City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester B 2020/21

Part I Course Overview

Course Title:	Experimental Design and Regression
Course Code:	SDSC6008
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)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

The aim of this course is to provide students with an understanding of design of experiments and regression methods, to develop their abilities to design and analyse physical and computer experiments, and to impress on them the value of such systematic approaches. Experimental designs for physical and computer experiments such as orthogonal arrays and space-filling designs will be introduced, and students will learn how and when to use these designs. The course will develop students' grasp of fundamental regression techniques for analysing data from physical experiments, which include linear models, least squares method, analysis of variance, and model selection approaches, and their ability to apply these techniques. In addition, students will learn to apply Gaussian process models for approximating highly nonlinear functional relationships from computer experiments.

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.	**Define** the types of experimental design, and statistical analysis methods.	10%	✓		
2.	**Design** experiments to efficiently gather data for specific empirical investigation settings involving a physical system.	20%	✓		
3.	**Apply** model building and selection techniques to discover relationships between inputs and outputs of a physical system.	30%	✓	✓	
4.	**Design** experiments to efficiently gather data for specific empirical investigation settings involving a computational system.	20%	✓	✓	
5.	**Apply** Gaussian process modelling to discover highly nonlinear relationships between inputs and outputs of a computational system.	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. Teaching and Learning Activities (TLAs)

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

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Learning through teaching is primarily based on lectures. Mini-lectures and small-group exercises will be used to facilitate conceptual understanding and industrial applications of various statistical tools and techniques.	✓	✓	✓	✓	✓	26 hours/sem
Tutorial Exercises	The team-based exercises provide students with the opportunities to familiarize and apply the statistical tools learnt during the lectures through practical problem solving.		✓		✓	✓	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: 75 %							
Test		✓	✓	✓		25%	
Assignments		✓	✓	✓	✓	25%	
Projects		✓	✓	✓	✓	25%	
Examination: 25 % (duration: 2 hours , if applicable)							
Examination	✓	✓	✓	✓	✓	25%	
						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.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	2-hour test to assess students' conceptual understanding of experimental design methods and ability to correctly analyze experiment data.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Students' ability to analyze data, apply relevant statistical tools, and draw informed conclusions about an experiment are assessed. Explanation and presentation of results are also assessed.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Project	Students' ability to apply an experimental design approach to collect and analyse data in a computer experiment to answer properly formulated scientific questions is assessed through written report and oral presentation. Such approach should be observable throughout the stream of problem identification, data collection, data analysis, inferences, and discussion of results.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Examination questions are designed to assess student's level of achievement of the intended learning outcomes, with emphasis placed on conceptual understanding and correct application, mostly through mathematical exposition and numerical calculation, of the various statistical design and analysis of experiments methodologies.	High	Significant	Moderate	Basic	Not even reaching marginal levels

The midterm, tutorial exercises and laboratory report will be numerically-marked, while examination will be numerically-marked and grades-awarded accordingly.

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).

- Physical experiments
- Principles of experimental design, least squares regression, analysis of variance (ANOVA)
- Factorial, fractional factorial designs, orthogonal arrays
- Bayesian model selection, information criteria
- Computer experiments
- Space-filling designs
- Gaussian process model

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.	Wu, C.F.J. and Hamada, M.S. (2009). Experiments: Planning, Analysis, and Optimization. 2nd Edition. Wiley: New York.
2.	Santner, T.J., Williams, B.J., and Notz, W.I. (2003). The design and analysis of computer experiments. Springer-Verlag, New York.

2.2 Additional Readings

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

1.	Mason, R.L., Gunst, R.F., and Hess, J.L. (2003). *Statistical Design and Analysis of Experiments with Applications to Engineering and Science* (2nd Edition). New York: John Wiley & Sons.