ChE book reviews

STATISTICAL METHODS FOR ENGINEERS AND SCIENTISTS

By Robert M. Bethea, Benjamin S. Duran and Thomas L. Boullion
Marcel Dekker, Inc., 1975. 583 pages.

Reviewed by Richard W. Mensing,
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Anyone writing a book on statistical methods for engineers is confronted with a decision about what statistical topics to include in the book. There are many areas of engineering and the most applicable statistical methods are not the same for all groups. For example, industrial, traffic and electrical engineers frequently use probability modeling as a tool in analysis. Thus, the most applicable statistical methods for these engineers includes estimation, tests of goodness of fit, regression analysis, and statistical analysis of data taken over time. Reliability is a topic of principle concern to nuclear and mechanical engineers so life test data, statistical analysis of exponential, Weibull and lognormal data and propagation of errors are of utmost importance to this group. On the other hand, chemical, sanitary and materials engineers are often concerned with experimental data and thus make heavy use of regression analysis and the analysis of variance. The authors of this book address themselves to the latter group of engineers and as such cover most of the usual topics which would be introduced in a first course in statistical methods for these engineers.

After a brief introduction, Chapter 2 introduces the basic concepts of probability. This is followed by a chapter on distributions. Included in this chapter are both experimental distributions (as usually derived from sample data) and theoretical or probability distributions. The notion of the mean and variance of a probability distribution is also introduced in this chapter. Expected values and moments are again covered in Chapter 5 along with joint probability distributions and the independence of random variables. These chapters represent the introductory background material on probability. Chapter 4 covers descriptive statistics. Basic statistical inference is the topic of Chapters 6 and 7. Estimation is covered in Chapter 6. Also introduced in this chapter are three sampling distributions, the t, X^2 and F distributions. Chapter 7 covers the usual tests of hypotheses about means, variances and proportions. The method of the analysis of variance is introduced in Chapter 8 as a method of comparing several normal populations. One, two and three way analyses of variance are covered. Also, Bartlett's test for comparing several variances is discussed in Chapter 8. Regression analysis, including simple linear, multiple linear, polynomial and nonlinear regression is the topic of Chapter 9. A separate chapter, Chapter 10, is devoted to orthogonal polynomials. The final chapter is on experimental design and covers the analysis of variance associated with completely randomized, randomized complete block, latin square and split plot designs. Factorial experiments are also discussed in this chapter.

In considering this book as a textbook for an introductory course in statistical methods for engineers and scientists, I believe it has several drawbacks. For one, there are several places where I think the book is too terse, particularly in introductory sections and sections on definitions. For example, in Chapter 3 on distributions, a random variable is defined as "a function from a sample space to the real line" with no further discussion. I do not believe this brief definitiion is enough for someone encountering this concept for the first time to really understand what a random variable is and what its importance is in statistics. Also, populations and a sample (defined as "part of a population") are only defined, but, although it is used throughout the book, there is no discussion of a *random* sample. In Chapter 11, much of the terminology surrounding experimental design (e.g. treatments, experimental units, experimental error, factors, etc.) are only *briefly* defined with only a minimal amount of discussion. This certainly would have to be supplemented by the instructor for a student to gain an understanding of these terms. On the other hand, for a methods book, I believe the authors go into too much theory on some topics. This is particularly true in Chapter 5 on expected values where there are several derivations which are unnecessary.

The authors mention that the book is intended for undergraduate students in engineering and the physical sciences. I believe the students should be upper level undergraduate or beginning graduate students. A two-quarter course which

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follows the outline of this text is taught at Iowa State University for advanced undergraduate and graduate level engineers. This sequence has a laboratory associated with it in which the students can apply the statistical methods to problems in their particular area of engineering. For these problems, the students have access to a computer to perform most of the routine computations. This is particularly true for regression analysis and analysis of variance computations. This, I believe, is another shortcoming of this book; namely, very little mention is mode of the availability of a computer to do much of the calculations. Most of the methods of regression analysis and analysis of variance are based on hand or desk calculator computations. These methods should be discussed with the use of a computer in mind.

Finally, as an introductory book for engineers, the important topics of (i) goodness of fit tests, (ii) propagation of errors and (iii) nonparametric methods are ignored or only treated briefly. The latter two topics are not covered while the chi-square goodness of fit test is used to test the parameter p of a binomial distribution and then it is mentioned that it can also be used for continuous distributions.

The authors do an excellent job of using examples to illustrate the statistical methods discussed. Most of the examples are related to chemical engineering. Also, each chapter contains many problems which should be interesting to the students (answers for selected problems are included).

In summary, the authors point out in the Introduction that "There are no statistical procedures which are applicable only to specific fields of study. Instead, there are general statistical procedures which are applicable to any branch of knowledge in which observations are made." This book introduces a subset of these procedures which are illustrated by examples taken from engineering. As such, there are several texts in this area which anyone considering a book for adoption might look at along with this book. □

BLOCK AND GRAFT COPOLYMERIZATION, VOLUME 2

Edited by R. J. Ceresa
John Wiley and Sons, 1976.

Reviewed by R. E. Cohen,
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The title of this book is misleading. Only about 75 of the more than 365 pages deal directly with block and graft *copolymerization* (polymer synthesis). The remainder focuses on interesting and rather informative material regarding properties and engineering applications of certain block and graft copolymers. This particular volume (evidently the second of a series, although neither the contents of volume 1 nor of forthcoming volumes could be found) treats only two varieties of copolymers . . . Chapters 1 and 2 on Block Copolymer Polyol Surfactants . . . Chapters 3 and 4 on Block and Graft Copolymers of Poly (vinyl chloride).

The two chapters on polyol surfactants (by L.G. Lundsted and I.R. Schmolka) suffer from the shopping-list approach for presenting properties and potential applications. There is little attempt to provide any basic connection between copolymer synthesis, resulting molecular structure, and the properties observed. The excessive use of (bold face, capitalized) trade name acronyms tends to detract the reader. However, it should be noted that the authors and editor have organized the physical properties data into easily used tables and data-grids.

Chapter 3 on PVC blocks and grafts (by R. J. Ceresa) is without question the most satisfying in terms of technical content and adherence to the title of the book. In brief fashion (30 pages) the many possible synthesis techniques are reviewed and the resulting copolymer structures described. Chapter 4 (by D. Hardt) on properties and applications of PVC copolymers follows logically from the synthesis material presented earlier. There is better balance between structure-property relations and applications in this chapter than in the first two chapters of the book.

In addition to his work in Chapter 3, the editor is to be congratulated for a fine organizational job with the overall volume. Tables and figures are conveniently located in the text, the table of contents and appendices are very complete and detailed, and there is a novel "addendum" section put together just prior to publication in order to bring the reader up to date in a fast-moving area of polymer technology. In summary, this is a well organized book which should be of great value to readers with very *specific* interests in the two classes of polymers described; however, the level of general interest among polymer scientists and technologists will no doubt be minimal. □