

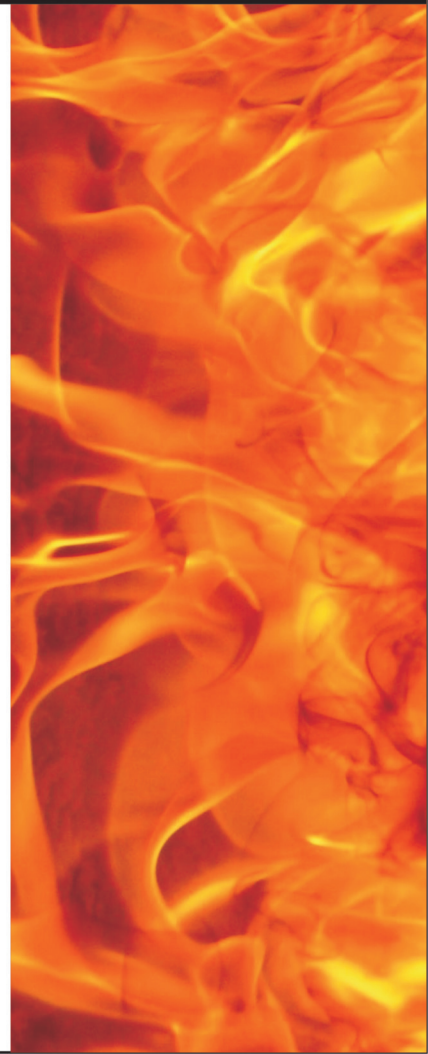


Third Edition

ENGINEERING HEAT AND MASS TRANSFER



Mahesh M. Rathore



**ENGINEERING
HEAT AND MASS
TRANSFER**

ENGINEERING HEAT AND MASS TRANSFER

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ENGINEERING HEAT AND MASS TRANSFER

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Printed and bound in India

Typeset at Goswami Associates

First Edition: 2004; Second Edition: 2006; Third Edition: 2015; Reprint: 2016

ISBN 978-81-318-0613-5

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PUBLISHED IN INDIA BY



UNIVERSITY SCIENCE PRESS

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113, GOLDEN HOUSE, DARYAGANJ,
NEW DELHI - 110002, INDIA

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C—10720/015/08

Printed at: Narain Printers & Binder, Noida

Contents

1.	CONCEPTS AND MECHANISMS OF HEAT FLOW	1–23
1.1.	What is Heat Transfer ?	1
1.2.	Modes of Heat Transfer	2
1.3.	Physical Mechanism of Modes of Heat Transfer	2
1.4.	Laws of Heat Transfer	3
1.5.	Combined Convective and Radiation Heat Transfer	7
1.6.	Thermal Conductivity	8
1.7.	Isotropic Material and Anisotropic Material	12
1.8.	Insulation Materials	14
1.9.	Thermal Diffusivity	17
1.10.	Heat Transfer in Boiling and Condensation	20
1.11.	Mass Transfer	20
1.12.	Summary	20
	<i>Review Questions</i>	21
	<i>Problems</i>	21
2.	CONDUCTION—BASIC EQUATIONS	24–41
2.1.	Generalised One Dimensional Heat Conduction Equation	24
2.2.	Three Dimensional Heat Conduction Equation	26
2.3.	Initial and Boundary Conditions	30
2.4.	Summary	39
	<i>Review Questions</i>	40
	<i>Problems</i>	40
3.	STEADY STATE CONDUCTION WITHOUT HEAT GENERATION	42–99
3.1.	Plane Wall	42
3.2.	Electrical Analogy of Heat Transfer Rate Through a Plane Wall	43
3.3.	Multilayer Plane Wall	44
3.4.	Thermal Contact Resistance	64
3.5.	Long Hollow Cylinder	68
3.6.	Critical Thickness of Insulation on Cylinders	81
3.7.	Hollow Sphere	86
3.8.	Summary	94
	<i>Review Questions</i>	95
	<i>Problems</i>	95
4.	STEADY STATE CONDUCTION WITH HEAT GENERATION	100–135
4.1.	The Plane Wall	100
4.2.	The Cylinder	113

4.3.	Hollow Cylinder with Heat Generation and Specified Surface Temperatures	114
4.4.	The Sphere	126
4.5.	Summary	131
	<i>Review Questions</i>	132
	<i>Problems</i>	132

