

SEE8212: DATA ANALYSIS IN ENVIRONMENTAL APPLICATIONS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Data Analysis in Environmental Applications

Subject Code

SEE - School of Energy and Environment

Course Number

8212

Academic Unit

School of Energy and Environment (E2)

College/School

School of Energy and Environment (E2)

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

SEE5211 Data Analysis in Environmental Applications

Exclusive Courses

Nil

Part II Course Details

Abstract

The course will provide students with knowledge in using statistical methods in environmental science. These analysis methods such as probability distributions, parametric, tests of significance against non-parametric tests, regression analysis and variance analysis etc. are very helpful for students to understand the physical processes occurring in the environment, and to work on climate prediction.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 app.)		DEC-A2	DEC-A3
1	Understand the concepts of basic statistical methods	20	x		x
2	Use probability distributions, parametric, tests of significance against non-parametric tests, regression analysis and variance analysis methods to describe environmental datasets and solve environmental problems creatively	30		x	x
3	Use correlation method to analyze environmental datasets and discover the linkage between the data results and with environmental problems	35		x	x
4	Apply these methods creatively to explain the basic physical processes in environmental science	15	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	Lecture	Explain numerical method of describing environmental data.	1, 2, 3, 4	
2	Tutorials	Apply theories and concepts on practical examples	1, 2, 3, 4	
3	Hands-on experiment	Require students to use statistical method to describe the characteristic of air pollutant concentration or other environmental datasets	2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("- for nil entry)	Allow Use of GenAI?
1	In-class Quizzes	1, 2, 3, 4	20	Formative Assessment Tasks	Yes
2	Hands-on experiment	2, 3, 4	20	-	Yes
3	Mid-term exam	1, 2, 3, 4	20	-	No

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Percentage of coursework, examination, etc.:

60% by coursework (assignments, mid-term exam, term paper); 40% by final exam

Notes: Each student are required to pick up one energy or environmental related problem (such as air pollutant concentration, weather data, power data, or others) to analyse the data by statistical method and computational tool (i.e. Python programming). They need to write a program and submit a report to present their findings, outcomes and conclusion. Their personal recommendation to address the problem is also needed.

To pass a course, a student must do ALL of the following:

- obtain at least 30% of the total marks allocated towards coursework (combination of assignments, pop quizzes, term paper, lab reports and/ or quiz, if applicable);
- obtain at least 30% of the total marks allocated towards final examination (if applicable); and
- meet the criteria listed in the section on Assessment Rubrics.

Assessment Rubrics (AR)**Assessment Task**

In-Class Quizzes (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems

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

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

Criterion

Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems

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

Hands-on experiment (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Capacity for self-directed learning in exploring the energy and environmental problems, and to analyse the data using Python

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

Ability to explain numerical method of describing environmental 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

In-Class Quizzes (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems

Excellent

(A+, A, A-) Excellent analysis and problem-solving skills to demonstrate in-depth understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Good

(B+, B) Good analysis and problem-solving skills to demonstrate good understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Marginal

(B-, C+, C) Marginally acceptable analysis and problem-solving skills to demonstrate some understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Failure

(F) Poor analysis and problem-solving skills and are barely able to demonstrate an understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Assessment Task

Mid-term (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems

Excellent

(A+, A, A-) Excellent analysis and problem-solving skills to demonstrate in-depth understanding of probability, population, distributions random variable (discrete & continuous).

Good

(B+, B) Good analysis and problem-solving skills to demonstrate good understanding of probability, population, distributions random variable (discrete & continuous).

Marginal

(B-, C+, C) Marginally acceptable analysis and problem-solving skills to demonstrate some understanding of probability, population, distributions random variable (discrete & continuous).

Failure

(F) Poor analysis and problem-solving skills and are barely able to demonstrate an understanding of probability, population, distributions random variable (discrete & continuous).

Assessment Task

Hands-on experiment (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Capacity for self-directed learning in exploring the energy and environmental problems, and to analyse the data using Python

Excellent

(A+, A, A-) Excellent report writing and no difficulties in identifying syntax errors. Programs conform to standard Python style and give the correct output. The energy and/or environmental problems can be solved creatively and innovatively by providing a very comprehensive recommendation.

Good

(B+, B) Good report writing and minor problems with syntax. Programs are structured correctly but some of the output are incorrect. The energy and/or environmental problems can be solved basically, and some recommendations are provided and discussed.

Marginal

(B-, C+, C) Marginally acceptable report writing and numerous problems with syntax. Programs are somewhat relevant but cannot solve the problem. Findings and recommendations are all missing.

Failure

(F) Poor report writing and little understanding of Python syntax. Programs are unrelated to the problem.

Assessment Task

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

Criterion

Ability to explain numerical method of describing environmental data.

Excellent

(A+, A, A-) Excellent analysis and problem-solving skills to demonstrate in-depth understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Good

(B+, B) Good analysis and problem-solving skills to demonstrate good understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Marginal

(B-, C+, C) Marginally acceptable analysis and problem-solving skills to demonstrate some understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Failure

(F) Poor analysis and problem-solving skills and are barely able to demonstrate an understanding of probability, parameter estimation, random variable, confidence interval and hypothesis testing, inferences involving one and two populations, simple linear regression, analysis of variance and goodness-of-fit test.

Assessment Task

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

Criterion

Ability to solve computational problems

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not reaching marginal levels

Assessment Task

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

Criterion

Ability to describe theory and formulate computational strategies

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not reaching marginal levels

Assessment Task

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

Criterion

Ability to solve non-trivial computational problems

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not reaching marginal levels

Assessment Task

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

Criterion

Ability to solve computational problems

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not reaching marginal levels

Assessment Task

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

Criterion

Ability to describe theory and formulate computational strategies

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not reaching marginal levels

Assessment Task

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

Criterion

Ability to solve non-trivial computational problems

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not reaching marginal levels

Part III Other Information

Keyword Syllabus**1. Probability distributions**

- Introduction - concepts of probability, random variables and probability distributions.
- Probability distributions (discrete and continuous): normal distribution, Central Limit theorem, t-distribution, and Fisher's F-distribution, gamma and other distributions.
- Application of probability distributions in environmental data analysis, e. g. particle size distributions, detection limit of environmental analysis.

2. Tests of hypothesis

- Type I error, Type II error, level of significance,
- One tailed tests and two tailed tests. Parametric tests of significance against non-parametric tests and Monte Carlo methods.
- Application of test of hypothesis in environmental data analysis, e.g. compliance of environmental standards etc.

3. Regression analysis

- Simple regression - estimation of regression line, analysis of variance, confidence interval for regression coefficients, and confidence band for regression line.
- Multiple regression - estimation of regression plane, partial correlation, and multiple correlation.

- Nonlinear regression
- Application of regression analysis in environmental data, e.g. calibration of environmental analysis.

Reading List

Compulsory Readings

Title	
1	Statistics: The exploration and analysis of data, 7th Edition, 2012. Roxy Peck Jay L DeVore. ISBN-10:0840058012.

Additional Readings

Title	
1	Statistics for Environmental Engineers, 2nd Edition, 2002. Linfield C. Brown, Paul Mac Berthouex, ISBN: 1566705924