考 試 科 目	計算機概論	所 別	資訊科學系甲組 a31	考 試 時 間	4月20日上午第1節 星期日

A. Show all details for non-trivial questions to receive partial credit, in case your answer is wrong.

B. You do not have to write everything in English.

1.	(10%, 1% for each problem) True, False, or select a number.
( )	(a) The largest integer can be represented by 8 bits using unsigned integer is 256.
( )	(b) Access to the beginning of a RAM takes less time than access to the end of a RAM.
( )	(c) The sizes of MAR and the size of MDR are the same, in general.
( )	(d) The data store on a disk or on a tape both needs an address mechanism for data retrieval.
( )	(e) The task of the linker is to read instructions from the object file and store them into memory for execution..
( )	(f) Which of the following tasks the computers will have better performance than human: (1)computation, (2)recognition, (3) reasoning, (4) learning, (5) none of the above tasks?.
( )	(g) WAN generally uses Ethernet protocol.
( )	(h) Neural networks can be used to simulate the connectionist architecture of the human brain.
( )	(i) Binding is the process of associating a symbolic name with a memory address.
( )	(j) Which of the following functions is handled by operating system? (1) language translation, (2) memory management, (3) file system management, (4) scheduling, (5) all of the above functions.

2. (4%)	(a) (2%) What shall an OS do in order to initiate the execution of a program?
	(b) (2%) Which program of the OS will do this process, in general?

3. (12%)	(a) (4%) What are the purposes of (1) the op-code table and (2) the symbol table generated by the assembler?
	(b) (8%) Explain the following four terms that are used in compiler or programming language design: (1) BNF, (2) grammar, (3) language, and (4) semantic record.

4. (6%)	A computer designer designs a new computer that has 50 instructions in the machine language and the maximal addressable memory space is 1GB. Answer, with explanations, the following questions:
	(a) (2%) How many bits will be used in the instruction register to hold a two-address instruction?
	(b) (2%) What are the input and output size of the memory address decoder if it is a two-dimensional memory?
	(c) (2%) What will be the decoder's input and output size used for IR_{op}?

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5. (10%)	(a) (2%) Describe how a two-input multiplexor works.
	(b) (3%) Suppose that the two inputs are A and B and the selection line is S. Construct the truth table for the two-input multiplexor.
	(c) (2%) Use the result in (b) to derive the Boolean expression of the two-input multiplexor.
	(d) (3%) Draw a simple circuit for this Boolean expression using only AND, OR, and NOT gates.

| 6. (8%) | Consider the 32-bit floating point number format shown below. |

s	exp	mantissa
1 2	8 9	32

The 24-bit mantissa and 7-bit exponent have a base of 16, and the exponent also has a bias of 64, so that the bit pattern represents

$$(-1)^s \times 16^{exp-bias} \times 0.mantissa_{16} \quad (i.e.\ 0.mantissa < 1)$$

(a) (4%) Using this definition, convert the following representation to decimal number:

$$C2572000_{16}.$$

(b) (2%) What is the hexadecimal representation for the word that encodes the largest positive number that can be represented in this format? Write this value to the nearest power of 2.

(c) (2%) What is the hexadecimal representation for the word that encodes the smallest positive normalized number that can be represented in this format? Write this value to the nearest power of 2.

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7. (10%)

(1) Please give the logarithmic time algorithm to find the minimum node of an AVL tree.

(2) Please modify the data structure of the AVL tree and give the logarithmic time algorithm to find the k-th node of this tree.

8. (10%)

Consider the infinite set of strings $S=\{WyW^R|$ W is in $\sum*$, $\sum=\{x, y\}\}$ where R denotes the reverse of W, the symbol '*' represents "any number." That is, $S=\{$ 'y', 'xyx', 'yyy', 'xxyxx', 'yyyyy', 'xyyxy', 'yxyyx', ... $\}$. Given a string T, please design the algorithm to check whether T belongs to the set S.

9. (7.5%)是非題，每題 1.5 分，答錯倒扣 1 分

(1) (　) While queue is used in topological sorting, stack can also be used and the correct ordering is produced.

(2) (　) Both the Dijkstra' algorithm for shortest path algorithm and the Prime's algorithm for minimum cost spanning tree are based on the greedy strategy.

