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 (fixed, random, and mixed effects 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