## Contents

**Preface**  
xxiii

**Before You Begin**  
xxxix

1  **Introduction**  
1.1 Introduction  
1.2 Microsoft’s Windows® Operating System  
1.3 C, C++ and Java  
1.4 Visual C#  
1.5 Key Software Trend: Object Technology  
1.6 The Internet and the World Wide Web  
1.7 Extensible Markup Language (XML)  
1.8 Introduction to Microsoft .NET  
1.9 The .NET Framework and the Common Language Runtime  
1.10 Test-Driving a C# **Advanced Painter** Application  
1.11 (Only Required Section of the Case Study) Software Engineering  
Case Study: Introduction to Object Technology and the UML  
1.12 Wrap-Up  
1.13 Web Resources  

2  **Dive Into® Visual C# 2008 Express**  
2.1 Introduction  
2.2 Overview of the Visual Studio 2008 IDE  
2.3 Menu Bar and Toolbar  
2.4 Navigating the Visual Studio IDE  
   2.4.1 **Solution Explorer**  
   2.4.2 **Toolbox**  
   2.4.3 **Properties** Window  
2.5 Using Help  
2.6 Using Visual Programming to Create a Simple Program that Displays  
   Text and an Image  
2.7 Wrap-Up  
2.8 Web Resources  

Contents

8.3 Declaring and Creating Arrays 241
8.4 Examples Using Arrays 242
8.5 Case Study: Card Shuffling and Dealing Simulation 251
8.6 foreach Statement 255
8.7 Passing Arrays and Array Elements to Methods 257
8.8 Passing Arrays by Value and by Reference 259
8.9 Case Study: Class GradeBook Using an Array to Store Grades 263
8.10 Multidimensional Arrays 268
8.11 Case Study: Class GradeBook Using a Rectangular Array 273
8.12 Variable-Length Argument Lists 279
8.13 Using Command-Line Arguments 280
8.14 (Optional) Software Engineering Case Study: Collaboration Among Objects in the ATM System 282
8.15 Wrap-Up 290

9 Introduction to LINQ and Generic Collections 292
9.1 Introduction 293
9.2 Querying an Array Using LINQ 294
9.3 Introduction to Collections 303
9.4 Querying a Generic Collection Using LINQ 306
9.5 Wrap-Up 308
9.6 Deitel LINQ Resource Center 308

10 Classes and Objects: A Deeper Look 309
10.1 Introduction 310
10.2 Time Class Case Study 311
10.3 Controlling Access to Members 315
10.4 Referring to the Current Object’s Members with the this Reference 316
10.5 Indexers 318
10.6 Time Class Case Study: Overloaded Constructors 321
10.7 Default and Parameterless Constructors 327
10.8 Composition 328
10.9 Garbage Collection and Destructors 331
10.10 static Class Members 332
10.11 readonly Instance Variables 336
10.12 Software Reusability 338
10.13 Data Abstraction and Encapsulation 339
10.14 Time Class Case Study: Creating Class Libraries 341
10.15 internal Access 345
10.16 Class View and Object Browser 347
10.17 Object Initializers 348
10.18 Time Class Case Study: Extension Methods 351
10.19 Delegates 354

Contents

12.7.2 Declaring Interface IPayable 435
12.7.3 Creating Class Invoice 435
12.7.4 Modifying Class Employee to Implement Interface IPayable 437
12.7.5 Modifying Class SalariedEmployee for Use with IPayable 438
12.7.6 Using Interface IPayable to Process Invoices and Employees Polymorphically 440
12.7.7 Common Interfaces of the .NET Framework Class Library 442
12.8 Operator Overloading 443
12.9 (Optional) Software Engineering Case Study: Incorporating Inheritance and Polymorphism into the ATM System 446
12.10 Wrap-Up 455

13 Exception Handling 456
13.1 Introduction 457
13.2 Exception-Handling Overview 458
13.3 Example: Divide by Zero without Exception Handling 458
13.4 Example: Handling DivideByZeroExceptions and FormatExceptions 461
  13.4.1 Enclosing Code in a try Block 464
  13.4.2 Catching Exceptions 464
  13.4.3 Uncaught Exceptions 464
  13.4.4 Termination Model of Exception Handling 465
  13.4.5 Flow of Control When Exceptions Occur 466
13.5 .NET Exception Hierarchy 466
  13.5.1 Class SystemException 467
  13.5.2 Determining Which Exceptions a Method Throws 467
13.6 finally Block 468
13.7 Exception Properties 476
13.8 User-Defined Exception Classes 481
13.9 Wrap-Up 484

