

Book Reviews

Advances in Heat Transfer, Volume 4, J. P. Hartnett and T. F. Irvine, Jr., Ed., Academic Press, New York (1967) 458 pages \$19.00

Those who specialize in heat transfer will recognize this volume as the fourth issue of what has become a welcome yearly event. The editors have maintained their practice of publishing select authoritative review articles that develop each topic from basic principles in a concise yet straight forward manner. It is my opinion that this volume is generally successful in meeting these objectives, although the five topics: "Advances in Free Convection," "Heat Transfer in Biotechnology," "Effects of Reduced Gravity on Heat Transfer," "Advances in Plasma Heat Transfer," "Exact Similar Solutions of the Laminar Boundary Layer Equations," span a range in quality that is as broad as the subject matter.

Clearly, the best treatments are given in the chapters on free convection by A. J. Ede, and plasma heat transfer by E. R. G. Eckert and E. Pfender. Ede's examination of free convection illustrates the essential details of evolving theoretical descriptions of laminar and turbulent flow over vertical plane and circular surfaces. Selected experimental data on heat transfer coefficient, temperature and velocity profiles are included. There are 111 references at the end of this chapter on the fundamentals of free convection.

Although many chemical engineers may never encounter fluids with temperatures from 4,000 to 40,000°K, the article on plasma heat transfer is nevertheless highly recommended. Beginning with a definition of the plasma state as a mixture of neutral particles, ions and electrons, the authors consider the particle and radiant energy transfer mechanisms needed to describe thermal and chemical spatial equilibrium. Readers are then introduced to the thermodynamic and transport properties of plasmas, followed by discussion of applications to the space vehicle reentry problem. Since plasmas are

studied principally with electric arc facilities, a discussion of heat transfer in the presence of electric and magnetic fields is included to complete this quite informative article.

The chapter "Heat Transfer in Biotechnology" is doubly interesting, as it relates to items of personal interest and presents heat transfer from the viewpoint of the natural sciences. Although the definition of heat transfer coefficient in units of the 'clo' (5.55 kcal./sq. m.hr°C, or the equivalent conductance of ordinary business clothing) is unique, the philosophy that "useful approximations can be achieved even in the most complicated situations" is not unfamiliar to the engineer. In particular, the author considers those thermal problems encountered by humans in underwater, earth-surface and space environments. Special experimental devices, such as the *pan-radiometer* are described, as well as design criteria for human enclosures for each environment. The chapter is concluded with a treatment of the thermal functions and limitations of the human skin.

The chapter on similarity solutions to the laminar boundary layer equations will prove of interest primarily to those specializing in this area. Eighty pages of computer generated similarity constants allow prediction of heat, mass, and momentum transfer through the boundary layer for varying leading edge sweep angles, mass transfer rates, pressure gradients, wall temperatures and fluid properties. The chapter on reduced gravity effects should be useful for its compilation of 118 references and its discussion of experimental techniques and results with free convection, boiling, condensation and, briefly, combustion.

In conclusion, it seems to this reviewer that **Advances in Heat Transfer**, Vol. 4, will be a broadening, yet basic, addition to the heat transfer specialist's library. If for no other reason, the book is recommended for its absorbing presentation of currently scattered information on Natural Convection and Plasma Heat Transfer, and for an en-

lightening introduction to the sometimes neglected area of natural and human science, for those of us who deal in physical science.

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The Variational Method in Engineering, R. S. Schechter, McGraw-Hill, Inc., New York (1967), 287 pages, \$13.50.

This book, written for engineering students, is a useful introduction to variational methods. It is clearly written and covers a wide range of applications in engineering. Each of the methods treated is developed with care, and is thoroughly demonstrated with examples and problems.

The book is divided into two parts. The first part (Chapters 1 and 2) deals with natural problems, that is, those which are naturally stated in variational form. These problems are treated by solving the appropriate Euler-Lagrange equations. Several excellent examples are analyzed, including optimal designs for a thermoelectric generator, a cooling fin, and various simple reactor systems. Pontryagin's maximum principle is derived and used in the reactor examples.

The second part of the book (Chapters 3 to 7) deals with synthetic problems, that is, problems that one chooses to rewrite as variational statements. Chapter 3 discusses approximate solutions obtained by direct and partial integration methods. Chapter 4 discusses the formulation of the equations of change as variational statements by using the local potential proposed by Glansdorff and Prigogine, and Chapter 5 gives several detailed examples solved by this approach. In Chapter 6 the Galerkin method is given, as well as some additional variational formulations of the equations of change. Chapter 7 contains a local potential formulation for hydrodynamic stability problems.

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