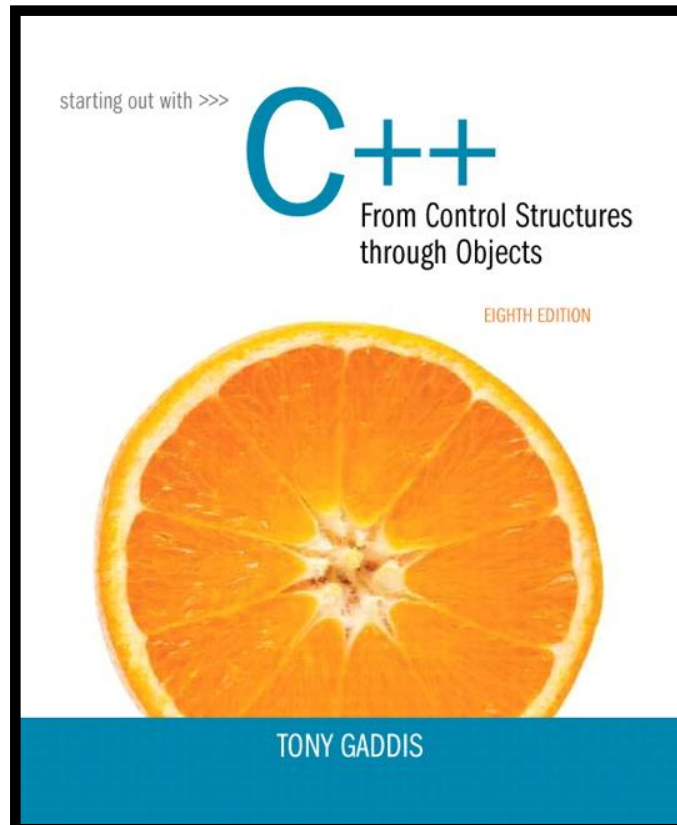


# LAB MANUAL

*to Accompany*



**Dean DeFino**

*Salisbury University*

**Michael Bardzell**

*Salisbury University*



Boston San Francisco New York  
London Toronto Sydney Tokyo Singapore Madrid  
Mexico City Munich Paris Cape Town Hong Kong Montreal

Editorial Director	<i>Marcia Horton</i>
Acquisitions Editor	<i>Matt Goldstein</i>
Program Manager	<i>Kayla Smith-Tarbox</i>
Editorial Assistant	<i>Kelsey Loanes</i>
Director of Marketing	<i>Christy Lesko</i>
Marketing Assistant	<i>Jon Bryant</i>

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and Addison-Wesley was aware of a trademark claim, the designations have been printed in initial caps or all caps.

**Copyright © 2015 Pearson Education, Inc.**

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America. For information on obtaining permission for use of material in this work, please submit a written request to Pearson Education, Inc., Rights and Contracts Department, 75 Arlington Street, Suite 300, Boston, MA 02116, fax your request to 617-848-7047, or e-mail at <http://www.pearsoned.com/legal/permissions.htm>.

ISBN 0-133-77864-9

1 2 3 4 5 6 7 8 9 10—BB—11 10 09 08

# Contents

## *Lab Manual Introduction vii*

### **LESSON SET 1 *Introduction to Programming and the Translation Process* 1**

---

#### **Pre-lab Reading Assignment 2**

Computer Systems 2  
Introduction to Programming 2  
Translation Process 3  
Integrated Environments 6

#### **Pre-lab Writing Assignment 6**

Fill-in-the-Blank Questions 6  
Learn the Environment That You Are Working In 7

#### **Lesson 1A 7**

LAB 1.1 Opening, Compiling and Running Your First Program 7  
LAB 1.2 Compiling a Program with a Syntax Error 7  
LAB 1.3 Running a Program with a Run Time Error 8

#### **Lesson 1B 9**

LAB 1.4 Working with Logic Errors 9  
LAB 1.5 Writing Your First Program (Optional) 11

### **LESSON SET 2 *Introduction to the C++ Programming Language* 13**

---

#### **Pre-lab Reading Assignment 14**

The C++ Programming Language 14  
Memory 15  
Variables and Constants 16  
Identifiers in C++ 16  
Data Types 16  
Integer Data Type 16  
Floating Point Data Type 17  
Character Data Type 17  
Boolean Data Type 17  
Assignment Operator 17  
Fundamental Instructions 17

