

CHEMICAL ENGINEERING 4C3/6C3

STATISTICS FOR ENGINEERS

2008-2009: TERM 2

Instructors: Mr. Ivan Miletic, Inf. Tech. Bldg. Rm. 103. Contact Information TBD

Teaching Assistants: One Teaching Assistant: TBD

Prerequisite: A previous course in statistics. An understanding of basic concepts in probability and statistics will be assumed. Concepts such as means, variances, confidence intervals, tests of hypothesis, and probability will be reviewed briefly and will be used throughout the course.

Course Structure: The course will be divided into two distinct halves. There will be a mid-term test (2 hours) for the first half of the course, tentatively set for **February, 2009**. There will be a comprehensive final exam covering material from the entire course to be held in **April, 2009**.

Grading:

Assignments	20%
Midterm Exam	30%
Final Exam	50%

Grade adjustment techniques such as bell curving may be used.

Course Notes: Lecture slides and supporting materials will be available in PDF form on the web site at least a few days before the corresponding lectures. The slides should be supplemented with readings from texts such as those listed below. These texts contain numerous applications of the methods discussed in the lectures; for those wanting to see more examples, please reference these texts.

Reference Texts: (All will be on reserve in the science library)

- Montgomery, D.C., G. C. Runger, "Applied Statistics and Probability for Engineers", Third Ed., Wiley, 2002.
- Box, G.E.P., W. G. Hunter, J. S. Hunter, "Statistics for Experimenters", Wiley.
- Draper, N.R., H. Smith, "Applied Regression Analysis", Wiley.
- Eriksson L., E. Johansson, N. Kettaneh-Wold, S. Wold, 2001. "Multi- and Megavariate Data Analysis Principles and Applications, Umetrics AB, Sweden

Supplementary Texts:

- Mason, R.L., R. F. Gunst, J. L. Hess, "Statistical Design and Analysis of Experiments, Wiley, 1989.
- Box, G.E.P., N. R. Draper, "Empirical Model Building and Response Surfaces", Wiley, 1987.
- Bates, D.M., D. G. Watts, "Nonlinear Regression Analysis and its Applications", Wiley, 1988.
- Mathews, P. "Design of Experiments with MINITAB", ASQ Quality Press, 2005.

Course Objectives:

- To review fundamental statistical inference and uncertainty concepts.
- To be able to fit models to data and to then judge the appropriateness of the models; the model fitting will cover linear models, nonlinear models and multi-response models.
- To provide an appreciation for the concepts of statistical process control.
- To understand the concepts behind the design of experiments and to be able to set up appropriate designs in practice.
- To provide an introduction to multivariate statistical methods for analyzing and using large databases commonly arising in science, engineering and business.

Course Focus:

The presentation of the material will emphasize the use of statistical techniques to collect data and to extract information from measured data, and the use of this information for decision making. The focus of the course will be on the practical use of various statistical techniques, and this will sometimes demand a close look at the mathematics underlying the techniques so as to understand their strengths and limitations.

Outline: Part I

Review

- measures of position (mean, median, mode)
- measures of spread (variance, standard deviation)
- measures of uncertainty (confidence intervals, hypothesis tests)

Statistical Process Control

- philosophy
- SPC charts

Empirical Modelling

- Classes of models (linear, nonlinear, dynamic, steady-state, multi-response, empirical, first principles)
- Parameter estimation
 - linear regression from an optimization perspective
 - uncertainty in parameter estimates
 - testing for lack of fit
 - multiple linear regression
 - use of dummy variables
 - nonlinear regression
 - ridge regression

Outline: Part II

Design of Experiments (DOE)

- Concepts behind DOE
- Randomization and blocking
- Factorial Designs
- Fractional Factorial Designs
- Response Surface Designs
- Optimal Designs

Introduction to Multivariate Statistics

- Introduction to Principal Component Analysis (PCA)

- Troubleshooting processes using plant data
- Multivariate SPC
- Industrial applications
- Introduction to Partial Least Squares
- Industrial applications of PLS