5. HEAT TRANSFER FROM EXTENDED SURFACES

136–179

5.1.	Types of Fins	136
5.2.	Fin Selection and Applications	137
5.3.	Governing Equation	137
5.4.	Fin Performance	151
5.5.	Approximate Solution of Fin: Concept of Corrected Fin Length	154
5.6.	Error in Temperature Measurement by Thermometers	167
5.7.	Design Considerations for Fins	170
5.8.	Summary	174
	<i>Review Questions</i>	175
	<i>Problems</i>	175

6. TRANSIENT HEAT CONDUCTION

180–233

6.1.	Approximate Solution	180
6.2.	Analytical Solution	199
6.3.	Transient Temperature Charts: Heisler and Gröber Charts	206
6.4.	Transient Heat Conduction in Semi Infinite Solids	219
6.5.	Transient Heat Conduction in Multidimensional Systems	222
6.6.	Summary	227
	<i>Review Questions</i>	228
	<i>Problems</i>	228

7. PRINCIPLES OF CONVECTION

234–265

7.1.	Mechanism of Heat Convection	234
7.2.	Classification of Convection	234
7.3.	Convection Heat Transfer Coefficient	235
7.4.	Convection Boundary Layers	238
7.5.	Laminar and Turbulent Flow	239
7.6.	Momentum Equation for Laminar Boundary Layer	241
7.7.	Energy Equation for the Laminar Boundary Layer	243
7.8.	Boundary Layer Similarities	245
7.9.	Determination of Convection Heat Transfer Coefficient	248
7.10.	Dimensional Analysis	248
7.11.	Physical Significance of the Dimensionless Parameters	253
7.12.	Turbulent Boundary Layer Heat Transfer	257
7.13.	Reynolds Colburn Analogy for Turbulent Flow Over a Flat Plate	260
7.14.	Mean Film Temperature and Bulk Mean Temperature	260
7.15.	Summary	261
	<i>Review Questions</i>	263
	<i>Problems</i>	263

8. EXTERNAL FLOW 266–292

8.1. Laminar Flow Over a Flat Plate	266
8.2. Reynolds Colburn Analogy: Momentum and Heat transfer Analogy for Laminar Flow Over Flat Plate	271
8.3. Turbulent Flow Over a Flat Plate	271
8.4. Combined Laminar and Turbulent Flow	272
8.5. Flow Across Cylinders and Spheres	281
8.6. Summary	288
<i>Review Questions</i>	289
<i>Problems</i>	289

9. INTERNAL FLOW 293–332

9.1. Flow Inside Ducts	293
9.2. Hydrodynamic Considerations	293
9.3. Thermal Considerations	296
9.4. Heat Transfer in Fully Developed Flow	298
9.5. General Thermal Analysis	299
9.6. Heat Transfer in Laminar Tube Flow	303
9.7. Flow Inside a Non-circular Duct	307
9.8. Thermally Developing, Hydrodynamically Developed Laminar Flow	310
9.9. Heat Transfer in Turbulent Flow Inside a Circular Tube	311
9.10. Heat Transfer to Liquid Metal Flow in Tube	325
9.11. Summary	326
<i>Review Questions</i>	329
<i>Problems</i>	329

10. NATURAL CONVECTION 333–371

10.1. Physical Mechanism	333
10.2. Definitions	334
10.3. Natural Convection Over a Vertical Plate	335
10.4. Empirical Correlations for External Free Convection Flow	338
10.5. Simplified Equations for Air	355
10.6. Natural Convection in Enclosed Spaces	361
10.7. Summary	366
<i>Review Questions</i>	367
<i>Problems</i>	367

11. CONDENSATION AND BOILING 372–401

11.1. Condensation	372
11.2. Laminar Film Condensation on a Vertical Plate	373
11.3. Condensation on a Single Horizontal Tube	375
11.4. Turbulent Filmwise Condensation	377
11.5. Condensate Number	377
11.6. Dropwise Condensation	378
11.7. Film Condensation Inside Horizontal Tubes	378
11.8. Boiling	385
11.9. Pool Boiling Regimes	385
11.10. Mechanism of Nucleate Boiling	388
11.11. Pool Boiling Correlations	389
11.12. Forced Convection Boiling	396
11.13. Summary	398
<i>Review Questions</i>	399
<i>Problems</i>	399

