

Chapter 1

Radiation Exchange Between Surfaces

1.1 Motivation and Objectives

Thermal radiation, as you know, constitutes one of the three basic modes (or mechanisms) of heat transfer, i.e., conduction, convection, and radiation. Actually, on a physical basis, there are only two mechanisms of heat transfer: diffusion (the transfer of heat via molecular interactions) and radiation (the transfer of heat via photons/electromagnetic waves). Convection, being the bulk transport of a fluid, is not precisely a *heat transfer mechanism*.

The physics of radiation transport are distinctly different than diffusion transport. The latter is a *local* phenomena, meaning that the rate of diffusion heat transfer, at a point in space, precisely depends only on the local nature about the point, i.e., the temperature gradient and thermal conductivity at the point. Of course, the temperature field will depend on the boundary and initial conditions imposed on the system. However, the diffusion heat flux at, say, one point in the system does not *directly* effect the diffusion flux at some distant point. Radiation, on the other hand, is not local; the flux of radiation at a point will, in general, be directly and instantaneously dependent on the radiation flux at all points in a system. Unlike diffusion, radiation can act over a distance. Accordingly, the mathematical description of radiation transport will employ an *integral* equation for the radiation field, as opposed to the *differential* equation for heat diffusion.

Our objectives in studying radiation in the short amount of time left in the course will be to

1. Develop a basic physical understanding of electromagnetic radiation, with emphasis on the properties of radiation that are relevant to heat transfer.
2. Describe radiation exchange among surfaces, in which the surfaces can be perfect absorbers of radiation (black) or diffusely absorbing (gray).
3. Introduce the topic of radiation transfer in a participating medium that absorbs, emits, and scatters radiation, and describe the formulation and application of the radiative transport equation.

Radiation Exchange An Introduction

Luc Thomas Ikelle



Radiation Exchange An Introduction:

Radiation Exchange Jack H. Taylor, 2012-12-02 Here is an introductory examination of electromagnetic radiation This book deals with the radiation laws the phenomenon of radiation exchange the quantification of radiation and the mechanisms whereby radiation is attenuated in passing through the Earth's atmosphere It can be used as a supplement to an introductory physics or astronomy text and also as a guide for members of the infrared community who would like additional insight into the area of radiation exchange The concepts discussed here are well within the grasp of undergraduate students After studying this book the reader will have developed a clear understanding of the phenomenon of radiation exchange and will appreciate more thoroughly its importance in nature and its numerous applications

Introduction to Heat Transfer

Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, 2011-06-13 Completely updated the sixth edition provides engineers with an in depth look at the key concepts in the field It incorporates new discussions on emerging areas of heat transfer discussing technologies that are related to nanotechnology biomedical engineering and alternative energy The example problems are also updated to better show how to apply the material And as engineers follow the rigorous and systematic problem solving methodology they'll gain an appreciation for the richness and beauty of the discipline

Introduction to Engineering Heat Transfer G. F. Nellis, S. A. Klein, 2020-07-30 Equips students with the essential knowledge skills and confidence to solve real world heat transfer problems using EES MATLAB and FEHT

A Textbook of Heat and Mass Transfer, 7e Rajput R.K., 2019 Heat and Mass Transfer is a comprehensive textbook for the students of Mechanical Engineering and a must buy for the aspirants of different entrance examinations including GATE and UPSC Divided into 5 parts the book delves into the subject beginning from Basic Concepts and goes on to discuss Heat Transfer by Convection and Radiation and Mass Transfer The book also becomes useful as a question bank for students as it offers university as well as entrance exam questions with solutions

Introduction to Radiative Heat Transfer Michael F. Modest, 2025-10-01 Michael Modest's Introduction to Radiative Heat Transfer provides instructors and students a concise more affordable alternative to the author's comprehensive signature textbook and reference Radiative Heat Transfer while retaining all of the content required for a one semester senior undergraduate or graduate course on thermal radiation The book retains the hallmark features of the original including its excellent writing style with nice historical highlights and clear and consistent notation throughout Introduction to Radiative Heat Transfer presents radiative heat transfer and its interactions with other modes of heat transfer in a coherent and integrated manner emphasizing the fundamentals It includes numerous worked examples a large number of problems many based on real world situations and an up to date bibliography Contains curated and respected content from the author's more comprehensive text Radiative Heat Transfer but developed specifically for one semester graduate courses in thermal radiation Each chapter shows the development of all analytical methods in substantial detail and contains a number of examples to show how the developed relations may be applied to

practical problems Details many computer codes ranging from basic problem solving aids to sophisticated research tools with actual codes provided on a companion website Includes extensive solution manual for adopting instructors

