

tegral. A number of examples illustrate the TD solution. The chapter concludes with a thoughtful mathematical description and derivation of random excitation. The input excitation is a stationary random process. This is applied to both TD and FD.

Chapter 6 considers multidegree of freedom (MDOF) systems. Beginning with the two degree of freedom (TDOF) system, the deterministic vibration is developed. This leads to random vibration of TDOF and MDOF systems with derivation and application of auto and cross correlation and response spectral density for both damped and undamped conditions. The alternative approach generalizes the complex frequency response for the equivalent response functions to matrix of functions. The complex frequency response, impulse response and stationary random function conclude the chapter.

Chapter 7 focuses upon response of continuous systems. The shear beam is used as the prime example. As a previous chapters, deterministic vibration via modal solutions initiates the subject. Stationary and concentrated random excitation follow in order. The author touches upon random vibration of a thin plate. Our next topic is the alternative solution of shear beams, where again, the uncoupled SDOF systems are applied in either time or frequency domain. The random vibration of a dam reservoir system subjected to vertical ground acceleration is exploited. The alternative impulse response function solves the dam problem where the hydrodynamic pressure corresponds to the shear force. The frequency response function and power spectral density response conclude this section. In a similar manner, the dam-reservoir is excited by a horizontal acceleration simulating an earthquake event. A very good chapter!

The next chapter covers the design of structures for random excitations. The stationary Gaussian process (random variable) is defined. The probability of upcrossings over a specified level and probability density of the peaks introduce this phase of the subject. The author applies this to the concept of structural design against yield failure using an SDOF and a dam-reservoir subjected to vertical ground acceleration. The chapter concludes with structural damage against fatigue and includes the Palmgren-Miner (PM) rule and stationary narrow band random loading. The reviewer would have preferred seeing actual random test data since PM is limited as to excitations and may be unconservative at times.

Chapter 9 treats nonstationary response which is a time dependent response of structures. Beginning with an SDOF system having stationary excitation, we again utilize the dam-reservoir system (vertical acceleration excitation). This continues into systems with nonstationary excitation containing Priestley's complex integral model. Zero damped and lightly damped SDOF systems inaugurate this topic. An alternative approach is Bendat and Piersol's model which employs the autocorrelation function for zero mean excitation and nonstationary spectrum. The dam-reservoir with nonstationary excitation concludes the chapter.

The last chapter develops random vibration of structures in the plastic range. The random walk model is the eye-opener. It encompasses basic probability definitions (mass probability, mass function, conditional probability) and then derives the Chapman-Kalmagarov-Smolchoewski equation applied to structural response. Application of random walk model to a nonlinear structure and solution of the Fokker-Plunck equation complete the chapter.

The appendices include Fast Fourier Transform (FFT) in random vibration and Monte Carlo simulation plus references.

In summary, this is a good book. The author spares no effort in making the reader understand random vibration. The

mathematics which may seem to be a roadblock are easily mastered. The reviewer would have preferred seeing sections on Hilbert Transform and cepstrum analysis. This would be a great help to those interested in the application of random vibrations to present-day problems. The reviewer recommends this book to those interested in learning about random vibrations and their applications.

Finite Elements—Special Problems in Solid Mechanics—Vol. V,

J. Tinsley Oden and G. F. Carey,
Prentice-Hall Inc., Englewood Cliffs, N.J.,
1984, 273 pages, \$37.95.

Finite element (FE) has tripped the light fantastic toe from the bare elements in the late 1950's to the more sophisticated state of today. This book resides in the latter realm and covers topics and procedures that are in the realm of modern research. This little volume is meant for the scholar and the analytical engineer interested in applying the latest information on FE. As stated by the editors, "A more useful objective was to identify a small collection of special problems in solid mechanics, that shares the following characteristics (1) they are important in a practical sense (i.e., the solutions are of significant interest in application), (2) they are difficult and involve intricate mathematical features that require special attention in order to obtain reasonable results, (3) an analysis of the problem based on sound mathematical and physical arguments is possible and methods for their solution can be described which have a reasonable degree of reliability, (4) their analysis and numerical results obtained have a degree of permanence (i.e., the accounts of the subject given should be of interest to readers working in these subjects for some time to come), and (5) the nature of the problems are such that they generally cannot be solved by brute force application of the FE methods—special FE algorithms must be tailored to deal with the special features of each problem." To this, the reviewer says "amen."

There are 5 chapters, each written by author or authors from both here and abroad. Chapter 1 describes numerical analysis of thin shell problems. The linear equations are derived at the mid-surface. This follows with classes of nonlinear shallow shell problems. The middle surface strain tensor and Koiter's modified change of curvature tensor are employed. This follows with stress measures which are derived from strain measures, variational formulations, exceedance, and uniqueness theories. This leads to conforming FE methods with numerical integration, effect of numerical integration (abstract error estimate), asymptotic error estimates with examples of the following c' triangular FE (a) Bell, (b) Hermite, (c) reduced Hermite, (d) Lagrange type, and (e), Argyris. This continues with c' composite triangular FE, i.e., (a) Hsieh-Clough-Tocher (HCT) and reduced HCT, (b) Hermite and reduced Hermite, and (c) Lagrange of type 2 and 3. The c' rectangular FE is the Bogner-Fox-Schmidt. This is then applied to the computation of an arch dam problem using the Argyris triangular scheme.

Chapter 2 reports on FE in nonlinear incompressible elasticity. The chapter begins with basic mechanic preliminaries, i.e., (a) stress-free response configuration, (b) equilibrium equation, and (c) minimization formulations. With this under our belt, the mathematical formulation, including equilibrium equations, are considered. This follows with the approximate problem, i.e., finite domain second discrete approximation spaces, compatibility conditions plus

the minimization and penalty formulation and mixed formulation. The solution of the FE set of equations are performed by Newton's method. The authors furnish a description and improvement of the method. The concluding section speaks about augmented Lagrangian algorithm. This entails a new formulation for handling equilibrium problems in nonlinear elasticity, an augmented Lagrangian formulation and the basic iterative method utilizing a positive definite matrix. The chosen example is the buckling of a thick rectangular beam.

