

IE 3255. Statistical Quality Control

3.0 cr; prerequisite: Stat 3611, BSIE or BSME candidate, or Instructor Consent

Statistical quality control in manufacturing; modeling, process quality, control charts, process capability, acceptance sampling methods, Six Sigma, and Lean Enterprise.

Instructor Name: Dr. Emmanuel Ugo Enemuoh

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Course Number and Title: IE 3255. Statistical Quality Control

Course Web Page: <http://www.d.umn.edu/~eenemuoh/Teaching/IE3255/index.htm>

Course Semester: Spring 2007

Lecture Time: Monday, Wednesday, and Friday. 10:00 – 10:50 A.M.

Lecture Location: Cina 202

Lab Location: ENGR 204

Course Learning Objectives:

When you finish this course, it is hoped that you will be able to:

- ❖ Explain in simple terms, the concepts of quality, quality improvement, and aspects of quality control and improvement (program outcomes f, h, j).
- ❖ Calculate average, sample standard deviation, sample median, and quartiles of a randomly sampled data using calculator, MSEXCEL, SPSS, and Minitab software (program outcomes a, b, e, k).
- ❖ Construct a frequency distribution, histogram, stem-and-leaf plot, box plot, normal probability of data readings of a process, using MS EXCEL and SPSS software (outcomes a, e, k).
- ❖ Describe variation in a process or data, using frequency distribution, histogram, stem-and-leaf plot, box plot, and normal probability plot (program outcomes a, e, k).
- ❖ Model and estimate process defects using Hypergeometric, Binomial, Poisson, Normal, and Exponential distribution functions (program outcomes a, e, k).
- ❖ Estimate the mean of a normally distributed population, when variance is known and variance is not known (program outcomes a, k).
- ❖ Estimate the variance of a normally distributed population (program outcomes a, k).
- ❖ Setup and conduct hypothesis test on the estimated population parameters above (outcomes a, j).
- ❖ Construct two-sided confidence interval on population parameters above (outcomes a, e, j).
- ❖ Setup control charts for variables data (x-bar and R charts) using both EXCEL, SPSS, and Minitab software (program outcomes a, e, k).
- ❖ Setup control charts for attribute data (p, np, c, and u charts) using both EXCEL, SPSS, and Minitab software (program outcomes a, b, e, k).
- ❖ Analyze and recommend control charts using Western Electric rules (outcomes a, g, j).
- ❖ Calculate and interpret process capability ratios (C_p , C_{pk} , and C_{pkm}) (outcomes a, b, e, g).
- ❖ Conduct and evaluate R & R studies on a measurement instrument (outcomes a, c, e).
- ❖ Compute main effects and sum of squares of 2^k factorial experiments using Minitab Software (outcomes a, b, e).
- ❖ Define 6 sigma. Understand the concept of 6 sigma initiation (program outcomes c, j).
- ❖ Understand the concept of Lean Manufacturing (program outcomes c, j).
- ❖ Model and estimate MTTF of a product, given failure rate (program outcomes a, e),

BSIE Program Outcomes (ABET): The BSIE program will produce graduates who are able to

- a. An ability to apply knowledge of mathematics, science and engineering appropriate to an industrial engineer
- b. An ability to design and conduct experiments, analyze and interpret data, and report findings
- c. An ability to design, develop, implement and improve integrated systems that include people, materials, information, equipment, and energy
- d. An ability to function on multi-disciplinary teams
- e. An ability to identify, formulate and solve industrial engineering problems
- f. An understanding of the professional and ethical responsibilities of an industrial engineer
- g. An ability to communicate effectively, including oral, written and visual forms
- h. The broad education necessary to understand the impact of industrial engineering solutions in a global and societal context
- i. A recognition of the need for, and the ability to engage in life-long learning
- j. A knowledge of contemporary industrial engineering issues
- k. An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice
- l. A working knowledge of manufacturing processes and systems

Required Text (and recommended readings): Introduction to Statistical Quality Control, by Douglas C. Montgomery, 5th Edition.

Grading Policy, including the weight given to each graded component:

Homeworks/Quizzes/Project	40 %
Midterm Tests	40 %
Final Exam	20 %
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	100 %

COURSE CONTENT: The course content is tentative depending on time and the instructor's discretion. The syllabus can be downloaded at "<http://www.d.umn.edu/~eenemuoh>"

PART I: Statistical Methods Useful in Quality Improvement

1. Introduction to Quality, Quality Control and Improvement
 - 1.1 Meaning of Quality, Quality Control and Quality Improvement
 - 1.2 Brief History of Quality Control and Improvement
 - 1.3 Statistical Methods of Quality Control and Improvement
 - 1.4 Other Aspects of Quality Control and Improvement
- 2 Modeling Process Quality
 - 2.1 Describing Variation
 - 2.2 Important Discrete Distributions
 - 2.3 Important Continuous Distributions
- 3 Inferences about Process Quality
 - 3.1 Statistics and Sampling Distributions
 - 3.2 Point Estimation of Process Parameters
 - 3.3 Statistical Inference for Two Samples
 - 3.4 Statistical Inference for more than Two Populations

