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Book Reviews

Computational Methods for Transient Analysis. Edited by Ted Belytschko and Thomas J. R. Hughes. North-Holland, The Netherlands, 1983. 523 Pages. Price $69.00.

REVIEWED BY P. BURGERS[1]

This book is a review of many topics fundamental to dynamic numerical analysis, and in particular to finite elements, although some chapters do discuss finite difference methods. The areas covered, in order of presentation, are an overview of transient finite element and difference methods, a detailed compendium of transient algorithms with a heavy emphasis on their stability, techniques of performing partitioned analyses of coupled systems, dynamic boundary element methods, dynamic relaxation, dynamic and spatial dispersion of discretised systems, methods of modeling infinite bodies with finite meshes for dynamic transient problems, explicit dynamic finite difference methods, implicit finite element methods and finally combined Lagragian-Eulerian (ALE) finite element methods. Each chapter has been written by different experts in the particular field but the editing has been thorough so that the cross referencing is quite good.

The introductory chapter was written by Belytschko and serves as very readable background material for the rest of the book, apart from a questionable statement on the most appropriate stress rate to use in finite elements. There is a brief but interesting presentation of 'hour-glass' control of finite elements and then short introductions to other topics in the book. The second chapter, by Hughes, discusses time integration algorithms and their stability in great detail, bringing together many results in dynamic numerical analysis in one place. The majority of the discussion is on linear symmetric systems, these being the ones that have received the most study. This chapter will serve very well as a starting point for anybody interested in getting a good background into the more theoretical side of numerical dynamics. The chapter on dispersion by discretised systems by Schreyer compliments this chapter very well and together they give a good all round review, although it would have been very interesting if the chapter on dispersion had continued in the detail that it started with. As with all the other chapters, there is a detailed reference list of recent work in the area so interested readers can pursue the subject further.

The history and current state of the art (as used by the authors) on the analysis of coupled systems by partitioning the system into a number of subsystems, each with degrees of freedom associated with a single system is presented by Park and Felippa. Examples of this are solid structures interacting with fluid systems or the pore fluid flow through soil. The suitability of the method with linear subsystems or even mildly nonlinear systems seems clear, but it is not obvious to the reviewer that this is true for highly nonlinear systems, e.g. if the problem involves large strains. This chapter is quite comprehensive (and lengthy) and will serve as a good starting point for a newcomer to the area. Modeling of infinite bodies by discretised methods always leads to difficulties. Chapter seven on 'silent boundary' methods in dynamics, by Cohen and Jennings, considers this problem in great detail. The difficulty is that the numerical problem must draw energy out of the mesh through the boundaries. A number of techniques are discussed with the advantages and disadvantages summarized.

The remaining chapters discuss implicit methods in dynamics, such as the BFGS algorithm, dynamic relaxation, explicit Lagrangian finite differences. In final chapter the problem of mesh distortion due to deformation or flow is considered using an arbitrary Lagragian-Eulerian formulation. The concept is very attractive – use a mesh that models the deformation in the best manner for all times of interest and still retains the ease of modeling boundaries that comes with the Finite Element method. The example used to illustrate the technique (which gives an automatic mesh rezoning using the same number of elements) is for fluid-solid interaction. However the idea is possibly suitable for problems just involving a single material type with regions of large deformation, such as seen in forging and extrusion problems. The problem of determining a suitable mapping for the mesh as a function of time remains but the idea certainly has great potential.

In summary this first volume in the series *Computational Methods in Mechanics* published by North-Holland makes for a broad review of the area of numerical dynamics which would be of benefit to both novices and experts in the field.

[1] Hibbitt, Karlsson & Sorensen, Inc., Providence, Rhode Island 02906. Assoc. Mem. ASME.

Random Vibrations of Elastic Systems. By V. V. Bolotin. Martinus Nijhoff, The Hague, 1984. 468 Pages. Price $86.00.

REVIEWED BY S. H. CRANDALL[1]

This masterly monograph on the theory of random vibration is a translation of the 1979 Russian edition. The author is the leading contributor to this theory in the Soviet Union. His book *Statistical Methods in Structural Mechanics* (Russian editions in 1961 and 1965, English translation in 1969) contained an excellent introduction to the subject at the time when activity in this field was just beginning to blossom.

Random vibration as the name of a technical discipline has come to mean the study of the random fields or processes which are the excitations and responses of deterministic dynamic systems. The discipline arose about thirty years ago out of the need to solve three distinct aerospace problems with the common thread of random excitation: turbulent buffeting

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of aircraft, acoustic fatigue of jet aircraft skin panels, and reliability of rocket payloads. In this country the first book with the title *Random Vibration* was edited by this reviewer in 1958. The field of application has now spread from aerospace vehicles to ships, road and track vehicles, buildings subjected to winds and earthquakes, off-shore structures, and heat exchanger tubes. Today the field has achieved a certain maturity and investigations tend to be carried out in well recognized branches of the subject.

The present monograph "sums up the author's work on the theory of random vibrations and its application since 1959." It is indeed impressive to see how many of the present branches of the field owe major contributions to Bolotin and his coworkers. These contributions were independent of, and in many cases came earlier than, comparable developments in the West. There are eight chapters which treat most of the topics in modern random vibration except data processing and the identification problem. After two introductory chapters on random excitation fields and on general methods in the theory, the succeeding chapters are largely devoted to surveying and extending the work of the Bolotin group. Some idea of the breadth of the investigations is given by the following list of Chapter titles with brief comments:

3 Random Vibrations of Linear Continuous Systems – mostly plates and shells;

4 The Asymptotic Method in the Theory of Random Vibrations of Continuous Systems – an approach with some similarities to Statistical Energy Analysis developed here by R. H. Lyon;

5 Parametrically Excited Random Vibration – analytical methods and computer simulations;

6 Random Vibration of Nonlinear Systems – Markov process methods, linearization, and closure of moments, applied to lumped and continuous systems;

7 Reliability and Longevity under Random Vibration – failures due to first excursion or cumulative damage;

8 The Planning of Vibration Measurements in Structures under Random Vibrations – optimum layout of sensors and correction of measurements due to distortions of the vibration field introduced by the presence of the sensors.

For someone working in the field this book is a joy to read. In each problem area the important physical ideas and their mathematical representations are clearly presented, the manipulations are briefly outlined, and the insights obtained from the development are illuminated in a masterly fashion. In fairness, it should also be said that the book is not recommended as an introductory text. The tone is a little too Olympian and the reader is referred to the original paper, too often, for missing details. For any serious researcher in random vibration, however, this is a book well worth reading and returning to from time to time.