



UNIVERSITY OF PUERTO RICO  
MAYAGÜEZ CAMPUS  
COLLEGE OF ENGINEERING  
INDUSTRIAL ENGINEERING DEPARTMENT



## COURSE SYLLABUS

### General Information

Course Number: ININ 4020  
Course Title: **Applied Industrial Statistics**  
Credit-Hours: Three

### Course Description:

Application of advanced statistical concepts in engineering. Joint probability functions, goodness of fit tests, regression analysis, multicollinearity, design and analysis of industrial experiments. Emphasis of the use of statistical computer packages and their use in engineering.

**Prerequisites:** ININ 4010: Probability and Statistics for Engineers; MATE 3063: Calculus III

### Textbook and References

Walpole, R. E., Myers, R. H., Myers, S. L., Keying, Y., 2012. ***Applied Probability & Statistics for Engineers & Scientists***, 9<sup>th</sup> Edition. Prentice Hall.

- Banks J. et al., 2010, *Discrete-event System Simulation*, 5<sup>th</sup> Edition, Prentice Hall.
- Devore, J. L., 2008. *Applied and Statistics for Engineers and the Sciences*, 7<sup>th</sup> Edition. Thomson Higher Education; Brooks/Cole.
- Draper, N. R., and Smith, H., 1998. *Applied Regression Analysis*. 3rd Edition. John Wiley and Sons.
- Hayter, A., 2007. *Probability and Statistics for Engineers and Scientists*. 3<sup>rd</sup> Edition. Thomson Higher Education; Brooks/Cole.
- Kleinbaum, D. G. et al., 2008. *Applied Regression Analysis and Other Multivariate Methods*. 4<sup>th</sup> Edition. Thomson Higher Education; Brooks/Cole.
- Lapin, L. L., 1998, *Probability and Statistics for Modern Engineering*. 2nd Edition. Waveland Press Inc.
- Milton, J. S. and Arnold, J. C., 2003. *Introduction to Probability and Statistics*. 4<sup>th</sup> Edition. McGraw Hill.
- **Montgomery, D. C., and Runger, G. C., 2014. *Applied Statistics and Probability for Engineers*, 6<sup>th</sup> Edition. John Wiley and Sons, Inc.**
- Sheskin, D., 2004. *Handbook of Parametric and Nonparametric Statistical Procedures*. Third Edition. Chapman & Hall / CRC. Available on-line at UPRM General Library.
- Tukey, J. W., 1977. *Exploratory Data Analysis*. Addison-Wesley.

**Purpose**

This course is primarily designed for majors in Industrial Engineering; however, it is appropriate for anyone interested in applied statistics, especially, multivariate distributions, regression analysis, and one-way ANOVA. The purpose course is to provide students the theoretical and applied background needed to understand, develop, and effectively use statistical and probabilistic models for decision making in industrial engineering and other engineering fields. The use of statistical computer packages and spreadsheets is strongly emphasized for problem solving. This course is a requirement in the B.S. in IE and it is a prerequisite for the following required course in the IE curriculum, ININ 4009 Work Measurement, and ININ 4155 Design and Analysis of Production and Inventory Systems.

**Course Goals**

At the completion of this course, students should be:

- Proficient in probability modeling and its applications to engineering problem solving.
- Able to identify engineering problems that require the use of experimental techniques.
- Proficient in the application of regression analysis to solve problems in industry.
- Able to use effectively software packages for One-Way ANOVA and regression analysis, to interpret their standard output, and to use it to solve engineering problems.
- Able to combine, mathematics, and engineering knowledge to develop stochastic models.

**Requirements**

All students are expected to come to class on time, and prepared; do all assigned readings and related homework; actively participate in class discussions; and satisfy all assessment criteria to receive credit for the course.

**Department and Campus Policies**

**Class attendance:** Class attendance is compulsory. The University of Puerto Rico, Mayagüez Campus, reserves the right to deal at any time with individual cases of nonattendance. Professors are expected to record the absences of their students. Frequent absences affect the final grade, and may even result in total loss of credits. Arranging to make up work missed because of legitimate class absence is the responsibility of the student. (Bulletin of Information Undergraduate Studies).

**Absence from examinations:** Students are required to attend all examinations. If a student is absent from an examination for a justifiable reason acceptable to the professor, he or she will be given a special examination. Otherwise, he or she will receive a grade of zero or "F" in the examination missed. (Bulletin of Information Undergraduate Studies).

**Final examinations:** Final written examinations must be given in all courses unless, in the judgment of the Dean, the nature of the subject makes it impracticable. Final examinations scheduled by arrangements must be given during the examination period prescribed in the Academic Calendar, including Saturdays. (See Bulletin of Information Undergraduate Studies).

**Partial withdrawals:** A student may withdraw from individual courses at any time during the term, but before the deadline established in the University Academic Calendar. For engineering students, the maximum total number of course withdrawals, while enrolled at UPRM, is seven (see Bulletin of Information Undergraduate Studies).

**Complete withdrawals:** A student may completely withdraw from the University of Puerto Rico, Mayagüez Campus, at any time up to the last day of classes (see Bulletin of Information Undergraduate Studies).

**Disabilities:** After introducing and identifying himself/herself to the instructor and the institution as a student with disability, the student will receive reasonable accommodations in his/her courses and evaluations. For additional information, contact Services to Students with Disabilities at the office of the Dean of Students; tel. 787–265–3862 or 787–832–4040 exts. 3250, 3258.

