

# GE2213: UNDERSTANDING UNCERTAINTY AND STATISTICAL REASONING

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## Effective Term

Semester B 2024/25

## Part I Course Overview

### Course Title

Understanding Uncertainty and Statistical Reasoning

### Subject Code

GE - Gateway Education

### Course Number

2213

### Academic Unit

Decision Analytics and Operations (DAOS)

### College/School

College of Business (CB)

### Course Duration

One Semester

### Credit Units

3

### Level

B1, B2, B3, B4 - Bachelor's Degree

### GE Area (Primary)

Area 2 - Study of Societies, Social and Business Organisations

### Medium of Instruction

English

### Medium of Assessment

English

### Prerequisites

Nil

### Precursors

Nil

### Equivalent Courses

Nil

### Exclusive Courses

CB2200 Business Statistics

GE2262 Business Statistics

## Part II Course Details

### Abstract

The use of statistics in the media and academe is now widespread. This course aims to equip students with a good understanding of the concept of uncertainty to help them to become informed decision-makers and critical consumers of statistical information in their future professional lives.

Uncertainty, variability and incomplete information are inherent in all disciplines. As there are minimal mathematical prerequisites for this course, students majoring in diverse disciplines will find it useful. The course content is based on real-world case studies that involve issues of current significance.

By the end of the course, students will be able to evaluate and make critical judgments about reports that involve uncertainty and statistical concepts, and will have developed the capacity to assume individual and social responsibilities.

### Course Intended Learning Outcomes (CILOs)

| CILOs |                                                                                                                                                                                                 | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------|--------|--------|
| 1     | Explain the concept of uncertainty and the uses and limitations of statistics.                                                                                                                  | 10                  | x      | x      | x      |
| 2     | Describe the key changes in the historical development of the concept of uncertainty and statistical reasoning principles.                                                                      | 10                  | x      | x      |        |
| 3     | Critique various methods of statistical reporting used in the media across different fields such as business, public administration, engineering, science, law, marketing, and the environment. | 20                  | x      | x      | x      |
| 4     | Apply concepts of uncertainty and statistical thinking to analyze and construct data-based arguments presented in various media formats (e.g., newspapers, magazines, videos).                  | 20                  | x      | x      | x      |
| 5     | Interpret and critically evaluate statistically-based reports from different disciplines                                                                                                        | 20                  | x      | x      | x      |
| 6     | Provide recommendations/innovations based on statistical data                                                                                                                                   | 20                  | x      | x      | x      |

#### 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.

### Learning and Teaching Activities (LTAs)

| LTAs | Brief Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CILO No.         | Hours/week (if applicable) |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------|
| 1    | <p>Lectures</p> <p>Students will learn the concepts and relevant knowledge of how to identify uncertainty and use basic statistical theories which are explained. Students learn how to identify uncertainty and become familiar with the use of basic statistical theories in lectures.</p> <p>Videos:<br/>Videos are shown to highlight real-life examples of uncertainty. Follow-up group discussions provide students with the opportunity to critique and identify relevant statistical solutions to the examples.</p> | 1, 2, 3, 4, 5, 6 |                            |

|   |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |  |
|---|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--|
| 2 | Tutorials | <p>Students will work in groups to research and discuss the latest issues related to uncertainty and statistics in group discussion. Students conduct a critical evaluation and make informed contributions to tutorial discussions on the basis of background reading.</p> <p>Case Studies:<br/>Prior to class students work in groups to read and critique academic research papers or business case studies that illustrate uncertainty and demonstrate how statistics are used in the real world. In class students brainstorm possible answers to questions arising from various case study problems before giving a brief presentation of their findings, their critiques and recommendations.</p> <p>Group Project:<br/>Students work in groups to study the statistics published in the Hong Kong Annual Digest of Statistics. They are required to identify the relevant data relating to critical social, economic or environmental problems in Hong Kong. Students need to understand the terms used in the Hong Kong Annual Digest of Statistics. They also need to decide how to present the important/significant information graphically so as to be able to clearly describe the trends or observable characteristics. The students are encouraged to identify and interpret the relationships between the selected</p> | 3, 4, 5, 6 |  |
|---|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--|

|   |                              |                                                                                                                                                                                                                                                                                                                                        |         |  |
|---|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--|
| 3 | Outside Classroom Activities | Students will be able to visit the Hong Kong Government Census and Statistics Department; a marketing research company, the analytic department of firms in the banking and/or other industries, etc.<br><br>Consultations: Additional help is provided to individuals and groups outside official class time within advertised hours. | 3, 5, 6 |  |
|---|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--|

**Assessment Tasks / Activities (ATs)**

| ATs |                            | CILO No.      | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|-----|----------------------------|---------------|---------------|----------------------------------------|
| 1   | Quiz                       | 1, 2, 3, 4, 5 | 40            |                                        |
| 2   | Group Project / Case Study | 3, 4, 5, 6    | 40            |                                        |
| 3   | Assignment                 | 1, 2, 3, 4, 5 | 20            |                                        |

**Continuous Assessment (%)**

100

**Examination (%)**

0

**Assessment Rubrics (AR)****Assessment Task**

Quiz

**Criterion**

Level of understanding of statistical concepts, sampling methods and statistical modelling featured in lectures and indicated readings.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

### **Assessment Task**

Group Project

### **Criterion**

Level of effective presentation and communication and with flair in oral and electronic format; Excellence coverage of materials and contents and demonstrates time management skills; quality answers to questions raised during presentation.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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### **Assessment Task**

Assignment

### **Criterion**

Level of evidence of critical capacity and analytic ability; understanding of concepts

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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## **Part III Other Information**

### **Keyword Syllabus**

Uncertainty and variability; logic of uncertainty; the uses of uncertainty; measuring uncertainty; what are statistics; statistical concepts and reasoning; data-based arguments; "data sense" development, modern use of statistics, limitations of statistics; current affairs; media, interpret and critique statistically-based reports.

