Course Syllabus

offered by School of Energy and Environment
with effect from Semester B 2021/22

Part I Course Overview

Course Title:	Data Analysis in Environmental Applications
Course Code:	SEE8212
Course Duration:	1 semester
Credit Units:	3 credits
Level:	P5/R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites:	Nil
Precursors:	Nil
Equivalent Courses:	Nil
Exclusive Courses:	Nil

Part II Course Details

1. 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.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Understand the concepts of basic statistical methods	20%	✓		✓
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%		✓	✓
3.	Use correlation method to analyze environmental datasets and discover the linkage between the data results and with environmental problems	35%		✓	✓
4.	Apply these methods creatively to explain the basic physical processes in environmental science	15%	✓	✓	✓
		100%			

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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 self-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. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
Lecture	Explain numerical method of describing environmental data.	✓	✓	✓	✓	
Tutorials	Apply theories and concepts on practical examples	✓	✓	✓	✓	
Hands-on experiment	Require students to use statistical method to describe the characteristic of air pollutant concentration or other environmental datasets		✓	✓	✓	

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.				Weighting*	Remarks
	1	2	3	4		
Continuous Assessment: 60 %						
In-class Quizzes	✓	✓	✓	✓	20%	
Hands-on experiment		✓	✓	✓	20%	
Mid-term exam	✓	✓	✓	✓	20%	
Examination: 40% (duration: 2hrs , if applicable)						
					100%	

Examination duration: 2 hrs

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:

1) 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);
2) obtain at least 30% of the total marks allocated towards final examination (if applicable); and
3) meet the criteria listed in the section on Grading of Student Achievement.

5. Assessment Rubrics

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Adequate (C+, C, C-)	Marginal (D)	Failure (F)
1. In-class Quizzes	Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Mid-term	Ability to use the statistical concepts and knowledge to analyse and solve the energy and environmental related application problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Hands-on experiment	Capacity for self-directed learning in exploring the energy and environmental problems, and to analyse the data using Python	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Ability to explain numerical method of describing environmental data.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information

1. Keyword Syllabus

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

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

3. Regression analysis
   (1) Simple regression - estimation of regression line, analysis of variance, confidence interval for regression coefficients, and confidence band for regression line.
   (2) Multiple regression - estimation of regression plane, partial correlation, and multiple correlation.
   (3) Nonlinear regression
   (4) Application of regression analysis in environmental data, e.g. calibration of environmental analysis.

4. Time series
   (1) Introduction- definitions of stochastic processes: purely random process, stationary process, auto-regressive process and non-stationary process.

5. Principal Component Analysis (SEE8212)
   (1) Introduction of Principal Components Analysis- rotated and complex empirical orthogonal functions, singular Value Decomposition, canonical Correlation Analysis.
   (2) Application of PCA on complicated environmental data sets, e.g. source identification of air pollutants etc.

2. Reading List

2.1 Compulsory Readings

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

2.2 Additional Readings

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