**Ethics:** Any academic fraud is subject to the disciplinary sanctions described in Article 14 and 16 of the revised General Student Bylaws of the University of Puerto Rico contained in Certification 018-1997-98 of the Board of Trustees. The professor will follow the norms established in articles 1-5 of the Bylaws.

**Sexual Harassment: Certification 130-2014-2015 states:** Sexual harassment in the workplace and in the study environment is an illegal and discriminatory act and is against the best interests of the University of Puerto Rico. All persons who understand they have been subject to acts of sexual harassment at the University of Puerto Rico may file a complaint and request that the institution investigate, where necessary, and assume the corresponding action by the university authorities. If the complainant is a student, he or she must refer his or her complaint to the Office of the Student Ombudsperson or that of the Dean of Students.

**Hostigamiento Sexual: La Certificación 130-2014-2015, indica:** El hostigamiento sexual en el empleo y en el ambiente de estudio es una práctica ilegal y discriminatoria, ajena a los mejores intereses de la Universidad de Puerto Rico. Toda persona que entienda ha sido objeto de actuaciones constitutiva de hostigamiento sexual en la Universidad de Puerto Rico podrá quejarse para que se investigue, de ser necesario, y se tome la correspondiente acción por parte de las autoridades universitarias. Si quien reclama fuera estudiante, deberá referir su queja a la Oficina de la Procuradora Estudiantil o al Decanato de Estudiantes.

**Certification 36 (2018-2019): Discrimination by Sex and Gender on Modality of Sexual Violence:**

“The University of Puerto Rico prohibits discrimination based on sex, sexual orientation, and gender identity in any of its forms, including that of sexual harassment. According to the Institutional Policy Against Sexual Harassment at the University of Puerto Rico, Certification Num. 130, 2014-2015 from the Board of Governors, any student subjected to acts constituting sexual harassment, may turn to the Office of the Student Ombudsperson, the Office of the Dean of Students, and/or the Coordinator of the Office of Compliance with Title IX for an orientation and/or formal complaint.”

**Certification 06-43 of the Academic Senate states, "The academic guidelines for offering online courses," defines:** Traditional face-to-face courses are those that have less than 25% of the course's regular contact hours via the Internet. Therefore, a three-credit course will be considered "face to face" if, of the 45 hours of regular contact, 11 or less are taught via the Internet. According to certification 16-43 of the Academic Senate, a course may include up to 25% of its total contact hours via the Internet. The objective of this is so that all professors have this alternative in the case of any unscheduled eventuality.

**Law 51:** The Comprehensive Educational Services Act for People with disabilities states that after identifying with the instructor and the institution, the student with disabilities will receive reasonable accommodation in their courses and evaluations. For more information contact the Department of Counseling and Psychological services at the Office of the Dean of Students (Office DE 21) or call 787-265-3864 or 787-832-4040 x 3772, 2040 and 3864.

## General Topics

Lecture	Topic	Reading
<b>1-8</b>	<b>One-Way Analysis of Variance</b>	
1	Introduction to industrial statistics. Short review of basic concepts in probability and statistics.	Ch. 2 (all); Secs. 3.1 & 3.2; 4.1 & 4.2; Ch. 5 (all); 6.1 to 6.5
2-5	One-factor experiments. Analysis-of-variance technique. The strategy of experimental design. One-way analysis of variance: completely randomized design (one-way ANOVA). Graphical methods and model checking.	Secs. 13.1 to 13.3
6	Bartlett's test to test if several samples come from populations with equal variances.	<b>Class notes</b>
7-8	Comparing a set of treatments in blocks. Randomized complete block designs. Graphical methods and model checking.	Secs. 13.6 & 13.7
<b>1-15</b>	<b>Probability Distributions, Goodness of Fit Tests &amp; Joint Distributions</b>	
9-13	The Gamma Distribution. The Beta Distribution. The Lognormal Distribution The Weibull Distribution. Applications and Reliability.	Ch. 6, secs. 6.6, 6.8, 6.9, & 6.10
14-15	Maximum Likelihood Estimation. Numerical methods using MathCad, Excel, or MatLab	<b>Class Notes</b>
16-19	The chi-squared goodness of fit test. The Kolmogorov-Smirnov test.	<b>Sheskin</b> , Tests 7 & 8, and class notes.
20-22	Joint Probability Distributions. Bivariate normal distribution.	Sec. 3.4 and class notes.
23-25	Means and variances of linear combinations of random variables. Mean and variances of functions of random variables.	Secs. 4.1-4.3 and class notes.
<b>16-30</b>	<b>Multiple Linear Regression</b>	

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26-29	Introduction to Linear Regression. Least Squares. Choice of a Regression Model. Data Plots and Transformations.	Chap. 11
30-33	Linear Regression Model Using Matrices. Properties of the Least Squares Estimators. Inferences in Multiple Linear Regression. Study of Residuals and Violation of Assumptions.	Secs. 12.1 to 12.5 and 12.10
34-36	Choice of a Fitted Model through Hypothesis Testing. Categorical or Indicator Variables.	Sec. 12.6 & 12.8
37-41	Multiple regression using Minitab: Sequential methods for model selection. Cross validation, $C_p$ , and other criteria for model selection. Special nonlinear models for non-ideal conditions.	Secs. 12.9 to 12.12

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