Chapter 3 covers the FE of localization in plasticity. As an example of localized plastic flow, the FE furnishes good results when compared to experimental information. The numerical analysis brings out an interesting observation concerning the development of shear bands for nonhomogeneous deformation status. Based upon numerical results, the shear bands propagate against adverse deformation gradients. Other studies show that bifurcation-related phenomena play important parts in shear band development. The geometry of the emerging shear band pattern is sensitive to the nature of shear band development. In considering problems of localized shear, important mesh effects plus a detailed comprehension of the relation between solution of this discretized problem and the underlying continuous problems require further development. One must include physically relevant length scale into the constitutive description rather than using the artifacts of the FE mesh. It is also noted that strong mesh distortion go along with localization. It shows up particularly in the analysis of localization in the vicinity of crack tips. In order to provide resolution in this strong nonuniform field, a redefinition near-tip mesh would be of extreme value. The constitutive relations as used in the numerical analysis have a number of self-contained features. They are yield surface vertices and microvoid nucleation and growth, material rate sensitivity, and coupled thermo-mechanical effects.

Chapter 4 dwells on contact problems in elastostatics. The chapter opens with a short description of Signorini's problem, i.e., problem of finding the deformation and contrast force for equilibrium conditions of the body under certain boundary and loading conditions. The initial problem considers small deformations. The equilibrium conditions and boundary conditions are employed in deriving the differential equations. The next phase is the variational formulations of Signorini's problem with friction. A special case considered is the prescribed tangential stress (due to friction). The author describes the resolutions and penalty resolutions of the contact problem. This leads to FE approximation and its convergence. The four-node isoparametric element applied to integration of the trapezoidal formula for each boundary segment. The second special case is the first special case except the normal stress and actual contact a priori; FE and convergence of the FE are then proven. The chapter concludes with three examples, (a) Hertzian problem with friction, (b) footing problem in a nonhomogeneous elastic foundation with friction, and (c) axisymmetric problem of an annular punch.

The last chapter describes the problem of nonlocal friction in contact problems in plane elasticity. The chapter begins with a description of the micromechanics of friction, rationale, and description of nonlocal friction model. This leads to the variational principle for Signorini's problem with nonlocal friction. This includes the existence and uniqueness of solution of nonlocal friction problems. The chapter concludes with an interesting short dissertation on FE approximations, its error estimates, and four algorithms for nonlocal friction problems. An example of the indentation of an elastic half space by a rigid cylindrical punch concludes the chapter.

In summary, this is a thought-provoking book. Each chapter is mathematically involved and requires intensive reading. The references are extensive, excellent, and up-to-date. The reviewer does recommend this book to those in-

terested in advanced applications of FE to specialized solid mechanics problems.

Shaft Alignment Handbook,

J. Piotrowski,
Marcel Dekker Inc., New York and Basel,
1986, 273 pages.

This book is a "sleeper." Although not widely publicized and quoted in the literature, it contains a great deal of useful and practical information. Usually, shaft alignment of rotating machinery does not occupy a high exalted "chair." One performs it when breakdown occurs or if it is thought that alignment should be considered. Present-day equipment is more complex than the previous reciprocating steam engines and requires meticulous scrutiny. This ensures that pumps, compressors, gears, and turbines operating for long periods of time will continue without any provocation. Careful maintenance and detailed records of the equipment (vibration measurement) are a prime necessity. In recent years, predictive maintenance programs and predictive maintenance techniques have joined hands. They raise the levels of improved performance in trying to presage the exact time of failure as the vibration amplitude steadily increases. This will prevent the machine from coming to an abrupt halt due to untimely maintenance and prediction of failure. All people concerned with alignment should know their job functions as well as being intimately acquainted with fundamental engineering concepts. They must understand the mechanical aspects of alignment. Poor training of mechanical people, improper tooling, and lack of desire cause machinery to be misaligned. Good training in understanding the tools, as well as the ideas associated with proper maintenance of running, are a *must*. This book contains 10 chapters and an appendix containing a detailed machinery data card and an excellent checklist.

Chapter 1 introduces the subject of alignment and details the proper way in performing the task. Alignment occurs in basic ways, i.e., parallel and angular. Misalignment is defined. The need for understanding the task of alignment and keeping records is a requisite. The chapter concludes with a detailed summary of an overall alignment job and points out the forthcoming chapters for more detailed discussion. Chapter 2 reports on the proper conditions for foundations, baseplates, and machine casings. Foundation or machine casings instigate alignment problems for rotating machinery. Care must be given as to proper inspection and detailed investigation of piping strains, cracks in concrete base, and any undue induced thermal strains to the rotating equipment. The book furnishes a detailed visual inspection checklist with special reference to foundations. The chapter concludes with good tips for designing foundations and installation of foundation and turbomachinery.

Chapter 3 expounds upon flexible couplings, i.e., device connecting rotating shafts. The book points out the active role of flexible couplings and methods of specifying a good coupling. The various pros and cons of different couplings are considered. They are (a) chain couplings, (b) diaphragm couplings, (c) elastomeric couplings, (d) flexible disc couplings, (e) flexible link couplings, (f) gear couplings, (g) leaf-spring, (h) metallic grid coupling, and (i) pen drive coupling. Each has its proper place. Since the couplings have to be attached to the shaft, the author enumerates a number of important concepts. The most prominent are straight base (sliding interference or interference fit with keyway) and locking taper