



2023 Academic Challenge

SECTIONAL COMPUTER SCIENCE EXAM

Computer Science Test Production Team

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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!

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Academic Challenge
2023 Sectional Computer Science Exam

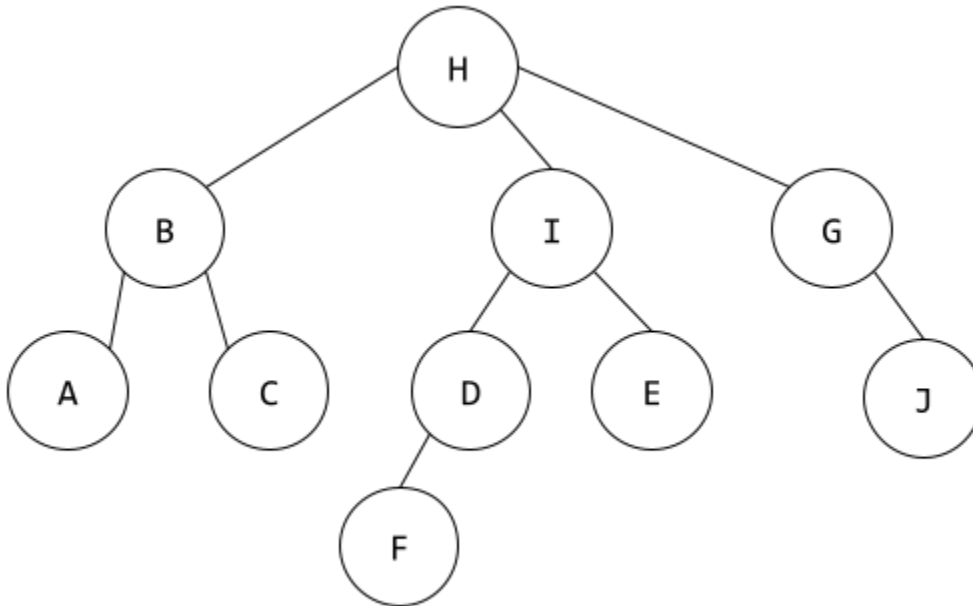
For each question select the best option. Assume required header files and libraries are included for example programs.

1. Which of the following will produce the logic table below?

A	B	C	Output
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

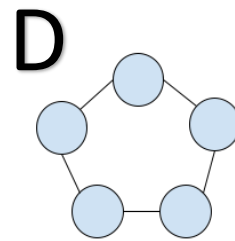
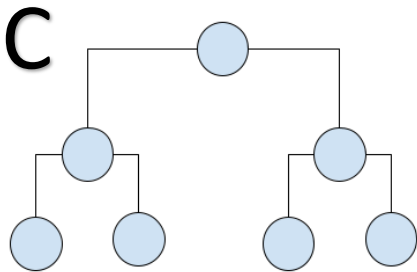
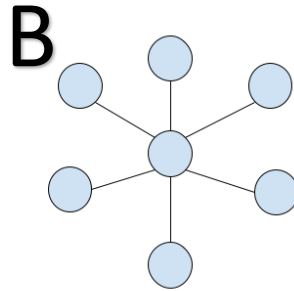
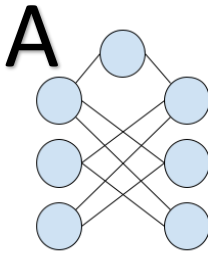
- a. $\overline{(\overline{A + B})} \cdot C$
 b. $\overline{A + B} + C$
 c. $(\overline{A} + \overline{B}) \cdot C$
 d. $\overline{A} \cdot B + C$
 e. $\overline{A} + \overline{B} + \overline{C}$
2. The command 'push' adds an element to a queue and 'pop' removes an element. What is the result of the following sequence of commands?
- push(A), push(B), push(C), push(D), pop(), pop(), push(E), push(F), pop()
- a. A B C D
 b. C D E
 c. A B E
 d. A B C E
 e. A B C D E F
3. What is the 8-bit two's complement representation of the decimal number -57?
- a. 1100 0110
 b. 0011 1001
 c. 1011 1001
 d. 0100 0110
 e. 1101 0101

