ACADEMIC CHALLENGE FOR ACES ENGINEERING AND SCIENCE

EASTERN ILLINOIS UNIVERSITY

2022 Academic Challenge

REGIONAL COMPUTER SCIENCE EXAM

Computer Science Test Production Team

Andrew Ian Chen, Independent Contractor – Author, Reviewer
Stephanie Brandt, Northrup Grumman Corporation – Author, Reviewer

GENERAL DIRECTIONS

Please read the following instructions carefully. This is a timed test; any instructions from the test supervisor should be followed promptly.

The test supervisor will give instructions for filling in any necessary information on the answer sheet. Most Academic Challenge sites will ask you to indicate your answer to each question by marking an oval that corresponds to the correct answer for that question. One oval should be marked to answer each question. Multiple ovals will automatically be graded as an incorrect answer.

Be sure ovals are marked as ● , not ⊙ , ⊕ , ◑ , etc.

If you wish to change an answer, erase your first mark completely before marking your new choice.

You are advised to use your time effectively and to work as rapidly as you can without losing accuracy. Do not waste your time on questions that seem too difficult for you. Go on to the other questions, and then come back to the difficult ones later if time remains.

Time: 40 Minutes Number of Questions: 30

DO NOT OPEN TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO!

2022 Academic Challenge
Regional Computer Science Exam

1. Which are of the following are not common ways of modeling data to be stored in a database:

   A. Ephemeral data model
   B. Logical data model
   C. Physical data model
   D. Recursive data model
   E. a and d

2. What function do Cascading Style Sheets serve in web development?

   A. Describing the content of a document
   B. Describing the presentation of a document
   C. Defining the network a document is served from
   D. Embedding programs in a document
   E. Rendering documents fetched from the web

3 Distributed disk drive systems like RAID do not have which of following potential advantages:

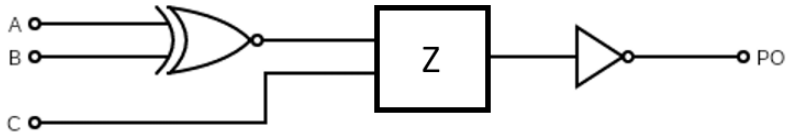
   A. Reduced need for independent backups
   B. Increased speed of access
   C. Increased data integrity from corruption
   D. Reduced cost compared to a single large dive of the same capacity
   E. Increased drive availability

4. Which of the following are properties of a packet-switched network:

   A. Fixed throughput
   B. Fixed network latency
   C. Resistance to interception for data streams
   D. Capacity for variable rate data delivery
   E. b and d

5. What logic gate replacing object Z in the diagram below would recreate the logic table

A	B	C	PO
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



A. xor
B. nand
C. and
D. or
E. xnor

6. A queue data structure is an example of a

A. First-in-first-out data structure
B. Random access data structure
C. Last-in-first-out data structure
D. Sorted data structure
E. Tree based data structure

7. Greedy algorithms have the property of:

A. Providing a polynomial time solution to all nondeterministic polynomial time problems
B. An optimal solution to dynamic programing problems
C. Making locally optimal choices
D. Making broadly optimal choices
E. Guaranteed not to produces an optimal solution

8. What is the output of the following program?

```
1   #include <iostream>
2   using namespace std;
3
4   int main()
5   {
6       int x = 5;
7       while(x > 0) {
8           cout << --x << " ";
9       }
10      return 0;
11  }
```

A. 5 4 3 2 1
B. 5 4 3 2 1 0
C. 4 3 2 1
D. 4 3 2 1 0
E. Infinite loop printing 4

9. Let A = 1000 000 and B = 1111 1111 where A and B are in 8-bit one's complement representation. What is A+B (in decimal)?

