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Book Reviews

Continuum Mechanics of Electromagnetic Solids, by Gerard A. Maugin. North Holland, Amsterdam, 1988. 598 pages, Price: $184.25.

REVIEWED BY A. C. ERINGEN[1]

With the development of nonlinear continuum mechanics in the 1960s, attention of engineering scientists was turned to the electromechanical theories of continua. During the following two decades some mechanicians have reopened research fields of continuum electrodynamics, which were considered to be closed by physicists. The present book is a culmination of several aspects of this research. The book consists of seven chapters and four short appendices.

Chapter 1 introduces various elementary concepts such as dielectrics, ionic crystals, ferroelectricity and piezoelectricity. Some divergences are made into the microscopic origin of different phenomenon, e.g., origin of magnetism, different types of magnetic materials, conduction of electricity, and electromagnetic waves. In this way the stage is set for the mathematical development of various interacting fields. Chapter 2 is a review of continuum mechanics. Concepts of strain, strain rates, balance laws, and constitutive equations are discussed and applied to thermoelasticity and some problems in elastic waves. Literature contains many excellent books and treatises on these topics. Therefore, one wonders why the author has devoted some 86 pages to continuum mechanics.

With Chapter 3 the main goal of this book begins. Here balance laws and Maxwell's equations are introduced both in integral and differential forms. Jump conditions at a discontinuity surface are obtained. Electromagnetic stress tensors, momenta, and energy are discussed and a principle of virtual power is formulated.

Chapter 4 is concerned with dielectrics and piezoelectricity. Nonlinear field and constitutive equations are developed. Voigt's linear theory of piezoelectricity is given and applied to the solutions of several problems which include piezoelectically-excited vibrations of plates, piezoelectric Rayleigh and Bleustein-Gulyaew waves.

Chapter 5 is devoted to elastic conductors. After the development of constitutive equations several problems are solved. Magnetothermoelastic waves, shock waves, simple waves, and a magnetoelastic piston problem are among these.

In Chapter 6 the author presents a recent theory on elastic ferromagnets. Because of the spin degree-of-freedom, balance laws and constitutive equations require extensions to include magnetic gyroscopic effects and the interactions of spin and lattice continua. Magnetoacoustic resonance, the Faraday effect, attenuation of magnetoacoustic waves, surface spin waves, Bloch and Neel walls, solitary waves, and buckling and vibrations of magnetoelastic plates are discussed expertly.

Chapter 7 deals with elastic ionic crystals, ferroelectricity, and ceramics. By means of principle of virtual power, two sets of field equations are obtained involving the usual Cauchy's equations of motion and polarization inertia. Constitutive equations include electric and polarization tensors which have been introduced previously by others. The theory is used to solve problems concerning free surfaces, capacitance of thin films, the acoustic activity of ionic crystals, surface, solitary, and shock waves. Some of the investigations, e.g., magnetoacoustic resonance, solitary waves in Chapter 6, and the discussion of waves in ferroelectrics in Chapter 7 are based on the work of the author and his collaborators. While they are sound mathematically, the results do not possess time-honored status and they must await experimental investigations. All chapters contain ample references, but they lack exercises for students.

The price of $184.25 for the book is excessive for student affordability. While the typing is excellent, because of the reduction in size, it requires good lighting and eye sight.

This reviewer became aware of Maugin's book only when he was asked recently to critique it. It is regrettable that nowhere in the book does the author make reference to the two-volume book (now in press) on electrodynamics of continua, which has been in preparation since 1976 under the joint authorship of A.C. Eringen and the author. Major parts of Chapters 1, 2, and 3 (excluding sections 3.6 to 3.8) and those of Chapters 4 and 6 (in total approximately one-third of the book) contain material and organization similar to that of the Eringen-Maugin manuscript, the precursor of this book. This is objectionable.

On the positive side, this book has dense coverage of a variety of contemporary theories of continuum mechanics of electromagnetic solids. It is well written by an author who has been actively involved in research. It should be on the shelves for research workers in the field.

The Nonlinear Theory of Elastic Shells: One Spatial Dimension, by A. Libai and J. G. Simmonds. Academic Press, Inc., 1988. 412 pages. Price: $49.50.

REVIEWED BY J. L. SANDERS, JR.[2]

This is not a textbook or an introduction to the subject for the uninitiated. It is a carefully written treatise on a limited part of the subject of shell theory authored by two experts in the field who have themselves contributed significantly to the literature. A second volume on the general theory (two spatial

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