CSI 140 Introduction to Programming
Additional Practice Problems

Note: Please reach out the the instructor to discuss the solutions or if you need help in solving the problems

Unit 1: Introduction to Computing and Number Systems

Problem set 1.1: Write a complete algorithm for each of the scenarios below.

1. **Cafe Billing System**
   Write an algorithm to calculate the total bill at a café where a customer orders 3 items. Each item has a price and quantity. Apply a 10% discount if the total exceeds $50.

2. **Library Late Fee**
   Write an algorithm to calculate the fine for returning a library book late. The fine is:

   - $1 per day for the first 7 days,
   - $2 per day for the next 7 days,
   - $5 per day beyond 14 days.

3. **Temperature Converter**
   Write an algorithm that converts temperature from Celsius to Fahrenheit and Kelvin.

4. **Guess the Number Game**
   Write an algorithm where the computer has a secret number between 1 and 50. The user keeps guessing until they find the correct number. The program gives hints: “Too High” or “Too Low.”

5. **Bus Seat Allocation**
   Write an algorithm to assign bus seats to passengers. The bus has 10 seats, numbered 1–10. Mark the seat as “Booked” once assigned.

6. **Student Grading**
   Write an algorithm to input marks of 5 subjects and calculate the average. Assign a grade:

   - A: Average ≥ 90
   - B: 80–89
   - C: 70–79
   - D: 60–69
   - F: Below 60

7. **Vending Machine**
   Write an algorithm for a vending machine that accepts money and dispenses an item worth $1.75. It should return the correct change.

8. **Simple ATM Simulation**
   Write an algorithm to simulate an ATM that allows a user to:

   - Check balance

   - Deposit money

   - Withdraw money (only if sufficient balance)

9. **Word Count in a Sentence**
   Write an algorithm to count how many words are present in a sentence given by the user.

10. **Palindrome Checker**
    Write an algorithm to check if a word entered by the user is the same when read backward.

Problem set 1.2:

1. **Convert the following decimal numbers into hexadecimal and binary.**
   - **$(1258)_{10}$**
   - **$(7089)_{10}$**
   - **$(66987)_{10}$**
   - **$(111111)_{10}$**
   - **$(10101010)_{10}$**
   - **$(99001100)_{10}$**

2. **Convert the following hexadecimal numbers into decimal and binary.**
   - **$(\text{FACE})_{16}$**
   - **$(\text{FEED})_{16}$**
   - **$(\text{DEED})_{16}$**
   - **$(\text{DECADE})_{16}$**
   - **$(\text{BEEBEE})_{16}$**
   - **$(\text{DEADBEEF})_{16}$**

3. **Convert the following binary numbers into hexadecimal and decimal.**
   - **$(111001)_2$**
   - **$(101000)_2$**
   - **$(1100101)_2$**
   - **$(1111110000)_2$**
   - **$(101010100000)_2$**
   - **$(111111111001100)_2$**

Unit 2: Basics of C++

Problem set 2.1:

1. Find the area and perimeter of the following geometrical shapes
   - Triangle
   - Rhombus
   - Parallelogram
   - n-sided polygon
2. Find the volume of the geometric 3D shapes
   - Cube
   - Cuboid
   - Cylinder
   - Sphere
   - Cone
   - Pyramid
3. What is the output of the following code

```
#include <iostream>
using namespace std;
int main() {
    double x = 5.7;
    int y = x;
    cout << x << endl;
    cout << y << endl;
    cout << x - y << endl;
    return 0;
}
```

```
#include <iostream>
using namespace std;
int main() {
    int a = 2, b = 3, c = 4;
    cout << a + b * c << endl;
    cout << (a + b) * c << endl;
    cout << a * b + c * 2 << endl;
    return 0;
}
```

```
#include <iostream>
using namespace std;
int main() {
    int x = 17, y = 5;
    cout << x / y << endl;
    cout << x % y << endl;
    cout << x / y * y + x % y << endl;
    return 0;
}
```

```
#include <iostream>
using namespace std;
int main() {
    cout << ((2 * 3) > (4 + 1) && 1 == 1) << endl;
    cout << ((10 / 2) == 5 && (6 * 2) < 4) << endl;
    cout << (!(7 > 5) || (8 % 13) == 2) << endl;
    return 0;
}
```

```
#include <iostream>
using namespace std;
int main() {
    int x = 5, y = 10;
    cout << ((x++ > 4) && (++y < 12)) << endl;
    cout << x << " " << y << endl;
    cout << ((x * 2) >= (y - 1) || (x % 2) == 0) << endl;
    return 0;
}
```

