

Course: CEE 304

UNCERTAINTY ANALYSIS IN ENGINEERING

GENERAL INFORMATION

2nd semester

Credits: 4CU-6UC

Lectures: M 09:30-11:30; W 09:30-11:30

INSTRUCTOR(S)

ALBERTO LUCEÑO

Catedrático de Universidad. Departamento de Matemática Aplicada y Ciencias de la Computación.

COURSE OBJECTIVE

The course provides an introduction to probability and statistics, statistical techniques, and uncertainty analysis with examples drawn from civil, environmental, industrial and related engineering disciplines. Specific topics include: data presentation, discrete probability theory, commonly used probability distributions (normal, lognormal, gamma, Weibull, Gumbel, Poisson, binomial, geometric), probability plotting papers, survey sampling & experimental design issues, parameter estimation (MLEs and moments), confidence intervals, hypothesis testing (Student t; one/two-sample/paired), some nonparametric statistical tests, simple linear regression and an introduction to multiple linear regression and model selection.

TEXTBOOK

Probability and Statistics for Engineering and the Sciences, last edition

Jay L. Devore

Duxbury, Belmont, CA.

(Optional material in packet includes Julie Ann Seely, Student Solution Manual for Devore's, Duxbury, 2004)

REFERENCES AND ADDITIONAL INFORMATION

2nd Text: Paul Velleman, ActivStats, Pearson/Addison Wesley, 2002. The CD includes DataDesk analysis software.

See www.datadesk.com/products/mediadx/activstats/.

Copies of the CD are available in E.T.S. de Ingenieros de Caminos Library; or, students can purchase their own copy and share with a friend - be social & enjoy! Runs on PCs and Macs. Lots of fun.

The course uses the Devore textbook and the CD-ROM ActivStats to supplement lectures. Seely's solutions manual for Devore is entirely optional - but many students like to see solved problems.

Internet (this is free): One can learn much using Internet facilities. For example, one may go to Google and write -"Erlang distribution" WIKIPEDIA- or -"lognormal distribution" NIST- to get reports on these distributions (NIST stands for National Institute of Standards and Technology of the U.S.).

Software: MINITAB Student Version 14 for Windows. Minitabstudent handbook by Thomas A. Ryan.

GRADING

Two preliminary exams, final, works in the classroom and/or homeworks, computing assignments, possible quizzes. (2 × 25% Prelims; 35% Final; 15% Everything else)

POLICIES

Each student is expected to every day “read” the texts (Devore and ActivStats) before coming to the classroom. Doing so, each student will be able to ask more interesting questions and everybody will have an opportunity to talk about important details.

Each student is also expected to every day “study” the texts (Devore and ActivStats) and perform homework assignments (if any) after each lecture. In doing so, students are strongly encouraged to help one another to understand the material and to develop solution strategies. With that strategy, each student is expected to work out their own solution to assignments. There should be no collaboration during exams - exams are when each student can demonstrate what they have learned.

COURSE SYLLABUS

UNCERTAINTY ANALYSIS FOR SAMPLES.

Describing and Measuring Variability in Samples.

Descriptive Statistics.

Day	Topic	Devore 7th Sections ActivStats Chapters	Page
1-2	Population & sample; Univariate Data: relative frequency, frequency distributions summary tables, display, statistics (quantiles)	Sec. 1.1-1.4, Ch. 1-4,6 Handout	1-45
3-4	Bivariate Data; joint frequency distribution: marginal & conditional distributions variance-covariance matrix & correlation	Handout	

UNCERTAINTY ANALYSIS FOR POPULATIONS.

Describing and Measuring Variability in Populations.

Probability Theory & Probability Distributions.

Day	Topic	Devore 7th Sections ActivStats Chapters	Page
5-6	Elements of probability Conditional prob., Total Prob., Bayes theor. Independence, (Counting)	2.1-2.2, Ch. 12-14 2.4 2.5, (2.3)	46-59 67-76 76-82, (59-65)
7-8	Discrete random variables, CDF, PMF Expectation, mean, variance, Bernoulli, binomial, geometric & neg. bin. dist. Poisson distribution and Poisson process	3.1-3.2, Ch. 15.1 3.3 3.4-3.5 3.6, Handout	87-100 100-108 108-121 121-9; 157-63
9-10	Continuous random variables, PDF Moments; Normal distribution Expon. & Erlang-Gamma dist. (Poisson process)	4.1-4.2, Ch.5 4.2-5.5; 4.3 4.4, handout	130-144 144-157, 219-24 157-163
11-12	Lognormal dist. (structural reliability) Gumbel and Weibull distributions Derived distributions & Simulation	4.5 4.5 5.3, Handout	163-170 202-12
13-14	Joint and conditional distributions & independence; joint moments	5.1, Ch. 7-8 5.2-5.3, 5.5	184-196, 189 196-212, 219-24
14-15	Distribution of sample mean (reliability ex.) Central Limit Theorem (CLT)	Ch. 16 5.4	 213-219
16	Review for Preliminary I. Preliminary I exam.		

¹This document is based on Professor J. R. Stedinger's teaching material with modifications.

UNCERTAINTY ANALYSIS FOR SAMPLES & POPULATIONS.

*Using the variability in Samples to Infer the Variability in Populations.
Statistical Inference².*

Day	Topic	Devore 7th Sections ActivStats Chapters	Page
17–18	Sampling & Simulation Probability Plots (PP), Quantile-Quantile (QQ) Plots, Goodness-of-fit tests, P-values	Ch. 10 4.6 Handout Handout, 8.4 § 16.1.5 & 16.2.3	170-9, 313-4
19–20	Bias, variance, mean squared error (MMSE est.) Maximum likelihood principle & estimators estimators of binomial p , exponential	6.1, §15.2-15.3 6.2	227-43 243-52
21–22	Method of moments, comparison of MM & MLE Confidence intervals (CIs) & sampling dist. sampling properties & CIs for normal mean and fraction p (large & small sample results) CIs for normal variance	6.2, Ch. 16-18 7.1 7.1-7.3 7.4	227-43 254-63 254-78 278-80
23	Another look at CIs: Hypothesis testing Normal test, Type II error Student t ; CI and test, (Tb A.5, p. 671) Testing a correlation coefficient with Student t	8.1, Ch. 19-20 8.2 8.2 handout	284-94 294-306
24	P-values, Choice of hypothesis (Tb A.8) Two-sample CIs and tests paired & unpaired; CIs and tests	8.4-8.5, Ch. 21, 25 9.1-9.2 9.3	311-21 325-43 344-64
25	Review for Preliminary II. Preliminary II exam.		
26	Sign, Wilcoxon sign rank, rank-sum tests	15.1-15.3	599-618
27–28	Regression - Linear Model analysis Regression precision; model choice; the meaning of “linear” model; etc.	12.1-12.2, Ch. 8-9, 24 12.3-12.4	446-68 468-85
29	Sec: Regression extras, Handout R ² and correlation	12.5, 13.1-13.5	485-567
30	Finish topics; Review for final Final Exam		

²Students are not responsible for material in Chapter 13 on the final exam; however, this material is often used in practice - really. Save Devore – Statistics happens.