國立清華大學 107 學年度碩士班考試入學試題

系所班組別：資訊系統與應用研究所

考試科目（代碼）：計算機概論(2401)

1. (10%)

(A) (5%) If a hash file is partitioned into 11 buckets, what is the probability of at least two of three arbitrary records hashing to the same bucket? (Assume the hash function gives no bucket priority over the others).

(B) (5%) If a hash file is partitioned into 11 buckets, how many records must be stored in the file until it is more likely for collisions to occur than not?

2. (5%) Suppose the surface of the planar patch with vertices (-1, 2, 0), (-1, 0, 2), (1, 0, 2), and (1, 2, 0) is smooth and shiny. If a light ray originates at the point (0, 1, 2) and strikes the surface at point P and the reflected ray passes through (0, 2, 1). What is the position of P?

3. (10%) A farmer with a fox, a goose, and a bag of beans came to the bank of a river and rented a boat to transport his items. The boat can only carry one item in addition to the farmer. If left unattended together, the fox would eat the goose, or the goose would eat the beans. The farmer's challenge was to carry himself and all the items to the other side of the river, ensuring that every item is intact.

(A) (5%) Describe how this problem could be framed as a production system with necessary *states* and *rules*.

(B) (5%) Show a small portion of the state graph (including at least five states) of this problem.

4. (10%) Suppose you get three identical boats of the same type and you are asked to do several rounds of testing to find out how many bricks a boat of this type can carry at most. Assume that you know the answer can be from one brick to one hundred bricks. For each round of testing, you may load any number of bricks on a boat, and if it is over the limit that the boat can carry, the boat will sink immediately. You have to give the answer of the maximum number of bricks that can be carried by a boat of this type once you sink all your three boats. What is the best strategy to find the answer by doing as few rounds of testing as possible?

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5. (10%) Please find the asymptotic upper bounds of the following recurrences in big-O notation, where $T(n)$ is assumed to be constant when n is sufficiently small. Make your bounds as tight as possible and justify your answers.

(A) (5%) $T(n) = T(n-1) + n$

(B) (5%) $T(n) = 2T\left(\frac{n}{2}\right) + 2n$

6. (10%) A *vertex cover* of an undirected graph $G = (V, E)$ is defined to be a subset $X \subseteq V$ such that if (u, v) is an edge of G, that is, $(u, v) \in E$, then either $u \in X$ or $v \in X$ (or both). The so-called *vertex cover problem* is to find a vertex cover of minimum size in G. Please design an algorithm of $O(n)$ time to solve the vertex cover problem when the given graph G is a tree, where n is the number of vertices in G. Please also justify your answer.

7. (15%) Determine whether the following statements are correct or not and also justify your answers

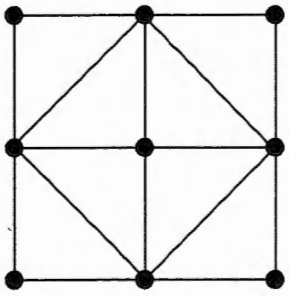
(A) (3%) The number of vertices of odd degree in any graph is odd.

(B) (3%) Both quick sort and merge sort are optimal sorting algorithms.

(C) (3%) If the given graph G is a dense graph, then Kruskal's algorithm is faster than Prim's algorithm for finding the minimum spanning tree of G.

(D) (3%) The satisfiability problem is known to be an NP-complete problem and hence it cannot be solved by any polynomial-time algorithm in worst case.

(E) (3%) The following graph has an Euler path that traverses each edge exactly once.



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8. (10%) What is open source software? What is closed source software? Please give at least two examples of each. What is the difference between these two?

9. (10%) What is boundary value analysis? Suppose we have to test a field in the online job application form which accepts Ages 18-65. Please derive test cases using boundary value analysis and explain your answer.

10. (10%) Suppose you were given three stacks and you were only allowed to move entries one at a time from one stack to another. Please design an algorithm for reversing two adjacent entries on one of the stacks. Give an example to illustrate your algorithm.