Physics based coding questions

Question 1

A car accelerates uniformly from rest to 25 m/s in 10 seconds. Write a program to calculate and display:

The acceleration of the car
The distance traveled during this time
Use the formulas: a = (v - u) / t and s = ut + (1/2) * a * t * t

---

Question 2

A ball is thrown vertically upward with an initial velocity of 30 m/s. Write a program that calculates:

The maximum height reached by the ball
The time taken to reach maximum height
The total time the ball stays in the air
Use g = 9.8 m/s^2 and the formulas: $v^2 = u^2 - 2gh$ and v = u - gt

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Question 3

Two trains are moving towards each other. Train A travels at 60 km/h and Train B travels at 80 km/h. They are initially 280 km apart. Write a program to calculate:

The time it takes for them to meet
The distance traveled by each train when they meet

Question 4

A projectile is launched at an angle of 45 degrees with an initial velocity of 50 m/s. Write a program to calculate:

- The horizontal range of the projectile
- The maximum height achieved
- The time of flight

Use g = 9.8 m/s^2.

Note: You'll need to include the <cmath> library for trigonometric functions. The sin() and cos() functions expect angles in radians, so convert degrees to radians using:

```
angle_in_radians = angle_in_degrees * (3.14159 / 180)
```

Formulas to use:

- horizontal_component = velocity * cos(angle_in_radians)
- vertical_component = velocity * sin(angle_in_radians)
- Range = (velocity^2 * sin(2 * angle_in_radians)) / g
- Maximum height = (vertical_component^2) / (2 * g)
- Time of flight = (2 * vertical_component) / g

Question 5
A stone is dropped from a building of height 100 meters. At the same time, another stone is thrown vertically upward from the ground with a velocity of 25 m/s. Write a program to find:

The time when both stones are at the same height
The height at which they meet
Use the equations: h1 = 100 - (1/2) * g * t * t and h2 = 25 * t - (1/2) * g * t * t

Unit 3: Selection Statements

Based on the given scenario, write the boolean condition that should be placed inside the `if` statement's parentheses.

Question 1: A shop offers a discount if a customer buys more than 5 items OR spends more than $100. Write the condition for the if statement.

Question 2: A password is weak if its length is less than 8 characters OR it contains only numbers. Given variables length and containsOnlyNumbers (boolean), write the condition.

Question 3: A player wins a bonus if their score is between 500 and 1000 (inclusive) AND they completed the level in under 60 seconds. Write the condition.

Question 4: A delivery is free if the order total is above $50 AND the customer is either a premium member OR lives within 10 km. Given variables orderTotal, isPremium (boolean), and distance, write the condition.

Question 5: A character is a vowel if it is 'a' OR 'e' OR 'i' OR 'o' OR 'u'. Given a variable ch, write the condition.

Question 6: A number is NOT in the restricted range if it is less than 20 OR greater than 80. Write the condition.

Question 7: An employee gets overtime pay if they work more than 40 hours in a week AND it's not a public holiday. Given variables hoursWorked and isPublicHoliday (boolean), write the condition.

Question 8: A ticket price is discounted if the person is a child (age less than 12) OR a senior (age 65 or above). Write the condition.

Question 9: Access is granted if the user has an admin role OR (has a manager role AND the request is approved). Given variables isAdmin, isManager, and isApproved (all boolean), write the condition.

Question 10: A triangle is a right-angled triangle if the square of one side equals the sum of squares of the other two sides. Given three sides a, b, and c, write the condition to

```
check all possible combinations.
```

What is the output of the following code blocks?

```
int x = 15;
if (x > 10)
    cout << "Large";
```

```
int age = 17;
if (age >= 18)
    cout << "Adult";
else
    cout << "Minor";
```

```
int score = 75;
if (score >= 90)
    cout << "A";
else if (score >= 80)
    cout << "B";
else if (score >= 70)
    cout << "C";
else
    cout << "F";
```

```
int num = 20;
if (num > 10) {
    if (num < 30)
        cout << "Between 10 and 30";
    else
        cout << "Greater than 30";
}
```

```
int a = 5, b = 10;
if (a > b)
    cout << "A is larger";
else if (a < b)
    cout << "B is larger";
else
    cout << "Equal";
```

```
int x = 8;
if (x % 2 == 0) {
    if (x > 5)
```

```
        cout << "Even and greater than 5";
    else
        cout << "Even but not greater than 5";
}
else
    cout << "Odd";
```

```
int year = 2024;
if (year % 4 == 0) {
    if (year % 100 != 0)
        cout << "Leap year";
    else if (year % 400 == 0)
        cout << "Leap year";
    else
        cout << "Not a leap year";
}
else
    cout << "Not a leap year";
```

```
int temp = 25;
if (temp < 0)
    cout << "Freezing";
else if (temp < 15)
    cout << "Cold";
else if (temp < 25)
    cout << "Moderate";
else
    cout << "Hot";
```

```
bool isPremium = true;
int amount = 40;
if (isPremium) {
    if (amount > 50)
        cout << "Free delivery";
    else
        cout << "Small delivery fee";
}
else {
    if (amount > 100)
        cout << "Free delivery";
    else
```

```
        cout << "Standard delivery fee";
}
```

