

# Contents

**Preface — V**

**Acknowledgments — VII**

## **Part 1: Engineering thermodynamics**

### **Chapter 1**

#### **Introduction — 3**

- 1.1 Energy — **3**
- 1.2 Energy source — **5**
- 1.3 Conversion and utilization of energy — **16**
- 1.4 Research contents of fundamentals of thermal engineering — **18**
  - Exercises — **19**
  - Answers — **20**

### **Chapter 2**

#### **Basic concepts — 21**

- 2.1 Review: introduction — **21**
- 2.2 Introduction to the basic concept — **21**
- 2.3 Thermodynamic system — **21**
- 2.4 Equilibrium state and state parameters — **23**
- 2.5 Equation of state and state parameter coordinate diagram — **26**
- 2.6 Quasi-static process and reversible process — **27**
- 2.7 Work and heat — **31**
- 2.8 Summary — **35**
  - Exercises — **36**
  - Answers — **37**

### **Chapter 3**

#### **First law of thermodynamics — 39**

- 3.1 Review: basic concepts — **39**
- 3.2 Introduction to the first law of thermodynamics — **39**
- 3.3 Storage energy of thermal system — **39**
- 3.4 The essence of the first law of thermodynamics — **40**
- 3.5 The expression of the first law of thermodynamics for closed system — **41**
- 3.6 Stable flow energy equation of open system — **44**
- 3.7 The application of stable flow energy equation — **50**

- 3.8 Summary — **57**
- Exercises — **60**
- Answers — **61**

## **Chapter 4**

### **Property and process of the ideal gas — 63**

- 4.1 Review: first law of thermodynamics — **63**
- 4.2 Introduction to property and process of the ideal gas — **63**
- 4.3 Ideal gas state equation — **63**
- 4.4 Thermal capacity, thermodynamic energy, entropy, and enthalpy of ideal gases — **65**
- 4.5 Thermodynamics, entropy, and enthalpy of ideal gases — **70**
- 4.6 Ideal gas mixture — **72**
- 4.7 Purpose of thermal process of ideal gas — **76**
- 4.8 Summary — **91**
- Exercises — **93**
- Answers — **94**

## **Chapter 5**

### **Second law of thermodynamics — 99**

- 5.1 Review: the first law of thermodynamics — **99**
- 5.2 Introduction to the second law of thermodynamics — **99**
- 5.3 The direction of spontaneous process and the expression of the second law of thermodynamics — **99**
- 5.4 Carnot cycle and Carnot theorem — **104**
- 5.5 Entropy — **111**
- 5.6 Summary — **118**
- Exercises — **118**
- Answers — **119**

## **Chapter 6**

### **Water vapor and wet air — 121**

- 6.1 Review: gaseous working medium — **121**
- 6.2 Review: water vapor — **121**
- 6.3 Water vapor generation process — **121**
- 6.4 State parameters of water vapor — **126**
- 6.5 Basic thermal process of water vapor — **131**
- 6.6 The nature of wet air — **134**
- 6.7 Summary — **136**
- Exercises — **137**
- Answers — **137**

**Chapter 7****Steam and gas power cycles — 141**

- 7.1 Review: power cycle — **141**
- 7.2 Steam power plant cycles — **141**
- 7.3 Piston internal combustion engine cycle — **151**
- 7.4 Ideal cycle of gas turbine plant — **153**
- 7.5 Summary — **156**
- Exercises — **156**
- Answers — **157**

**Chapter 8****Refrigeration equipment and cycle — 161**

- 8.1 Refrigeration — **161**
- 8.2 Air compression refrigeration cycle — **161**
- 8.3 Vapor compression refrigeration cycle — **164**
- 8.4 Absorption refrigeration cycle — **166**
- 8.5 Heat pump — **168**
- Exercises — **169**
- Answers — **169**

**Part 2: Heat transfer****Chapter 9****Basic ways of heat transfer — 177**

- 9.1 Thermal conduction — **178**
- 9.2 Thermal convection — **181**
- 9.3 Thermal radiation — **184**
- 9.4 Heat transfer process — **186**
- 9.5 Summary — **190**
- Exercises — **190**
- Answers — **191**

**Chapter 10****Thermal conduction — 193**

- 10.1 The theoretical basis of thermal conduction — **194**
- 10.2 Steady-state heat conduction — **203**
- 10.3 Summary — **209**
- Exercises — **209**
- Answers — **210**

**Chapter 11**

**Convection heat transfer — 213**

- 11.1 Convective heat transfer — **213**
- 11.2 Newton's cooling law — **214**
- 11.3 Influence factors on convective heat transfer — **217**
- 11.4 Summary — **220**
  - Exercises — **220**
  - Answers — **222**

**Chapter 12**

**Radiative heat transfer — 225**

- 12.1 Basic concepts of thermal radiation — **225**
- 12.2 The basic law of blackbody radiation — **231**
- 12.3 Emission characteristics of actual objects — **234**
- 12.4 Atmospheric greenhouse effect and greenhouse effect — **236**
  - Exercises — **238**
  - Answers — **239**

**Chapter 13**

**Heat transfer process and heat exchanger — 241**

- 13.1 Heat transfer process — **241**
- 13.2 Heat exchanger — **247**
- 13.3 Enhancing and weakening of heat transfer — **256**
- 13.4 Summary — **259**
  - Exercises — **259**
  - Answers — **259**

**Appendix Table A1: Saturated and unsaturated vapor (by temperature) — 261**

**Appendix Table A2: Saturated and unsaturated vapor (by pressure) — 265**

**Appendix Table A3: Unsaturated water and superheated water vapor — 269**

**References — 277**

**Index — 279**