Arithmetic Operators 19

#### **Pre-lab Writing Assignment 19**

Fill-in-the-Blank Questions 19

#### **Lesson 2A 20**

LAB 2.1 Working with the cout Statement 20  
LAB 2.2 Working with Constants, Variables and Arithmetic Operators 21

#### **Lesson 2B 22**

LAB 2.3 Rectangle Area and Perimeter 22  
LAB 2.4 Working with Characters and Strings 22

### **LESSON SET 3 *Expressions, Input, Output and Data Type Conversions* 25**

---

#### **Pre-lab Reading Assignment 26**

Review of the cout Statement 26  
Input Instructions 26  
Strings 27  
Summary of storing and inputting strings 28  
Formatted Output 28  
Expressions 29  
Precedence Rules of Arithmetic Operations 29  
Converting Algebraic Expressions to C++ Expressions 30  
Data Type Conversions 30  
Files 31

#### **Pre-lab Writing Assignment 32**

Fill-in-the-Blank Questions 32

#### **Lesson 3A 33**

LAB 3.1 Working with the cin Statement 33  
LAB 3.2 Formatting Output 35  
LAB 3.3 Arithmetic Operations and Math Functions 36

#### **Lesson 3B 37**

LAB 3.4 Working with Type Casting 37  
LAB 3.5 Reading and Writing to a File 38  
LAB 3.6 Student Generated Code Assignments 39

### **LESSON SET 4 *Conditional Statements* 41**

---

#### **Pre-lab Reading Assignment 42**

Relational Operators 42  
The if Statement 42  
The if/else Statement 43  
The if/else if Statement 43  
The Trailing else 44

Nested if Statements 44  
Logical Operators 45  
The switch Statement 46  
Character & string comparisons 47

