displacement method and analysis of support settlements conclude the chapter. The computer program entitled "PROGD" (Displacement Method of Truss Analysis) is studied in great detail.

Chapter 5 treats continuous beam analysis. The initial topics are transfer of loads on elements to degrees of freedom and stiffness matrix of a beam span. This continues with the derivation of the stiffness matrix of the entire beam model and the effect of support settlements. The accompanying computer program is entitled "PROGE" (Analysis of Continuous Beams by the Displacement Method). The concluding section extends the use of "PROGE" to rigid frames without joint translation. Chapter 6 proceeds with plane frame analysis. Beginning with the calculation of joint jorces from fixed-end forces, this forges ahead to the analysis of the local stiffness matrix of combined truss and beam element. This continues with the previously derived local stiffness matrix of a truss element. The rigid frame analysis includes axial deformation. Program, "PROGF" (Plane Frame Analysis) solves a combined truss and beam element plus the proper checks.

Chapter 7 neglects axial deformation in rigid frame analysis. The chapter opens with a choice of 2 sideways freedom action from the 4 static horizontal and vertical deflections. We journey ahead into the composition of the global stiffness and deformation matrices. This encompasses the solution of the acting gravity and wind loads on the truss and their redistribution to the joints. The conjugate beam method is employed to determine the member stiffness matrix. This continues with the implementation of the matrix displacement method. A detailed solution is furnished using "PROGG" (Rigid Frame Analysis Neglecting Axial Deformation).

Chapter 8 speaks about plane grid analysis and its variations. The local stiffness matrix is derived using the beam element with torsion effect. The principle of virtual work explains the torsional effect quite well. The local stiffness matrix (east-west and north-south) can be easily obtained from the more elaborate local stiffness matrix which includes the effect of torsion. Elastic supports are included since they do play an important role. An elaborate solution utilizing "PROGH" (Plane Grid Analysis) is made. This includes rigid supports under uniform load. The next chapter covers space rigid frame analysis. This is a 3-D space frame and includes the 12 degrees of freedom and the proper angle inclination. The element deformation and stiffness matrices are derived and used in a computational version using "PROGI" (Space Rigid Frame Analysis).

Chapter 10 reports on limit analysis of continuous beams and rigid frames. The author defines plastic moment capacity, plastic hinge rotation and stepwise elastic analysis to collapse. The latter comprises the first and second stage elastic analysis and can be employed to shorten the solution of the plastic analysis of a truss element. "PROGJ" (Limit Analysis of Rigid Frames) studies numerically an example of a continuous beam and rigid frame. Based on knowledge gleaned in previous chapters, this leads to truss analysis by methods of parts. One divides a truss into interior connecting degrees of freedom. The most direct and economical way of assigning element numbers are pointed out. One uses them in obtaining the local and connecting stiffness matrices. We employ "PROGK" (Truss Analysis by Method of Parts) in solution of the truss.

The concluding chapter focuses upon plane frame analysis by the method of parts. The standard method of finite elements with the proper significance of the element numbers for a box girder containing diagonal braces is the computational subject of this chapter utilizing "PROGL" (Plane Rigid Frame Analysis by Parts).

Appendix A contains additional examples with accompanying solutions employing "PROGA" to "PROGL."

In summary, this is a good book. The worked out problems and their solutions are the highlights of this book. The reviewer would have liked to see more extensive analysis of beam elements including shear deformation. Transfer matrices applied to beams would be a great asset to this book. A short section on vibration analysis would be a most welcome addition to this book. This would employ matrix methods and stiffness matrices. The reviewer further believes that FORTRAN should be stressed instead of BASIC. The former is used extensively in engineering office computer programs on microcomputer and main frames. However, the reviewer does recommend this book to those interested in the matrix analysis of structures.

Probability, Random Variables and Stochastic Processes—2nd Edition,
A. Papoulis,
McGraw-Hill Book Co., New York, NY,
1984, 576 pages, $44.

This is not an ordinary book on stochastic processes! The author revised the first edition in a very complete scientific manner and included a number of new topics. This authoritative text is seldom referred to in the technical journals. It is a gem; the author explains the various facets in a clear and lucid manner devoid of higher mathematics. Random variables and stochastic processes have trudged along a rocky road. This stems from the vagueness and obvious lack of continuity between the various aspects of probability as studied in introductory courses and the more sophisticated ideas required in present-day applications. Books on this subject present a short discourse on the above topics but lack the basic understanding of the fundamental concepts. The book remedies this situation by taking the reader in hand and cleverly leads us along a straight path devoid of obstacles. As stated by the author, "I made a special effort to stress the conceptual difference between mental constructs and physical reality . . . . In physical sciences the theories are so formulated as to correspond in some useful sense to the real world, whatever that may mean . . . . The physical justification of all the theoretical conclusions is based on some form of inductive reasoning." The book consists of 3 parts divided into 15 chapters and a fairly comprehensive bibliography.

