Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year (New format)	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Assoc Prof Eleanor Slade
Course Author Email	eleanor.slade@ntu.edu.sg
Course Title	Experimental Design & Analysis for Ecology
Course Code	ES3307
Academic Units	4
Contact Hours	52
Research Experience Components	Research Defined Course (at least 50% of deliverables involve practical research activities: problem identification, hypothesis forming, data collection/analysis/interpretation, result communication)

Course Requisites (if applicable)

Pre-requisites	ES2305 - Introductory Statistics and Numerical Thinking OR BS1008 Bioinformatics & Statistics & MH3511 Data Analysis with Computer
Co-requisites	NIL
Pre-requisite to	ES4002 Final Year Project Ecology specialization students.
Mutually exclusive to	NIL
Replacement course to	NIL
Remarks (if any)	

Course Aims

This course introduces you to the basic principles of experimental design and analysis of ecological experiments. It introduces you to methods and key concepts for designing and implementing experiments in both the field and laboratory. You will learn how to plan and execute an experiment, key concepts in designing experiments, and how to analyse and present your results. This course builds on the statistical and R skills you should have learned in BS1008, ES0002, and MH311, and you will learn how to apply these statistical methods to real-life ecological field and lab experiments. This course uses R, and assumes some introductory knowledge of statistics and the R language.

This course is a pre-requisite for ES4002 Final Year Project Ecology specialization students.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Plan and design an experiment or field study.
ILO 2	Formulate hypotheses and predictions.
ILO 3	Recognise, chose, and justify when to use different designs and key statistical tests.
ILO 4	Select and employ appropriate experimental designs and statistical tests to analyse ecological datasets.
ILO 5	Critically evaluate the methods and results of published papers.
ILO 6	Analyse and present your data using R statistical package.
ILO 7	Interpret graphs, figures and statistical tests.
ILO 8	Present and communicate your results clearly and concisely.

Course Content

1. Questions, hypotheses & predictions

Understand how to graph data, interpret results, and write and present results. Critically evaluate published work. Identify questionable research practices and explain the importance of open science.

Understand the difference between inaccuracy vs imprecision. Explain the difference between statistical vs biological significance, and how to use and report P-values. Recognise the difference intervals that can be fitted and when to use them.

Presenting your results and evaluating published papers

Understand how to analyse community datasets, and account for environmental covariates.

Effect sizes

Recognize the difference between observational and experimentally-designed studies and when to use the information theoretic approach and AICs versus the likelihood approach and P values

Multivariate analyses

Apply different experimental designs (single, factorial, split-plot). Understand how to account for interactions. Apply the correct statistical tests for count, proportional, and continuous data.

Model Selection

Understand the concept of blocking/grouping variables, and the advantages and disadvantages. Understand interactions between covariates and factors. Understand random vs fixed effects and how specify these.

Selecting the correct design and statistical test

Understand the importance of spatial, temporal, and with-in subject variation, and how to design replicated experiments, and select appropriate sampling designs.

Blocking/Grouping variables, co-variates, and random effects

Understand how to formulate a question, hypotheses, and predictions. Understand the difference between observational and experimental studies and why they might differ in the way they are analysed.

Variation, randomisation, replication and sampling

Reading and References (if applicable)

Main course texts

Ruxton & Colegrave (2011) Experimental Design for the Life Sciences, OUP.

This is the main course text book on the process of designing experiments. I encourage you to read the relevant chapter(s) between lectures to help you get a more in depth knowledge of the subject discussed each week. The book is in the library.

Hector (2018 or 2021 edition) The New Statistics with R

More advanced statistics and R coding. We will follow this book in later parts of the course on statistical tests. This book is in the library.

Other texts

Holmes et al. (2010) Research Methods for the Biosciences. OUP.

A more mathematical and statistically focused book, for those more mathematically minded.

Spiegelhalter, D. The Art of Statistics: Learning from data.

Accessible non-technical and entertaining introduction to statistical thinking.

Knell (2014) Introductory R

Good introductory R book – if you want to start with the basics start here. Good for revising basic R coding.

