

KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.Sc.

Year : III

Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : COMP 314

Semester : II

F. M.

2¹⁰
22 DEC 2024

Date :

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

- Which of the following is **NOT** an algorithm design strategy?
 - Divide-and-conquer
 - Branch-and-bound
 - Randomization
 - Minimization
- Which of the following is **NOT** true about backtracking?
 - Backtracking is a systematic way to search for the solution to a problem.
 - The solution space is searched in a LIFO breadth first manner.
 - Backtracking method attempts to extend a partial solution toward a complete solution.
 - Backtracking algorithms can be implemented using recursion.
- Suppose we want to multiply 4 matrices, A, B, C, and D, of the size 30x1, 1x40, 40x10, and 10x25 respectively. How many multiplications are done for the ordering (AB)(CD)?
 - 20,700
 - 11,750
 - 1,400
 - 41,200

4. Consider the following pseudocode:

```
sort ( A )
// An unordered array A of size n.
// Assuming the index of elements starts from 1.
for (i = 1 to n-1)
  m = i
  for (j = i + 1 to n)
    if ( A[j] < A[m] )
      m = j
    endif
  endfor
  temp = A[i]
  A[i] = A[m]
  A[m] = temp
endfor
```

Which algorithm strategy is used here?

- Backtracking
 - Greedy
 - Brute force
 - Dynamic programming
5. The recurrence $T(n) = 4T(n/4) + 1000n$ solves to
- $T(n) = O(n)$
 - $T(n) = O(n \lg n)$
 - $T(n) = O(1)$
 - $T(n) = O(n^4)$

6. Which of the following **MUST** hold in a red-black tree?
- A red-black tree must satisfy all properties of a binary search tree.
 - All leaf nodes must be at the same level.
 - Leaf nodes can be either red or black.
 - Black height of a red-black tree must not exceed the black height of nodes other than the root node.
7. Which of the following statements is **TRUE**?
- In Message Passing Model, there is no shared memory.
 - Parallel Random Access Model is useful in a distributed environment.
 - Increasing the number of processors will always increase the speedup.
 - A scalable parallel algorithm is the one whose efficiency increases when both the number of processors and the size of the problem are increased.
8. Consider the following numbers: 221, 342, 209, 444, 390, 200, 312. What will be the order of these number after the first iteration of radix sort?
- 221, 209, 200, 342, 390, 312, 444.
 - 200, 390, 221, 342, 312, 444, 209.
 - 200, 209, 221, 312, 342, 390, 444.
 - 390, 200, 221, 342, 312, 444, 209.
9. Suppose the Huffman coding algorithm encodes the character a as 000, m as 001, c as 0100, o as 11, d as 10000, and n as 1001. What can you say about the characters from this Huffman table?
- o must be the most frequent character.
 - o must be the least frequent character.
 - d must but the most frequent character.
 - Either a or m must be the least frequent character.

10. Consider the following set of activities with their start time (s) and finish time (f).

| | a | b | c | d | e | f | g |
|---|---|---|---|---|---|----|----|
| s | 1 | 0 | 4 | 5 | 1 | 8 | 12 |
| f | 6 | 5 | 8 | 7 | 0 | 11 | 13 |

Which of the following is the maximal set of compatible activities?

- {a, b, c, d, e}
 - {a, d, g}
 - {b, d, f, g}
 - {a, f, g}
11. Which of the following problems is **NOT** NP-complete?
- The satisfiability problem
 - The vertex-cover problem
 - The traveling salesman problem.
 - Linear programming
12. A graph without any edges is called _____.
- an acyclic graph
 - a dense graph
 - a null graph
 - a bipartite graph
13. What is the minimum height of a B-tree with 10 nodes, and each node having a maximum of 3 children?
- 4
 - 3
 - 2
 - 1

