1. True/False questions: (18%)

    a. Greedy method, NP-hardness, dynamic programming, branch and bound, and divide and conquer are all algorithm design strategies.

    b. $n! = O(k^n)$ where k is a positive integer.

    c. There are four basic control structures in structured programming.

    d. In object-oriented programming, there can be no polymorphism without inheritance.

    e. If a problem turns out to be NP-complete, it cannot be solved in polynomial time.

    f. A binary tree can represent trees of any degree.

    g. Direct memory access is a technique generally used for transferring data between memory and high-speed peripherals.

    h. A time-sharing operating system must be a multiprogramming system.

    i. Let x and y be two nodes in a binary tree. If x follows y in the preorder listing, and x precedes y in the postorder listing, then x is a descendent of y.

    j. An AVL tree of height 4, where the height of a tree is the number of edges on the longest path from the root to a leaf, must have at least 12 nodes.

    k. Through the transport layer of the OSI model, mail services and directory services are available to network users.

    l. Modularity is a measure of how closely the processes in a program are related.

2. How does deadlock occur?　How does starvation occur?　What is demand paging?　What is a context switch?　What is a critical region?　What is a semaphore? (23%)

3. Please give the state transition diagram for the following transition function and characterize the input strings acceptable by this finite automaton. (10%)

States	inputs 0	1
q_0	q_2	q_1
q_1	q_3	q_0
q_2	q_0	q_3
q_3	q_1	q_2

q_0 serves both as the initial and final states.

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4. Given N records to be sorted in nondecreasing order, fill in the table below. Express time complexity in big-O notation. Copy the table onto your answer sheet. (15%)

	average time	worst-case time	Requires extra space?
selection sort			
insertion sort			
quick sort			
merge sort			
heap sort			

5. Consider hashing using open addressing with linear probing. When an element is deleted, the corresponding location in the hash table is marked as deleted. Why is the location not marked as empty? (3%)

6. Given n species of animals $S_1 \cdots S_n$ and k relations of the form ``species S_i is in the same category as species S_j", the problem is to determine the number of different categories and the number of species in each category. What ADT (abstract data type) should be used? What is the performance in terms of n and k? (5%)

7. Assume you are given n integers in the range 1 to k. The query range(a:b) reports the number of integers x, $a < x <= b$. Describe a data structure that needs to be set up in O(n+k) time and an implementation of range(a:b) having an O(1) performance. (5%)

8. Design a circuit to find the squares of 0, 1, 2, 3. Please show both the truth table and the logic diagram of your design. (5%)

9. Interpret 1001_2 in decimal if the number was stored as an unsigned integer, as a one's complement integer, as a two's complement integer, and as a sign-and-magnitude integer. (8%)

10. Give a topological order for the following digraph: (4%)
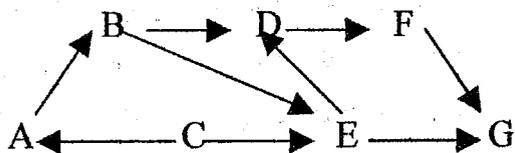
11. An engineer notices that the data received by computers at the two ends of a bus local area network contain many errors. What do you think is the problem? What can be done to solve the problem? (4%)