University of Waterloo
Department of Systems Design Engineering
SY DE 121 – Digital Computation
Fall 2007 Midterm Exam
2:30 – 4:30pm, Wednesday, October 24

NAME (PRINT): _____

STUDENT ID NO.: _____

SIGNATURE: _____

EXAMINATION GUIDELINES

a) No candidate will be permitted to leave the examination room during the last 15 minutes of the examination. All candidates remaining during the last 15 minutes of the examination period must remain at their desks until an instructor has collected their papers.

b) No electronic calculators or computers may be used during the test.

c) This is a closed-book test. You must not refer to books or notes during the test.

d) Candidates are requested to write only in spaces provided. If you write any rough work on the question paper, cross it out with a large "X" . Rough work will not be marked. You may use the back of the pages for rough work.

e) If you pull out individual papers from this exam, make sure that your name and id are written at the top of the loose pages. Ensure that loose pages are inserted within the rest of the intact exam when handed in.

f) A candidate must report to a supervisor before leaving the examination room.

g) Exam papers must be handed in promptly when the signal is given.

Programming Style

When answering questions that ask you to write programs or functions, you should follow the style guidelines that we have discussed in class, unless otherwise directed. Always leave out the file-header comment that gives the file name, your name and ID, and the date. There is no need to provide documentation other than to explain your solution, if necessary.

Some predefined functions from <cmath> and <cstdlib>

Declaration	Description	Example	Value of Example
`int abs(int i);`	absolute value	abs(-2)	2
`double fabs(double x);`	absolute value	fabs(-2.4)	2.400000000
`double pow(double x, double y);`	power x^y	$pow(2,3) \Rightarrow 2^3$ $pow(2,0.5) \Rightarrow \sqrt{2}$	8.0000 2.0000
`double sqrt(double x);`	square root	sqrt (3)	1.732050808
`double exp(double x);`	exponential e^x	exp(1)	2.718281828 $e \approx 2.718281828$
`double log(double x);`	base e logarithm	log (2.7183) $[2.7183 \approx e]$	1.000006685 $[1.000006685 \approx 1]$
`double log10(double x);`	base 10 logarithm	log10(100)	2.0000
`double sin(double x);`	sine of <u>radian</u> angle	sin(0.7854) $[0.7854 \approx \pi/4]$	0.707108080 $[0.7071 \approx 1/\sqrt{2}]$
`double cos(double x);`	cosine of <u>radian</u> angle	cos(3.14) $[3.14 \approx \pi]$	-0.999998732 $[-0.999998732 \approx -1]$
`int rand();`	random number	int val = rand( );	???

Question	1	2	3	4		Total
Marks	/10	/10	/15	/25		/60

QUESTION 1 [Total: *10 marks*] MULTIPLE CHOICE

For each problem, choose the <u>most</u> appropriate answer.

1) Pseudo-code:
   a) is used to generate ideas for an algorithm.
   b) assists transition from an idea into working computer code.
   c) refines the working computer code.
   d) is never used in real programming practice.
   e) None of the above.

2) Which of the following represents an invalid method to indicate comments in C++:
   ```
   a) /*  These are appropriate comments in C++. */
   b) /*  These are appropriate comments
      /*  in C++.
   c) //  These are appropriate comments
      //  in C++ and C.
   d) // // These are appropriate comments in C++.
   ```
   e) None of the above.

3) Which of the following statements is inappropriate in C++ ?
   ```
   a) unsigned short int value = 9847;
   b) double value = 3;
   c) int value, val = 10;
   d) int val = 3.2;
   ```
   e) None of the above.

4) Which of the following statements is appropriate in C++ ?
   ```
   a) char BluJays = u;   // u is not previously defined
   b) char RedSox = "b";
   c) char Tigers = 'hi';
   d) char Marlins = '2';
   ```
   e) None of the above.

5) How many bits in a byte?
   a) 2
   b) 4
   c) 8
   d) 16
   e) None of the above.

6) In C++, the term 'object' can be defined as:
   a) the ability of a variable to store data and call functions
   b) the output from a class
   c) 'cin' and 'cout'
   d) as a verb, "to object" means to disagree with the computer code
   e) None of the above.

7) Which of the following `for` loops will count exactly 10 times?
   ```
   a) for ( int j = 0; j < 31; j += 3 )
   b) for ( int j = 15; j <= 25; ++j )
   c) for ( int j = 10; j > -10; j -= 2 )
   d) for ( int j = 3; j >= -7; --j )
   ```
   e) None of the above.

8) Pass-by-reference is a term used to describe a way to:
   a) pass a parameter into a function
   b) pass an argument into a function so that the function is not modified
   c) pass an argument into a function so that the argument is modifiable within the function
   d) pass an argument into a function so that the corresponding formal parameter is not modifiable
   e) None of the above.