A. −127
B. −255
C. 0
D. 127
E. 383

10. Which of the following are properties of a CPU cache?

A. Reduced power consumption with large cache size
B. Reduced average access time for retrieval operations
C. Persistence with power off
D. Reduced on-chip area required for memory
E. a and b

11. N-bit one's complement representation can represent integers within what range?

A. $[0, 2^N]$
B. $[-2^{N-1}, 2^{N-1}]$
C. $[-2^{N-1} + 1, 2^{N-1}]$
D. $[-(2^{N-1} - 1), 2^{N-1} - 1]$
E. $[1, 2^N]$

12. Convert the hexadecimal number 0xD8A to decimal

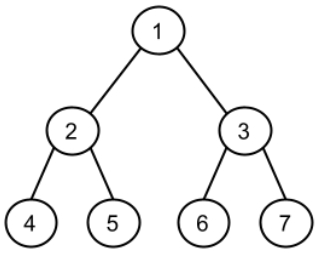
A. 3466
B. 3722
C. 481
D. 346
E. 1418

13. Which expression is equivalent to $\overline{A \cdot (\overline{B} + C) + \overline{A}}$?

A. $A + A \cdot B + A \cdot \overline{C}$
B. $A \cdot B \cdot \overline{C}$
C. $\overline{A} \cdot (B + C)$
D. $\overline{B} \cdot C$
E. $\overline{A} + \overline{B} + C$

14. Consider the following tree. What is a result of a post-order traversal on this tree?

A. 1234567
B. 1245367
C. 4526731
D. 4256371
E. 4567231



15. Consider the following program:

```
1   #include <iostream>
2   using namespace std;
3
4   int main()
5   {
6       int a[6] = {1, 2, 3, 4, 5, 6};
7       for(int i = 0; i < 6; ++i) {
8           a[i] = a[(i + 3) % 6];
9          cout << a[i];
10      }
11      return 0;
12  }
```

What is printed to the console?

A. 123456
B. 456123
C. 456456
D. 123123
E. 654321

16. Consider the following program:

```
1   #include <iostream>
2   using namespace std;
3
4   void function(int x)
5   {
6       cout << x - 10 << " ";
7       if((x - 10) > 0) {
8           function(x - 10);
9       }
10      cout << x - 10 << " ";
11  }
12
13  int main()
14  {
15      function(25);
16      return 0;
17  }
```

What is printed to the console?

A. 25 15 5 -5
B. 15 5 -5 -5 5 15
C. 25 15 5 -5 5 15
D. 15 5 5 15
E. 25 15 5 5 15 25

Consider the following program for Question 17 and Question 18:

```
1   #include <iostream>
2   using namespace std;
3
4   struct circle {
5       int r;
6       double area()
7       {
8           return 3.14 * r * r;
9       }
10  };
11
12  circle operator*(circle a, int x)
13  {
14      circle tmp;
15      tmp.r = a.r * x;
16  }
17
18  int main()
19  {
20      circle a;
21      a.r = 5;
22      circle b = a * 2;
23      cout << b.area() << endl;
```

```
24      return 0;
25  }
```

17. What will be printed to the console?

A. 25
B. 78.5
C. 100
D. 314
E. Compiler Error

18. What term best describes line 12?

A. Multiple Inheritance
B. Operator Overloading
C. Functional Dimorphism
D. Class Attribute
E. Illegal Constructor

19. What is output from the following program?

```
1   #include <iostream>
2   using namespace std;
3
4   int main()
5   {
6       for (int i = 0; i < 10; ++i) {
7           if(i % 3 == 0) {
8               cout << i << " ";
9               i += 1;
10          } else if(i % 5 == 0) {
11              break;
12          }
13      }
14  }
```

A. 0 3 6
B. 0 1 2 3 4 5
C. 0 3 6 9
D. 0 3
E. 1 4

20. Which of the following are characteristics of a binary search algorithm?

(I) Implemented on a sorted list or array
(II) Worst case run-time is *O(log(n))*
(III) Spatial complexity is *O(log(n))*

A. I only
B. I and II
C. II only
D. II and III
E. I, II, and III

21. A teacher wants to assign letter grades to their class using the following scheme:

90 and above: A
80 and above, but less than 90: B
70 and above, but less than 80: C
Less than 70: D

Which of the following code snippets will assign letter grades corresponding to the above description?

