Overview
CLFS 725 is a two-credit graduate course that focuses on helping participants develop the skills necessary to plan, conduct and analyze original biological experiments. The course is designed for teachers developing new innovative laboratories for their students, or participating in research projects with other investigators. Unlike traditional laboratory courses which focus on the laboratory and field techniques for collecting data, this course emphasizes the development of effective experimental designs. Participants completing this course will be expected to design innovative research projects for their own students that will be presented to the other class members.

All of the laboratory exercises in CLFS 725 can either be performed within the course website, or by using materials that are readily available locally. A fundamental component of the course is an experimental design package within the course website. This package consists of a hyperlinked, design tool that uses information provided by an investigator to identify appropriate experimental designs and analytical tools for a particular study. Further, the design tool is linked to conceptual overviews and customized spreadsheets of specific statistical tests and recommendations of the appropriate forms of tables and graphs to use with different experimental designs.

The course is based on a cooperative learning model, with participants assigned to research groups that work together to investigate the principles of experimental design and apply these principles to research problems presented in the course. This course contains a number of components that will help research groups (and individual participants) to develop effective designs for biological experiments:

- **Readings** are used to provide the basic theory behind the experimental designs used in biological research. These readings are in the form of web-based notes and sections from the course textbook.
- **Discussion questions** are used to explore the practical and applied aspects of the topics presented in the readings and laboratories in greater depth. Each research group posts answers to these questions for grading.
- **Research problems** are short summaries of experiments that contain flaws in their experimental design. Research problems are not graded, but are intended to help you assess your understanding of experimental design principles covered during the course.
• **Laboratories** are the most critically important portion of the course. In these exercises, research groups (which change every four weeks) apply the experimental design principles they have learned to specific research problems. Unlike traditional laboratories, each research group constructs, implements, and analyzes an experiment of their own design.

• **Chat sessions** are online synchronous discussions of course material. Chats are used to clarify the mechanics, concepts, and assignments in the course.

• **Individual portfolios** are required of each participant. Each portfolio consists of two research projects selected and designed by an individual participant in the format most appropriate for their own students.

**Webtext**
The course website contains an online textbook, *A Conceptual Review of Experimental Design for the Life Sciences* that provides a compact, essentially non-mathematical overview of experimental design.

**Textbook**
There is an optional textbook for this course: Townend, John. 2002. *Practical Statistics for Environmental and Biological Scientists*. John Wiley and Sons, Ltd., 276 pp. This is a good, general introduction to experimental design in the life sciences. It can be used as a reference to supplement readings from the webtext in the course website.

**Laboratories**
The laboratory exercises for the course are available online within the course website. Each unit in the course contains one exercise. The exercises contain a problem to be investigated experimentally, accompanied by reference articles and web sites on useful experimental procedures. Exercises are available in condensed, downloadable formats for use as hard copies away from networked computers.

**Grading**
The course consists of eight units, each one week in length. There are two assignments due at the end of each unit, an experimental laboratory exercise and an answer to a discussion question. To facilitate work on these assignments, the following time table will be followed:

- **Monday:** The new unit becomes available online.
- **Wednesday:** Individual experimental designs for the laboratory exercise are due.
- **Thursday:** Individual responses to the discussion question are due.
- **Sunday:** Group laboratory report and group written response to the discussion question are due.

The grade for both types of assignment will be based on two components: (1) the group submissions, and (2) each individual's contributions to these.

**Laboratory Exercises**
The group submissions for the laboratory exercises will be graded on a 10 point scale, with the grade determined by the overall scope and completeness of the response. Grading for individual contributions are more complicated, but is also based on 10 points:

- **2 points** for submitting an individual response to the assignment.
- **2 points** for completing the individual responses on time (i.e., by Wednesday).
4 points for actively participating in group discussions during the completion of the final submissions for grading. Active participation will be defined as providing two substantive suggestions that move the discussion forward. Comments such as "I don't think this portion of the answer is clear. Perhaps we should rewrite it as ...", or "I think ______ is more important to this process and we should place greater emphasis on it." would be substantive and would clearly indicate active participation. Responses such as "Good job!" or "I completely agree." would not be considered substantive.

2 points for work beyond the minimum necessary for completing the discussion question. For example, someone who made more than the minimum two substantive suggestions during the completion of the final answer or who took the lead in writing the final submission would receive these points.

Note that if someone does the minimum work: (1) submits an individual response, (2) submits it on time, and (3) provides two substantive suggestions during the drafting of the final answer, they would receive a total of 8 points (= 80%, or a B) for the individual portion of the assignment. To receive an A for this portion of the grade, they would need to do work beyond the minimum and earn the remaining 2 points.

Discussion Questions
The grading for the answers to the discussion questions are similar to that of the laboratory exercises, except that it is based on a total of 10 points (5 points for the group submission and 5 points for individual contributions). The point breakdown for individual contributions is:

- 2 points for submitting an individual response to the assignment.
- 1 point for completing the individual responses on time (i.e., by Thursday).
- 1 point for providing one substantive suggestion during the completion of the final submission.
- 1 point for work beyond the minimum necessary for completing the discussion question answer.

As with the laboratory exercises, someone does the minimum work would receive 4 points, or a grade of 80%.

Individual Portfolios
Individual portfolios are not group activities. They consist of two laboratory exercises selected by each participant and presented in a format for use with the participant’s own students. They can be modifications of existing laboratories or original exercises. Each exercise will be graded on a total of 65 points:

- 5 points for feasibility and suitability.
- 10 points for correctly identifying relevant variables.
- 30 points for the suitability for the overall experimental design.
- 20 points for appropriate analysis.

Summary
The course grade is based on a total of 350 points, divided among the three listed activities. The total points are distributed among these activities in the following manner:
140 points
Experiments designed by research groups and posted to the course website. Experiments for the laboratories during Units 1-7 are graded on a 20 point scale (= 10 points for the group response and 10 points for individual responses; see above). There is no group experiment due during Unit 8.

80 points
Discussion question answers to each of the eight discussion questions posted by each research group. Each set of answers is graded on a 10 point scale (= 5 points for the group response and 5 points for individual responses; see above).

130 points
Individual portfolios of two laboratory exercises presented in a format for use with the participant's own students. Each exercise will be graded on a 65 point scale (see above).

350 points TOTAL

**Missed Work**
Occasionally, course participants may miss a unit due to other obligations (e.g., illness, family vacation, etc.) Notify both the members of your group and the course staff of any absences. Missed work will be completed as an individual, rather than a group, assignment within one week of returning to the course.

**Course Schedule**

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Restrictions on statistical tests:
1 chi-square tests only
2 chi-square tests or quick tests (i.e., Tukey's quick test, sign test for two samples, sign test for correlation) only
3 any basic statistical test (i.e., tests using either one or two samples)
4 any basic statistical test, complex contingency table, or one-way ANOVA
5 no restrictions