4. What is the result of a postorder traversal of the tree below?



- a. ACBFDEIJGH
 - b. HBACIDFEGJ
 - c. HBIGACDEJF
 - d. ABCHFDIEHGJ
 - e. FACDEJBIGH
5. A _____ operation is an operation which can be applied multiple times and will not result in a change of result beyond the initial application of the operator.
- a. Recursive
 - b. Iterative
 - c. Idempotent
 - d. Omnipotent
 - e. Transient

6. Which of the following diagrams corresponds to a tree (hierarchical) network topology?



- a. A
- b. B
- c. C
- d. D
- e. There is no such thing as a tree network

7. Convert the hexadecimal number 0xB2F to decimal.

- a. 45808
- b. 45806
- c. 2862
- d. 2863
- e. 178

8. What does ROM stand for?

- a. Readable Optical Mechanism
- b. Rapid Output Memory
- c. Random Order Memory
- d. Read Optional Memory
- e. Read Only Memory

9. Consider the class declaration and statements below.

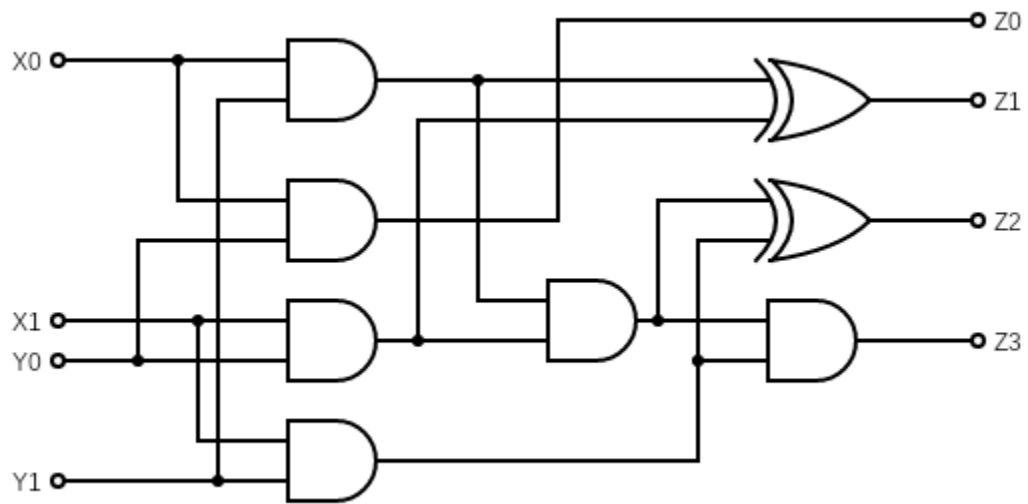
```
class Rectangle : public Shape
```

- I. Any private members of class Shape are accessible to class Rectangle
- II. Any protected members of class Shape are public members of class Rectangle
- III. Any public members of class Shape are public members of class Rectangle

Which of the statements are true?

- a. III only
 - b. I and II
 - c. I and III
 - d. II and III
 - e. I, II, and III
10. A network mechanism which can create a secure connection between a device and network, over insecure connections, is called a _____. (general computing / networking)
- a. Internet Area Network
 - b. Virtual Private Network
 - c. Wide Area Network
 - d. Local Area Network
 - e. Software-Defined Wireless Network
11. Which of the following is equivalent to $\overline{(\overline{A} + \overline{B})} \cdot (A + \overline{C})$? (number systems / digital logic)
- a. $A \cdot B$
 - b. $A + B + \overline{C}$
 - c. $\overline{A \cdot B} + \overline{C}$
 - d. $B \cdot \overline{C}$
 - e. $\overline{A + B + C}$

12. Consider the following digital logic circuit: (number systems / digital logic)



What operation is applied on X and Y to form Z?