I

```
if(score >= 90)
    {
        grade = "A";
    } else if(score >= 80)
    {
        grade = "B";
    } else if(score >= 70)
    {
        grade = "C";
    } else
    {
        grade = "D";
    }
```

II

```
if(score >= 90)
    {
        grade = "A";
    }
    if(score >= 80)
    {
        grade = "B";
    }
    if(score >= 70)
    {
        grade = "C";
    } else
    {
        grade = "D";
    }
```

III

```
if(score >= 90)
    {
        grade = "A";
    }
    if(score >= 80 && score < 90)
    {
        grade = "B";
    }
    if(score >= 70 && score < 80)
    {
        grade = "C";
    }
    if(score < 70)
    {
        grade = "D";
    }
```

A. I and II
B. I and III
C. II and III
D. I, II, and III
E. III only

22. A Von Neumann architecture is best described by which of the following:

A. A computer architecture where data and instructions share the same storage and signal pathway
B. A computer architecture where data and instructions have different storage locations and signal pathways
C. A hardware architecture only programmable by punch cards
D. A processor architecture using vacuum tubes
E. A computer architecture where new instructions never need to be fetched by the processor

Consider the following program for questions 23, 24, and 25:

```
1   #include <iostream>
2   using namespace std;
3
4   int func(int x, int &y, int z)
5   {
6       return ++x + ++y + ++z;
7   }
8
9   int main()
10  {
11      int a = 1;
12      int *b = &a;
13      int c = func(a, a, *b);
14      cout << a << " " << *b << " " << c << endl;
15  }
```

23. What is the first line of output from the program?

A. 1
B. 2
C. 3
D. 4
E. An address in memory

24. What is the second line of output from the program?

A. 1
B. 2
C. 3
D. 4
E. An address in memory

25. What is the third line of output from the program?

A. 3
B. 4
C. 5
D. 6
E. 7

Consider the following program for Question 26 and Question 27:

```
1   #include <iostream>
2   #include <cmath>
3   using namespace std;
4
5   class point
6   {
7   protected:
8       double x;
9       double y;
10
11  public:
12      point(double x = 0, double y = 0):x(x), y(y) {}
13      virtual void print()
14      {
15          cout << "My Euclidean position is: (" << x << ", " << y <<
")";
16      }
17
18      double distance()
19      {
20          return sqrt(x*x + y*y);
21      }
22  };
23
24  class taxi:public point
25  {
26  public:
27      taxi(double x, double y):point(x, y) {}
28      virtual void print()
29      {
30          cout << "My taxi position is: (" << x << ", " << y << ")";
31      }
32
33      double distance()
34      {
35          return x + y;
36      }
37  };
38
39  int main()
40  {
41      point *euclid;
42      taxi hackney(8, 15);
43      euclid = &hackney;
44
45      euclid->print();
46      cout << ". I am " << euclid->distance()
47           << " units from the origin.\n";
48  }
```

26. What is the output of the program?

A. `My Euclidean position is: (8, 15). I am 23 units from the origin.`
B. `My Euclidean position is: (8, 15). I am 17 units from the origin.`
C. `My taxi position is: (8, 15). I am 17 units from the origin.`
D. `My taxi position is: (8, 15). I am 23 units from the origin.`
E. Runtime error

27. The resolution to the call of the print method on line 45 is an example of:

A. Runtime Polymorphism
B. Compile time Polymorphism
C. Function overloading
D. Memory Allocation
E. An illegal operator

Consider the following program for Question 28 and Question 29:

```
1   #include <iostream>
2   using namespace std;
3
4   struct shape {
5       int height;
6       int width;
7       shape() : height (1), width(2) {}
8       shape(int w, int h) : height (w), width(h) {}
9   } B(3,5);
10
11  int main()
12  {
13      shape *A = &B;
14      cout << A->height << endl;
15  }
```

28. What is the output of the program?

A. 1
B. 2
C. 3
D. 5
E. A memory address

29. Which of the following expressions could replace line 14

A. `cout << (&A).height << endl;`
B. `cout << (&A)->height << endl;`
C. `cout << (*(&A)).height << endl;`
D. `cout << (&(*A))->height << endl;`
E. `All of the above`

30. Consider an in place implementation of Quicksort, using the leftmost element as the pivot, and sorting in the least to most direction. Starting with an array {22, 21, 15, 27, 18, 16, 24}, which of the following is a possible intermediate array state representation:

A. {{27, 24, 22, 21}, {18, 16, 15}}
B. {{16, 21, 15, 18}, {27, 22, 24}}
C. {{15, 21}, {16, 27, 18, 22, 24}}
D. {{{15, 24}, 21}, 16, {22, 18, 27}}
E. {{22, 16, 18, 15}, {24, 21, 27}}