Full Name: _____ Gannon Identification Number: _____

ECE 217: Data Structure and Algorithm
Fall 2022, Final Examination
Gannon University (GU)
December 14, 2022

Please do not turn the page until you are informed.

Rules:
- The exam is closed-book, closed-note, closed shared calculator, and closed electronics.
- Please stop promptly at **6:00 PM**.
- There are **100 points** total, distributed **evenly** among **10** questions.

Question	Maximum	Earned
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
9	10	
10	10	

Advice:
- Read questions carefully. Understand a question before you start writing your answer.
- Write down thoughts and intermediate steps so you can get partial credit. Clearly circle your final answer.
- The questions are not necessarily in order of difficulty. **Skip around.** Make sure you get to all the problems.

Wishing you the best of luck,
Dr. Shayan (Sean) Taheri

Question 1. (10 points) Provide and explain the output of the following program. <u>Assuming all the desired header files are already included</u>, which are required to run the code.

```cpp
struct Pixel
{
        int C, R;
};


void Display(Pixel P)
{
        cout << "Column: "<< P.C << ", Row: " << P.R << endl;
}


int main()
{
        Pixel X = {40,50};
        Pixel Y, Z;
        Z = X;
        X.C += 10;
        Y = Z;
        Y.C += 10;
        Y.R += 20;
        Z.C -= 15;
        Display(X);
        Display(Y);
        Display(Z);

        return 0;
}
```

Question 2. (10 points) Define a **Class** student in the C++ programming language with the following specification. There is **<u>No Need</u>** to write the **int main()** function.,

Private members of class student:
- **sname**: string
- **eng, math, science**: float
- **total**: float
- **totalFunction()**: Function to calculate **eng + math + science** with return type of float.

Public member functions of class student:
- **takeData()**: Function to accept values for **sname, eng, math,** and **science**. Call **totalFunction()** inside it to calculate **total**.
- **showData()**: Function to display all the data members on the screen.

Question 3. (10 points) Run the **Bubble Sort Algorithm** on the following list and show figures for computations.

Note: It is **Not Required** to write any code for this question.

list[5] = {12, 8, 20, 4, 17}

Question 4. (10 points) Build a **Linked List** in **<u>Forward</u>** configuration based on the following numbers and show figures for computations. Explain the difference(s) of the built linked list when it is **Ordered** and **Unordered**.

<u>Note</u>: It is **<u>Not Required</u>** to write any code for this question.

```
Numbers = {3, 12, 5, 21, 33}
```

Question 5. (10 points) Execute the following computations **<u>in order</u>** and show figures for computations:
    a.   Create a **Binary Search Tree** and insert the following items into it: {15, 4, 11, 1, 20}.
    b.   Find the **Pre-Order Traversal**, the **In-Order Traversal**, and the **Post-Order Traversal** for the tree.
    c.   Delete the following item from it: {4}.

<u>Note</u>: It is **<u>Not Required</u>** to write any code for this question.

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Question 6. (10 points) Execute the following computations **in order** and show figures for computations:
    a.   Create an **AVL Tree** and insert the following items into it: {2, 24, 8, 30, 17, 10}.
    b.   Delete the following item from it: {17}.

Note: It is **Not Required** to write any code for this question.

Question 7. (10 points) Encrypt the plaintext message of "**I Love Gannon University**" using <u>an</u> **<u>Alphabetical Circular Left Shift</u>** of **5** (i.e., <u>using left-shifted English alphabet</u>). Explain the strength of this encryption.

<u>Note</u>: It is **<u>Not Required</u>** to write any code for this question.

Question 8. (10 points) Write a simple program in C++ programming language to perform **Exclusive-OR Encryption and Decryption** between <u>an input text data</u> and <u>a "**char**"-type key with multiple elements</u>. Show <u>the output of your program for Encryption mode in binary format</u> (without using computer) when the input data is "**GU**" (abbreviation of **Gannon University**) and the key is "**PA**" (abbreviation of **Pennsylvania**).

"**GU**" in Binary Format = "01000111 01010101".

"**PA**" in Binary Format = "01010000 01000001".

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Question 9. (10 points) Create a **Hierarchical Finite-State Machine** and show <u>its state transitions</u> based on an **<u>Acceptable</u>** <u>input sequence</u>.

Note: It is **<u>Not Required</u>** to write any code for this question.

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Question 10. (10 points) Show and explain **<u>mapping</u>** of a program/code onto **Memory Layout**.