PART II: Basic Methods of Statistical Process Control and Capability Analysis

- 4 Methods and Philosophy of Statistical Process Control
 - 4.1 Introduction
 - 4.2 Chance and Assignable Causes of Quality
 - 4.3 Statistical Basis of the Control Chart
 - 4.4 The Rest of the “Magnificent Seven”
 - 4.5 Implementing SPC
 - 4.6 An Application of SPC
- 5 Control Charts for Variables
 - 5.1 Introduction
 - 5.2 Control Charts for \bar{x} and R
 - 5.3 Control Charts for \bar{x} and S
 - 5.4 The Shewhart Control Chart for Individual Measurements
 - 5.5 Summary of Procedures for \bar{x} , R, and S Charts
 - 5.6 Applications of Variables Control Charts
- 6 Control Charts for Attributes
 - 6.1 Introduction
 - 6.2 Control Charts for Fraction Nonconforming
 - 6.3 Control Charts for Nonconformities (Defects)
 - 6.4 Choice between Attributes and Variables Control Charts
 - 6.5 Guidelines for Implementing Control Charts
- 7 Process and Measurement System Capability Analysis
 - 7.1 Introduction
 - 7.2 Process Capability Analysis Using a Histogram or a Probability Plot
 - 7.3 Process Capability Ratios
 - 7.4 Process Capability Analysis Using a Control Chart
 - 7.5 Process Capability Analysis Using Designed Experiments
 - 7.6 Gage and Measurement System Capability Studies
 - 7.7 Setting Specification Limits on Discrete Components

PART III: Acceptance Sampling

- 8 Lot-by-Lot Acceptance Sampling for Attributes
 - 8.1 Acceptance Sampling Problem
 - 8.2 Single-Sampling Plans for Attributes
 - 8.3 Double, Multiple, and Sequential Sampling
 - 8.4 Military Standard 105E (ANSI/ASQC Z1.4, ISO 2859)

PART IV: Six Sigma/Lean

- 9 Six Sigma
 - 9.1 DMAIC
 - 9.2 Application of Six Sigma tools to minimize production variability
 - 9.3 Taguchi Loss Function
- 10 Lean Production and Quality
 - 10.1 The Birth of Lean Production
 - 10.2 The Lean Production System
 - 10.3 Stability
 - 10.4 Just-In-Time

TENTATIVE COURSE SCHEDULE

This course schedule may be altered by the instructor depending on availability of time.

WEEK	CLASS	DATE	DAY	CLASS ACTIVITY
1	1	1/17	Wed.	Meaning of Quality, Q. C. and Improvement, Brief History of Q.C.& Improv.
	2	1/19	Fri.	Statistical Methods of Q. C. and Improvement, Other Aspects of Q. C. and Improv
2	3	1/22	Mon.	Describing Variation:
	4	1/24	Wed.	Important Discrete Distributions
	5	1/26	Fri.	Important Continuous Distributions
3	6	1/29	Mon.	Statistics and Sampling Distributions, Point Estimation of Process Parameters
	7	1/31	Wed.	Statistical Inference for Two Samples
	8	2/2	Fri.	Statistical Inference for more than two populations
4	9	2/5	Mon.	Intro to statistical process control, Chance and assignable causes of quality
	10	2/7	Wed.	Statistical basis of the control chart, The rest of the "Magnificent Seven"
	11	2/9	Fri.	Implementing SPC, An Application of SPC
5	12	2/12	Mon.	An application of SPC
	13	2/14	Wed.	Intro to Control Charts of Variables
	14	2/16	Fri.	Control Charts for \bar{x} and R
6	15	2/19	Mon.	Midterm Exam 1
	16	2/21	Wed.	Control Charts for \bar{x} and S
	17	2/23	Fri.	The Shewhart Control Chart for Individual Measmt.
7	18	2/26	Mon.	Summary of Procedures for \bar{x} , R, and S Charts
	19	2/28	Wed.	Applications of variables control charts
	20	3/2	Fri.	Introduction to Control Charts for attributes
8	21	3/5	Mon.	Control charts for fraction Nonconforming,
	22	3/7	Wed.	Control charts for nonconformities (defects)
	23	3/9	Fri.	Choice between attributes and variables control charts
9	24	3/12	Mon.	SPRING BREAK! SPRING BREAK!! SPRING BREAK!!!
	25	3/14	Wed.	
	26	3/16	Fri.	
10	27	3/19	Mon.	Guidelines for implementing control charts
	28	3/21	Wed.	Intro to process and measurement system capability analysis
	29	3/23	Fri.	Process capability (Cp) analysis using a histogram or a probability plot
11	30	3/26	Mon.	Process capability (Cp) analysis using a histogram or a probability plot
	31	3/28	Wed.	Process capability ratios
	32	3/30	Fri.	Cp analysis using a control chart
12	33	4/2	Mon.	Cp analysis using designed experiments
	34	4/4	Wed.	Gage and measurement system capability studies
	35	4/6	Fri.	Setting specification limits on discrete components
13	36	4/9	Mon.	Midterm Exam 2
	37	4/11	Wed.	Estimating the natural tolerances limits of a process
	38	4/13	Fri.	Acceptance Sampling problem
14	39	4/16	Mon.	Single-Sampling Plans for Attributes
	40	4/18	Wed.	Double, Multiple, and Sequential Sampling
	41	4/20	Fri.	Military Standard 105E (ANSI/ASQC Z1.4, ISO 2859)
15	42	4/23	Mon.	DMAIC
	43	4/25	Wed.	Application of Six Sigma Tools to minimize variability
	44	4/27	Fri.	Design of Experiment
16	45	4/30	Mon.	The Birth of Lean Production, Lean Production System
	46	5/2	Wed.	Stability, Just-In-Time
	47	5/4	Fri.	Review for Finals, Class Evaluation
17	48	5/11	Wed	Finals, May 11th, 8:00 - 9:55 A:M.

