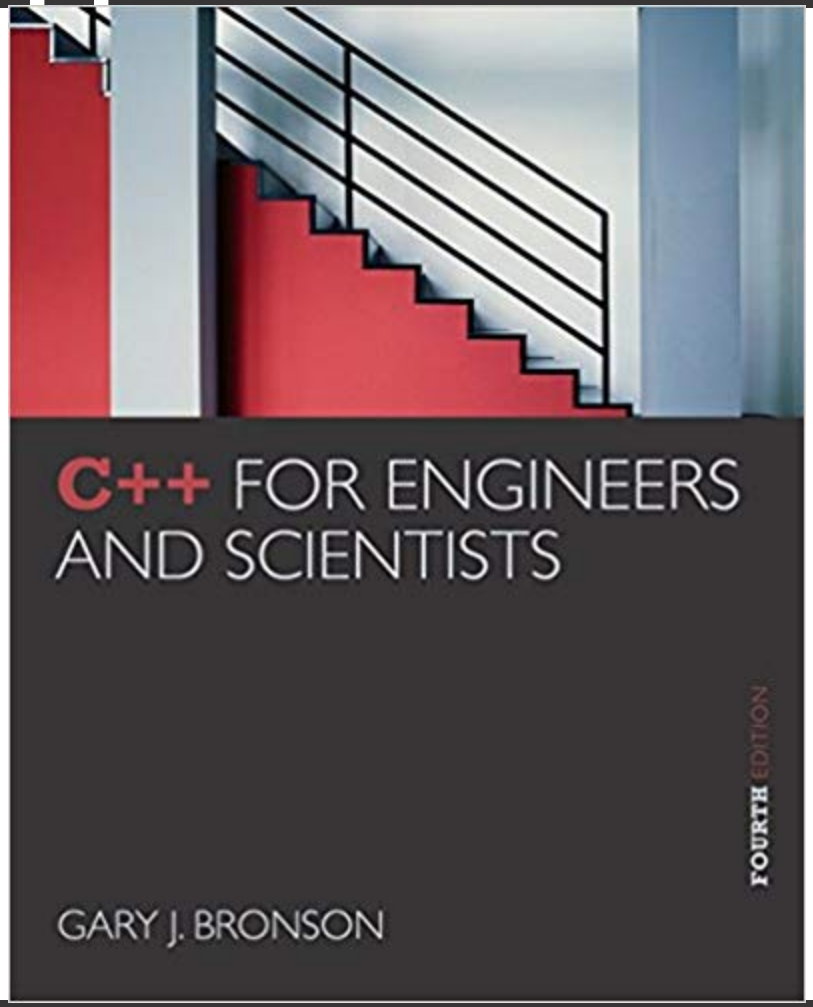
ELEG 1043
Computer Applications in Engineering



Chapter 3: Assignment, Formatting, and Interactive Input

C++ FOR ENGINEERS AND SCIENTISTS

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Objectives

In this chapter, you will learn about:

- Assignment operations
- Formatting numbers for program output
- Using mathematical library functions
- Program input using the **`cin`** object
- Symbolic constants
- A case study involving acid rain
- Common programming errors

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Using Mathematical Library Functions

- C++ has preprogrammed mathematical functions that can be included in a program
- You must include the **`cmath`** header file:

```
#include <cmath>
```

- Math functions require one or more arguments as input, but will return only one value
- All functions can be used with integer and real arguments

Using Mathematical Library Functions (continued)

Function Name	Description	Returned Value
`abs(a)`	Absolute value	Same data type as argument
`pow(a1,a2)`	`a1` raised to the `a2` power	Same data type as argument `a1`
`sqrt(a)`	Square root of a real number	Double-precision
`sin(a)`	Sine of `a` (`a` in radians)	Double
`cos(a)`	Cosine of `a` (`a` in radians)	Double
`tan(a)`	Tangent of `a` (`a` in radians)	Double
`log(a)`	Natural logarithm of `a`	Double
`log10(a)`	Common log (base 10) of `a`	Double
`exp(a)`	`e` raised to the `a` power	Double

Table 3.5 Common C++ Functions

Using Mathematical Library Functions (continued)

- To use a math function, give its name and pass the input arguments within parentheses
- Expressions that can be evaluated to a value can be passed as arguments

