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

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

**Part I    Course Overview**

**Course Title:**    Advanced Statistical Theory

**Course Code**:    BIOS8004

**Course Duration:**    One Semester

**Credit Units**:    3

**Level**:    R8

**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)*    Nil

**Exclusive Courses**:
*(Course Code and Title)*    Nil

**Part II    Course Details**

1.   **Abstract**

The course aims to provide students with some theoretical background and mathematical tools in theoretical statistics to access the literature on biostatistics methodologies and applications. Topics covered include: efficiency of estimators; efficiency of tests; empirical processes; functional delta method; quantile and order statistics; L-statistics; bootstrap; high-dimensional models, gradient descent optimization. Selected topics such as empirical likelihood, U-statistics, counting process methods in survival analysis, functional data analysis, nonparametric estimation, shape-constrained inference, and semiparametric inference and efficiency will also be included.

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

| No. | CILOs | Weighting | Discovery-enriched curriculum related learning outcomes | | |
|---|---|---|---|---|---|
| | | | *A1* | *A2* | *A3* |
| 1. | Understand the fundamental concepts in statistical estimation and inference | 20% | ✓ | ✓ | |
| 2. | Be familiar with empirical process and resampling techniques | 20% | ✓ | ✓ | |
| 3. | Acquire the techniques of evaluating the efficiency for various estimation and testing procedures | 20% | ✓ | ✓ | ✓ |
| 4. | Ability to apply the skills and techniques to solve real problems in health-related studies | 20% | ✓ | ✓ | ✓ |
| 5. | Effectively summarize and present research results from the literature | 20% | ✓ | ✓ | ✓ |
| | | 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. Learning and Teaching (LTAs)

| LTA | Brief Description | CILO No. | | | | | Hours/week (if applicable) |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Lectures | Learning through teaching is primarily based on lectures | ✓ | ✓ | ✓ | ✓ | ✓ | 3 hours/week |
| Assignments | Learning though take-home assignments helps students understand the key concepts and acquire the techniques | ✓ | ✓ | ✓ | ✓ | ✓ | After class |

## 4. Assessment Tasks/Activities (ATs)

| Assessment Tasks/Activities | CILO No. | | | | | Weighting | Remarks |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | |
| Continuous Assessment: 50% | | | | | | | |
| Assignments | ✓ | ✓ | ✓ | | | 30% | Help to train students with basic knowledge, concepts, and analysis techniques |
| Midterm/quizzes | ✓ | ✓ | ✓ | ✓ | ✓ | 20% | Test students' capabilities in applying the knowledge to solve relevant problems |
| Examination: 50% (duration: 3 hours) | ✓ | ✓ | ✓ | ✓ | ✓ | 50% | Examination questions are designed to see how well students have achieved the learning objectives and acquired the requisite techniques for problem-solving |
| | | | | | | 100% | |

## 5. Assessment 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. Assignments | Problem solving skills | Consistently exhibits adept comprehension of statistical estimation and inference and their practical implementation | Sufficiently applies comprehension of statistical estimation and inference to moderately complex problems | Demonstrates a moderate understanding of comprehension of statistical estimation and inference and their practical application to intermediate-level problems. | Displays basic grasp of statistical estimation and inference and their application to straightforward problems. | Shows limited comprehension of statistical estimation and inference and lacks the ability to apply them to problem-solving |
| 2. Midterm/quizzes | Problem solving based on comprehensive understanding | Exhibits a thorough grasp of statistical estimation and inference and effectively applies them to intricate problems | Displays sufficient understanding of statistical estimation and inference and effectively applies them to moderately complex problems | Exhibits a moderate level of statistical estimation and inference and effectively applies them to intermediate-level problems. | Shows basic comprehension of statistical estimation and inference and applies them to straightforward problems | Displays limited grasp of statistical estimation and inference and lacks the ability to apply them to problem-solving |
| 3. Examination | Problem solving based on comprehensive understanding | Consistently exhibits a deep understanding of statistical estimation and inference and effectively applies them to complex problems | Effectively applies statistical estimation and inference concepts to moderately complex problems, demonstrating sufficient understanding | Applies statistical estimation and inference concepts to intermediate-level problems with a moderate level of understanding. | Applies statistical estimation and inference to simple problems with a basic understanding | Lacks understanding of statistical estimation and inference and cannot apply them to problem-solving |

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. Assignments | Problem solving skills | High | Significant | Moderate | Not even reaching marginal levels |
| 2. Midterm/quizzes | Problem solving based on comprehensive understanding | High | Significant | Moderate | Not even reaching marginal levels |
| 3. Examination | Problem solving based on comprehensive understanding | High | Significant | Moderate | Not even reaching marginal levels |

**Part III   Other Information**

1.   **Keyword Syllabus**

Efficiency of estimators; efficiency of tests; empirical processes; functional delta method; quantile and order statistics; L-statistics; bootstrap; high-dimensional models, gradient descent optimization.

2.   **Reading List**
2.1  **Compulsory Readings**

Nil.

2.2   **Additional Readings**

| 1. | Asymptotic Statistics (Cambridge University Press Series in Statistical and Probabilistic Mathematics), by A. W. van der Vaart. |
|---|---|