Product Quality (ME 518)
Boston University, College of Engineering
Mechanical Engineering Department
Spring 2020

Syllabus

Course description: Introduction to statistical methods for design, control and improvement of quality. Includes Statistical Process, Quality Control (SPC & SQC) and Acceptance Sampling. Extensive coverage of Design of Experiments (DOE) with applications to designing quality into products, process and product performance improvement. The course utilizes Excel, Excel VBA, R, RStudio and R Markdown to enable students to learn quality control as implemented in an industrial environment.

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Office hours:
Mondays 5-6 pm
Wednesday 5-6 pm

Textbooks:
1. *Introduction to Statistical Quality Control*, 7th edition, by D.C. Montgomery, Wiley, 2013.

Software:
1. Excel
2. R
3. RStudio

Grading:
Homework 24%, class participation 10%, work process 20%, midterm exams 20%; final Exam 26%

Outline of the course

Part I - Introduction to Statistic (DMAIC)

Introduction to statistical methods for design, control and improvement of quality:

- Statistical Process and Quality Control (SPC & SQC)
- Acceptance Sampling.

The following topics are reviewed in this part:

- Six Sigma -**DMAIC**
- Data Science Process
- Define Problem
- SIPOC
- Cause and Effect Diagram
- Cause and Effect Matrix
- 7-Data Selection
- Descriptive Statistic
- Normal Distribution
- The Magnificent Seven

Part II - Statistical Process Control (SQC)

The following topics are reviewed in this part:

1. Control Charts for Variables
   - X & R charts
   - X-Bar & R Charts
   - X-Bar & S Charts
   - X & MR Charts
2. Control Charts for Attributes
   - P Chart
   - nP Chart
   - c Chart
   - u Chart
3. Process Capability Analysis

Part III - Multivariable Analysis (MSQC)

The industrial data is analyzed to demonstrate the implementation of quality control in an industrial environment

The following topics are reviewed in this part:

- Exponentially Weighted Moving Average (EWMA)
- Cumulative Sum Control Chart (CUSUM)
- Partial Component Analysis (PCA)
- Partial List Square (PLS)
- Multivariable (MSQC)
- Correlation Analysis
- Fast Fourier Transform (FFT)

Part IV - Statistical Methods for Quality Improvement and Optimization: Design of Experiments (DOE) and Response Optimization

Extensive coverage of Design of Experiments (DOE) with applications to designing quality into products and designing quality into processes and product performance improvement.

The following topics are reviewed in this part:

- Define the Objective
- Define the Process and Select Factors to be Studied
- Select a Response and Measurement System
- Select the Experimental Design
- Execute Experiments Accurately
- Check the Results Obtained for any Issues
- Model Data
- Verify Predicted Results

Course Content/Concepts

1. Modern view of quality:

- *Role of customers*
- *Who is most responsible for achieving high quality?*
- *Quality in design vs. quality in production*
- *Robustness*
- *How to achieve high quality, TQM and Six-Sigma*

2. General Statistics:

- *How to make decision under uncertainty*
- *Taking variation into account*
- *Quantifying risks associated with decisions*
- *Statistical summary of data, mean, standard deviation*

3. SPC tools

- *Sampling methods (basic principles, how to use them)*
- *Process Capability indices and how to estimate them*
- *Control charts (the main purpose being how to design, how is it used in different stages of quality control and improvement)*

4. Process/product improvement/optimization (DOE)

- *How to run experiments*
- *Model building (linear/interaction/quadratic models)*
- *Understanding interactions*
- *Analysis of variance (ANOVA)*
- *Factorial and fractional factorial designs*
- *Using software*