STAT 513/IE 530 — Statistical Quality Control

Spring 2015

Credit Hours: 3

Lectures: T & Th / 9:00-10:15 AM & 10:30-11:45 AM / REC 114

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Required Textbook: Montgomery, D.C. (2013). *Introduction to Statistical Quality Control* (6th or 7th ed.). John Wiley & Sons, Inc. ISBN 978-1-118-14681-1.

Course Description: This course will cover statistical techniques underlying modern quality control. These important methodologies are not limited to applications in traditional manufacturing: they can also be applied in health care, service industries, pharmaceuticals, education, non-profits, small businesses, software reliability, among others. Conceptual understanding, not memorization or theoretical derivation of equations, is required and emphasized throughout the course. Topics include: Six Sigma, statistical and graphical data summaries, basic tools (flowcharts, fishbone diagrams, Pareto charts), control charts for measurement and attribute data, proper and effective use of control charts, capability studies, continuous improvement, experimental design, Taguchi methodology, and acceptance sampling. Specific topics covered and the course outline are subject to change as the semester progresses.

Course/Learning Objectives:

- Acquire fluency in the language and techniques of modern quality control and its applications.
- Conceptually understand the utility of statistics for quality control.
- Apply control charts and experimental design techniques to solve real-life quality control problems.
- Utilize JMP for statistical computation, visualization, control chart construction, and design of experiments.
  - JMP is freely available via Software Remote and in ITaP labs. Free manuals are available online.
  - Help with statistical software packages is available at the help desk in MATH G175.
- Discuss what is learned in lecture and assignments through oral and written presentations.

Prerequisite: One semester of post-calculus statistics such as IE 230, MGMT 305, or STAT 511, or permission of the professor.

Course Outline:

- **Week 1**: Introduction to modern quality control (Chapters 1 – 2).
  - **Lecture 1 (1-13-2015)**: Overview of statistical quality control, control charts, and experimental design.
  - **Handout (Due 1-15-2015)**: Background survey.
  - **Lecture 2 (1-15-2015)**: Six Sigma, with a focus on the Define and Measure steps.
  - **Homework 1 (Due 1-20-2015)**: Problems based on Chapters 1 – 2.
- **Week 2**: Overview of basic probability, statistics, and JMP (Chapters 3 – 4).
  - **Lecture 3 (1-20-2015)**: Review of probability distributions.
  - **Lecture 4 (1-22-2015)**: Review of statistical inference and applications of JMP.
  - **Homework 2 (Due 1-27-2015)**: Problems based on Chapters 3 – 4.
- **Week 3**: The Magnificent Seven (Chapter 5).
  - **Lecture 5 (1-27-2015)**: An introduction to the Shewhart control chart. Basic assumption (spike signal), ingredients, and issues in the design of Shewhart control charts.
  - **Lecture 6 (1-29-2015)**: The rest of the Magnificent Seven.
  - **Homework 3 (Due 2-3-2015)**: Problems based on Chapter 5.
- **Week 4**: Control charts for variables (Chapter 6).
  - **Lecture 7 (2-3-2015)**: Shewhart control chart for $\bar{x}$ and R. Construction via JMP.
  - **Lecture 8 (2-5-2015)**: Shewhart control chart for $\bar{x}$ and s, and for individual measurements. Construction via JMP.
  - **Homework 4 (Due 2-10-2015)**: Problems based on Chapter 6.
- **Week 5**: Control charts for attributes (Chapter 7).
  - **Lecture 9 (2-10-2015)**: Shewhart control chart for fraction nonconforming. Construction via JMP.
  - **Lecture 10 (2-12-2015)**: Shewhart control chart for nonconformities (defects). Construction via JMP.
  - **Homework 5 (Due 2-17-2015)**: Problems based on Chapter 7.
  - **Project Description: Due 2-19-2015**.
- **Week 6**: Midterm I.
  - **Review Lecture (2-17-2015)**: Review of Lectures 1 - 10.
  - **Midterm I (2-19-2015, in class)**: Primary focus: Six Sigma, basic probability and statistics, Shewhart control charts for variables and attributes.
- **Week 7**: CUSUM and EWMA charts, capability analysis (Chapters 8 – 9).
  - **Lecture 11 (2-24-2015)**: Introduction to CUSUM and EWMA charts, their interpretations, and relevant assumptions (step signal and increasing exponential signal). Construction via JMP.

