radiation below the critical frequency plus using numerical methods as an alternative to experimental endeavors for determining sound radiation. The author employs full blown mathematics in explaining these phenomena.

The next chapter develops the application of signal energy, i.e., mean or integral square of the signal resolved into narrow or broad band frequency. In order to measure noise in a rotating fully assembled machine, vibration and acoustic information must be obtained during operation. Faults in a rotating machine consider employment of an envelope method in measurement of high frequency resonance and gear transmission errors from noise data. The powerful cepstrum method separates the source and path from each other. This also furnishes a smoothing procedure by extracting the low time components of the cepstrum plus separation of different frequency multiples in a complicated spectrum. Excellent examples consider diagnostics of a horizontal centrifuge, valve and valve-seat impacts with an expanded analysis of valve resonance. An inverse filter could be employed in undoing spectral distortion due to propagation in the valve-valve seat impact. The chapter ends with the aspect of uncertainty in vibration transmission due to a distant location from the source plus the re-evaluation of transfer function behavior in structures due to their low modal overlap.

Chapter 7 opens up with the topic of diagnostics using signal phase and discusses the recovery of a temporal wave form of a source of vibration and the diagnostics that employ the phase of a signal. The initial topic studies experimentally cylindrical pressure waveform recovery via pressure transducer. The experimenters accomplish this by drilling a hole in the head of a diesel engine. Cepstrum analysis rears its head by separating a source and path characteristics in the diesel engine problem. Structural problems could affect the transfer function phase but mathematical relations permit us to relate the phase to other measured quantities. A good example would be to compare the phase of the transfer function with the phase delay of a bending wave between source and receiver. An interesting discussion of the poles and zeros of a transfer function are in order with due explanation of the drive point system functions. We now venture forth in expanding the phases in one-dimensional acoustic pipe and two-dimensional rectangular rooms. The next topics report on experimental studies of phase travel in a plate and the phase variability of the structural transfer function of an engine structure. The final section shows how it is possible to relate the phase and log magnitudes via Hilbert transform of a lightly damped structure.

The final chapter covers advanced topics in diagnostics using machine monitoring systems. The possibility of designing a diagnostic system using wave form recovery would be in the future. However, much remains to be accomplished in achieving such a system. Future diagnostic system design and application require the adaptive processor. This is hampered by the tremendous expense of both hardware and software. The chapter concludes with the identification of systems employing orthonormal functions, i.e., Laguerre and Hermite functions. The former has problems concerning large number of terms in obtaining the proper order of the frequency spectrum or complexity in the impulse response. Hermite functions don't have this problem with respect to representing the transfer function. Work is in progress in attempting to utilize Hermite function expressions in system representation.

In summary, this is an excellent book. The author accomplishes his goal and more. The reviewer would have preferred seeing (a) table of nomenclature (aid to reader), (b) relation of modal analysis to acoustic intensity, (c) transfer matrices applied to acoustics, and (d) more elaborate examples in the excellent acoustic intensity section. Furthermore, the reviewer feels that in the bibliography section for journals, this publication, the Journal of Vibration, Acoustics, Stress Analysis and Reliability in Design, should have been included. A number of excellent papers have been published in our journal. Nevertheless, the reviewer does recommend this book to those interested in tackling the problem of machinery noise reduction.


This book delves into the inelastic behavior and buckling performance of tubular members. This information is absolutely essential in assessing realistically the strength and risk in offshore structures. Most tubular members undergo a combination of flexural and axial loads in offshore structures and must be treated as beam-columns. In solving the latter, virtually all available techniques (experimental and analytical) are used. They range from the simple to computer-based methods which incorporate material and geometrical nonlinearities. As stated by the authors, "This book has been planned so that it can be used as a text for the practitioner and as a reference work for the research worker. The purpose of this book is to ... (a) review the course of research on cylindrical beam-columns as used in offshore structures, (b) discuss the beam-column problem to highlight the particular difficulties associated with cylindrical tubes in offshore structures, (c) present analytical techniques that are capable of dealing with tubular members in framed structures, and (d) show how existing design rules can be improved and new design rules can be developed".

The book consists of 8 chapters. Each chapter contains an excellent set of references.

