City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2024/25

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 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	
Lectures	Students will engage in formal lectures to gain knowledge about the theory and methods of experimental design and regression.	✓	✓	✓	✓	✓	26 hours/semester
Demonstration of MATLAB/R codes	Students will develop an understanding of the MATLAB/R codes included in the course materials by following an in-class demonstration and explanation of the codes.		✓		✓	✓	13 hours/semester

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%	

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. Test	Midterm test to assess students' level of achievement of CILOs 2-4 on material covered before the midterm test.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Assignments are designed to assess student's level of achievement of CILOs 2-5.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Project	The project is designed to assess student's level of achievement of CILOs 2-5. Students' ability to apply an experimental design approach to collect and analyse data in a physical/computer experiment to answer properly formulated scientific questions is assessed through written report and oral presentation.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Examination questions are designed to assess student's level of achievement of CILOs 1-5, with emphasis placed on 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

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. Test	Midterm test to assess students' level of achievement of CILOs 2-4 on material covered before the midterm test.	High	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Assignments are designed to assess student's level of achievement of CILOs 2-5.	High	Moderate	Basic	Not even reaching marginal levels
3. Project	The project is designed to assess student's level of achievement of CILOs 2-5. Students' ability to apply an experimental design approach to collect and analyse data in a physical/computer experiment to answer properly formulated scientific questions is assessed through written report and oral presentation.	High	Moderate	Basic	Not even reaching marginal levels
4. Examination	Examination questions are designed to assess student's level of achievement of CILOs 1-5, with emphasis placed on correct application, mostly through mathematical exposition and numerical calculation, of the various statistical design and analysis of experiments methodologies.	High	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.