12. THERMAL RADIATION: PROPERTIES AND PROCESSES 402–433

12.1. Theories of Radiation	402
12.2. Spectrum of Electromagnetic Radiation	403
12.3. Black Body Radiation	403
12.4. Spectral and Total Emissive Power	404
12.5. Surface Absorption, Reflection and Transmission	404
12.6. Black Body Radiation Laws	406
12.7. Emissivity	413
12.8. Radiation from a Surface	419
12.9. Radiosity	421
12.10. Solar Radiation	423
12.11. Summary	429
<i>Review Questions</i>	431
<i>Problems</i>	431

13. RADIATION EXCHANGE BETWEEN SURFACES 434–485

13.1. Radiation View Factor	434
13.2. Black Body Radiation Exchange	451
13.3. Radiation from Cavities	453
13.4. Radiation Heat Exchange between Diffuse, Gray Surfaces	455
13.5. The Radiation Exchange between Three Surface Enclosures	458
13.6. Radiation Heat Transfer in Three Surface Enclosures	467
13.7. Radiation Shields	470
13.8. Temperature Measurement of a Gas by Thermocouple: Combined Convective and Radiation Heat Transfer	475
13.9. Summary	477
<i>Review Questions</i>	478
<i>Problems</i>	479

14. HEAT EXCHANGERS 486–553

14.1. Classification of Heat Exchanger	486
14.2. Temperature Distribution	489
14.3. Overall Heat Transfer Coefficient	489
14.4. Fouling Factor	491
14.5. Heat Exchanger Analysis	493
14.6. Log mean Temperature Difference Method	494
14.7. Multipass and Cross Flow Heat Exchangers	496
14.8. The Effectiveness-NTU Method	511
14.9. Rating of Heat Exchangers	517
14.10. Sizing of Heat Exchangers	517
14.11. Compact Heat Exchangers	536
14.12. Plate Heat Exchanger (PHE)	540
14.13. Requirements of Good Heat Exchanger	541
14.14. Heat Exchanger Design and Selection	542
14.15. Practical Applications of Heat Exchangers	543
14.16. Heat Pipes	543
14.17. Summary	545
<i>Review Questions</i>	547
<i>Problems</i>	547

15. MASS TRANSFER**554–591**

15.1. Introduction	554
15.2. Modes of Mass Transfer	554
15.3. Comparison between Heat and Mass Transfer	555
15.4. Concentrations, Velocities and Fluxes	555
15.5. Fick's Law of Diffusion	558
15.6. General Mass Diffusion Equation	561
15.7. Boundary Conditions	563
15.8. Mass Diffusion Without Homogeneous Chemical Reactions	564
15.9. Mass Diffusion with Homogeneous Chemical Reactions	576
15.10. Convective Mass Transfer	577
15.11. Dimensional Analysis of Convective Mass Transfer	580
15.12. Evaporation of Water into Air	581
15.13. Summary	588
<i>Review Questions</i>	589
<i>Problems</i>	590

16. EXPERIMENTS IN ENGINEERING HEAT TRANSFER**592–619**

Expt. 1 Thermal Conductivity of Metallic Rod	592
Expt. 2 Thermal Conductivity of Insulating Powder	595
Expt. 3 Thermal Conductivity of Composite Wall	597
Expt. 4 Natural Convection Experiment	599
Expt. 5 Forced Convection Experiment	601
Expt. 6 Heat Transfer from Pin Fins	603
Expt. 7 Stefan Boltzmann Constant	606
Expt. 8 Measurement of Emissivity of a Test Surface	607
Expt. 9 Heat Exchanger Experiment	609
Expt. 10 Critical Heat Flux	613
Expt. 11 Heat Pipe	615
Expt. 12 Thermocouples Calibration Test Rig	617
<i>Review Questions</i>	619

APPENDIX**621–645**

Appendix A. Thermophysical Properties of Matter	621
A.1 Thermophysical Properties of Selected Metallic Solids	622
A.2 Thermophysical Properties of Selected Non-metallic Solids	626
A.3 Thermophysical Properties of Common Materials	628
(a) Structural Building Materials	628
(b) Insulating Materials and Systems	629
(c) Industrial Insulation	630
(d) Other Materials	632
(e) Properties of Common Materials	633
A.4 Thermophysical Properties of Gases at Atmospheric Pressure	634
A.5 Thermophysical Properties of Saturated Liquids	638
A.6 Thermophysical Properties of Saturated Liquid-Vapour, 1 atm	639
A.7 Thermophysical Properties of Saturated Water	640
A.8 Thermophysical Properties of Liquid Metals	641
A.9 Emissivities of Some Surfaces	642
(a) Metals	642
(b) Non-metals	643
A.10 Solar Radiative Properties for Selected Materials	644
A.11 Diffusion Coefficient of Gases and Vapours in Air at 25°C and 100 kPa	644
A.12 Molal Specific Volumes and Latent Heats of Vaporization for Selected Liquids at their Normal Boiling Points	645

INDEX**647–651**

Preface to the Third Edition

The first edition of Comprehensive Engineering Heat Transfer was published in 2000. It was written principally to cater syllabi of Pune and North Maharashtra Universities.