Chapter 1 introduces the book and details the information to be furnished in later chapters. The chapter continues with the plastic response of tubular sections as described by four parameters, i.e., moment, thrust, axial deformation (cycle buckling and straightening) and curvature. The current AISC-CRC column curve and interaction formulas can be employed in the design of tubular columns in offshore structures. However, there is a need for developing an analysis capability for predicting the strength and behavior of these members. The action of external pressure due to hydrodynamic consideration may significantly reduce the axial load carrying capacity of these tubes to less than predicted by AISC-CRC column curve. The authors review the Shanyan model curve for beam columns and furnish their basic assumptions. The book considers limit state design. The basic aim is to provide a reasonable margin of safety for the structure upon entering a limit state (plastic deformation).

Chapter 2 derives the moment-curvature relations between moment (M), axial load (P) and curvature (ψ) for the beam column control. The pure bending (M-ψ) relationship is derived for both elastic and plastic regions. This leads to the derivation of the M-P-ψ relations, boundaries of stress state and simplified M-P-ψ relations in the elastic-plastic region. The tangent stiffness method (TSM) divides the tube into cross sections (small elements) and obtains total axial force and bending moment by summing up the effects of stresses on all elements. The book continues by introducing effective Young's modulus and employs the Tresca yield diagram. Residual stresses are then considered and Marshall proposes a simplification of the slicing method. This compares favorably with the hole drilling technique. A computer subroutine (TANGENT) calculates the generalized strains for a given stress increment step-by-step. Residual stresses significantly reduce the stiffness of cross sections in the
Chapter 3 reports on buckling strength. Real columns contain imperfections. At the beginning of application of an axial force \( P \), deflections begin with initial deflection \( w_o \). There is no bifurcation or sudden change of deflection as load increases. The eigenvalue approach is exemplified by the critical load of the Euler column which is for a highly idealized column. It requires a number of assumptions in order to determine the effective length. The more representative beam columns employ the reduced modulus (tangent modulus) in obtaining the critical load. The tangent modulus approach takes into account the effect of residual stresses and other material related nonlinearities. This proceeds ahead into the study of the Column Research Council (CRC) guide in deriving the column strength curves. The author furnishes an example of the elastic analysis of beam columns in bending eccentrically load- ed accompanied by a full blown discussion of the SSRC curves. For numerical procedures, the Newmark integration method is proposed to compute the deflected shape of the beam from a given curvature distribution. This is applicable due to the nonlinear nature of the beam-column system. A subroutine, "NEWMARK" employs the numerical integration method. This can be used for initially loaded and eccentrically loaded columns. The NEWMARK program was utilized in comparing Lehigh University test data for full scale pinned-ended long column specimens. They were found to be quite agreeable with computed results.

Chapter 4 experiences post buckling behavior of individual tube members. The load displacement curve becomes nonlinear near the ultimate or peak value. Beyond the latter, a plastic hinge gradually forms at the critical section of the beam-column. A simplified approach called assumed deflection method (ADM) is called into play in order to perform the behavior of beam columns to ultimate load. This includes post-buckling unloading. Mathematical formulation for pinned-ended and fixed-ended beam columns are derived in the elastic range, primary and secondary yield range. A subroutine, DFLCTN, which contains a subsidiary routine "SHOT G2" for calculating shortening and ROTCUB for solving the cubic equations. For a beam column with a small imperfection, the load deflection or shortening curve shows an apparent sharp peak. For large imperfections (> 0.01), the curve becomes more flat. After reaching ultimate strength, the peak load remains almost constant in the past peak range. Axial shortening's main contribution is due to axial strain and not geometrical change. After buckling, the opposite occurs. Tests were conducted and agreement between experiment and theory were fair. Certain discrepancies arose in the axial load versus deflection and axial load versus shortening.

Chapter 5 focuses upon cyclic behavior of a beam column by an approximate method. Cyclic behavior can be considered as the first cycle of axial load-deformation hysteresis loop. The chapter begins with a study of the hinge-hinge method for elastic-plastic behavior of steel structures. The initial attempt in the general formulation in compression is (a) initial elastic loading, (b) one hinge formed in compression, (c) both hinges formed in compression, and (d) elastic unloading in compression. For a tensile axial load force, the same equations previously utilized in the compressive case are employed except the sign of the axial load is reversed. The analysis considers (e) elastic tension, (f) one hinge formed in midspan in tension, and (g) both hinges formed in tension. The axial load-axial deformation relations for axial shortening (elongation) occur where elastic axial straining happens along the length of the column and the other one is due to lateral deflection. A subroutine "FIXCYCL" calculates the hinge-by-hinge method. Although the latter is quite crude, it agrees reasonably well with experimental results. The main discrepancy occurs at stages of post-buckling and elastic-plastic tension. They are probably induced by inaccurate evaluation of axial shortening.