Question 1: A program displays the day name based on a number (1-7, where 1 is Monday). Given a variable day, write the switch statement to display the corresponding day name.

Question 2: A calculator performs operations based on an operator (+, -, *, /). Given variables num1, num2, and op (char), write the switch statement to perform the correct operation.

Question 3: A grading system converts marks to grades: 90-100 → 'A', 80-89 → 'B', 70-79 → 'C', 60-69 → 'D', below 60 → 'F'. Given a variable grade (char), write the switch statement to display the grade description.

Question 4: A vending machine dispenses items based on button number (1-5). If buttons 1 or 2 are pressed, dispense "Soda". If buttons 3 or 4 are pressed, dispense "Juice". If button 5 is pressed, dispense "Water". Write the switch statement.

Question 5: A menu system shows options: 'A' for Add, 'D' for Delete, 'U' for Update, 'V' for View. Both uppercase and lowercase letters should work. Given a variable choice (char), write the switch statement.

Question 6: A traffic light system: 'R' or 'r' displays "Stop", 'Y' or 'y' displays "Slow down", 'G' or 'g' displays "Go". Any other input displays "Invalid color". Write the switch statement.

Question 7: A month number (1-12) determines the season: 12, 1, 2 → "Winter", 3, 4, 5 → "Spring", 6, 7, 8 → "Summer", 9, 10, 11 → "Fall". Given a variable month, write the switch statement.

Question 8: A game controller: 'W' moves up, 'A' moves left, 'S' moves down, 'D' moves right. Write the switch statement with a default case for invalid input.

What is the output of the following code?

```
int choice = 2;
switch(choice) {
    case 1:
        cout << "One";
        break;
    case 2:
        cout << "Two";
        break;
    case 3:
        cout << "Three";
        break;
}
```

```
int num = 2;
switch(num) {
    case 1:
        cout << "First";
    case 2:
        cout << "Second";
    case 3:
        cout << "Third";
        break;
    default:
        cout << "Other";
}
```

```
char grade = 'B';
switch(grade) {
    case 'A':
        cout << "Excellent";
        break;
    case 'B':
    case 'C':
        cout << "Good";
        break;
    case 'D':
        cout << "Pass";
        break;
    default:
        cout << "Fail";
}
```

```
int day = 7;
switch(day) {
    case 1:
    case 2:
    case 3:
    case 4:
    case 5:
        cout << "Weekday";
        break;
    case 6:
    case 7:
        cout << "Weekend";
        break;
}
```

```
char op = '+';
int a = 10, b = 5;
switch(op) {
    case '+':
        cout << a + b;
        break;
    case '-':
        cout << a - b;
        break;
    case '*':
        cout << a * b;
        break;
}
```

```
int x = 3;
switch(x) {
    case 1:
        cout << "One";
        break;
    case 2:
        cout << "Two";
        break;
    default:
        cout << "Other";
    case 3:
        cout << "Three";
}
```

```
char ch = 'a';
switch(ch) {
    case 'a':
    case 'e':
    case 'i':
    case 'o':
    case 'u':
        cout << "Vowel";
        break;
    default:
        cout << "Consonant";
}
```

```
int month = 2;
switch(month) {
    case 12:
    case 1:
    case 2:
        cout << "Winter";
        break;
    case 3:
    case 4:
    case 5:
        cout << "Spring";
        break;
}
```

```
int num = 5;
switch(num) {
    case 5:
        cout << "Five";
    case 4:
        cout << "Four";
    case 3:
        cout << "Three";
    default:
        cout << "Done";
}
```

```
char letter = 'M';
switch(letter) {
    case 'M':
        cout << "Monday";
        break;
    case 'T':
        cout << "Tuesday";
        break;
    case 'W':
        cout << "Wednesday";
        break;
    default:
        cout << "Invalid";
        break;
}
```

Unit 4: Loops

Problem 1: Sum of Natural Numbers

Write a program that takes a positive integer n as input and calculates the sum of all natural numbers from 1 to n using a loop.