The initial part describes probability and random variables. Chapter 1 reports on the meaning of probability and its various definitions. This encompasses relative frequency definition, probability of an event, validity of data and choice of possible and favorable outcomes, i.e., (*a*) Maxwell-Boltzman statistics, (*b*) Einstein statistics, and (*c*) Fermi-Dirac statistics. The three proposed models are in reality only hypothesis and the researcher will only select one of the above where his consequences agree with his experience. This continues with the relative concept of probability and the idea of induction and follows with the category of casualty versus randomness. The author concludes that scientific theorems are not discoveries of the laws of nature but rather inventions of the human mind.

Chapter 2 reports on the axioms of probability. He defines set theory and operations, probability space, axiomatic definition of an experiment, and the conditional probability of an event. The book investigates the idea of total probability, independence of events, and introduction to Bayes theorem. Chapter 3 follows with the topic of repeated trials. This proceeds with asymptotic theorems (Gaussian function) and DeMoivre-Laplace theorem. This is noted as an equality of the limit plus Poisson processes. An application of the latter is "random points" where the probability of a certain number of points will be within a specified interval and respective length. The chapter concludes with a short but clear concept of Bayes theorem and its respective statistics. A number of illustrative examples explain the different concepts.

Chapter 4 delves into the concept of a random variable (RV), i.e., process of assigning a specified number to each of the outcomes. The cumulative distribution function and properties of distribution function (continuous, discrete, and mixed types) and density function (frequency function) proceed in a definite order. The normal (Gaussian), binomial, Poisson, gamma, and Erlang densities are special cases of RV. Our next topics are conditional distributions and conditioned failure rate of a system. The chapter ends with a vivid consideration of the total probability theorem and a clear understanding of Bayes theorem. The author applies in detail to the employment of "past observations in determining the unknown probabilities."

Chapter 5 continues with functions of one random variable. The author details in clear language the distribution of a function within its proper limits as to staircase function, discontinuous and a relatively smooth staircase function. We next consider the definition of mean with both discrete and conditional mean of an RV. The mean can also be interpreted as a Lebesque integral. The book states the relationship of the variance to the standard deviation for the discrete type and Poisson distributed RV's. Our next topic is moments (normal, absolute, and generalized) in normal random variables for Rayleigh and Maxwell densities. The concluding section covers Tchebychev inequality, its generalization and characteristic functions of an RV. This includes moment theorem, cumulants for discrete and lattice type of RV. A good chapter with excellent illustrative examples!

Chapter 6 speaks about two random variables. The opening sections consider both joint distribution and joint density, marginal and joint statistics and existence theorem. This leads to the masses (joint, probability, and line), statistical independence and circular symmetry. This proceeds with one function of two random variables which includes normal density with its consequent independence and convolution. Next, we meet two functions of two random variables and their respective joint densities plus linear transformation. The next chapter reports on moments and conditional statistics. This comprises concepts of joint moments, covariance, vector sums of random variables, and estimate of the mean. We then encounter joint distribution functions, conditional distribution, Bayes theorem, and total probability. This forges ahead to conditional expected values in RV's and mean square (MS) estimate (linear, nonlinear, orthogonality principle) and geometric interpretation of the orthogonality principle. Chapter 8 explains the general concepts of random variable, its independence, correlation, and covariance matrices. Then, we cover conditional densities and its expected values, characteristic function and normality, Chi square statistics, random sequences plus various concepts of stochastic convergence. Ergodicity and Markoff's theorem are introduced with mention of first order theorem.

Part II initiates stochastic processes. Chapter 9 opens with statistics of stochastic processes, its second order properties and autocorrelation. Special processes encompass Poisson and Weiner. The authors define correlation and covariance, white noise, normal processes plus point and renewal processes. Stochastic inputs constitute memoryless system, square law distribution, fundamental theorem of linear systems, and output correlation. Ergodicity closes the chapter with its various analog techniques. Appendix 9A and B discuss continuity, differentiation, integration, and use of shift operators in stationary processes.