#### **Pre-lab Writing Assignment 48**

Fill-in-the-Blank Questions 48

**Lesson 4A 48**

LAB 4.1 Working with Relational Operators and the  
if Statement 48

LAB 4.2 if/else and Nested if Statements 49

LAB 4.3 Logical Operators 50

**Lesson 4B 51**

LAB 4.4 The switch Statement 51

LAB 4.5 Student Generated Code Assignments 52

**LESSON SET 5 *Loops and Files* 55****Pre-lab Reading Assignment 56**

Increment and Decrement Operator 56

The while Loop 56

Counters 58

Sentinel Values 59

Data Validation 60

The do-while Loop 60

The for Loop 61

Nested Loops 63

Files 64

**Pre-lab Writing Assignment 65**

Fill-in-the-Blank Questions 65

**Lesson 5A 65**

LAB 5.1 Working with the while Loop 65

LAB 5.2 Working with the do-while Loop 67

**Lesson 5B 69**

LAB 5.3 Working with the for Loop 69

LAB 5.4 Nested Loops 70

LAB 5.5 Reading and Writing to a File 72

LAB 5.5 Student Generated Code Assignments 73

**LESSON SET 6.1 *Introduction to Void Functions (Procedures)* 75****Pre-lab Reading Assignment 76**

Modules 76

Pass by Value 78

Pass by Reference 81

**Pre-lab Writing Assignment 83**

Fill-in-the-Blank Questions 83

**Lesson 6.1A 84**

LAB 6.1 Functions with No Parameters 84

LAB 6.2 Introduction to Pass by Value 84

**Lesson 6.1B 86**

LAB 6.3 Introduction to Pass by Reference 86

LAB 6.4 Student Generated Code Assignments 89

**LESSON SET 6.2 *Functions that Return a Value* 91****Pre-lab Reading Assignment 92**

Scope 92

Scope Rules 93

Static Local Variables 94

Default Arguments 94

Functions that Return a Value 96

Overloading Functions 99

Stubs and Drivers 99

**Pre-lab Writing Assignment 101**

Fill-in-the-Blank Questions 101

**Lesson 6.2A 101**

LAB 6.5 Scope of Variables 101

LAB 6.6 Parameters and Local Variables 104

**Lesson 6.2B 106**

LAB 6.7 Value Returning and Overloading Functions 106

LAB 6.8 Student Generated Code Assignments 110

**LESSON SET 7 *Arrays* 113****Pre-lab Reading Assignment 114**

One-Dimensional Arrays 114

Array Initialization 115

Array Processing 115

Arrays as Arguments 116

Two-Dimensional Arrays 121

Multi-Dimensional Arrays 122

Arrays of Strings 122

**Pre-lab Writing Assignment 122**

Fill-in-the-Blank Questions 122

**Lesson 7A 123**

LAB 7.1 Working with One-Dimensional Arrays 123

LAB 7.2 Strings as Arrays of Characters 126

**Lesson 7B 129**

LAB 7.3 Working with Two-Dimensional Arrays 129

LAB 7.4 Student Generated Code Assignments 134

**LESSON SET 8 *Searching and Sorting Arrays* 137****Pre-lab Reading Assignment 138**

Search Algorithms 138  
 Linear Search 138  
 The Binary Search 140  
 Sorting Algorithms 142  
 The Bubble Sort 143  
 The Selection Sort 145

**Pre-lab Writing Assignment 148**

Fill-in-the-Blank Questions 148

**Lesson 8 149**

LAB 8.1 Working with the Linear Search 149  
 LAB 8.2 Working with the Binary Search 150  
 LAB 8.3 Working with Sorts 152  
 LAB 8.4 Student Generated Code Assignments 156

**LESSON SET 9 *Pointers* 157****Pre-lab Reading Assignment 158**

Pointer Variables 158  
 Using the & Symbol 158  
 Using the \* Symbol 159  
 Using \* and & Together 160  
 Arrays and Pointers 161  
 Dynamic Variables 162  
 Review of \* and & 166

**Pre-lab Writing Assignment 167**

Fill-in-the-Blank Questions 167

**Lesson 9A 167**

LAB 9.1 Introduction to Pointer Variables 167  
 LAB 9.2 Dynamic Memory 168

**Lesson 9B 170**

LAB 9.3 Dynamic Arrays 170  
 LAB 9.4 Student Generated Code Assignments 171

**LESSON SET 10 *Characters and Strings* 175****Pre-lab Reading Assignment 176**

Character Functions 176  
 Character Case Conversion 177  
 String Constants 178  
 Storing Strings in Arrays 179  
 Library Functions for Strings 179  
 The get and ignore functions 181  
 Pointers and Strings 184

**Pre-lab Writing Assignment 186**

Fill-in-the-Blank Questions 186

**Lesson 10 187**

LAB 10.1 Character Testing and String Validation 187  
 LAB 10.2 Case Conversion 190  
 LAB 10.3 Using getline() 192  
 LAB 10.4 String Functions—strcat 193  
 LAB 10.5 Student Generated Code Assignments 193

**LESSON SET 11 *Structures and Abstract Data Types* 195****Pre-lab Reading Assignment 196**

Access to Structure Members 197  
 Arrays of Structures 200  
 Initializing Structures 201  
 Hierarchical (Nested) Structures 202  
 Structures and Functions 204

**Pre-lab Writing Assignment 205**

Fill-in-the-Blank Questions 205

**LESSON 11 A 205**

LAB 11.1 Working with Basic Structures 205  
 LAB 11.2 Initializing Structures 206  
 LAB 11.3 Arrays of Structures 208

**LESSON 11 B 209**

LAB 11.4 Nested Structures 209  
 LAB 11.5 Student Generated Code Assignments 211

**LESSON SET 12 *Advanced File Operations* 213****Pre-lab Reading Assignment 214**

Review of Text Files 214  
 Opening Files 214  
 Reading from a File 215  
 Output Files 218  
 Files Used for Both Input and Output 219  
 Closing a File 220  
 Passing Files as Parameters to Functions 220  
 Review of Character Input 221  
 Binary Files 224  
 Files and Records 226  
 Random Access Files 228

**Pre-lab Writing Assignment 231**

Fill-in-the-Blank Questions 231

**Lesson 12A 231**

LAB 12.1 Introduction to Files (Optional) 231  
 LAB 12.2 Files as Parameters and Character Data 233

**Lesson 12B 235**

LAB 12.3 Binary Files and the write Function 235  
 LAB 12.4 Random Access Files 238  
 LAB 12.5 Student Generated Code Assignments 240

