

ECE 462 Final Exam

08:00-10:00AM, December 18, 2008

I certify that I will not receive nor provide aid to any other student for this exam.

Signature:

You must sign here. Otherwise, the exam is not graded. Please put your photo ID on the desk.

This exam is also available on-line in Blackboard. Please **circle here** if you take the exam on-line. In Blackboard, you can see "Final Exam" and "Final Exam (Attachment)". The latter is used when your code is too long to fit in the space given by Blackboard.

*This exam is printed **double sides**.*

This is an *open-book, open-note* exam. You can use any book or note or program printouts. No electronic device is allowed. Please turn off your cellular phone **now**.

There are 8 questions and you can select **at most** 5 questions to answer. Please mark (on the next page) which questions to grade. If you mark 6 questions, only 4 will be graded. If you mark 7 questions, only 3 will be graded. If you mark 8 questions, only 2 will be graded. Each question is worth 20 points.

If the specification is incomplete, inconsistent, or incorrect, please explain how you would modify the specification. You need the ability to detect and handle imperfect specifications.

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Mark **at most** 5 questions to be graded. If you mark 6 questions, only 4 will be graded. If you mark 7 questions, only 3 will be graded. If you mark 8 questions, only 2 will be graded.

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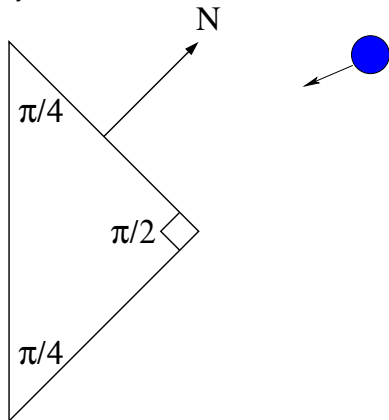
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1 Programming Assignment 1-2

In the first two programming assignments, the paddles are parts of two circles. If each paddle is a triangle, as shown below, how do you calculate the ball's direction after the collision? Write the code in C++ or Java (your choice). Please remember to declare and define the necessary classes and objects.



2 C++ Pass by Value, by Pointer, and by Reference

Briefly explain the differences between pass by value, by pointer, and by reference. Show at least three examples to illustrate the differences. Please pay special attention to (1) If an object is changed inside a function, is this change visible after the function returns? (2) What is the effect on performance? (3) If an object contains an attribute that requires dynamic memory allocation, what are the differences among the three methods for argument passing?

3 Java Applet

Write a dual-purpose Java program that (1) can be an application (2) can be an Applet. This program has a JPanel object and a red ball bounces within this panel. You also need to write an HTML file that uses this Applet.

4 Java RMI

Write both the server and the client for Java RMI. The server extends interface `EngineInterface` and the client extends interface `TaskInterface`. When the client's `executeCode` is called, it returns a `String` object saying "Hello ECE462."

```
// ::::::::::::::
// EngineInterface.java
// ::::::::::::::
package RMIInterface;

import java.rmi.Remote;
import java.rmi.RemoteException;

public interface EngineInterface extends Remote {
    <T> T executeTask(TaskInterface<T> t)
```

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```

        throws RemoteException;
    }

// ::::::::::::::
// TaskInterface.java
// ::::::::::::::
package RMIInterface;

public interface TaskInterface<T> {
    T executeCode();
}

```

5 Lab Exercise

Consider the following program that uses threads to add the elements in an array. The correct answer should be $0 + 1 + 2 + 3 + 4 + \dots + (\text{arraySize} - 1)$. (1) Is it possible that the program's two output values are different? Why? (2) What problem does this program have? Your answer might be "syntax error", "memory leak", "segmentation fault", or other problems. Please indicate the line (or lines) where the problem occurs. If there are several problems, you need to find **all problems**. (3) If the program has problem (or problems), how do you fix it?

```

#include <QThread>
#include <QMutex>
#include <QWaitCondition>
#include <cstdlib>
#include <iostream>
#include <ctime>
#include <sys/time.h>
using namespace std;

class AdderThread: public QThread
{
public:
    AdderThread(int * a, int f, int l)
    {
        array = a;
        first = f;
        last = l;
    }
    void addElement(int v)
    {
        mutex.lock();
        sum += v;
        mutex.unlock();
    }
    void run()
    {
        for (int cnt = first; cnt <= last; cnt++)
        {
            addElement(array[cnt]);
        }
    }
};

```

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```

    }
}
int getSum() const { return sum; }
private:
    QMutex mutex;
    int * array;
    int first;
    int last;
    static long sum;
};

long AdderThread::sum = 0; // initialize

int main(int argc, char* argv[])
{
    int arraySize = 1000000;
    int * dataArray = new int[arraySize];
    long actualSum = 0;
    for (int cnt = 0; cnt < arraySize; cnt ++)
    {
        // initialize the elements to 1, 2, 3, ...
        dataArray[cnt] = cnt;
        // cout << dataArray[cnt] << endl;
        actualSum += dataArray[cnt];
    }
    const int numThread = 4; // this is always a factor of arraySize
    AdderThread * * thrd = new AdderThread * [numThread];
    int first = 0;
    int last;
    for (int cnt = 0; cnt < numThread; cnt ++)
    {
        last = first + arraySize / numThread - 1;
        // cout << first << " " << last << endl;
        thrd[cnt] = new AdderThread(dataArray, first, last);
        first = last + 1;
    }

    for (int cnt = 0; cnt < numThread; cnt ++)
    {
        thrd[cnt] -> start();
    }

    for (int cnt = 0; cnt < numThread; cnt ++)
    {
        thrd[cnt] -> wait();
    }

    cout << "The sum by threads is " << thrd[0] -> getSum() << endl;
    cout << "The actual sum is " << actualSum << endl;

    for (int cnt = 0; cnt < numThread; cnt ++)

```

```

    {
        delete thrd[cnt];
    }

delete [] thrd;
delete [] dataArray;

return 0;
}

```

6 C++ Multiple Inheritance

Write the C++ code to implement this class hierarchy.

- `Person` is a class and has an attribute `name`; its type is `string`. The name of a `Person` object is a *constant* and cannot be changed after initialization.
- `Student` is a direct derived class of `Person` and has an additional attribute called `GPA`; its type is `float`.
- `Teacher` is a direct derived class of `Person` and has an additional attribute called `course`; its type is `string`.
- `TeachingAssistant` is a direct derived class of **both** `Student` and `Teacher`. `TeachingAssistant` has an additional attribute called `numberStudent`; its type is `int`. Each `TeachingAssistant` has **one and only one** name from the `Person` class.

Create a `TeachingAssistant` object whose name is “Tom Johnson”, GPA is 3.85, course is “ECE 462 C++ and Java”, and the number of student is 50. Print this object’s attributes.

Your answer should include (1) the declaration of the class hierarchy (2) constructors to properly initialize the attributes. All attributes should be `private` or `protected`.

7 C++ Echo Server

Write a C++ (using Qt) *echo server*. The server can accept multiple clients. When the server receives a string (ending with an new line character, `\n`), the server sends back the string to the client. If the string is “bye\n”, the server closes the connection and the client can no longer communicate with the server.

8 Programming Assignment 3

Write the C++ code to detect and eliminate a line in a Tetrix game. Please remember to declare and define the necessary classes and objects.