Chapter 10 plunges ahead into studying the concepts of spectral analysis. Initially the author considers autocorrelation and power spectrum for linear systems and their various phases. The important Hilbert transforms and their relationships to quadrature filter (shot and thermal noises) with a direct application of Nyquist theorem. The Paley-Weiner condition is applied to the square integrable spectrum that is regular. The chapter concludes with spectral representation by means of Fourier series, Karhunen-Loeve expansion, Fourier integrals and transforms plus their respective properties. The appendices elaborate on spectral representation by means of Fourier series.

Chapter 11 covers application of random modulation. The latter can be expressed by Rice's representation via Hilbert's transforms. This proceeds with bandpass processes and frequency modulation (FM). They can be represented by Woodward's theorem and proper consideration of wide and narrow band FM's, pulse amplitude modulation or cyclostatimarity process. This includes frequency shift keying (FSK), continuous in phase FSK, discontinuous phase FSK, differentiated phase shifting FSK. The book expounds upon normal processes with a short discussion on Price's and Bassgang's theorems. The next topic is Brownonian movement where the motion is described by a differential equation. The last topic ponders upon the many facets of level crossing problem. This involves (*a*) expected number of crossings, (*b*) level crossing density, (*c*) zero crossing density in normal processes, and (*d*) first passage time.

Part III stresses selected topics. Chapter 12 exposes queing theorem, shot noise, the continued version of Markoff process. The initial scheme extends Poisson points to random intervals and distance between stated points. Queing theory utilizes Markoff chain and is tempered by ergodicity. The authors explain shot noise with reference to its density and moment functions, normality and high density and intensity. All are stated in terms of the power spectrum. The book expands Markoff processes with due explanation to Chapman-Kolmogaraff and Kolmogaraff theorems. The author extends it to discrete and continuous Markoff chains and continuous state processes, accompanied by an interesting solution employing the Fokker-Planck equation.

Chapter 13 deals with mean square estimates. The initial topic is the orthogonality principle employing Yule-Walker equation and geometric interpretations of the RV's as vectors. Stochastic processes are further extended and stated by means of (*a*) predictions, (*b*) filtering, (*c*) interpolation as a deterministic approach, and (*d*) quadrature. Smoothing and prediction follow. The latter concerns itself with continuous-time signals, employment of Levinson's algorithm, Wold's decomposition, lattice filter, wide sense Markoff process, and autoregressive signals. One accomplishes filtering of white noise in terms of discrete-time processes. The important Kalman's filter is applied to nonlinear systems using ARMA process and accompanying Kalman-Lucy equation. The concluding section examines adaptive filters and approaches it by employing filters, time varying parameters, Widrow algorithm, and time varying estimates. Appendices delve into minimum phase functions and all pass functions.

Chapter 14 covers spectral estimation, i.e., assessing the power spectrum of random data in terms of expressed data. Starting with deterministic aspect of random data, i.e., given a value of the autocorrelation $R(\tau)$ for every τ in terms of a specified interval. For the window method, one replaces the unknown part of $R(\tau)$ by zero and employs the estimates of the power spectral density. Good windowing requires fine resolution and reduction of leakage. The four special cases of typical windowing are (*a*) Bartlett, (*b*) Tukey, (*c*) Parzen, and (*d*) minimum bias. Maximum entropy (ME) uses the results of Chapter 13. This method is a special form which fits the autocorrelation functions in a specified manner. Should the data be strongly stochastic, bias for both rectangular and triangular impulses became important. Other important factors are (*a*) variance of the spectral sample, and (*b*) spectral and log window. Burg's method estimates the power spectral density.

The last chapter delves into all ramifications of the entropy theory applied to stochastic problems. In heuristic interpretation of entropy, the measures of uncertainty and information always play important roles in the event. An important application of entropy determines the probability of an event, subject to various constraints. Entropy is a number assigned to a partition consisting of a number of events. Important features of entropy consider continuous RV, joint entropy of two discrete RV's and conditional entropy. For ME, the determination of various parameters of a probability spare subject to given restraints must usually be accomplished numerically. Certain special cases concentrate on constraints in the form of expected values. This is accomplished by means of familiar variational techniques, i.e., Lagrange's multiplier or Euler's equation. The chapter concludes with the various codes employed in binary order, Shannon, Fanno, and Hoffman, plus channel capacity. The prime purpose of the latter is to determine the rate of information that can be transmitted through the channel.