**LESSON SET 13    *Introduction to Classes*    243**

---

**Pre-lab Reading Assignment 244**

Introduction to Object-Oriented Programming    244  
Client and Implementation Files    246  
Types of Objects    247  
Implementations of Classes in C++    247  
Creation and Use of Objects    247  
Implementation of Member Functions    248  
Complete Program    251  
Inline Member Functions    254  
Introduction to Constructors    255  
Constructor Definitions    256  
Invoking a Constructor    256

Destructors    256

Arrays of Objects    258

**Pre-lab Writing Assignment 260**

Fill-in-the-Blank-Questions    260

**Lesson 13A    261**

LAB 13.1 Squares as a Class    261

LAB 13.2 The Circles as Class    263

**Lesson 13.B    265**

LAB 13.3 Arrays as Data Members of Classes    265

LAB 13.4 Arrays of Objects    267

LAB 13.5 Student Generated Code Assignment    269

**APPENDIX A    *Visual C++ Environment*    271**

---

**APPENDIX B    *UNIX*    273**

---

*Index*    277

# Lab Manual Introduction

## **To the Student...**

A closed laboratory in computer programming is a vital activity for helping you gain valuable programming skills. Programming cannot be learned by “spectators”. In other words, you cannot become a skilled programmer simply by watching others do it. You must spend numerous hours working on programs yourself. A closed laboratory experience gives you the opportunity to edit, write, compile, build, and execute programs of varying length and complexity under the guidance of your instructor. You will be able to reinforce concepts learned in class with a “hands on” approach. Throughout the course, your programming skills should steadily progress by applying knowledge learned in class to the laboratory setting.

This lab manual is divided into chapters called “Lesson Sets”. At the beginning of each lesson set you will see a Purpose section which outlines the goals and expected outcomes of the lesson. This is immediately followed by a Procedure section. The first two steps of this section ask you to complete the Pre-lab Reading and Pre-lab Writing Assignments as a prerequisite to attempting the labs. It is imperative that you do both assignments before coming to your lab session. The laboratory exercises assume you have read and understood the key points of the corresponding lesson. The Pre-lab Writing Assignment usually consists of 8 – 10 very simple fill in the blank questions. Once the Pre-lab Reading is complete, you should have no trouble completing these questions. Your instructor may choose to collect this assignment at the beginning of your lab session. Although each Pre-lab Reading Assignment gives a concise overview of key concepts from the corresponding chapter in the text, it is not a substitute for reading your text. The text develops ideas in much more detail and also covers certain topics that cannot be included in a closed lab due to time constraints. Hence, this lab manual should be used as a supplement, not a replacement, for the text.

Your instructor will tell you which lab assignments should be completed during the lab session and which should be completed outside of class for homework. Although a hard copy of all code used for the lab assignments is included at the end of each lesson set, the code is also included in electronic form on the Web at [www.aw.com/cssupport](http://www.aw.com/cssupport), under author “Gaddis.” You should use this code rather than re-typing it from scratch.

## **To the Instructor...**

A closed laboratory in computer programming is a vital activity for helping students gain valuable programming skills under your guidance. Many different opinions concerning the content of such labs have been generated over the past few years, ranging from programming assignments to scheduled exercises using prepared materials. Although this manual emphasizes the latter approach and has pre-developed code for students to complete or edit, there are assignments

that ask each student to independently create small programs which may be assigned as lab activities or as post-lab homework. These student generated code assignments are not intended as a substitute for larger programming assignments. Rather, they are small programs designed to test students on the material given in the lessons. The length of the lab activities vary from fifty minutes to two hours, depending on the particular institution. For this reason, the manual is divided into “Lesson Sets”, each consisting of two fifty to sixty minute lessons of lab work. A fifty minute lab session should be able to complete an individual lesson and a one and a half to two hour session should be enough time for an entire lesson set. These times refer to “average classes”. It is of course impossible to set a time frame for each student in a given lab. It is natural that some advanced students may finish a little early, while others will need more than the suggested time frame. Each Lesson Set corresponds to a chapter from *Starting Out with C++: From Control Structures through Objects*, Eighth Edition, by Tony Gaddis. The one exception, however, is Chapter 6. This chapter deals with functions and the corresponding laboratory exercises are broken into two lesson sets.

