Midterm review (30% grade)

- **Study materials:** Textbook chapter 15 to 21; Lecture note week 1 to 8; Quiz#1-3; Homework
- **Policy:**
  - closed book test; no computer
  - you can bring one page (8.5 x 11 in) sheet of note only. A calculator is allowed, but not necessary since there are only easy calculations. We provide you a blank scratch paper.

Understanding of the following important concepts (***Note:*** Below includes minimum knowledge. You should study thoroughly text book material and lecture notes to be well prepared for the exam):

Fundamental Statistical Concepts (prerequisite)

Appendix A; Lecture note 1A: estimation, testing, regression and association, etc.

Chapter 15: Introduction

1. What is the difference of experimental study and observational ?
2. Observational studies (confounding factors; prospective vs. retrospective studies)
3. Identify the response/outcome variable, explanatory/treatment factors, experiment units

Chapter 16-18: Single factor studies

1. Sample size planning:
   a. based on power and type I error or based on estimation precision
   b. balanced design, treatment levels, target treatment effect size and variability.
   c. How to design parameter changes affect the sample size (α, β, Δ, σ, CI-width) ?
2. Diagnostics of ANOVA model assumptions and remedial measures
   a. What statistical tests can be used to examine these assumptions
   b. Residual analysis
   c. Transform the data + ANOVA vs. nonparametric test
3. Understand the cell means model and the factor effects model: parameters and estimates
4. Understand the source of variation, the sum of square partition and ANOVA table decomposition: the relationship of SS, MS, df.
5. The hypothesis testing regarding factor level means: how to compute the *F*-statistics and its distribution based on corresponding df, and interpret the results.
6. Compute estimate and CI for factor level means, their paired differences or contrasts given the summary statistics (mean, sample size, ANOVA table) and critical values.
7. Understand the multiple comparison methods: Tukey, Bonferroni, and Scheffé methods
   a. How to choose the most efficient procedure for various scenarios
   b. How to interpret the output/figure for pairwise comparison

Chapter 19: Two-factor studies

1. For classic balanced two-factor study with n>1 per treatment:
   a. Full model: cell mean model and factor effects model with interaction term
   b. Model assumption, ANOVA table, hypothesis testing, estimation and interpretation
   c. How to identify interaction from treatment mean plot, and interpret interaction effect
   d. How to estimate the factor level means, treatment means and contrasts.

Chapter 20-21: two factor studies with no replication

1. How we can test for additivity (interaction)?
2. Factor effect model (no interaction): ANOVA table and interpretation
3. How to estimate the treatment means (given a summary of factor level means)
4. Randomized complete block design:
   a. Why use blocking
   b. Factor effects model: model assumption, ANOVA table and interpretation
   c. Estimation of the model parameters and treatment effects (from data summary statistics)