I Course Overview**

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|---|---|
| **Course Title:** | Estimation and Control of Random Dynamic Systems |
| **Course Code**: | SYE6101 |
| **Course Duration:** | One Semester |
| **Credit Units**: | 3 |
| **Level**: | P6 |
| **Medium of Instruction:** | English |
| **Medium of Assessment:** | English |
| **Prerequisites**: *(Course Code and Title)* | Nil |
| **Precursors**: *(Course Code and Title)* | Nil |
| **Equivalent Courses**: *(Course Code and Title)* | SEEM6101 Estimation and Control of Random Dynamic Systems (offered until 2021/22) / ADSE6101 Estimation and Control of Random Dynamic Systems (offered until 2023/24) |
| **Exclusive Courses**: *(Course Code and Title)* | Nil |

The course is self contained, but requires motivated students, interested in learning mathematical techniques for systems control.

**Part II Course Details**

## 1. Abstract

This course aims to teach the students the basic concepts and methods related to random dynamic systems. They apply to dynamic systems originated from Engineering as well as from Economics. General principles as well as more specific techniques will be presented.

The state representation approach will be used. The way decisions are taken will be explained, in relation with the available information. The concept of feedback control will be discussed.

The course will develop estimation techniques, for identification as well as for forecasting. In particular the Kalman filter will be fully presented.

Particular attention will be devoted to the Dynamic Programming approach to define optimal control. We will also present the idea of reinforcement learning as a technique for solving complex dynamic optimization problems.

## 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. | Model dynamic systems with uncertainties | 20% | ✓ | | |
| 2. | Forecast the behaviour of the system in the future | 10% | ✓ | | |
| 3. | Decide control variables according to objectives | 15% | | ✓ | |
| 4. | Define prototypes with increasing complexity | 10% | ✓ | | |
| 5. | Apply mathematical techniques for dynamic systems analysis | 45% | | ✓ | |
| | | 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 | 4 | 5 | |
| Lecture | Presentation and discussion | ✓ | ✓ | ✓ | ✓ | ✓ | 26 hours/sem |
| Tutorial | Help to assignments | ✓ | ✓ | ✓ | ✓ | ✓ | 13 hours/sem |

## 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: 50 % | | | | | | | |
| Assignment | ✓ | ✓ | ✓ | ✓ | ✓ | 20% | |
| Midterm | ✓ | ✓ | ✓ | ✓ | ✓ | 30% | |
| Examination: 50 % (duration: 2 hours , if applicable) | | | | | | | |
| | | | | | | 100% | |

For a student to pass the course, at least 30% of the maximum mark for the examination should be obtained.

**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. Assignment | Correctness and clarity of concepts and results | High | Significant | Moderate | Basic | Not even reaching marginal levels |
| 2. Midterm | Correctness and clarity of concepts and results | High | Significant | Moderate | Basic | Not even reaching marginal levels |
| 3. Final exam | Correctness and clarity of concepts and results | High | Significant | Moderate | Basic | Not even reaching marginal levels |

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. Assignment | Correctness and clarity of concepts and results | High | Significant | Moderate/Basic | Not even reaching marginal levels |
| 2. Midterm | Correctness and clarity of concepts and results | High | Significant | Moderate/Basic | Not even reaching marginal levels |
| 3. Final exam | Correctness and clarity of concepts and results | High | Significant | Moderate/Basic | Not even reaching marginal levels |

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

## 1. Keyword Syllabus

*(An indication of the key topics of the course.)*

- Dynamic Systems
- Uncertainty
- Control Theory
- Dynamic Programming
- Estimation
- Filtering
- State of System
- Decision Variables
- Optimization

## 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. | Lecture Notes |

### 2.2 Additional Readings

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

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|---|---|
| 1. | Supplementary Reading: A. Bensoussan, *Dynamic Programming and Inventory Control* (IOS Press 2011) |
| 2. | Supplementary Reading: F. Lewis, D. Vrabie, V. Syrmos *Optimal Control* (John Wiley and Sons 2012) |
| 3. | Supplementary Reading: D. Bertsekas, *Dynamic Programming and Optimal Control, Vol. I* (Athena Scientific 2017) |