14 Graphical User Interfaces with Windows Forms: Part I 485
14.1 Introduction 486
14.2 Windows Forms 487
14.3 Event Handling 490
  14.3.1 A Simple Event-Driven GUI 490
  14.3.2 Another Look at the Visual Studio Generated Code 492
  14.3.3 Delegates and the Event-Handling Mechanism 493
  14.3.4 Other Ways to Create Event Handlers 494
  14.3.5 Locating Event Information 495
14.4 Control Properties and Layout 497
14.5 Labels, TextBoxes and Buttons 500
14.6 GroupBoxes and Panels 503

## 15 Graphical User Interfaces with Windows Forms: Part 2

15.1 Introduction 531  
15.2 Menus 531  
15.3 MonthCalendar Control 541  
15.4 DateTimePicker Control 542  
15.5 LinkLabel Control 545  
15.6 ListBox Control 549  
15.7 CheckedListBox Control 553  
15.8 ComboBox Control 556  
15.9 TreeView Control 560  
15.10 ListView Control 565  
15.11 TabControl Control 571  
15.12 Multiple Document Interface (MDI) Windows 576  
15.13 Visual Inheritance 584  
15.14 User-Defined Controls 587  
15.15 Wrap-Up 592

## 16 GUI with Windows Presentation Foundation

16.1 Introduction 594  
16.2 Windows Presentation Foundation (WPF) 595  
16.3 XML Basics 596  
16.4 Structuring Data 599  
16.5 XML Namespaces 604  
16.6 Declarative GUI Programming Using XAML 608  
16.7 Creating a WPF Application in Visual C# Express 610  
16.8 Laying Out Controls 612  
16.8.1 General Layout Principles 612  
16.8.2 Layout in Action 613  
16.9 Event Handling 618  
16.10 Commands and Common Application Tasks 625  
16.11 WPF GUI Customization 630  
16.12 Using Styles to Change a Control’s Appearance 631  
16.13 Customizing Windows 636  
16.14 Defining a Control’s Appearance with Control Templates 639

## 17 WPF Graphics and Multimedia

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.1 Introduction</td>
<td>652</td>
</tr>
<tr>
<td>17.2 Controlling Fonts</td>
<td>652</td>
</tr>
<tr>
<td>17.3 Basic Shapes</td>
<td>654</td>
</tr>
<tr>
<td>17.4 Polygons and Polylines</td>
<td>656</td>
</tr>
<tr>
<td>17.5 Brushes</td>
<td>659</td>
</tr>
<tr>
<td>17.6 Transforms</td>
<td>665</td>
</tr>
<tr>
<td>17.7 WPF Customization: A Television GUI</td>
<td>668</td>
</tr>
<tr>
<td>17.8 Animations</td>
<td>677</td>
</tr>
<tr>
<td>17.9 (Optional) 3-D Objects and Transforms</td>
<td>680</td>
</tr>
<tr>
<td>17.10 Wrap-Up</td>
<td>687</td>
</tr>
</tbody>
</table>

## 18 Strings, Characters and Regular Expressions

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.1 Introduction</td>
<td>689</td>
</tr>
<tr>
<td>18.2 Fundamentals of Characters and Strings</td>
<td>690</td>
</tr>
<tr>
<td>18.3 string Constructors</td>
<td>691</td>
</tr>
<tr>
<td>18.4 string Indexer, Length Property and CopyTo Method</td>
<td>692</td>
</tr>
<tr>
<td>18.5 Comparing strings</td>
<td>693</td>
</tr>
<tr>
<td>18.6 Locating Characters and Substrings in strings</td>
<td>697</td>
</tr>
<tr>
<td>18.7 Extracting Substrings from strings</td>
<td>699</td>
</tr>
<tr>
<td>18.8 Concatenating strings</td>
<td>700</td>
</tr>
<tr>
<td>18.9 Miscellaneous string Methods</td>
<td>701</td>
</tr>
<tr>
<td>18.10 Class StringBuilder</td>
<td>702</td>
</tr>
<tr>
<td>18.11 Length and Capacity Properties, EnsureCapacity Method and Indexer of Class StringBuilder</td>
<td>704</td>
</tr>
<tr>
<td>18.12 Append and AppendFormat Methods of Class StringBuilder</td>
<td>705</td>
</tr>
<tr>
<td>18.13 Insert, Remove and Replace Methods of Class StringBuilder</td>
<td>708</td>
</tr>
<tr>
<td>18.14 Char Methods</td>
<td>710</td>
</tr>
<tr>
<td>18.15 Card Shuffling and Dealing Simulation</td>
<td>713</td>
</tr>
<tr>
<td>18.16 Introduction to Regular-Expression Processing</td>
<td>717</td>
</tr>
<tr>
<td>18.16.1 Simple Regular Expressions and Class Regex</td>
<td>718</td>
</tr>
<tr>
<td>18.16.2 Complex Regular Expressions</td>
<td>723</td>
</tr>
<tr>
<td>18.16.3 Validating User Input with Regular Expressions and LINQ</td>
<td>724</td>
</tr>
<tr>
<td>18.16.4 Regex Methods Replace and Split</td>
<td>729</td>
</tr>
<tr>
<td>18.17 Wrap-Up</td>
<td>731</td>
</tr>
</tbody>
</table>