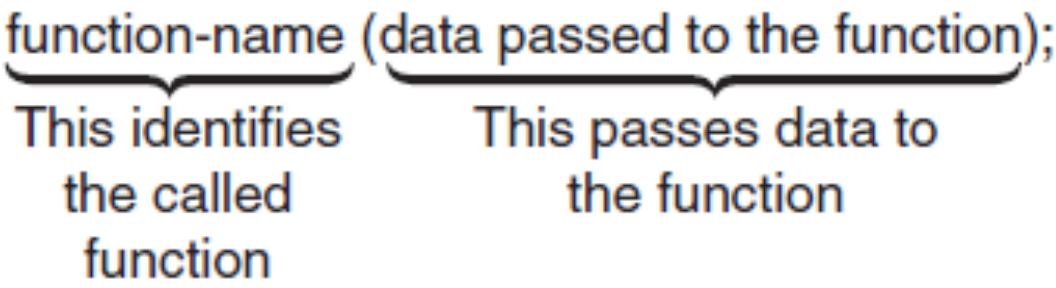

Figure 3.10 Using and passing data to a function

- Function calls can be nested
  - Example: `sqrt(sin(abs(theta)))`

Using Mathematical Library Functions (continued)

Program 3.9

```
#include <iostream>  // this line can be placed second instead of first
#include <cmath>     // this line can be placed first instead of second
using namespace std;

int main()
{
  int height;
  double time;

  height = 800;
  time = sqrt(2 * height / 32.2);
  cout << "It will take " << time << " seconds to fall "
       << height << " feet.\n";

  return 0;
}
```

Program Input Using `cin`

- **`cin` Object:** Allows data entry to a running program
- Use of the **`cin`** object causes the program to wait for input from the keyboard
- When keyboard entry is complete, the program resumes execution, using the entered data
- An output statement preceding the **`cin`** object statement provides a **prompt** to the user

Program Input Using `cin` (continued)

Program 3.12

```
#include <iostream>
using namespace std;

int main()
{
  double num1, num2, product;

  cout << "Please type in a number: ";
  cin  >> num1;
  cout << "Please type in another number: ";
  cin  >> num2;
  product = num1 * num2;
  cout << num1 << " times " << num2 << " is " << product << endl;

  return 0;
}
```

Program Input Using `cin` (continued)

- `cin` can accept multiple input values to be stored in different variables
- Multiple numeric input values must be separated by spaces

  Example:

  ```
  cin >> num1 >> num2
  ```

  with keyboard entry: `0.052 245.79`

Program Input Using `cin` (continued)

Program 3.13

```
#include <iostream>
using namespace std;

int main()
{
   int num1, num2, num3;
   double average;

   cout << "Enter three integer numbers: ";
   cin  >> num1 >> num2 >> num3;
   average = (num1 + num2 + num3) / 3.0;
   cout << "The average of the numbers is " << average << endl;

   return 0;
}
```

Program Input Using `cin` (continued)

- **User-input validation:** The process of ensuring that data entered by the user matches the expected data type
- **Robust program:** One that detects and handles incorrect user entry

Symbolic Constants

- **Symbolic constant:** Constant value that is declared with an identifier using the **`const`** keyword
- A constant's value may not be changed

  Example:

```
const int MAXNUM = 100;
```

- Good programming places statements in appropriate order

Symbolic Constants (continued)

- Proper placement of statements:

```
preprocessor directives
int main()
{
      symbolic constants
      main function declarations

      other executable statements
      return value
}
```

A Case Study: Acid Rain

- **Acid Rain:** Develop a program to calculate the pH level of a substance based on user input of the concentration of hydronium ions
  - Step 1: Analyze the Problem
  - Step 2: Develop a Solution
  - Step 3: Code the Solution
  - Step 4: Test and Correct the Program

A Closer Look: Programming Errors

- Program errors may be detected in four ways:
  - Before a program is compiled (desk checking)
  - While it is being compiled (compile-time errors)
  - While it is being run (run-time errors)
  - While examining the output after completion
- Errors may be:
  - Syntax errors
    - typos in the source code
  - Logic errors
    - often difficult to detect and difficult to find the source

Common Programming Errors

- Failure to declare or initialize variables before use
- Failure to include the preprocessor statement when using a C++ preprogrammed library
  - #include "stdafx.h"
- Passing the incorrect number or type of arguments to a function
- Applying increment or decrement operator to an expression instead of an individual variable
  - `++(a + b), --(b + 3)`

Common Programming Errors (continued)

- Failure to separate all variables passed to **`cin`** with the extraction symbol >>
  - `int a = 0, b = 1;`
  - `cin>>ab;`
- Failure to test thoroughly

Summary

- Expression: A sequence of one or more operands separated by operators
- Assignment operator: =
- Increment operator: ++
- Decrement operator: --

Summary (continued)

- Use **`#include <cmath>`** for math functions
- Arguments to a function must be passed in the proper number, type, and order
- **`cin`** object provides data input from a keyboard; program is suspended until the input arrives
- Use a prompt to alert the user to provide input
- Constants are named values that do not change