Problem 2: Star Pyramid

Write a program that takes a number n and prints a pyramid pattern with n rows. Each row should have an increasing odd number of stars (1, 3, 5, 7...), centered with appropriate spaces.

Problem 3: Reverse a Number

Write a program that takes an integer as input and displays its digits in reverse order. Use the modulo operator (%) to extract digits and division (/) to remove them.

Problem 4: Factorial Calculator

Write a program that calculates the factorial of a given number n. The factorial is the product of all positive integers from 1 to n.

Problem 5: Fibonacci Series

Write a program that prints the first n numbers in the Fibonacci sequence, where each number is the sum of the two preceding numbers (starting with 0 and 1).

Problem 6: Prime Number Checker

Write a program that determines whether a given number is prime. A prime number is greater than 1 and only divisible by 1 and itself. Check divisibility from 2 up to n-1.

Problem 7: All Prime Numbers in Range

Write a program that prints all prime numbers from 2 to n. Use nested loops: the outer loop iterates through each number, and the inner loop checks if that number is prime.

Problem 8: Sum of Digits

Write a program that calculates the sum of all individual digits in a given integer. Extract each digit using modulo and division operations in a loop.

Problem 9: GCD using Euclidean Algorithm

Write a program that finds the Greatest Common Divisor (GCD) of two positive integers using the Euclidean algorithm. Repeatedly replace the larger number with the remainder of dividing the larger by the smaller until one number becomes zero.

Problem 10: Diamond Pattern

Write a program that prints a diamond shape made of stars. The diamond should have n rows in the upper half (expanding) and n-1 rows in the lower half (contracting). Use nested loops to control spaces and stars for both the upper and lower portions.

What is the output of the following code

```
for (int i = 1; i <= 5; i++) {
    cout << i * 2 << " ";
}
```

```
int x = 10;
while (x > 5) {
    cout << x << " ";
    x -= 2;
}
```

```
for (int i = 1; i <= 10; i++) {
    if (i == 6) {
        break;
    }
    cout << i << " ";
}
```

```
int num = 0;
while (num < 8) {
    num++;
    if (num % 2 == 0) {
        continue;
    }
    cout << num << " ";
}
```

```
int count = 5;
while (true) {
    cout << count << " ";
    count--;
    if (count == 0) {
        break;
    }
}
```

```
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 2; j++) {
        cout << i << j << " ";
    }
}
```

```
for (int i = 1; i <= 7; i++) {
    if (i == 3 || i == 5) {
        continue;
    }
    cout << i << " ";
}
```

```
int a = 1;
while (true) {
    if (a > 5) {
        break;
    }
    if (a % 2 == 0) {
        a++;
        continue;
    }
    cout << a << " ";
    a++;
}
```

```
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 4; j++) {
        if (j == 3) {
            break;
        }
        cout << j;
    }
    cout << " ";
}
```

```
int n = 0;
while (true) {
    n++;
    if (n > 10) {
        break;
    }
    if (n % 3 == 0) {
        continue;
    }
    if (n % 2 == 0) {
        cout << n << " ";
    }
}
```

```
int sum = 0;
for (int i = 1; i <= 5; i++) {
    sum += i;
}
```

a) What is the value of sum after iteration 3?

b) What is the value of sum after the loop completes?

```
int a = 10;
int b = 2;
while (a > 5) {
    a -= b;
    b++;
}
```

a) What are the values of a and b after iteration 2?

b) What are the values of a and b after the loop completes?

```
int count = 0;
for (int i = 1; i <= 10; i++) {
    count += 2;
    if (i == 6) {
        break;
    }
}
```

a) What is the value of count after iteration 4?

b) What is the value of count after the loop completes?

c) What is the value of i after the loop completes?

```
int x = 5;
int y = 0;
while (true) {
    y += x;
    x--;
    if (x == 2) {
        break;
    }
}
```

a) What are the values of x and y after iteration 2?

b) What are the values of x and y after the loop completes?

```
int total = 0;
int skipped = 0;
for (int i = 1; i <= 8; i++) {
    if (i % 3 == 0) {
        skipped++;
        continue;
    }
    total += i;
}
```

a) What are the values of total and skipped after iteration 5?

b) What are the values of total and skipped after the loop completes?

```
int product = 1;
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 2; j++) {
        product *= 2;
    }
}
```

a) What is the value of product after the outer loop's iteration 2 completes?

b) What is the value of product after both loops complete?

c) What is the final value of i?