MTH 546/646: Analysis of Variance and Design of Experiments

Spring 2019

Instructor: Songfeng (Andy) Zheng

Email: SongfengZheng@MissouriState.edu Phone: 417-836-3037

Room and Time: Cheek 173, 12:20pm – 1:10pm, MWF

Office and Hours: Cheek Hall 22M, 1:30 pm – 3:00 pm, M to F; or by appointment. Office hours are offered for individual help and getting to know how you understand the material, so please use them.


Course webpage:

http://people.missouristate.edu/songfengzheng/teaching/MTH546_S19.htm will provide the download of various course materials, including the lecture notes, homework assignments, announcements, topics covered and suggested reading materials, and data for exercises.

Objectives & Prerequisites: Experiments involving statistical methods are performed in a variety of fields such as agriculture, biology, engineering, medical, physical, and social sciences. The methods introduced in this course are of great importance in the planning and conducting of the experiments, and in the collection and analysis of the resulting data. This course is application oriented. The prerequisite for this course is MTH 345 (Probability and Statistics for Science and Engineering), Math 545 (applied statistics), or MTH 541 (Statistics Theory II), or equivalent. The computer statistical package R will be used extensively to carry out the data analysis.

Materials to be covered (tentative): Single-factor experiments; Complete Block Design; Incomplete Block Designs; Factorial Designs; Fractional Factorial Designs; Experiments with Random Factors; Nested and Split-Plot Designs; Response Surface Methods and Designs.

Grading Policy and Studying Suggestions:

Homework: 20% Two In-class Tests: 40% Final Exam: 40%

Grading policy: A (>90%), B (80 --- 89%), C (70 --- 80%), D (60 – 70%), F(<60%)

Final exam date: 11 to 1, May 15, Wednesday.
Note: for students enrolled in MTH646, you are expected to finish one more question in each exam!

It is important that you read the textbook and lecture notes regularly (I will list the suggested reading materials online for each week), understand the problems worked out in the text and practice by doing the problems. Doing the homework problems is absolutely essential to get a better grade in this course. You are allowed to discuss the homework problems among yourselves or with me. However the final work handed in must be completely your own. Anyone who receives or gives an unauthorized aid on a homework or test is considered to be cheating. Late Homework will not be accepted!

There will be two midterm exams: Midterm 1 will cover chapters 1 and 2, and midterm 2 will cover chapters 4 and 5. The final exam will be comprehensive! No make-up test or exam will be given under ordinary conditions. The only acceptable excuse for missing a test is an extreme emergency. However, you must obtain a written explanation from a physician, etc. The exam date will be announced in class (and on the course webpage) about two weeks ahead. If you cannot take the test on the scheduled day, you must contact me at least three days before the test date.

Emailing format:

Email is an important means to communication in everyday life as well as in this course. Due to the large amount of emails sent to me every day, and due to different courses I am teaching, I suggest you clearly write a subject in the email, and in the subject, clearly tell which course you are from. For example, a good email subject would be like

Subject: MTH 546: Q about #4 in HW2

Thus, I can quickly locate your problem and will reply quickly. Emails which don’t have a clear subject may be simple ignored!

Miscellaneous Notes:

Attendance policy: The University expects instructors to be reasonable in accommodating students whose absence from class resulted from: (1) participation in University-sanctioned activities and programs; (2) personal illness; or (3) family and/or other compelling circumstances. Instructors have the right to request documentation verifying the basis of any absences resulting from the above factors. Please see The University’s attendance policy can be found in the 2010-2011 Undergraduate Catalog at www.missouristate.edu/registrar/attendan.html.

Academic integrity: Missouri State University is a community of scholars committed to developing educated persons who accept the responsibility to practice
personal and academic integrity. You are responsible for knowing and following the university’s Student Academic Integrity Policies and Procedures, available at www.missouristate.edu/policy/academicintegritystudents.htm. You are also responsible for understanding and following any additional academic integrity policies specific to this class (as outlined by the instructor). Any student participating in any form of academic dishonesty will be subject to sanctions as described in this policy. If you are accused of violating this policy and are in the appeals process, you should continue participating in the class.

**Nondiscrimination:** Missouri State University is an equal opportunity/affirmative action institution, and maintains a grievance procedure available to any person who believes he or she has been discriminated against. At all times, it is your right to address inquiries or concerns about possible discrimination to the Office for Equity and Diversity, Park Central Office Building, 117 Park Central Square, Suite 111, (417) 836-4252. Other types of concerns (i.e., concerns of an academic nature) should be discussed directly with your instructor and can also be brought to the attention of your instructor’s Department Head. Please visit the OED website at www.missouristate.edu/equity/.