- a. Division
 - b. Multiplication
 - c. Ripple-carry addition
 - d. Full subtractor with borrow
 - e. Adder-subtractor
13. If a 16 nm process node processor architecture has a transistor (T_r) density of 19 MTr/mm^2 , what would be the expected density from a die shrink to a 10 nm process.
- a. 7 MTr/mm^2
 - b. 12 MTr/mm^2
 - c. 19 MTr/mm^2
 - d. 30 MTr/mm^2
 - e. 50 MTr/mm^2
14. An AI accelerator is a computer system :
- a. That controls a particle accelerator
 - b. That implements an automated software development assistant
 - c. Consisting of a class of specialized hardware for machine learning applications
 - d. That controls the electronic throttle on an engine or motor
 - e. For automating software development project management

15. In computer networking UDP stands for?
- Universal Digital Packet
 - Undefined Delay Ping
 - Unten Diagonale Phase
 - User Datagram Protocol
 - Ultra-Definition Photo
16. Given an associative container (e.g. `std::set`, `std::map`) with n elements, what is the time complexity for search, removal, and insertion?
- $O(1)$, $O(n)$, $O(n)$
 - $O(n)$, $O(n)$, $O(n)$
 - $O(n)$, $O(1)$, $O(1)$
 - $O(\ln(n))$, $O(\ln(n))$, $O(\ln(n))$
 - $O(n)$, $O(\ln(n))$, $O(\ln(n))$
17. Which of the following is NOT a heuristic optimization algorithm
- Simulated annealing
 - Branch and bound
 - Genetic algorithm
 - Greedy algorithm
 - Particle swarm optimization
18. What makes it possible to override a function from a base class in a derived class?
- Static member function
 - Virtual function
 - Overloaded function
 - Multiply Inherited Function
 - Polymorphic Overloading

For questions 19 and 20, refer to the following program:

```
01 #include <iostream>
02 #include <bits/stdc++.h>
03 using namespace std;
04
05 int main()
06 {
07
08     unordered_map<int,int> tmp;
09
10     for (int i = 0; i < 20; ++i) {
11         if (i % 4 == 3) tmp[i] = 1;
12     }
13
14     for (auto i = tmp.begin(); i != tmp.end(); i++) {
15         cout << i->first << " ";
16     }
```



```

17
18     return 0;
19 }

```

19. Which of the following could be the result of running the program?

- 19 15 11 7 3
- 00030007000110001500019
- 11111
- 00010001000100010001
- 3171111151191

20. Which of the following alternate Line 8's would result in an error-free program where tmp stores the same set of key-value pairs as Question 19?

- vector<int> tmp;
- table<int, int> tmp;
- map<int, int> tmp;
- int tmp[] = {};
- No possible alternatives

For questions 21 and 22, refer to the following program:

```

01 #include <iostream>
02 using namespace std;
03
04 void func1(int* a, int& b)
05 {
06     a = a+1;
07     b = *a+b;
08 }
09
10 int main()
11 {
12     int arr[5] = {1, 3, 2, 4, 0};
13
14     for (int i = 0; i < 4; ++i) {
15         // Question 21
16     }
17
18     for (int i = 0; i < 5; ++i) {
19         cout << arr[i] << " ";
20     }
21     return 0;
22 }

```

21. Which of the following when placed in Line 15 will allow the program to compile and run without errors?

- func1(arr[i], arr[i+1]);
- func1(&arr[i], arr[i+1]);
- func1(*arr[i], arr[i+1]);
- func1(&arr[i], *arr[i+1]);
- func1(*arr[i], &arr[i+1]);

22. Assuming the valid replacement of Line 15 as in Question 21, what will be printed to the terminal when the program is run?
- 1 7 5 9 1
 - 5 7 11 11 10
 - 4 3 5 1 1
 - 1 6 4 8 0
 - Five memory addresses

Refer to the following program for Questions 23 – 24

```

01 #include <iostream>
02 using namespace std;
03 #define funcA(a, b) (((2*a)<b)?a+1:b-1)
04 #ifdef funcA
05 #define sum(a, b) (a+b)
06 #define funcB(a, b, c) (sum(funcA(a, b),funcA(b, c)))
07 #endif
08 #undef funcA
09 #define funcA(a, b) (2*a)
10
11 int main()
12 {
13
14     int a = 1, b = 10, c = 100;
15
16     cout << funcB(a, b, c) << endl;
17
18     return 0;
19 }
```

23. What is printed to the terminal as a result of running the program?
- 13
 - 15
 - 20
 - 22
 - 30
24. Lines 3-9 are an example of what?
- Preprocessor Directives
 - Hashtag Function List
 - Operator Overloading
 - Preamble Hashmap
 - Include statements

Refer to the following program for Question 25:

```

01 #include <iostream>
02 using namespace std;
03
04 int main()
```

```

05 {
06
07     int* arr[5];
08     for (int i = 0; i < 5; ++i) {
09         // Question 25
10         arr[i] = a;
11     }
12
13     return 0;
14 }

```

25. Which of the following could be inserted into the _____ on line 9 such that arr[i] is a pointer to an int, where the int has value i+2?