## 19 Files and Streams

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.1 Introduction</td>
<td>733</td>
</tr>
<tr>
<td>19.2 Data Hierarchy</td>
<td>733</td>
</tr>
</tbody>
</table>
20 XML and LINQ to XML

21 Databases and LINQ to SQL
22 ASP.NET 3.5 and ASP.NET AJAX 861
22.1 Introduction 862
22.2 Simple HTTP Transactions 863
22.3 Multitier Application Architecture 867
22.4 Creating and Running a Simple Web-Form Example 868
22.4.1 Examining an ASPX File 868
22.4.2 Examining a Code-Behind File 870
22.4.3 Relationship Between an ASPX File and a Code-Behind File 871
22.4.4 How the Code in an ASP.NET Web Page Executes 872
22.4.5 Examining the XHTML Generated by an ASP.NET Application 872
22.4.6 Building an ASP.NET Web Application 874
22.5 Web Controls 882
22.5.1 Text and Graphics Controls 883
22.5.2 AdRotator Control 889
22.5.3 Validation Controls 892
22.6 Session Tracking 899
22.6.1 Cookies 900
22.6.2 Session Tracking with HttpSessionState 908
22.7 Case Study: Connecting to a Database in ASP.NET 915
22.7.1 Building a Web Form That Displays Data from a Database 916
22.7.2 Modifying the Code-Behind File for the Guestbook Application 923
22.8 Case Study: Secure Books Database Application 924
22.8.1 Examining the Completed Secure Books Database Application 925
22.8.2 Creating the Secure Books Database Application 928
22.9 ASP.NET AJAX 952
22.9.1 Traditional Web Applications 952
22.9.2 Ajax Web Applications 953
22.9.3 Examining an ASP.NET AJAX Application 953
22.10 New ASP.NET 3.5 Data Controls 960
22.11 Wrap-Up 961
22.12 Web Resources 962

23 Windows Communication Foundation (WCF) Web Services 963
23.1 Introduction 964
23.2 WCF Services Basics 965
23.3 Simple Object Access Protocol (SOAP) 965
23.4 Representational State Transfer (REST) 966
23.5 JavaScript Object Notation (JSON) 966
23.6 Publishing and Consuming SOAP-Based Web Services 967
23.6.1 Creating a WCF Web Service 967
23.6.2 Code for the WelcomeSOAPXMLService 967
23.6.3 Building a SOAP-Based Web Service 968
23.6.4 Deploying the WelcomeSOAPXMLService 971
23.6.5 Creating a Client to Consume the WelcomeSOAPXMLService 973
23.6.6 Consuming the WelcomeSOAPXMLService 975

23.7 Publishing and Consuming REST-Based XML Web Services 976
23.7.1 Creating a REST-Based XML Web Service 976
23.7.2 Consuming a REST-Based XML Web Service 979

23.8 Publishing and Consuming REST-Based JSON Web Services 980
23.8.1 Creating a REST-Based JSON Web Service 980
23.8.2 Consuming a REST-Based JSON Web Service 982

23.9 Blackjack Web Service: Using Session Tracking in a SOAP-Based Web Service 984
23.9.1 Creating a Blackjack Web Service 984
23.9.2 Consuming the Blackjack Web Service 988

23.10 Airline Reservation Web Service: Database Access and Invoking a Service from ASP.NET 997

23.11 Equation Generator: Returning User-Defined Types 1002
23.11.1 Creating the REST-Based XML EquationGenerator Web Service 1005
23.11.2 Consuming the REST-Based XML EquationGenerator Web Service 1006
23.11.3 Creating the REST-Based JSON EquationGenerator Web Service 1010
23.11.4 Consuming the REST-Based JSON EquationGenerator Web Service 1011