  - **Lecture 12 (2-26-2015)**: Process capability analysis by various means including control charts.
  - **Homework 6 (Due 3-3-2015)**: Problems based on Chapters 8 – 9.
- **Week 8**: Review of ANOVA and linear regression (Chapter 4.5 – 4.6).
  - **Lecture 13 (3-3-2015)**: Review of the Analysis of Variance (ANOVA).
  - **Lecture 14 (3-5-2015)**: Review of linear regression.
  - **Homework 7 (Due 3-10-2015)**: Problems based on Chapter 4.5 – 4.6.
- **Week 9**: Introduction to factorial experiments (Chapter 13).
  - **Lecture 15 (3-10-2015)**: The 2^2 full factorial design.
  - **Lecture 16 (3-12-2015)**: The 2^k full factorial design.
  - **Homework 8 (Due 3-24-2015)**: Problems based on Chapter 13.
- **Week 10**: Spring Break
- **Week 11**: Two-level fractional factorial experiments (Chapter 13).
  - **Lecture 17 (3-24-2015)**: Design and analysis of two-level fractional factorial experiments.
  - **Lecture 18 (3-26-2015)**: Applications of two-level fractional factorial designs for quality control.
  - **Homework 9 (Due 3-31-2015)**: Problems based on Chapter 13.
- **Week 12**: Response surface and Taguchi methodology (Chapter 14).
  - **Lecture 19 (3-31-2015**: Response surface methods and designs.
  - **Lecture 20 (4-2-2015)**: Process robustness studies.
  - **Homework 10 (Due 4-7-2015)**: Problems based on Chapter 14.
- **Week 13**: Midterm II
  - **Review Lecture (4-7-2015)**: Review of Lectures 11 - 20.
  - **Midterm II (4-9-2015, in class)**: Primary focus: CUSUM and EWMA charts, process capability analysis, design of experiments for two-level factors, and response surface and Taguchi methodology.
- **Week 14**: Acceptance sampling, and failure modes and effects analysis (Chapters 15 – 16).
  - **Lecture 21 (4-14-2015)**: Acceptance sampling, and why it is a bad idea.
  - **Lecture 22 (4-16-2015)**: Failure modes and effects analysis.
  - **Homework 11 (Due 4-21-2015)**: Problems based on Chapters 15 – 16, lecture slides, and handouts.
- **Week 15**: Project presentations
- **Week 16**: Project presentations and review for Final Exam
- **Week 17**: Final Exam

Course Work and Requirements:

- *Homework* will generally be posted on a Tuesday, and due the following Tuesday (**before lecture begins**). There will be 11 homework assignments accounting for 15% of your course grade. No late homework will be accepted.

	Percentage of Grade
Homework	15%
Group project	15%
Midterm I	20%
Midterm II	20%
Final Exam	30%

- *Group projects* will be due at the end of the semester. Specific details on the project will be given in a separate handout.
- The two *midterms* will be written exams during the regular class period, and each will account for 20% of the course grade. There will be no retaking of exams. On the rare occasion when a student is sick for an exam, the student *must* contact Professor Sabbaghi *before* the exam begins, or accept a zero as the grade for that test.
- The *final exam* will constitute 30% of the course grade. Please do not make plans to leave campus before the scheduled final.
- Exams are based primarily on lecture and designated reading material. You are responsible for what is discussed in class. All exams are closed book and closed notes. While exam questions vary in difficulty, the answers are generally quite brief given time constraints on the exams.

Course Policies

Addressing Questions via E-mail: Please feel free to e-mail me questions to the instructor, but reserve those that involve extensive computation or mathematical expressions for office hours.

Incompletes: Incompletes will only be given under emergency circumstances, e.g., a serious auto accident, death of family member, etc. (see the grief absence policy for further information). Incompletes will not be given to students failing the course.