The next chapter explains a more refined method for cyclic behavior by improving the hinge-by-hinge method. This refined procedure combines the finite segment method (FSM) and influence coefficient method (ICM). This is a type of the Newton-Raphson iterative technique and is based on conditions of equilibrium. The author rigorously formulates the ICM. This is applied to pinned-ended beam columns, a fixed ended beam column and an end restraint column. All are characterized by matrix equations for ease of computation. The main problem in ICM occurs when the local deflection is not reasonable; i.e., convergence cannot be guaranteed. The subroutine ICM combined with FSM solves the beam column problems. A subroutine "BCYCL" solves the cyclic behavior of pinned, fixed or any type of restraint when the rotation relations of the supports are specified. In order to precisely predict cyclic behavior \( M - P - \phi \) and \( M - P - \epsilon \), relations are required. Appendix I states the expressions for \( M - P - \phi \) relations and Appendix II presents the \( M - P - \epsilon \) relations.

Chapter 7 delves into hydrostatic pressure effect on tubular members in deep water. The tubes must be designed as imperfect beam columns. An additional compressive hoop stress combined with axial strain must be included. The inelastic buckling of perfect and imperfect thin walled columns are now on the agenda. The chapter continues with the derivation of the nonlinear analysis for large shortening by finite elements. Calculations performed by use of computer program, determines the strength of centrally loaded and unloaded columns. The authors propose design formulas for sectional capacity of the ultimate strength relations of the bending moment and the external non-hydrostatic axial load for a fabricated tubular cross section. Based on their work, the authors furnish design formulas for columns with axial end loads and eccentrically end loads in a beam column. The last chapter considers pipe bending analysis. Due to nonlinearity of the pipe, which is caused by large final lateral deflection, the authors approach the problem by means of FSM and incremental tangential stiffness (ITS). The FSM replaces the actual tubular pipeline by an assembly of finite segments. They formulate the problem and solve it approximately in terms of the behavior of these segments without recourse to the complicated differential equation. Displacements and rotations are taken into account at each nodal section. The direct stiffness method is employed in computing the segment stiffness matrix. Geometric and material nonlinearities are handled by application of a modified tangential stiffness approach. The segment stiffness matrix relates the six forces to the six displacements, similar to the finite element method. The axial load bending deformations are considered separately. The section properties are deemed to be constant within the segment. Axial stiffness, bending and shear stiffness (with the effect of axial tension and compression) matrices are derived for the segment. The differential equations. They are placed in proper matrix form. If the axial compression (tension) is small, simplified expressions are used and the resulting stiffness matrices are derived. Furthermore, the book presents expressions for coordinate transformation. For large displacements, the stiffness matrix no longer remains constant during loading and relies upon the deformed geometry. Here, the nonlinear problems are solved as a series of linear steps. The programming of FSM is similar to the typical finite element problem but the iteration process for large displacement analysis is somewhat different. Subroutine "MTANGNT" contains the iterative process. The authors provide illustrative examples utilizing this subroutine. The book concludes with a detailed example of a pipeline under laying operation.
In summary, the reviewer was greatly impressed by the merits of this book. The methods stated in this book can be employed in underground piping at ambient temperature in nuclear and chemical plants. The reviewer would have preferred seeing sections on fatigue analysis, employment of random vibration analysis in offshore structures and application of seismic loading in offshore piping. The reviewer recommends this book to mechanical engineers who are interested in applying tubular piping in structural analysis.


Coupled problems exist in engineering. In order to be amenable to calculations, the coupled problem has to be reduced in complexity and many times sharply simplified. This permits easy analysis. Due to the involved difficulties, the coupling was not considered. Lately, better understanding of the algorithms and physical processes, coupled with vast improvements in computer power, permits one to employ in greater detail the coupled effects. As quoted in the book, “Many important engineering problems require an integrated treatment of coupled fields. These problems are characterized by the dynamic interaction between fields, so that the response of the overall field has to be calculated concurrently... . These physical couplings can be subdivided... throughout a domain and coupling at interface.”

This book consists of 21 contributed chapters plus an introduction. This volume is a tribute to Olgierd (Olek) C. Zienkiewicz who is often called “The Man.”

Section 1 recounts the life of “The Man,” who may be considered the “god father” of finite elements (FE). His life is traced from his birth in 1921 to the present time. His contributions are vast, informative and truly outstanding. This chapter sets the stage for the rest of the book.