The second revised and enlarged edition was published in year 2005, in which I had tried to incorporate the relevance of heat and mass transfer applicable to Mechanical, Chemical, Aerospace, Civil Engineering, Computer Science, Information Technology, Biotechnology, Pharmacology, and Alternative Energy generation.

Confronted with economic realities, many colleges and universities have set clear priorities. In recognition of its value and applications to society, investment in engineering education has increased. Pedagogically, there is reintroduced emphasis on the fundamental principles that are the foundation for lifelong learning. The important and sometimes dominant role of heat transfer in many applications, particularly in conventional as well as in alternative energy generation and concomitant environmental effects, has reaffirmed its relevance.

In preparing third edition, I have attempted to incorporate recent heat transfer research at a level that is appropriate for an undergraduate student. I have strived to include new examples and problems that motivate students with interesting applications, but whose solutions are based firmly on fundamental principles. We have remained true to the pedagogical approach of previous editions by retaining a rigorous and systematic methodology for problem solving. I have tried to continue the tradition of providing a text that will serve as a valuable, everyday resource for students and practicing engineers throughout their careers.

Approach and Organization

Previous editions of the text have adhered to four learning objectives:

1. The student should adopt the meaning of the terminology and physical principles associated with heat transfer.
2. The student should be able to describe relevant transport phenomena for any process or system involving heat transfer.
3. The student should be able to use requisite inputs for calculating heat transfer rates and/or material temperatures.
4. The student should be able to develop representative models of processes and systems and draw conclusions concerning process/system design or performance from the attendant analysis.

Moreover, as in previous editions, specific learning objectives for each chapter are clarified, as are means by which achievement of the objectives may be assessed. The summary and glossary at the end of each chapter highlight key terminology and concepts developed in the chapter and poses questions designed to test and enhance student comprehension.

What's New in the Third Edition?

In order to reduce the volume and cost of book, it is prepared in two columns and two colours to make it attractive and interesting. The constructive criticisms and suggestion sent by users have been amalgamated. Answer(s) to almost all problems presented for practice at the end of each chapter are provided.

Chapter-by-Chapter Content Changes

Chapter 1, Concepts and Mechanisms of Heat Flow is re-written and modified to accentuate the significance of heat transfer in various contemporary applications. It has also been improved to elaborate the complementary nature of heat transfer and thermodynamics. The economic thickness of insulation is augmented with a new section with the help of cost and year of service. Two more sections on heat transfer in boiling and condensation and mass transfer are included at the end of chapter.

Chapter 2, deals with Conduction-Basic equations and their applications with the help of boundary conditions. In this edition, the boundary conditions are elaborated with extensive graphical support. The radiation and interface boundary conditions are incorporated.

Chapters 3, 4 and 5 have undergone extensive revision and some examples are reorganized in order to give them justification. Some parallel illustrations are withdrawn from these Chapters.

Chapter 6, Transient Conduction was substantially modified in the previous edition and has been augmented in this edition with a streamlined presentation of the methods. The multi-dimensional, semi-infinite body transient heat transfer has been restructured.

Chapter 7, Principles of Convection includes clarification of how temperature-dependent properties should be evaluated when calculating the convection heat transfer coefficient. Specifically, presentation of the similarity solution for flow over a flat plate has been simplified.

Chapter 8, External Flow has been updated and reduced in length. New results for flow over noncircular cylinders have been added, replacing the correlations of previous editions. The discussion of flow across circular tubes has been reduced, abolishing redundancy without sacrificing content.

Chapter 9, Internal Flow; entry length correlations have been updated and rearranged.

Chapter 10, Free Convection include a new correlation for free convection from flat plates, replacing a correlation from previous editions. The discussion of boundary layer effects has been modified.