Special out-of-class requirements (computers, software, field trips, etc.): You need knowledge of a spreadsheet and statistical analysis software to complete some of your homework. Microsoft Excel, SPSS, Minitab, and Design Expert (Stat Ease) are installed on the computers in the Lab (Engr 204).

Assignment Make-up and Incomplete Policies: Complete your homework problems and turn them in at the beginning of the period on the day that they are due. Homework that is not turned in at the beginning of class will be accepted for half credit. Late homework will not be accepted and will be returned ungraded. If you will be absent, turn the homework in to the instructor early or have someone turn it in for you in class. Write your student number, your name and the problem number in the upper right corner of the pages that you turn in. Write on only one side of the paper. Staple all sheets together in the upper left hand corner. Put problems in order that they are in on the assignment sheet. Be neat and show all work. Plot any needed charts with computer. Be sure to include units on all final answers. Problems that are not in the book may at times be assigned. Some class time may be used to answer questions about the problems.

Tests Make-up and Incomplete Policies: If your schedule will not allow you to take midterm tests on the specified dates and time, you must make arrangement with the instructor to take your test prior to the test date. If you fail to make arrangement and take the test after the test dates, your score for that test will be 80% of your test score. You must take the final exam on the date scheduled by the University.

Final Exam Date: Final exam will be given during the exam week of May 7 – May 11 (Wednesday, May 11th, 8:00 - 9:55 A.M., Cina 202).

Lecture Attendance: You are expected to attend the classes. Students with excessive absences usually do not do well in the course. Quizzes may or may not be announced in advance. Missed quizzes cannot be made up.

Dropping Class: You will be given an early performance evaluation in the 7th week. The aim of early evaluation is to help you make decision about dropping class before the University's deadline.

Statement on Participation

It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact the instructor to discuss their individual needs for accommodations. The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

Student Academic Integrity Policy

Academic dishonesty tarnishes UMD's reputation and discredits the accomplishments of students. UMD is committed to providing students every possible opportunity to grow in mind and spirit. This pledge can only be redeemed in an environment of trust, honesty, and fairness. As a result, academic dishonesty is regarded as a serious offense by all members of the academic community. All faculty, staff, and students are expected to participate in maintaining the highest levels of academic integrity.

Prohibited Conduct

All forms of academic dishonesty are prohibited, including (but not limited to):

- submission of false records of academic achievement
- cheating on assignments or examinations
- submitting sentences or ideas as your own without proper acknowledgment or citation (plagiarizing)
- altering, forging, or misusing a University academic record or forging the signature of any member of the University community
- taking, acquiring, using, or circulating test materials without faculty permission
- acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement
- facilitating academic dishonesty by knowingly assisting another student to violate the Student Academic Integrity Policy, such as providing course work for another student to turn in as his or her own effort or taking an exam for another student
- presenting as one's own a plot, succession of ideas, or list/outline of another without proper acknowledgment
- attending a class, completing an assignment, or taking a quiz/test in the name of another student
- altering or viewing computer records, dispensing or releasing information gained via unauthorized access, modifying computer programs or systems, or interfering with the use or availability of computer systems or information (refer to UMD policy)
- purchasing or otherwise presenting work as your own when it was done by another person
- submitting the same paper or work (or generally similar papers or work) to meet the requirements of more than one course without the approval and consent of faculty
- depriving another student of necessary study or research materials or in any way impeding another student's work and pursuit of education
- submitting falsified data, such as bibliographic resources and experimental data or altering graded academic work/quizzes/tests and resubmitting them in order to get a higher grade
- use of electronic devices for the unauthorized assistance in academic work, quizzes, or tests