Chapter 1 describes “coupled” in the context of solving physical problems. Two prime categories arise: (a) coupling occurs only at the interface, and (b) in reality different physics occur and there can be an overlapping of problems. The numerical techniques differ in both domains. The author discusses solution techniques and furnishes illustrative examples of fluid-structure and fluid-soil response.

Chapter 2 covers thermo-mechanical deformation of solids subject to both large and inelastic deformation. Due to instability of modern concepts of mechanical constitutive assumptions, the precise generalization of incorporating thermodynamic effects conveys a partial theory of coupled problems. However, the authors consider uniqueness and bifurcation of the problem, plus critical deformations are taken into account. Furthermore, the authors expound upon algorithms needed in the solution of nonlinear algebraic equations. In particular, the quasi-Newtonian technique is stressed. Examples are given concerning cold and hot rolling plus plastic buckling of columns.

Chapter 3 presents the modelling of subelements, i.e., general plasticity, viscoplasticity, and creep behavior of solids under conditions of multiaxial loading. The author formulates a time-independent elastic-plastic analysis. This is founded on viscoplasticity theory plus an associated FE method. The variational formulations of the Hellinger-Reissner principle are considered and an example of a shear lag panel is given.

Chapter 4 explains a numerical formulation for dynamic finite deformation of solids where the rate-independent constitutive equations are exposed. This dogma is founded on uniform 1 linearization of a weak form of the momentum balance equation.

The spatial stress pattern is needed. This is in accord with the spatial rate constitutive equations. This allows linearization of the weak form. In consort with the Newton-Raphson method, one updates the stresses by introducing an unconditionally stable and incremental tangible algorithm. This is needed in the numerical integration of the spatial rate constitutive equations. Examples are provided that involve hyperelastic material and elastic-perfectly-plastic infinite cylinder subjected to internal pressure.

Chapter 5 speaks about an FE study of drying stresses in timber employing viscoelastic and elastoviscoplastic rheological models. At first one determines the shrinkage stresses developed due to the departure and moisture content from the respective initial values as calculated in the second stage. In modelling the initial stage, coupled nonlinear heat and mass transfer differential equations are employed. The first steps of the drying process are modelled by a viscoelastic imposition. The latter states are modelled using an elastoviscoplastic mathematical concept. For mass and heat transfer, we evaluate the influence of the selected time marching concepts plus that of nonlinearity of the thermophysical parameters. Illustrations are given of a typical section of lumber plus the occurrence of stress reversal.

Chapter 6 focuses on two simple models which demonstrate complex dynamic behavior in soil-structure interaction problems. The coupling between a flexible plate or foundation and soil plus other resonances caused by plate flexibility have not always been uncovered. The author delves into this behavior by considering the dynamic response of a beam on an elastic foundation. This example emphasizes the above point by definitely including the distributed mass and damping of the beam in order to acquire sound solutions of the response. The next problem reports on wave excitation of foundations in an elastic media. Usually, one considers vertical incidence. By incorporating horizontal incidence, we encounter an averaging effect which causes the translatory motion of the centroid of the foundation to subside. In proper consideration of a rectangular block on an elastic layer, the rotation on peripheral amplitudes are larger for a vast range of wavelengths on a horizontal incidence rather than vertical incidence.

The next chapter dwells on the classical model of Coulomb friction for static friction. This brings forth a number of difficulties in both mathematical and physical entities and points of view. Mathematically, the existence of solutions to boundary value problems in elasticity employing Coulomb’s law can only be used for very special cases. Recently, a nonlocal model advances the idea that relative motion of a point happens when a weighted average of the stresses in the neighborhood of a point reaches an acute value. The authors study the characterization of nonlocal friction with that of the Signorini problem. The latter deals with nonlocal friction. The authors develop excitation and unique results, plus an approximate theory. A numerical example is presented acclaiming these results.

Chapter 8 encompasses the problem of elasto-plastic analysis of contact problems. In developing an iterative technique, one obtains the correct contact configuration during progressive loading. The authors use this concept in analyzing practical problems via numerical examples.

Chapter 9 investigates concrete on a meso-level. Emphasis is directed towards the effect of pores and inclusions (aggregates). The latter are imbedded in a dispersing medium. It is treated as an elastoviscoplastic porous material having a liquid phase. The applied mathematical model regards both the saturated and saturated-unsaturated flow in the porous media. Numerical results using time-dependent and time-independent behavior of concrete are compared to experimental observations. The author proves that the composite material model...