SDSC4110: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Statistical Design and Analysis of Experiments

Subject Code
SDSC - School of Data Science
Course Number
4110

Academic Unit
School of Data Science (DS)

College/School
School of Data Science (DS)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA2506 Probability and Statistics or MA2510 Probability and Statistics

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 advanced statistical data analysis methods in quality engineering. The principles and techniques of experimental design for systematic data collection, estimation of statistical models using the collected data, and their practical implementation issues in quality improvement are introduced.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe and discuss the types of experimental design, and statistical analysis methods.	10	x	x	
2	Apply various types of experimental designs and experimental design principles to efficiently gather data to discover relationships between system parameters or optimize a complex system.	30	x	x	
3	Apply statistical analysis methods and model selection principles to correctly analyse experiments.	30	x	x	
4	Use statistical software package in data collection and analysis for quality problem solving.	10		x	x
5	Design experiments and interpret results for specific industrial settings and quality problems.	20		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 primarily engage in formal lectures to gain knowledge about statistical computing. Students will participate in mini-lectures and small-group exercises to consolidate their knowledge of principle concept and industrial applications of various statistical tools and techniques.	1, 2, 3, 4, 5	39 hours/ semester
2	Laboratory/ Tutorial Exercises	Students will engage in team-based tutorial exercises (e.g., practical problem solving) to extend their use of statistical techniques learnt during the lectures and computer software tools for statistical analysis tasks.	3, 4, 5	In or after class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2, 3	30	
2	Assignments (four assignments) & Laboratory Work	2, 3, 4, 5	20	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Note: To pass the course, apart from obtaining a minimum of 40% in the overall mark, a student must also obtain a minimum mark of 30% in both continuous assessment and examination components.

Assessment Rubrics (AR)

Assessment Task

Test

Criterion

2-hour test to assess students' conceptual understanding of experimental design methods and ability to correctly analyze experiment data.

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 & Lab work

Criterion
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.

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

Criterion
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 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

Additional Information for AR
The test, assignments and laboratory report will be numerically-marked, while examination will be numerically-marked and grades-awarded accordingly.

Part III Other Information

Keyword Syllabus
Concept of process variability and its relevance to modern quality engineering
Confidence interval and hypothesis testing
Measurement system analysis: Gage R&R study
Principles of experimental design
Least squares regression for orthogonal designs, and relationship to main effects and interactions
Factorial and fractional factorial experiments
Analysis of variance (ANOVA) for factorial and fractional factorial designs
Response surface design

Reading List

Compulsory 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.

Additional Readings

	Title
1	R. H. Myers, D. C. Montgomery and C. M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 3rd ed., Wiley, 2009. ISBN: 978-0-470-17446-3
2	D.C. Montgomery, Design and Analysis of Experiments, 8th ed., Wiley, 2012
3	D.C. Montgomery, Introduction to Statistical Quality Control, 7th ed., Wiley, 2012
4	W.W. Hines & D.C. Montgomery, D.M. Goldsman, and C.M. Borror, Probability and Statistics in Engineering, 4th ed., Wiley, 2003
5	A. Mitra, Fundamentals of Quality Control and Improvement, 3rd ed., Wiley, 2008