Aspects of Boiling and Condensation have been updated to incorporate recent advances in, for example, external condensation on finned tubes in *Chapter 11*, Condensation phenomena and heat transfer rates are explained. The coverage of forced convection condensation and related enhancement techniques has been expanded.

The concepts of emissive power, irradiation, radiosity, radiation function and net radiative flux are presented in *Chapter 12*, Radiation: Properties and Processes. The coverage of environmental radiation has undergone substantial revision, with the inclusion of separate discussions of solar radiation, the atmospheric radiation balance, and terrestrial solar irradiation. Concern for the potential impact of anthropogenic activity on the temperature of the earth is addressed.

Chapter 13, Radiation Exchange Between Surfaces highlights the difference between geometrical surfaces and radiative surfaces, a key concept that is often difficult for students to appreciate. Increased coverage of radiation exchange between diffused grey surfaces, included in older editions of the text, has been retained. In doing so, radiation exchange between differentially small surfaces is briefly introduced.

The content of *Chapter 14*, Heat Exchangers is experiencing a resurgence in interest due to the critical role such devices play in conventional and alternative energy generation technologies. Much of the coverage of compact heat exchangers included in the previous edition was limited to a specific heat exchanger. Although general coverage of compact heat exchangers have been retained.

Chapter 15, Mass Transfer has been entirely revised extensively from the previous edition. General mass diffusion equation and boundary conditions are restructured. Concept of solubility, permeability, mass diffusion with and without homogeneous chemical reaction, steady state diffusion through a plane membrane, water vapour migration have been incorporated in new sections.

Chapter 16, Experiments in Engineering Heat Transfer have been updated in the interest of students to cater curriculum. Appendix is added as it was in previous edition.

—Author

Acknowledgements

We wish to acknowledge and thank many of our colleagues in the heat transfer community. In particular, we would like to express our appreciation to Prof. (Dr.) R. M. Warkhedkar, Govt. Engg. College Karad (M.S.), Prof. S. B. Patil of MET's IoE. Nashik, Prof. H. R. Thakare of SNJB's CoE. Chandwad, Prof. D. H. Dubey of B.S. Deore CoE. Dhule, Prof. P. A. Deshmukh of R.S. CoE Pune and many friends, students, users whose constructive suggestions helped me to improve the text and to bring out this edition.

I would like to extend my gratitude to administration and executive management of SNJB's Late Sau. K. B. Jain College of engineering, Neminagar, Chandwad (M.S.), India, for providing me facilities, moral support and cherish cooperation during the preparation of this manuscript.

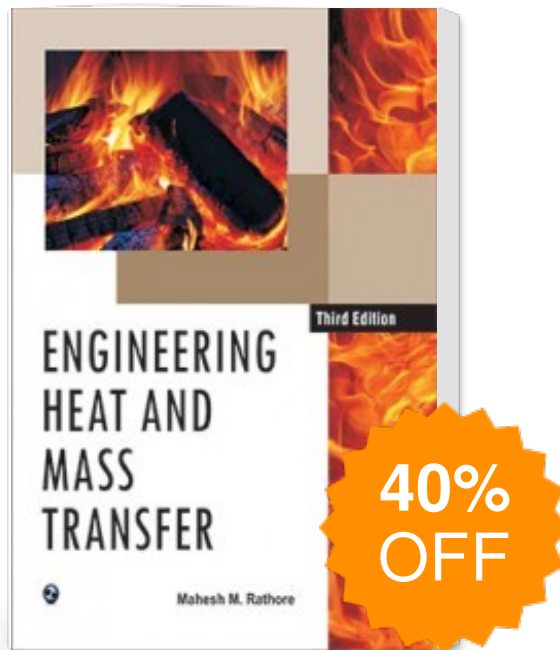
I also take the opportunity to express my heartiest thanks to Mr. Saurabh Gupta, Managing Director, Laxmi Publications (P) Ltd. New Delhi, who adapted my desire to bring this volume in two columns and two colours, even after three proof readings of manuscript.

In closing, I am deeply grateful to my spouse and children, Dr. Ankit, and Pratik for their endless love and patience.

A human creation can never be perfect. Some mistakes might have crept in the text. My effort in writing the book will be rewarded, if readers send their constructive suggestions and objective criticism with a view to improve the usefulness of the book.

—Author

Engineering Heat And Mass Transfer



Publisher : [Laxmi Publications](#) ISBN : [9788131806135](#)

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