

REVIEW

Variational Principles in Heat Transfer. By M. A. BIOT. Oxford University Press, 1970. 185 pp. £4.50.

This book describes an attempt to formulate and solve problems associated with irreversible processes by methods analogous to those of classical mechanics. In particular, the phenomena of heat transfer are expressed in terms of Lagrangian-type equations and generalized co-ordinates, and variational principles are developed. Apart from these motivating analogies, the treatment has points of contact with transform methods, with Onsager's work on the thermodynamics of irreversible processes, and with the currently fashionable finite-element methods of numerical analysis.

The concepts and principles are introduced through linear systems of heat flow but subsequently extended to cover temperature-dependent heat parameters and non-linear boundary conditions. These include moving boundaries associated, for example, with problems of melting and ablation. Later chapters deal with convective heat transfer and with boundary layers. An appendix suggests that the approach developed in the book can usefully be applied to a large class of phenomena that involve energy dissipation. Brief reference is made to mass transport, including neutron diffusion, thermoelasticity, viscous fluids and electrodynamics. Finally, the Lagrangian methods are interpreted in the context of functional analysis.

The substance of this account has been published in research papers by the author and others over the last ten to fifteen years. It does appear that the numerical results obtained are sometimes very approximate indeed. Certainly this is true of some solutions obtained for relatively elementary heat-flow problems, largely because practical application of the methods rests on the assumption, for example, of a simple approximation to the temperature profile through the medium. This is not easily capable of improvement nor can the accuracy readily be estimated. Nevertheless, the unifying nature of the concepts is helpful and can have a stimulating effect on the cross fertilization of ideas.

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