Ebook www.introductoryr.co.uk

Wickham & Grolemund (2016) R for Data Science

A good reference for some more advanced codes and data visualization

Free online at https://r4ds.had.co.nz/

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introduction: why you should care about experimental design	1	In-person	Lecture & tutorial	Introduction to why good experimental design is important and relationship between experimental design and statistics.
2	Starting at the beginning: What is your question & hypothesis?	1,2	In-person	Lecture & tutorial	Questions, hypotheses, and predictions.
3	Linear models	3,4,6,7,8	In-person	Lecture & computer lab tutorial	Simple linear model structures. R Markdown and graphics packages such as ggplot.
4	Experimental designs	1,2,3,4,5	In-person	Lecture & tutorial	Experimental vs observational studies. Field vs lab studies. Different types of data and sampling and designs
5	Variation, randomization, replication and sampling	1,2,3,4,5,7	In-person	Lecture & tutorial	Variation, replicated experiments, and appropriate sampling designs. Pseudoreplication.
6	Factorial designs, covariates sums of squares, interactions	1,2,3,4,6,7	In-person	Lecture & tutorial	Blocking, covariates, Sums of squares and interactions
7	Mixed models & split-plot designs	1,2,3,4,5,6, 7,8	In-person	Lecture & computer lab tutorial	Linear mixed effects models - random vs fixed effects
8	Effect sizes and p values	1,2,3,4,5,7,8	In-person	Lecture & computer lab tutorial	Inaccuracy vs imprecision. Statistical vs biological significance. Calculating effect sizes and error bars.
9	Model selection: AIC and causal models	1,2,3,4,5,6,7,8	In-person	Lecture & computer lab tutorial	Introduction to causal models and using the AIC approach
10	GLMS	1,2,3,4,6,7,8	In-person	Lecture & computer lab tutorial	Statistical tests for count, proportional, and binary data. Lecture & computer lab tutorial Project discussions - analysis

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
11	Multivariate analyses	1,2,3,4,5,6,7,8	In-person	Lecture & tutorial	Understand how to analyse community datasets and account for environmental covariates.
12	Statistical literacy	1,2,3,4,5,7,8	In-person	Lecture & tutorial	Visualizing data, interpreting outputs, and writing and presenting results. Pre-registering. Open science. Biases.
13	Projects	1,2,3,4,5,6,7,8	In-person	Presentations	Project Presentation and wrap-up

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	There will be lectures at the beginning of each week to pass on the theoretical knowledge required to understand the different components of experimental design and analysis. These will be done in an interactive way, involving your participation in the form of discussions and contributions. The discussion board will also allow a forum to ask questions and discuss topics, and you are expected to actively engage in this. The assignments will also allow you hands-on application of the content covered during lectures (LO 3, 4,6,7,8).
Quizzes	The MCQs will be based on the topic of the previous lectures, tutorials, and readings. These will facilitate content assimilation and ensure that you are learning in an active way (LO 1,3,4,7).
Computer Lab Tutorials	During the computer tutorials you will have access to computers you will complete the exercises that will help you build connections between the theory and concepts of design and the practical applications and links to statistical analysis. (LO 3,4,6,7,8). You will also become familiar with using the statistical programme R (LO 6,7).
Tutorials	During tutorials we will discuss pre-assigned papers and datasets. The tutorials will allow you a space to discuss in-depth what you have learned in the lectures and readings. You will learn to critically evaluate methods and designs in the literature and to think about potential pitfalls when designing your own experiments (LO 2,3,4,5,7,8). You will be encouraged to share your thoughts and observations with your classmates informally through discussion groups and as presentations to learn how to present and communicate results clearly and concisely (LO 5,8).
Project & presentation	You will work in pairs to come up with a question you would like to test and design an experiment to test this. You will then construct a representative dataset to analyse and interpret, or if you have datasets already you can use these (LO 1,2,3,4,6,7,8). You will work together but produce independent reports. Together you will then present your experiment and analyses to your classmates (LO 8), who will peer-review your presentation. This will allow you to put everything you have learnt into practice, and enable both independent learning and critical thinking, as well as learning from each other. This will develop both your research, team-work and presentation skills.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Others(Contributions during class time, online discussion board, and tutorials)	2,3,5,7,8	1,2,3,4,5,6	5		Individual	Holistic	Relational
2	Continuous Assessment (CA): Test/Quiz(MCQs quizzes – 5 online quizzes (5% each quiz))	1,3,4,7	1,2,3,4	25		Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Assignment(Computer tutorial assignments 1-4 (10% each assignment))	1,2,3,4,6,7,8	1,2,3,4	40		Individual	Analytic	Relational
4	Continuous Assessment (CA): Report/Case study(Project report)	1,2,3,4,5,6,7,8	1,2,3,4,5,6	20		Team	Holistic	Extended Abstract
5	Continuous Assessment (CA): Presentation(Project presentation)	1,2,3,4,6,7,8	1,2,3,4,5,6	10		Team	Holistic	Extended Abstract