Grading: The grading scale is predetermined so as to eliminate competition with other students, and to ensure that you always know your grade in the class. Your grade is based upon *your* performance only. Grades will not be curved.

Grade	Numerical range
A	90.00-100.00
B	80.00-89.99
C	70.00-79.99
D	60.00-69.99
F	0.00-59.99

Evaluation: Student feedback is essential for any course to be successful. Feedback questionnaires will be included in each week's assignment. These evaluations should be taken seriously, and will be addressed directly by the instructor.

Re-grading: All grade disputes are to be made on paper, and submitted *directly* to Professor Sabbaghi. Discussions or arguments for re-grades will *not* be done in person.

A student has until one week after receiving his/her grade to dispute the grade (in writing). Handling re-grades in this manner eliminates the "end of the semester" digging for points.

When disputing a grade, you should state the question, the dispute, and the number of points you feel you should have received for the question. If you do not state the number of points you think are reasonable for the re-grade, zero points will be give as the re-grade. Please note that when you ask for a question to be re-graded, the entire assignment may be re-graded, and there is a possibility of losing points.

Dropping the Course: I reserve the right to *not* sign anyone out of the course once the deadline for dropping without the instructors signature has passed. Please take care to pay attention to these dates.

Attendance and Participation: Students: You are expected to attend lectures. You are expected to arrive on time, or before. You are expected to stay until the end of lecture unless you have asked in advance to leave early. You are expected to be prepared and participate. On the rare occasion that a student is extremely close to the cut-off value between letter grades, attendance and class participation may help.

When conflicts or absences can be anticipated, such as for many University sponsored activities and religious observations, you should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification is not possible, you should contact the instructor as soon as possible by e-mail, or the Department of Statistics main office. When you are unable to make direct contact with the instructor and unable to leave word with the Department of Statistics because of circumstances beyond your control, and in cases of bereavement, you or your representative should contact the Office of the Dean of Students. Links to the complete attendance policy and implications can be found at www.purdue.edu/odos/sac/attendance-and-absence/ and www.purdue.edu/studentregulations/regulations_procedures/classes.html.

Professor: You can expect that I will attend lectures. I will arrive in the lecture room prior to the start of lecture, and will end lecture on time. You can expect that I will be prepared for lecture, try my best to convey the information for the course, and show respect for all students.

If I am unable to attend lecture you will know in advance, and I will either cancel class or provide a guest instructor. I will be present for my office hours, and available for scheduled appointments.

The amount of material covered in each lecture is governed by the speed with which we complete the material. Every group of students is different, and I would rather teach the material well (and have you learn it) than speed through the topics for the purpose of covering a preset number of topics. Accordingly, the course outline is subject to change as the course progresses.

Grief Absence Policy for Students: Purdue University recognizes that a time of bereavement is very difficult for a student. The University therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). Students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the

learning outcomes for missed assignments or assessments in the event of the death of a member of the student's family.

University Emergency Information: A safety briefing will be conducted on the first day of class. In the event of a major campus emergency or temporary suspension of classes, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. You can get information about changes in this course by means of the course web page, or contacting the instructor via e-mail or phone. You are expected to read your Purdue e-mail on a frequent basis.

Violent Behavior Policy: Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent behavior impedes such goals. Therefore, violent behavior is prohibited in or on any University Facility or while participating in any university activity. See the following website for more details: www.purdue.edu/policies/pages/facilities_lands/i_2_3.shtml.

Academic Dishonesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]. For more information, please refer to Purdue's student guide for academic integrity (www.purdue.edu/odos/osrr/academic-integrity-brochure). Instances of cheating may be reported to the Office of Student Rights and Responsibilities (www.purdue.edu/odos/osrr/report-an-incident).

Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion,

and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Students with Disabilities: Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University.

If you have a disability that requires special academic accommodation, please make an appointment to speak with the instructor within the first three (3) weeks of the semester in order to discuss any adjustments. It is important to talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications.

Nondiscrimination: Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.