SDSC6008: DESIGN OF EXPERIMENTS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Design of Experiments

Subject Code
SDSC - Data Science
Course Number
6008

Academic Unit
Data Science (DS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Define the types of experimental design, and statistical analysis methods.	10	x		
2	Design experiments to efficiently gather data for specific empirical investigation settings involving a physical system.	20	x		
3	Apply model building and selection techniques to discover relationships between inputs and outputs of a physical system.	30	x	x	
4	Design experiments to efficiently gather data for specific empirical investigation settings involving a computational system.	20	x	x	
5	Apply Gaussian process modelling to discover highly nonlinear relationships between inputs and outputs of a computational system.	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	Lectures	Students will engage in formal lectures to gain knowledge about the theory and methods of experimental design and regression.	1, 2, 3, 4, 5	26 hours/semester

2	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.	2, 4, 5	13 hours/semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test	2, 3, 4	25	-	No
2	Assignments	2, 3, 4, 5	25	-	Yes
3	Projects	2, 3, 4, 5	25	-	Yes

Continuous Assessment (%)

75

Examination (%)

25

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Midterm test to assess students' level of achievement of CILOs 2-4 on material covered before the midterm test.

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
Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Assignments are designed to assess student's level of achievement of CILOs 2-5.

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
Project (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
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.

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
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
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.

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
Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Midterm test to assess students' level of achievement of CILOs 2-4 on material covered before the midterm test.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Assignments are designed to assess student's level of achievement of CILOs 2-5.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task

Project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Additional Information for AR

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

Keyword Syllabus

- 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

Reading List

Compulsory Readings

	Title
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.

Additional Readings

	Title
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.