9) A 'switch' decision structure is used over an 'if … else if … else' decision structure when:
   a) making a comparison based on specific integer values
   b) making a comparison based on specific double values
   c) making comparisons between ranges of data
   d) binary decisions have to be made
   e) None of the above.

10) Which of the following variable names is allowed in C++?
    ```
    a) _cool
    b) latatime
    c) shhhhhhhhhhhhh[4]
    d) $whatever$
    ```
    e) None of the above.

Sometimes, existing code can be very disorganized, probably due to inefficient coding and perhaps the result of many programmers reworking the logic. Below is an example of such code. Rewrite this if-else code in a condensed format (ie. remove the redundancies), maintaining the same logic as the original. Then write down the output it will produce. <u>Note</u>: there are no typos in the following codes.

(a)

```cpp
int a = 2;
int x = 0;
if (a < 5) if (a < 0) x = 1; else if (a < 4) if (a = 1) x = 2; else if (a < 3) if (a == 2) x = 3;
cout << "x is " << x << endl;
cout << "a is " << a << endl << endl;
```

REWRITTEN CODE:

```cpp
int a = 2;
int x = 0;
if (a < 5)
{
    if (a < 0)
        x = 1;
    else if (a < 4)
    {
        if (a = 1)
            x = 2;
        else if (a < 3)
            if (a == 2)
                x = 3;
    }
}
cout << "x is " << x << endl;
cout << "a is " << a << endl << endl;
```

OUTPUT:

```
x is 2
a is 1

```

(b)

```
int a = 3;
int b = 5;
int c = a;
if ( a < 0 )
{
    cout << "A" << endl;
}
else
{
    if ( b > 0 )
        cout << "B" << endl;
    else
        cout << "C" << endl;
}
```

REWRITTEN CODE:

OUTPUT:

QUESTION 3 [15 marks] OUTPUT DETERMINATION

(a) Determine the output produced by the following program.

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

int giraffe( int b, int &a);

int main()
{
    int a = 1;
    int b = 2;
    a = giraffe(a,a);
    a = giraffe(b,b);
    cout << "main a is: " << a << endl;
    cout << "main b is: " << b << endl;
    system("pause");
    return 0;
}

int giraffe( int a, int &b )
{
    cout << "giraffe a is: " << a << endl;
    a += b;
    b += a;
    cout << "giraffe b is: " << b << endl;
    return a;
}
```

OUTPUT:

(b) Determine the output produced by the following code fragment.

```cpp
int i = 5, j = 2, k = 4, l = 3, m = 7, n = 8;
for ( i = 1, j = 3, k = 4; i++ < l || ++j < m && k < n; )
   cout << i << " " << j << " " << k << " " << l << " " << m << endl;
```

OUTPUT:

(c) Determine the output produced by the following code fragment.

```cpp
int x = 0, y = 0;
for ( x = 1; x <= 6; x++ )
{
    for ( y = x; y <= 6; y++ )
        if ( x%y == 0 )
            cout << 0 << " ";
        else
            cout << ( x*y ) << " ";
        cout << endl;
}
```

OUTPUT:

```
0 2 3 4 5 6 
0 6 8 10 12 
0 12 15 18 
0 20 24 
0 30 
0 
```
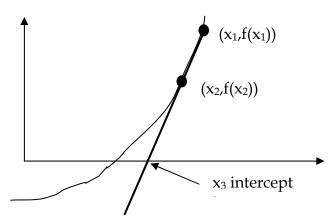
QUESTION 4 [Total: *25 marks*] PROGRAM IMPLEMENTATION

(a) [15 marks] The Secant method is an alternative method for finding the root x of the equation f(x) = 0. This method involves creating a line between two initial points $(x_0, f(x_0))$ and $(x_1, f(x_1))$ and approximating the root of the function f(x) with the x-intercept (i.e. root) of this secant line:

$$x_{n+1} = x_n - \frac{f(x_n)(x_n - x_{n-1})}{f(x_n) - f(x_{n-1})}$$

Iterations continue until either a maximum number of iterations occur or the two most recent root approximations differ by less than some tolerance.

Write a complete working program that asks the user to input two initial estimates of the root from the console and then uses the Secant method to attempt to find the root of a function f(x) to a tolerance of 10^{-4} without exceeding 10 iterations (these should be defined as consts). Assume that the function is defined as **f(x) = cos(x) − x³** (and this should be programmed as a function!). The displayed output should include an estimate of the root and, if necessary, a message warning that the tolerance was not achieved. You may also assume that $f(x_{i-2})$ is not equal to $f(x_{i-1})$.

QUESTION 4   PROGRAM IMPLEMENTATION

b) [10 marks] Write a complete working program that will calculate the area and perimeter of a circle. In the main function, prompt the user to enter the circle's radius and make sure the value is positive. Use an appropriate <u>single</u> function that will provide the area and the perimeter of the circle. Provide statements in the main function to display the calculated values for the area and the perimeter.