The following is an indicative of likely modules and topics students will undertake to learn in this course. Final details and specific reading materials for specific topics will be provided to students in their first week of attendance in this course.

#### Module 1: Introduction

- What is uncertainty?
- The role of uncertainty in people's lives
- Approaches to uncertainty – probabilistic, fuzzy logic, ...
- Historical development of the concept of uncertainty and statistical reasoning principles
- Statistics concepts relating to post-renaissance modernization
- Statistics as data and as methodology
- Data vs information: a distinction between data on the individual entity and statistics

#### Module 2: Understanding Uncertainty

- Uncertainty about specific future, present, or past events
- Uncertainty about the parameters within models
- Uncertainty about the structure of models
- Uncertainty about the relevance to particular problems of the entire modeling process

#### Module 3: Case studies and applications

##### 3.1 Applications in business management

- Investment strategies: trends, moving average and noise
- Premium estimation: pricing of insurance products
- Utility functions: how to make decisions
- Quality management: reliability, six-sigma

##### 3.2 Applications in science and technology

- Ignorance, chaos and quantum mechanics: causes of randomness
- Evolution, genes, and viruses: randomness in biology
- Medical decision making: specificity and sensitivity
- Spam, probability, and spam: blocking unwanted e-mail

##### 3.3 Applications in everyday life

- Commonly encountered social and economic statistics
- Fifty-one percent to forty-nine percent: the true meaning of polls
- Laying down the law: why casinos always win
- Final exam: do you have probability perspective?

#### Module 4: Statistical concepts and reasoning

- Use of statistics to support claims or positions
- Common errors in the use and presentation of numerical measures
- Making judgments from surveys and experiments

### Reading List

#### Compulsory Readings

| Title |                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------|
| 1     | Lindley D V, Understanding Uncertainty, Latest edition, Wiley                                          |
| 2     | Best J, Damned Lies and Statistics, Latest edition, University of California Press                     |
| 3     | Moore D S and Notz W I, Statistics: Concepts and Controversies, Latest edition, New York: W.H. Freeman |
| 4     | Rosenthal J S, Struck by Lightning, Latest edition, Joseph Henry Press                                 |
| 5     | Utts J M, Seeing Through Statistics, Latest edition, Brooks/Cole, Thomson                              |
| 6     | Tanur J, Statistics: A Guide To The Unknown, Latest edition, Wiley                                     |

|   |                                                                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7 | Stigler (1986): The History of Statistics: The Measurement of Uncertainty before 1900, The Belknap Press of the Harvard University Press. Cambridge, Massachusetts |
| 8 | Stigler (1999): Statistics on the Table: The History of Statistical Concepts and Methods, Harvard University Press. Cambridge, Massachusetts                       |
| 9 | David (1962): Games, Gods and Gambling, Republished by Dover in 1998.                                                                                              |

### Additional Readings

| Title |                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------|
| 1     | Chance, American Statistical Association                                                                          |
| 2     | Stats: The Magazine For Students of Statistics, American Statistical Association                                  |
| 3     | Annual Digest of Statistics, Latest issue, Census and Statistics Department, HKSAR Government                     |
| 4     | Grier (2006): When Computers Were Human, Princeton University Press                                               |
| 5     | Understanding Uncertainty <a href="http://understandinguncertainty.org/">http://understandinguncertainty.org/</a> |
| 6     | American Statistical Association <a href="http://www.amstat.org/">http://www.amstat.org/</a>                      |
| 7     | Royal Statistical Society <a href="http://www.rss.org.uk/">http://www.rss.org.uk/</a>                             |
| 8     | Statistical Society of Canada <a href="http://www.ssc.ca/">http://www.ssc.ca/</a>                                 |
| 9     | Statistical Society of Australia <a href="http://www.statsoc.org.au/">http://www.statsoc.org.au/</a>              |
| 10    | Hong Kong Statistical Society <a href="http://www.hkss.org.hk/">http://www.hkss.org.hk/</a>                       |
| 11    | Census and Statistics Department, HKSAR Government <a href="http://censtatd.gov.hk">http://censtatd.gov.hk</a>    |

## Annex (for GE courses only)

**A. Please specify the Gateway Education Programme Intended Learning Outcomes (PILOs) that the course is aligned to and relate them to the CILOs stated in Part II, Section 2 of this form:**

Please indicate which CILO(s) is/are related to this PILO, if any (can be more than one CILOs in each PILO)

**PILO 1: Demonstrate the capacity for self-directed learning**

6

**PILO 2: Explain the basic methodologies and techniques of inquiry of the arts and humanities, social sciences, business, and science and technology**

1, 2, 3

**PILO 3: Demonstrate critical thinking skills**

4

**PILO 4: Interpret information and numerical data**

4

**PILO 6: Demonstrate effective oral communication skills**

5

**PILO 7: Demonstrate an ability to work effectively in a team**

5

**PILO 10: Demonstrate the attitude and/or ability to accomplish discovery and/or innovation**

6

**B. Please select an assessment task for collecting evidence of student achievement for quality assurance purposes. Please retain at least one sample of student achievement across a period of three years.**

**Selected Assessment Task**

Quiz, Group Project Presentation, Individual Assignment