23.12 Wrap-Up 1014
23.13 Deitel Web Services Resource Centers 1015

24 Silverlight, Rich Internet Applications and Multimedia 1016

24.1 Introduction 1017
24.2 Platform Overview 1018
24.3 Silverlight Runtime and Tools Installation 1019
24.4 Building a Silverlight WeatherViewer Application 1019
24.4.1 GUI Layout 1022
24.4.2 Obtaining and Displaying Weather Forecast Data 1024
24.4.3 Custom Controls 1028
24.5 Animations and the FlickrViewer 1031
24.6 Images and Deep Zoom 1037
24.6.1 Getting Started With Deep Zoom Composer 1040
24.6.2 Creating a Silverlight Deep Zoom Application 1042
24.7 Audio and Video 1050
24.8 Isolated Storage 1055
24.9 Silverlight Demos and Web Resources 1056
24.10 Wrap-Up 1057
## 25 Data Structures

25.1 Introduction 1060
25.2 Simple-Type structs, Boxing and Unboxing 1060
25.3 Self-Referential Classes 1061
25.4 Linked Lists 1062
25.5 Stacks 1075
25.6 Queues 1079
25.7 Trees
   25.7.1 Binary Search Tree of Integer Values 1083
   25.7.2 Binary Search Tree of IComparable Objects 1090
25.8 Wrap-Up 1095

## 26 Generics

26.1 Introduction 1098
26.2 Motivation for Generic Methods 1099
26.3 Generic-Method Implementation 1101
26.4 Type Constraints 1103
26.5 Overloading Generic Methods 1106
26.6 Generic Classes 1107
26.7 Wrap-Up 1116

## 27 Collections

27.1 Introduction 1119
27.2 Collections Overview 1120
27.3 Class Array and Enumerators 1122
27.4 Nongeneric Collections 1125
   27.4.1 Class ArrayList 1126
   27.4.2 Class Stack 1130
   27.4.3 Class Hashtable 1132
27.5 Generic Collections 1137
   27.5.1 Generic Class SortedDictionary 1137
   27.5.2 Generic Class LinkedList 1140
27.6 Wrap-Up 1144

## A Operator Precedence Chart

## B Simple Types

## C Number Systems

## D ATM Case Study Code

- D.1 ATM Case Study Implementation 1159
- D.2 Class ATM 1159
- D.3 Class Screen 1160
- D.4 Class Keypad 1160
- D.5 Class CashDispenser 1161
- D.6 Class DepositSlot 1162
- D.7 Class Account 1163
- D.8 Class BankDatabase 1164
- D.9 Class Transaction 1166
- D.10 Class BalanceInquiry 1167
- D.11 Class Withdrawal 1168
- D.12 Class Deposit 1170
- D.13 Class ATMCaseStudy 1171
- D.14 Wrap-Up 1171

## E UML 2: Additional Diagram Types

- E.1 Introduction 1185
- E.2 Additional Diagram Types 1185

## F ASCII Character Set

1187

## G Unicode®

- G.1 Introduction 1188
- G.2 Unicode Transformation Formats 1189
- G.3 Characters and Glyphs 1190
- G.4 Advantages/Disadvantages of Unicode 1191
- G.5 Using Unicode 1192
- G.6 Character Ranges 1193

## H Using the Visual C# 2008 Debugger

- H.1 Introduction 1196
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.2</td>
<td>Breakpoints and the <strong>Continue</strong> Command</td>
<td>1197</td>
</tr>
<tr>
<td>H.3</td>
<td><em>DataTips</em> and Visualizers</td>
<td>1203</td>
</tr>
<tr>
<td>H.4</td>
<td>The <strong>Locals</strong> and <strong>Watch</strong> Windows</td>
<td>1204</td>
</tr>
<tr>
<td>H.5</td>
<td>Controlling Execution Using the <strong>Step Into</strong>, <strong>Step Over</strong>, <strong>Step Out</strong> and <strong>Continue</strong> Commands</td>
<td>1207</td>
</tr>
<tr>
<td>H.6</td>
<td>Other Debugging Features</td>
<td>1210</td>
</tr>
<tr>
<td>H.6.1</td>
<td><strong>Edit and Continue</strong></td>
<td>1210</td>
</tr>
<tr>
<td>H.6.2</td>
<td><strong>Exception Assistant</strong></td>
<td>1212</td>
</tr>
<tr>
<td>H.6.3</td>
<td><strong>Just My Code™</strong> Debugging</td>
<td>1213</td>
</tr>
<tr>
<td>H.6.4</td>
<td>Other Debugger Features</td>
<td>1213</td>
</tr>
<tr>
<td>H.7</td>
<td>Wrap-Up</td>
<td>1213</td>
</tr>
</tbody>
</table>

---

## Index

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1215</td>
</tr>
</tbody>
</table>