The lab exercises in each lesson set are generally very simple to start and then increase in difficulty. Consequently, the student generated code assignments, which ask students to write complete programs, are given at the end of the second lesson. Most lesson sets contain three such assignments, so you have some flexibility as to how many of these programs are written during the laboratory session. A few lessons do have one somewhat sophisticated (to a beginning programmer) student generated code assignment. Other programming assignments may also be found at the end of each chapter of the text.

Each lesson set consists of the following:

**Pre-lab Reading Assignment.** This will prepare the students for material presented in the lab. This section gives a good, but brief, review of the corresponding chapter of the text. Examples and sample code are provided throughout this section, some of which are used in the subsequent labs. Students should thus be required to read this section before coming to lab.

**Pre-lab Writing Assignment.** These consist of short and easy questions on the reading material so that you may make sure students completed the pre-lab reading.

**Two Lessons of Lab Assignments.** These are done during the lab time, one lesson per hour (or fifty minute period).

**Supplements:** The following items are available at Addison-Wesley’s Instructor Resource Center. Visit the Instructor Resource Center at [www.aw.com/irc](http://www.aw.com/irc) to register for access.

- Solutions to the lab exercises
- Teacher’s Notes which consist of the following:

**Objectives for Students.** These are similar to the Purpose section given at the beginning of each lesson set in the lab manual. However, the objectives listed are geared more for the lab work whereas the Purpose section in the manual refers to the Pre-lab Reading material as well. In some lessons they are the same.

**Assumptions.** This section gives a brief list of what students should already know before attempting the corresponding lab assignment. It is generally assumed that the students have completed and understood the previous lessons (although some of the later lessons can be skipped) and that they have read and understood the Pre-lab Reading Assignment for the current lesson.



**Pre-lab Writing Assignment Solutions.** This section contains the answers to the Pre-lab Writing Assignment.

**Lab Assignments.** This section first lists the labs and then gives a more detailed description of each lab. Labs are broken into the lessons in which they are assigned.

Each instructor is encouraged to pick and choose labs based on the needs of their individual classes. The following is a suggested outline for a 14 week course that meets in a closed lab once a week for 50-60 minutes. This allows you to still cover one chapter a week for most weeks. As a general rule, a one hour lab session is enough time to complete section A of each lesson set. Assignments from section B, including the student generated code assignments, could be given as homework assignments.

Week 1	Lesson Set 1	Lab 1.1	Lab 1.2	Lab 1.3	Lab 1.4 (Optional Homework)
Week 2	Lesson Set 2	Lab 2.1	Lab 2.2		Lab 2.4 (Optional Homework)
Week 3	Lesson Set 3	Lab 3.1	Lab 3.2	Lab 3.3	Lab 3.4 (Optional Homework)
Week 4	Lesson Set 4	Lab 4.1	Lab 4.2	Lab 4.3	Lab 4.4 (Optional Homework)
Week 5	Lesson Set 5	Lab 5.1	Lab 5.2		Lab 5.5 (Optional Homework)
Week 6	Lesson Set 6.1	Lab 6.1	Lab 6.2		Lab 6.3 (Optional Homework)
Week 7	Lesson Set 6.2	Lab 6.5	Lab 6.6		Lab 6.7 (Optional Homework)
Week 8	Lesson Set 7	Lab 7.1	Lab 7.2		Lab 7.3 (Optional Homework)
Week 9	Lesson Set 8	Lab 8.1	Lab 8.2		Lab 8.3 (Optional Homework)
Week 10	Lesson Set 9	Lab 9.1	Lab 9.2		Lab 9.3 (Optional Homework)
Week 11	Lesson Set 10	Lab 10.1	Lab 10.2	Lab 10.3	Lab 10.4 (Optional Homework)
Week 12	Lesson Set 11	Lab 11.1	Lab 11.2	Lab 11.3	Lab 11.4 (Optional Homework)
Week 13	Lesson Set 12	Lab 12.2	Lab 12.3		Lab 12.4 (Optional Homework)
Week 14	Lesson Set 13	Lab 13.1	Lab 13.3	Lab 13.4	Lab 13.2 (Optional Homework)

For a one semester course that meets 2 hours a week in a closed lab, one lesson set per week will cover the manual in a fourteen week semester.