INTRODUCTION TO HEAT TRANSFER S. K. SOM, 2008-10-24 This book presents a comprehensive treatment of the essential fundamentals of the topics that should be taught as the first level course in Heat Transfer to the students of engineering disciplines The book is designed to stimulate student learning through clear concise language The theoretical content is well balanced with the problem solving methodology necessary for developing an orderly approach to solving a variety of engineering problems The book provides adequate mathematical rigour to help students achieve a sound understanding of the physical processes involved Key Features A well balanced coverage between analytical treatments physical concepts and practical demonstrations Analytical descriptions of theories pertaining to different modes of heat transfer by the application of conservation equations to control volume and also by the application of conservation equations in differential form like continuity equation Navier Stokes equations and energy equation A short description of convective heat transfer based on physical understanding and practical applications without going into mathematical analyses Chapter 5 A comprehensive description of the principles of convective heat transfer based on mathematical foundation of fluid mechanics with generalized analytical treatments Chapters 6 7 and 8 A separate chapter describing the basic mechanisms and principles of mass transfer showing the development of mathematical formulations and finding the solution of simple mass transfer problems A summary at the end of each chapter to highlight key terminologies and concepts and important formulae developed in that chapter A number of worked out examples throughout the text review questions and exercise problems with answers at the end of each chapter This book is appropriate for a one semester course in Heat Transfer for undergraduate engineering students pursuing careers in mechanical metallurgical aerospace and chemical disciplines

Heat Transfer Gregory Nellis, Sanford A. Klein, 2009 This book provides engineers with the tools to solve real world heat transfer problems It includes advanced topics not covered in other books on the subject The examples are complex and timely problems that are inherently interesting It integrates Maple MATLAB FEHT and Engineering Equation Solver EES directly with the heat transfer material **Introduction to Thermal Systems Engineering** Michael J. Moran, Howard N. Shapiro, Bruce R. Munson, David P. DeWitt, 2002-09-17 Ein blick ber technische Aspekte thermischer Systeme In einem Band besprochen werden Thermodynamik Str mungslehre und W rmetransport ein Standardwerk auf diesem Gebiet st tzt sich auf die bew hrtesten Lehrb cher der einzelnen Teilgebiete Moran Munson Incopera f hrt strukturierte Ans tze zur Probleml sung ein diskutiert Anwendungen die f r Ingenieure verschiedenster Fachrichtungen von Interesse sind

Introduction to Catalytic Combustion R.E. Hayes, 2021-10-24 In a clear and concise manner this book explains how to apply concepts in chemical reaction engineering and transport phenomena to the design of catalytic combustion systems Although there are many textbooks on the subject of chemical reaction engineering catalytic combustion is mentioned either

only briefly or not at all The authors have chosen three examples where catalytic combustion is utilized as a primary combustion process and natural gas is used as a fuel stationary gas turbines process fluid heaters and radiant heaters these cover much of the area where research is currently most active In each of these there are clear environmental benefits to be gained illustrating catalytic combustion as a cleaner primary combustion process The dominant heat transfer processes in each of the applications are different as are the support systems flow geometrics and operating conditions

Introduction to Multidisciplinary Science with Artificial Intelligence Luc Thomas Ikelle, 2024-06-24 The book is about multidisciplinary science education The challenges of our time such as improving the length and quality of lives on Earth and short and long distance communication and transportation In this book we provide readers with the multidisciplinary education necessary to meet the scientific and technological challenges of our time while optimizing the college experience for students The fundamental notions addressed in this book include gravitational forces and energy dark matter and dark energy heat transfer in solid Earth stars interiors and human bodies electromagnetic radiation and spectroscopy quantum entanglement and computing accretion disks matter in plasma state and exoplanets We illustrate the importance of these notions with applications across disciplines including monitoring the deformation of the solid Earth s surface using satellite measurements unusual gravity anomalies in Antarctica a view and characterization of the far side of our Moon Earth s climate Titan s anti greenhouse effect long distance communication between Earth and the planets and exoplanets etc Finally the book contains analytical and computational problems including MATLAB software developed especially for the classes associated with this book Key Features Contains multiple analytic and computational MATLAB exercises Explores applications related to space programs discoveries Provides an accessible introduction and response to growing Multidisciplinary Science programs

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