Description of Assessment Components (if applicable)

These are the ASE Learning Outcomes:
At the completion of your course of study in ASE, you will be able to:

1. Demonstrate intellectual flexibility and critical thinking in order to apply environmental knowledge in the real world
2. Communicate environmental concepts with enthusiasm to varied audiences both orally and in writing
3. Formulate scientific questions, and be able to access and analyse quantitative and qualitative information to address them
4. Exhibit the motivation, curiosity and skills for lifelong learning
5. Demonstrate ethical values and responsibility
6. Collaborate and lead by influence

Formative Feedback

Feedback is central to this course. You will receive formative feedback through written responses to your assignments and discussion Slack, and verbal feedback through in-class discussion and tutorials.

The MCQs will have the correct answers given on completion. These check your understanding of the key concepts in previous lectures and encourage you to revise and raise questions on subjects which you do not understand. Questions will be discussed in class on completion of the quiz.

A discussion group online will be set up for students to communicate between themselves and with the instructors.

You will work on a project in pairs. You will discuss the project and do the analysis together, but produce individual reports, and qualitative feedback will be provided on the report at the end of the semester. You will give a joint presentation to your peers, and feedback will be given during your presentation and through peer-review appraisal.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Intermediate
Curiosity	Intermediate
Sense Making	Advanced
Information Literacy	Intermediate
Critical Thinking	Advanced

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned pre-class readings and activities, attend all classes punctually and take all scheduled assignments and quizzes by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for classes you have missed. You are expected to participate in all class and tutorial discussions and activities.

Policy (Absenteeism)

Absence from class without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.
If you miss a lecture, you must inform the course instructor via email prior to the start of the class. A student who is absent from assessment without valid Leave of Absence
will be given zero mark for the missed assessment. Course lecturers may, however, use his/her own discretion for extenuating circumstances. Policy on medical leave for student may be found from
http://www.ntu.edu.sg/Students/Undergraduate/AdminServices/Pages/Applyforshortleave.aspx.

Policy (Others, if applicable)

Compulsory Assignment
You are required to submit compulsory assignments on due dates, unless a valid reason is provided. Valid reasons include falling sick supported by a medical certificate. If you will miss a deadline for a valid reason you must inform me via email (eleanor.slade@ntu.edu.sg) prior to the deadline, and as soon as is possible.

Special Accommodations
All courses will have some form of assessment and if you envision that you will have difficulty satisfying an assessment component due to your disability then you are advised to contact the Course Coordinator within the first 2 weeks of the course.
Students requiring assistance in the learning environment should contact and notify the
Associate Chair (Academic) in their School within the first 2 weeks of their first semester so that you and School can work together to optimise your learning experience. Examples of services that may be provided or supported in individual courses include an editor service to help those with reading and writing difficulties, and access to a personal mentor within the School. Please access the NTU Office of Academic Services' website
http://www.ntu.edu.sg/sasd/oas/Pages/

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal at ASE to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, a peer or senior, Janelle or Michel (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or an ASE faculty member.

Last Updated Date: 26-03-2026 10:47:49

Last Updated By: Sze Chun Chau (Dr)