The Theory of Linear Statistical Models

1. Review of Some Linear Algebra

The fundamental theorem of algebra
Basic notions for real matrices such as range and null space
Projections
Diagonalization of symmetric matrices
Partitioned matrices
Generalized inverses
Direct sums
Tensor Products
Mean and covariance matrix of a random vector
Some distribution theory for normal random vectors

2. The Structure of the Linear Model

The coordinate-free formulation of the model with normal errors
Estimation
Testing linear hypotheses, confidence regions, and simultaneous confidence intervals

3. Models Defined by a Design Matrix

The model with a design matrix which is not necessarily of full rank
Identifiability
Estimation
Estimable linear functions
A general test
Tests, confidence regions, and simultaneous confidence intervals involving estimable functions

4. Regression

Full rank design matrices
The standard and canonical model
Estimation, testing, confidence intervals
Residuals and lack of fit
Coefficient of determination
Subset selection
Ridge regression
Prediction
Multiple correlation coefficient

5. The One-Way Layout

The one sample model: estimation, testing, and confidence intervals

The multiple sample model: estimation, testing, and (simultaneous) confidence intervals

6. The Two-Way Layout

Without interaction and one observation per cell: tensor notation, estimation, testing hypotheses, confidence intervals for contrasts
With interactions and the same number of observations for each cell: tensor notation, basic tests

7. Analysis of Covariance

Partitioned models
An example of an ANCOVA model, using tensor notation

8. Abandoning Normality and Some Asymptotics

The model when errors are not necessarily normal
Asymptotic normality of the least squares estimator of the model parameter

Design of Experiments

After completing this course the student should be able to implement, formulate, and analyze the resulting data for:
- Completely randomized design
- Randomized blocks and related designs
- Factorial design (_xed, random, and mixed e_ects models)
- Nested design
- Split-Plot design
- Response surface methods
- Unbalanced Factorial design
- Factorial designs with covariates
- Use Multiple comparison techniques to draw simultaneous inference about parameters
- Use residual analysis to check for violation of the model assumptions
- Perform power analysis and calculate the sample size required for a design