- int a = i+2;
- int *a = i+2;
- int *a = *(i+2);
- int *a = new int(i+2);
- int *a = &i+2;

For Questions 26, refer to the following program:

```

01 #include <iostream>
02 using namespace std;
03
04 struct Book {
05     static int n;
06     string title;
07     int pages;
08     Book()
09     {
10         ++n;
11     };
12     Book(string t, int p)
13     {
14         title = t;
15         pages = p;
16     };
17 };
18
19 int Book::n=0;
20
21 int main()
22 {
23
24     Book trilogy[3];
25     Book novel("Hello World", 100);
26     Book poems;
27
28     cout << "I own " << trilogy[3].n << " books" << endl;
29     return 0;
30 }

```

26. What is printed to the terminal as a result of running the program?

- a. I own 0 books
- b. I own 1 books
- c. I own 3 books
- d. I own 4 books
- e. I own 5 books

Refer to the following program for Questions 27-30

```
01 #include <iostream>
02 using namespace std;
03
04 class Disc
05 {
06 protected:
07     int rpm;
08
09     Disc()
10     {
11         rpm = -1;
12     };
13     Disc(int rp)
14     {
15         rpm = rp;
16     };
17     string getInfo()
18     {
19         return to_string(rpm)+"rpm";
20     }
21 };
22
23 class Movie
24 {
25 protected:
26     int runtime;
27     string title;
28
29     string getInfo()
30     {
31         string tmp = title + " (" + to_string(runtime)+" min)";
32         return tmp;
33     }
34     Movie()
35     {
36         title = "";
37         runtime = -1;
38     }
39     Movie(string ttl, int run)
40     {
41         title = ttl;
42         runtime = run;
43     };
44
45 public:
46     void setTitle(string ttl)
```

```
47     {
48         title = ttl;
49     }
50 };
51

// Program continues next page

52 class DVD : public Disc, public Movie
53 {
54 public:
55     DVD() : Disc(), Movie() {};
56     // -----
57     // Question 28
58     // -----
59     void getInfo()
60     {
61         cout << Movie::getInfo() << " " << Disc::getInfo() << endl;
62     }
63 };
64
65 int main()
66 {
67     DVD dvd1("tmp", 90, 1000);
68
69     Movie *mov = &dvd1;
70     mov->setTitle("Greatest Hits"); // Question 30
71     dvd1.getInfo();
72
73     return 0;
74 }
```

27. The class declaration “class DVD : public Disc, public Movie” is an example of ____.
- Multiple Inheritance
 - Polymorphism
 - Recursive namespaces
 - Object overloading
 - Domain names

28. Which of the following is a valid constructor for DVD (e.g lines 56-58) where the first argument is the movie title, second argument is movie runtime, and third argument is the disc RPM?

- I.

```
DVD(string ttl, int run, int rp) {
    Disc(rp);
    Movie(ttl,run);
};
```
- II.

```
DVD(string ttl, int run, int rp) : Disc(rp), Movie(ttl,run) {};
```
- III.

```
DVD(string ttl, int run, int rp) {
    title = ttl;
    runtime = run;
    rpm = rp;
};
```

- a. I only
- b. I and II
- c. II and III
- d. I and III
- e. I, II, and III

29. What is the result of running the program? Assume that the constructor selected in Question 28 is correct and will not cause any errors. (Program Logic)

- a. Compile-time error as `Movie::getInfo()` and `Disc::getInfo()` need to be public but are instead protected
- b. Compile-time error as `Movie::setTitle(string ttl)` can only be accessed through the derived class
- c. `tmp (90 min) 1000rpm`
- d. `Greatest Hits (90 min) 1000rpm`
- e. `(-1 min) -1rpm`

30. Which of the following could replace Line 70 and produce the same result?(Program Logic)

- a. `dvd1->setTitle("Greatest Hits");`
- b. `mov->title = "Greatest Hits";`
- c. `dvd1.setTitle("Greatest Hits");`
- d. `dvd1.title = "Greatest Hits";`
- e. `dvd1.movie::title = "Greatest Hits";`

