

SDSC8004: ADVANCED STATISTICS

Effective Term

Semester A 2026/27

Part I Course Overview

Course Title

Advanced Statistics

Subject Code

SDSC - Data Science

Course Number

8004

Academic Unit

Data Science (DS)

College/School

College of Computing (CC)

Course Duration

One Semester

Credit Units

3

Level

R8 - Research Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to provide students with a solid foundation of statistical concepts, theory, and methods including probability theory, statistical estimation and inference methods, and multivariate statistics. It also aims to provide students

with a rigorous introduction to the theory and implementation of linear regression models. Emphasis will be placed on rigorous mathematical derivations of the fundamentals of statistics but implementation of the statistical methods via computer programming in MATLAB or R will be an important part of the course as well.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Prove and apply various fundamental results in probability theory.	20	x	x	
2	Implement the techniques of parametric inference such as maximum likelihood estimation and Bayesian inference.	35	x	x	
3	Derive key results in the theory of linear models and linear model selection.	25	x	x	
4	Derive key results in the theory of nonparametric statistical models and methods such as the bootstrap method and Gaussian process regression.	10	x	x	
5	Implement statistical inference methods and modelling methodologies with computer codes.	10	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	Lecture	Students will engage in formal lectures to gain knowledge about the theory and methods of advanced statistics.	1, 2, 3, 4, 5	26 hours/semester
2	Demonstration of computer codes	Students will develop an understanding of the computer codes included in the course materials by following an in-class demonstration and explanation of the codes.	1, 2, 3, 4, 5	12 hours/semester

Assessment Tasks / Activities (ATs)

ATs		CILO No.	Weighting (%)	Remarks ("- for nil entry)	Allow Use of GenAI?
1	Midterm Students will be assessed via the midterm their understanding of concepts theory, and methods learned in class, textbooks, and reading materials.	1, 2, 3, 4	25	-	No
2	Two assignments Students will work individually to derive or prove results in probability and statistical theory, and apply statistical methods to analyse data with the help of software.	1, 2, 3, 4, 5	50	-	No

Continuous Assessment (%)

75

Examination (%)

25

Examination Duration (Hours)

3

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Examination - Students will be assessed via the examination their understanding of concepts theory, and methods learned in class, textbooks, and reading materials.

Assessment Rubrics (AR)**Assessment Task**

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

Criterion

Midterm exam to assess students' level of achievement of CILOs 1-4 on material covered before the midterm exam.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

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 1-5.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

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 1-4 on all material covered. Students will need to demonstrate understanding of various elements of statistical theory and methods taught in the course through precise mathematical exposition.

Excellent

A+, A, A-

Good

B+, B, B-

Fair

C+, C, C-

Marginal

D

Failure

F

Assessment Task

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

Criterion

Midterm exam to assess students' level of achievement of CILOs 1-4 on material covered before the midterm exam.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

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 1-5.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

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 1-4 on all material covered. Students will need to demonstrate understanding of various elements of statistical theory and methods taught in the course through precise mathematical exposition.

Excellent

A+, A, A-

Good

B+, B

Marginal

B-, C+, C

Failure

F

Part III Other Information**Keyword Syllabus**

- Probability theory and distributions (probability space, random variables, expectation, inequalities, and convergence of random variables)
- Parametric statistical inference theory and methods (maximum likelihood estimation, Fisher's scoring, Fisher information, consistency and limiting distribution of maximum likelihood estimators, statistical decision theory, Rao-Blackwell theorem, minimum variance unbiased estimation, Bayesian inference)
- Multivariate statistics (covariance matrix estimation, James-Stein estimator, principle components analysis), linear model theory (least squares, Gauss Markov theorem, ridge regression, leave-one-out cross validation, optimal design of experiments), variable selection methods (Bayesian information criterion, LASSO, LARS).
- Nonparametric statistical models and methods (bootstrap, Gaussian process models, local polynomial regression, kernel methods)

Reading List**Compulsory Readings**

Title	
1	Wasserman, L. (2013). All of statistics: a concise course in statistical inference. Springer Science & Business Media.
2	Keener, R. W. (2011). Theoretical statistics: Topics for a core course. Springer.
3	Resnick, S. I. (2013). A probability path. Springer Science & Business Media.
4	Casella, G., & Berger, R. L. (2002). Statistical inference (Vol. 2). Pacific Grove, CA: Duxbury.
5	Rasmussen, C. E., & Williams, C. K. (2006). Gaussian Process Regression for Machine Learning. The MIT Press

Additional Readings

Title	
1	Nil