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Book Review

Frank P. Incropera and David P. DeWitt: Introduction to Heat Transfer
John Wiley & Sons, New York, Third Edition, 1996, 801 pp.

The third edition of this book can be regarded as a mature representative of heat transfer pedagogy. The main objective of the text is to extend thermodynamic analysis through study of the models of heat transfer and through development of relations to the calculation of heat transfer rates.

In Chapter 1, the foundation for much of the material treated in the text is laid. First, physical mechanisms are explained which underline the heat transfer modes. Subsequently, the rate equations are introduced that quantify the amount of energy being transferred per unit time. Finally, the conservation of energy for a control volume is treated; in heat transfer, this corresponds to a general formulation of the first law of thermodynamics.

Chapter 2 considers the important properties associated with conduction phenomena in some detail: the conduction rate equation and the relationship of energy conservation to the conduction process. In Chapters 3 to 5, the applications involving various geometrical and time-dependent conditions are dealt with. In this treatment, the authors gradually introduce more complicated conditions. The simple case of one-dimensional, steady-state conduction with no internal thermal energy generation is first considered, and subsequently, the complications due to multidimensional and thermal energy generation effects. Finally, the unsteady or transient heat transfer problems are evaluated, especially the lumped capacitance method. The essence of this method is the assumption that the temperature of the solid is spatially uniform at any instant during the transient process.

Chapter 6 is primarily devoted to providing an understanding of the physical mechanisms that underline convection transfer. Chapters 7 and 8 present methods for computing the coefficients associated with forced convection in external and internal flow configurations, respectively. Chapter 9 describes methods for determining these coefficients in free convection, and Chapter 10 considers the problem of convection with phase change (boiling and condensation). Chapter 11 develops methods for designing and evaluating the performance of heat exchangers, devices that are widely used in engineering practice to effect heat transfer between fluids.

In Chapter 12, the authors examine the means by which thermal radiation is generated, the specific nature of the radiation, and the manner in which the radiation interacts with matter. Particular attention is devoted to radiative interactions at a surface and to the properties that must be introduced to describe these interactions. Chapter 13 demonstrates the means for computing radiative exchange between two or more surfaces.

This book provides a comprehensive introduction to heat transfer for engineering students and for practising engineers working in the energy field. The book can be sug-

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gested as a text book for students in mechanical, chemical and energy systems engineering. Sufficient end-of-chapter problems are provided for these uses.

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Budugur Lakshminarayana: Fluid Dynamics and Heat Transfer of Turbomachinery
John Wiley & Sons, Inc., 1996, 809 pp.

The objective of the book is to cover fluid dynamics and aerothermodynamics in turbomachinery. The author introduces the reader gradually into the science of turbomachinery fluid mechanics and gives an insight into the up-to-date approach to computational fluid mechanics. However, no attempt has be made to address structural or other mechanical aspects of turbomachinery and unsteady flow.
The book consists of 7 chapters 2 appendices and a list of books on turbomachinery.
Chapter # 1 is a useful review of some basic concepts and equations which are useful in the analysis and design of turbomachinery. The author has also provided a critical review of various turbulence models and their application to complex flows.
Chapter # 2 deals with one-dimensional analysis and overall performance, efficiency, non-dimensional representation and bladings used in various types of turbomachinery. Recent advances and projected developments are also briefly discussed.
Chapter # 3 includes the analysis of cascade inviscid flows. The introduced model is an externally useful tool for carrying out a parametric study of the variables of incompressible, compressible, transonic and supersonic cascade flows. For a deeper understanding, numerous special textbooks are referred to.
Chapter # 4 deals with three-dimensional inviscid, quasi-viscous and inviscid effects, which are hardly negligible in present-day turbomachinery. Quasi-viscous method, which incorporate the real fluid effects in an approximate or global manner, are also included in this chapter.
A very important topic discussed in Chapter # 5 is the computation of turbomachinery flows. The suitable approximations and simplifications introduced help by giving the chance to solve the problem of saving calculation time. This very new topic is discussed in a clear way, providing a good understanding through the support of a brief overview of the basic techniques useful in turbomachinery in Appendix B.
Chapter # 6 deals with two- and three-dimensional viscous effects and losses, wich play a major role in affecting the performance of turbomachinery. The author presents a general overview and classification of loss, mechanisms and sources specific to turbonachinery flows.
Chapter # 7 affords a comprehensive picture of turbine cooling and heat transfer. This is a key issue for gas turbines with high inlet temperature.

The author's ability to systematise knowledge, well combined with his critical approach towards the referred scientific literature, makes this book a standard work for anyone interested in the subject matter concerned.
The theoretical establishment of certain details very often means significantly more than turbomachinery application; in this way, the book may greatly assist with problem solving in the fields of fluid dynamics and heat transfer.
This book can be considered one of the most comprehensive works on this subject matter in recent years. Its overall value is emphatically underlined by its up-to-date approach to computational fluid mechanics.
The book is an indispensable tool for professionals, but graduate and postgraduate students in mechanical engineering will also find it very valuable in its comprehensive coverage and numerous references. The appendices help to lay the foundation for a better understanding of the discussed numerical methods.

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D. P. Almond and P. M. Patel
Photothermal Science and Techniques, in the series 'Physics and its Applications' (ser. no.: 10), Chapman & Hall, London, 1996, 241 pp.

Photothermal Science and Techniques is a marvellous source both for students just entering the photothermal field and for researchers already deeply involved in it. One can pick almost any subject within this highly diverse area and Almond and Patel have a chapter devoted to that subject. Even more, the presentation of the book ensures that this is not simply a mere collection of different research topics to be dealt with during the applications of photothermal techniques. It has a clear structure based on the thermal wave approach, i.e. on the wave-like nature of temperature oscillations generated by periodical heating of a sample. This approach makes it possible to use optical theoretical methods which help the reader to understand the potential of thermal wave techniques for both spectroscopic and imaging applications.
An account of the considerable pre-history of photothermal science is presented in the first chapter, 'Photothermal science'. The heart of the book is undoubtedly Chapter 2, 'Thermal waves', in which the thermal wave approach is established. Reflection, refraction, interference and scattering effects of thermal wave approach is established. Reflection, refraction, interference and scattering effects of thermal waves are treated in detail here. Chapter 3, 'Optical generation of thermal waves – photothermal effect', gives the reader the necessary background to understand the details of the optical generation of

thermal waves in different materials such as metals and semiconductors. A clear and sound presentation of the wealth of different photothermal techniques is to be found in Chapter 4, 'Instrumentation and detection techniques'. Next, in Chapter 5, the problem of 'Transient thermal phenomena' is treated. It is the Fourier transformation theory which helps us to understand that the thermal wave theory is still applicable in the event of pulsed heating. The remaining part of the book is devoted to the application of photothermal effects. The two distinct types of application are 'Photoacoustic spectroscopy' and 'Non-destructive evolution', treated in Chapters 6 and 7, respectively. Chapter 8 is devoted to the very special and important area of the photothermal characterisation of semiconductors: 'Thermal wave characterisation of semiconductors'. Yet another large area of application, 'Thermal property determination by photothermal techniques', is presented in Chapter 9. The last chapter, 'Application of photothermal techniques in gases and liquids', is devoted to one of the most active areas of photothermal research, though perhaps not to the extent this important area deserves.

In summary, this is a well-written and sufficiently detailed text on photothermal research and application. As the jacket of the book promises, 'This book provides a sound framework for advanced students, researchers and engineers wishing to enter the photothermal area'. In addition, I would highly recommend this book for those already giving courses on this subject or wishing to do so.

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