(3) (　) The third minimum element of an minimum heap must be one of the two children of the root.

(4) (　) If we can prove that the lower bound of an NP-complete problem is exponential, then we have proved that NP ≠ P.

(5) (　) Given a graph with n vertex, the minimum cost spanning tree of this graph contains exactly n-1 edges.

10. (7.5%)選擇題，每題 1.5 分，答錯到扣 1 分

(1) (　) Which of the following sequence of data will produce a complete binary search tree?

(a) 'Mary', 'Lily', 'John', 'James', 'Grace', 'Chris'

(b) 'James', 'Grace', 'John', 'Chris', 'Lily', 'Mary'

(c) 'Chris', 'Grace', 'James', 'John', 'Lily', 'Mary'

(d) 'John', 'Mary', 'Grace', 'Chris', 'Lily', 'James'

(2) (　) Which of the following is the prefix form of the expression A/B^C+D*E-A*C, where B^C means the C-th power of B.

(a) -*+^/ABCDE*AC

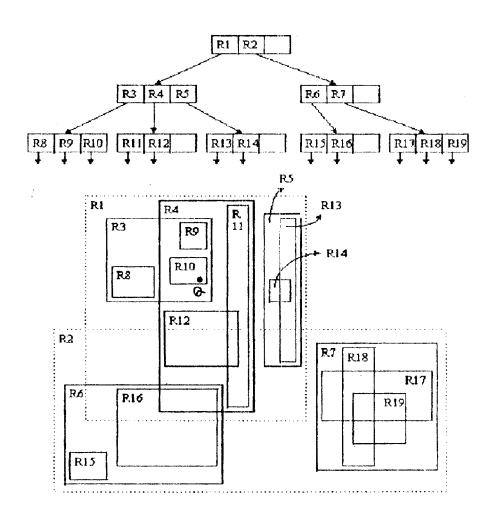(b) -+^/ABC*DE*AC

(c) +-^/ABC*DE*AC

(d) -+/A^BC*DE*AC

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(3) ( ) Concerning the heap, which of the following is **wrong**?

(a) The sum of the heights of all the nodes in the N-node heap is O(N)

(b) In the worst case, the time complexity of insertion into an N-node heap is O(logN)

(c) A heap is a complete binary tree.

(d) Heap sort is a stable sorting algorithm

(4) ( ) Given the following six records with two field name and age, in the sequence of (Chris, 25), (James, 40), (Lily, 22), (Grace,25), (John, 20), which of the following sorting method on the age field will produce the result in the sequence of (John, 20), (Lily, 22), (Grace, 25), (Chris, 25), (James, 40) ?

(a) radix sort

(b) merge sort

(c) selection sort

(d) insertion sort

(5) ( ) Concerning the graph, please choose the correct one.

(a) The adjacency list representation is suitable for dense graph.

(b) There exist no topological ordering for cyclic graph.

(c) Heap is useful in the Kruskal's algorithm for minimum cost spanning tree problem.

(d) The critical path is the shortest path of the graph in the critical path analysis.

11. (7%) Please prove that any sorting algorithm that uses only comparisons between elements requires $\Omega(N\log N)$ comparisons.

12. (8%) Given a query point Q and a set of rectangles in 2-dimensional space, the 'where am I' query is to search for the set of rectangles which enclose the query point Q. **R-Tree** is useful for fast processing of 'where am I' query. An R-tree is a balanced tree structure with the indexed rectangles stored in leaf nodes, much like a B$^+$-tree. Each non-leaf node stores the minimum bounding boxes of the corresponding children nodes along with the pointers to the children nodes. For example, the following figure shows an example of twelve indexed rectangles and the corresponding 3-way R-tree. The twelve indexed rectangles are rectangle R8, R9, ..., R19. In root node, there are two entries. The first entry stores the minimum bounding box R1 of entries (R3, R4, R5) of its children node. The entry R3 stores the minimum bounding box R3 of entries (R8, R9, R10) of its children

node. Note that some of the bounding rectangles of the entries in the non-leaf nodes overlapped each other.

(1) Please design the algorithm to process the 'where am I' query using R-tree.

(2) Given the query point Q shown in the figure, please denote the nodes visited in order to process the 'where am I' query.