14. What is the length of the longest common subsequence between “algorithms” and “complexity”?
 a. 4 b. 3 c. 2 d. 1
15. Which of the following statements is NOT correct?
 a. Reliability of randomized algorithms can be increased by running them multiple times.
 b. Randomized algorithms may return different results on different runs.
 c. Fermat’s Primality Testing never report prime numbers as composite.
 d. Fermat’s Primality Testing never report composite numbers as prime.
16. Suppose the following data are inserted into a binomial heap in that order: 2, 4, 6, 8, 10, 12, 14. Which of the following statements is correct about the constructed binomial heap?
 a. The binomial heap contains 1 binomial tree of order 3.
 b. The binomial heap contains 2 binomial trees of order 2.
 c. The binomial heap contains 3 binomial trees of order 0, 1, and 2.
 d. The binomial heap contains 3 binomial trees of order 1, 2, and 3.
17. Which of the following is NOT a solution of 8-queens problem?
 a. [5, 7, 6, 2, 3, 1, 8, 4]
 b. [1, 5, 8, 6, 3, 7, 2, 4]
 c. [1, 6, 8, 3, 7, 4, 2, 5]
 d. [6, 3, 1, 8, 4, 2, 7, 5]
18. Consider the following two forests represented using disjoint set data structure:
 Forest1: {{a, b, c, d, e}, {f}, {g}}
 Forest2: {{a}, {b, c}, {d}, {e}, {f, g}}
 What will be the result of merging these forests using the find and union operations?
 a. {{a}, {b}, {c}, {d}, {e}, {f}, {g}}
 b. {{a, b, c, d, e}, {f, g}}
 c. {{a}, {b, c}, {d, e}, {f, g}}
 d. {{a, b, c, d, e, f, g}}
19. Which of the following statements is TRUE?
 a. The flow in a flow network is maximum when there is no augmenting path in the residual graph.
 b. In a flow network, incoming flow must be equal to outgoing flow for all nodes including the source and the sink.
 c. Flow on each edge can exceed the capacity of the edge.
 d. The net flow across a cut in a flow network is equal to the capacity of the cut.
20. Linked lists are best suited for _____.
 a. a large collection of static data.
 b. a permanent collection of data.
 c. for a small collection of heterogeneous data.
 d. for constantly changing data size.

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SECTION "B"

[6Q. × 4 = 24 marks]

Attempt *ANY SIX* questions.

1. While computing the time complexity of an algorithm, we discard low-order terms and constant factors in the running time function. Explain, with examples, why we do this. [4]
2. Compare and contrast B-tree with B+ tree. [2+2]
3. What is the main idea behind dynamic programming? Find the longest common subsequence of the sequences "kathmandu" and "bhaktapur" using the bottom-up approach. [2+2]
4. Are heuristics the same as greedy methods? Write a pseudocode of any one greedy algorithm. Explain why your algorithm is a greedy one. [1+2+1]
5. Write down the properties of a binary heap. Explain how a binary heap can be used to implement a priority queue. [2+2]
6. Define NP-complete problems. Give an example of a polytime reduction of an NP-complete problem to another problem. [1+3]
7. Write short notes on (*ANY TWO*): [2+2]
 - a. Optimal substructure
 - b. Stable sorting algorithm
 - c. Data parallelism

SECTION "C"

[2Q. × 8 = 16 marks]

Attempt *ANY TWO* questions.

8. Explain different methods of searching a state space tree for solving a problem. Solve the following knapsack problem using the branch-and-bound technique:
4 objects are to be put in a knapsack of capacity 12. The objects have the following weights and values: $W = \{5, 2, 7, 4\}$, $V = \{15, 12, 21, 12\}$. [3+5]
9. Write an algorithm to find a given element in a binary search tree. Prove that your algorithm is correct. Discuss the time complexity of major operations that can be performed in a binary search tree. [3+2+3]
10. How are probabilistic algorithms different from approximation algorithms? Give some examples of real-world applications that require probabilistic algorithms. Write a pseudocode for solving the N-Queens problem using a probabilistic algorithm. Explain which operations of your algorithm can (or cannot) be run in parallel. [2+1+3+2]