**Disability Accommodation:** If you are a student with a disability and anticipate barriers related to this course, it is important to request accommodations and establish an accommodation plan with the University. Please contact the Disability Resource Center (DRC) (https://www.missouristate.edu/disability/), Meyer Library, Suite 111, 417-836-4192, to initiate the process to establish your accommodation plan. The DRC will work with you to establish your accommodation plan, or it may refer you to other appropriate resources based on the nature of your disability. In order to prepare an accommodation plan, the University usually requires that students provide documentation relating to their disability. Please be prepared to provide such documentation if requested. Once a University accommodation plan is established, you may notify the class instructor of approved accommodations. If you wish to utilize your accommodation plan, it is suggested that you do so in a timely manner, preferably within the first two weeks of class. Early notification to the instructor allows for full benefit of the accommodations identified in the plan. Instructors will not receive the accommodation plan until you provide that plan, and are not required to apply accommodations retroactively.

**Cell phone policy:** As a member of the learning community, each student has a responsibility to other students who are members of the community. When cell phones or pagers ring and students respond in class or leave class to respond, it disrupts the class. Therefore, the Office of the Provost prohibits the use by students of cell phones, pagers, PDAs, or similar communication devices during scheduled classes. All such devices must be turned off or put in a silent (vibrate) mode and ordinarily should not be taken out during class. Given the fact that these same
Communication devices are an integral part of the University’s emergency notification system, an exception to this policy would occur when numerous devices activate simultaneously. When this occurs, students may consult their devices to determine if a university emergency exists. If that is not the case, the devices should be immediately returned to silent mode and put away. Other exceptions to this policy may be granted at the discretion of the instructor.

**Emergency Response policy:** Students who require assistance during an emergency evacuation must discuss their needs with their professors and Disability Services. If you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible. For additional information students should contact the Disability Resource Center, 836-4192 (PSU 405), or Larry Combs, Interim Assistant Director of Public Safety and Transportation at 836-6576. For further information on Missouri State University’s Emergency Response Plan, please refer to the following web site: http://www.missouristate.edu/safetran/erp.htm

**Dropping a Class:** It is your responsibility to understand the University’s procedure for dropping a class. If you stop attending this class but do not follow proper procedure for dropping the class, you will receive a failing grade and will also be financially obligated to pay for the class. For information about dropping a class or withdrawing from the university, contact the Office of the Registrar at 836-5520.

**Changes to this syllabus:**

The instructor reserves the right to make changes to this syllabus, and the changes will be announced in class and on the course webpage.
Tentative Lecture Schedule in Spring 2019 (MTH 546/646)

Lecture 1: Course Statement. Introduction to design and analysis experiments, examples. R example for getting summary statistics and box plots on example data.


Lecture 5: Some quantities in ANOVA: SST, SSTr, SSE, and their degrees of freedom. Decomposition of SST into SSTr and SSE, mean squares, F-value, ANOVA table. Means model and effects model, distribution assumptions, parameter estimation in effects model.

Lecture 6: Estimation for the error terms, checking the normal assumption, equal variance assumption, and independent assumption by looking at different plots, computer example.


Lecture 8: Constructing Multiple Confidence intervals for contrasts: Scheffe's method and Tukey's method, example and R commands. Randomized Complete Block Design: idea and example. Going over the code.

Lecture 9: Random Complete Block Design: Ideas, model, parameter estimation, hypotheses, testing statistic, ANOVA table, example code.

Lecture 10: Checking the assumptions in RCBD: randomness, constancy of variance, nonparametric tests.


Lecture 12: Balanced Incomplete Block Design: concept, model, example, and R commands. Notes for BIBD.


Lecture 14: Factorial Design: ANOVA table, example R commands, model checking by graphs, comparing different mean values.
Lecture 15: Testing for additivity if there is only one observation per cell. 3-factor design: example and R commands. $2^k$ design: concept and illustration of $2^2$ design by example and R code.

Lecture 16: $2^2$ design: data, model, estimation, Sum of squares, ANOVA, example code. General $2^k$ design.

Lecture 17: General $2^k$ design. Unreplicated observation in $2^k$ design, example code. Blocking and Confounding in $2^k$ design: ideas, concepts, example.

Lecture 18: Blocking and Confounding in $2^k$ design: ideas, concepts, example. Algebraic method to assign blocks. Example code. $2^k$ factorial design with $2^p$ blocks, example for $2^4$ design in $2^2$ blocks.

Lecture 19: Example for $2^4$ design in $2^2$ blocks. Partial confounding: concepts, example code.

Lecture 20: Fractional factorial design: ideas and related concepts, example.

Lecture 21: Single factor random effect model: Motivation, ideas, model, ANOVA, parameter estimation, and example.

Lecture 22: Two-factor random effect model: Motivation, ideas, model, ANOVA, parameter estimation, and example.

Lecture 23: Two-factor mixed model: motivation, model, ANOVA, parameter estimation, Confidence interval, example.

Lecture 24: Two-stage nested design: concept, model, ANOVA, Example.

Lecture 23: Design with both nested and factorial factors: example and ANOVA.

Lecture 24: Split-plot design: examples, model for the data, R commands.

Lecture 25: Review of Regression Analysis.

Lecture 26: Anova via regression, theory and example.


Lecture 27: Example for Analysis of covariance.