In summary, this is an excellent book. It covers a good deal of information seldom found in other books on the subject. The book must be read carefully. The reviewer would have preferred seeing a table of abbreviations, a section on cepstrum analysis, and a more elaborate discussion of digital data processing accompanied by simple computer programs. The important topics of cross-spectrum and partial coherence are barely mentioned. Nevertheless, the reviewer recommends this book to those interested in obtaining information on random processes.

Proceedings of Sixth International Modal Analysis Conference (IMAC),
D. J. DeMichele, Editor and Director,
Union College and Society of Experimental Mechanics,
1988, 1729 pages, $200.

This is a "humdinger" of a conference. Each succeeding conference attains greater esteem. From its inception to the present conference, the topics become "meatier." This is truly an international conference with authors from various countries. The entire collection of papers present interesting information pertaining to modal analysis and its various "cousins", i.e., vibration, acoustics, instrumentation accompanied by finite elements and associated computer programs. The newest addition this year are the topics on "Lanczos Method" and "System Identification and Control." As stated by the editor, "An international body of distinguished authors share their knowledge and experience in solving complex problems using modal analysis technology and offer them as a guide to readers in the pursuit of their own particular activities. These proceedings will act as a guide to individuals and institutions in pursuing analytical and experimental endeavors." The 2 volumes comprise a keynote address, 22 different topics containing 275 papers, plus an addendum.

Professor L. D. Mitchell opened the conference with a keynote address. He states that experimental modal analysis (EMA) reached its present status due to the difficulty of properly analyzing commercial type structures. Finite Element Analysis (FEA) jumped into the breach. Present day analysis employs EMA to pinpoint and improve the modelling differences of FEA. The trend towards increased activities in EMA has reached a plateau. This is exemplified by reduction of new entries to the modal analysis field, slowness in development of linking FEA to EMA plus difficulty in reducing labor and capital costs in EMA. New innovations in EMA will spur growth. This is indicated by the modal analysis helping designers produce a product for redesign before the prototype is installed. Essentially EMA and FEA approached each other in the early 60's and 70's. Both communities, i.e., FEA and EMA are trying to make a lasting marriage but we have a long way to go. Although given great hurdles and "hurrahs," only the aeronautical and certain elements of the automotive industry employ EMA extensively. The present "foundation" firms are not prepared for the CAD/CAE/CAM revolution since the basic and fundamental CAE and CAD are still in their infancy. Both FEA and EMA have areas that must be resolved in order to move the modal analysis upward from the plateau. For future growth, there must be an integration of CAD/CAE/CAT/CAM communities and, above all, reduce computing time and increase computer power. More extensive use of multiple parallel processors should be factored in this effort in order to reduce computer time and analysis procedures.

The topics presented at this conference comprise the following:

Topic	Papers
Experimental Case Histories	13
Analytical Methods	34
Modal Test Methods	23
Lanczos Method	4
Processing Modal Data	10
Damping	5
Noise/Acoustic	12
Nonlinear Structures	12
Modal Techniques for Rotating Machinery Diagnostics	13
Finite Element Analysis	11
Transducers & Instrumentation	5
Linking Analyses and Test	15
Structural Dynamics Modification	33
Experimental Techniques	17
System Identification and Control	5
Machinery Diagnostics	10
Seismic Topics	4
Substructuring	12
Space Structures	8
Design Methods	5
Modelling Structures	14
Vehicular	6
Addendum	2

In "Experimental Case Histories," the initial paper claims that control scientists do not give credit to structural dynamacists idea and breakthrough in modal analysis. Other prominent papers state that results based on inadequate emphasis on details for a lightly damped structure can be significantly altered, proper utilization of tools in successful troubleshooting of structural problems, investigation of air baffle faiiures in motor generators (analyses and testing), troubleshooting using modal analysis for a crooked centrifuge. This continues with a new complex condensation method on use of time domain analysis and operational deflection shapes computed from time histories, vibration and noise reduction of thermowindows and a case study of propeller induced vibrations in the afterbody of fast patrol boats.

Analytical methods consist of a number of different topics. The opening papers report on a perturbation approach in determining eigenvalues and eigenvectors for nonproportionally damped systems, presentation of old and new modal identities in structural dynamics, further study of modal damping matrix for multidegrees of freedom systems plus investigation of a component modal synthesis technique in determining dynamic characteristics of a system. Additional papers consider ARMA use in determining Frequency