

**Master Networks-IoT.
Operations Research.**

**Quiz
November 2024**

In the following, we consider that the number of edges (resp. arcs) in an undirected (resp. directed) graph is m , and the number of vertices is n .

1. Let $T(n) = 8n^4 + 3n^2$. Which of the following statements are true?
(There might be more than one correct answer.)
 - A) $T(n) = O(n)$
 - B) $T(n) = \Omega(n^2)$
 - C) $T(n) = \Theta(n)$
 - D) $T(n) = O(n^4)$

2. What is the maximum number of edges does a path of a connected acyclic graph with n vertices contain?
 - A) n
 - B) $n - 1$
 - C) It depends on the paths
 - D) $\frac{n(n-1)}{2}$

3. Consider an undirected graph with n vertices. Assume that the graph is connected. What are the minimum and maximum numbers of edges, respectively, that the graph could have?
 - A) $n - 1$ and $\frac{n(n-1)}{2}$
 - B) $n - 1$ and n^2
 - C) n and 2^n
 - D) n and n^n

4. We consider two algorithms A and B solving the same problem on a graph G . A is in $O(m)$ and B is in $O(n \log n)$. Which algorithm to use if G is a dense graph?
 - A) Algorithm A
 - B) Algorithm B

5. We consider two algorithms A and B solving the same problem on a graph G . A is in $O(m)$ and B is in $O(n \log n)$. Which algorithm to use if G is a tree?
- A) Algorithm A
 - B) Algorithm B
6. How much space does the adjacency list representation of a graph require?
- A) $O(n)$
 - B) $O(m)$
 - C) $O(n + m)$
 - D) $O(n^2)$
7. How much space does the adjacency matrix of a graph require?
- A) $O(n)$
 - B) $O(n^2)$
 - C) $O(n + m)$
 - D) $O(m^2)$
8. What is the time complexity of a graph search algorithm (choose the most accurate possible answer)?
- A) $O(n^2)$
 - B) $O(m)$
 - C) $O(nm)$
 - D) $O(n + m)$
9. In the graph G_1 , what is $\{A, B, E\}$?

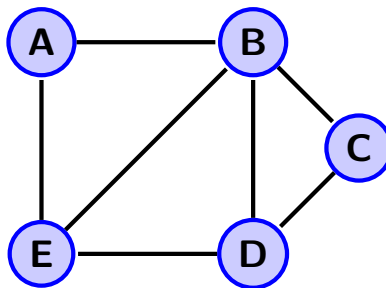


Figure 1: Graph G_1 .

- A) an arc
- B) an edge
- C) a path
- D) a cycle

10. In the graph G_1 , propose a list of explored nodes using the generic graph search algorithm from E . Represent the selected edges in the graph to show the exploration.

11. In the graph G_2 , propose a list of explored nodes in BFS order starting from D . Represent the selected arcs in the graph to show the BFS exploration.

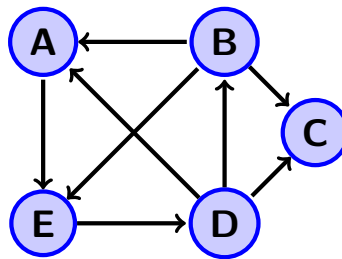


Figure 2: Graph G_2 .

12. In the graph G_2 , propose a list of explored nodes in DFS order starting from D . Represent the selected arcs in the graph to show the DFS exploration.

13. In the graph G_2 , the number of strongly connected components is:

- A) 1
- B) 2
- C) 3
- D) 5

14. In the graph G_2 , the number of connected components is:

- A) 1
- B) 2
- C) 3
- D) 5

15. How many connected components does a tree with n vertices ($n \geq 4$) contain after deleting 2 edges?

- A) n
- B) 3
- C) It depends on the trees
- D) $n - 1$

16. Consider an undirected graph G represented by an adjacency matrix. Given a vertex v , how many operations are required to compute the degree of v ?

- A) $O(n)$
- B) $O(\min(n, m))$
- C) $O(m)$
- D) $O(n + m)$

17. Consider a directed graph G represented by adjacency lists (each storing the outgoing arcs of a vertex). Given a vertex v , how many operations are required to identify the indegree of v ?

- A) $O(n)$
- B) $O(\min(n, m))$
- C) $O(m)$
- D) $O(n + m)$

Answers

1. B.D.
2. B.
3. A.
4. B.
5. A.
6. C.
7. B.
8. C.
9. C.
10. (E, A, B, C, D) . Arcs of the tree (root node E): (E, A) , (E, B) , (B, C) , (C, D) .
Other answers are possible.
11. (D, A, B, C, E) . Arcs of the tree (root node D): (D, A) , (D, B) , (D, C) , (A, E) .
Other answers are possible.
12. (D, B, A, E, C) . Arcs of the tree (root node D): (D, B) , (B, A) , (A, E) , (B, C) .
Other answers are possible.
13. B.
14. A.
15. B.
16. A.
17. D.