國立政治大學 九十七學年度 碩士班暨碩士在職專班招生考試 命題紙

考試科目	計算機概論	所別	資訊科學系 碩士班 8141	考試時間	3 月 15 日 星期 六 第 1 節

可用中文或英文回答。

1. **(10%) True or False** (Please write **T** or **F** as an answer to each of the following statements.)
   1) The width of a data bus could be two times larger than the size of a register in a computer system.
   2) The size of virtual memory is limited by the width of MAR.
   3) You should pass the parameters of a function *by value* in order to change their values.
   4) The LRU (Least Recently Used) page replacement policy replaces a page that is used least frequently.
   5) Loader is the program for initiating the execution of a program.
   6) In general, a complier has a better chance to do global optimization than local optimization.
   7) If we can find a symbol manipulation task that no Turing machine can perform, then there is no algorithm for this task.
   8) Duplicated labels in an assembly language will be discovered during the first pass to the assembler.
   9) The principle of locality can be used for code optimization.
   10) Ethernet technology is used for local area network (LAN) but not for wide area network (WAN).

2. **(12%) Single Selection**
   1) Which of the following concepts or technologies adopts the same principle as a web proxy server?
      (a) cache memory (b) time sharing (c) pipeline (d) virtual memory
   2) What does the following C statement print when two's complement notation is used?
      ```
      printf("%d", (unsigned char) (-2+1));
      ```
      (a) -1 (b) 1 (c) 3 (d) 255
   3) Which of the following network protocols is below the session layer in the OSI 7-layer model?
      (a) HTTP (b) FTP (c) SMTP (d) UDP
   4) Which of the following network devices cannot be used for "microsegmentation" in LAN (Local Area Network)?
      (a) bridge (b) hub (c) switch (d) router
   5) Which of the following strings cannot be produced by the BNF rules below?
      <index> ::= <letter><num>
      <num> ::= <digit>|<num><digit>
      <letter> ::= i|j
      <digit> ::= 0|1|2|3|4|5|6|7|8|9
      (a) i (b) i1 (c) j01 (d) j9876
   6) What is the prefix notation of the following expression? (assuming '*' has precedence over "+")
      ((A+B) *C+D* (E+F) *G) +H
      (a) * + + A B C * * D + + E F G H
      (b) + * + + A B C * * D + E F G H
      (c) + + * + A B C * * D + E F G H
      (d) * + + + A B C * * D + E F G H

備考	試題隨卷繳交
命題委員：	（簽章） 97 年 3 月 7 日

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3. **(7%) Number System:**
Consider an 8-bit number with the following bit pattern: 10101010_2
(a) What is the decimal number if the bit pattern is in excess-128 notation?
(b) What is the decimal number if the bit pattern is in 2's complement notation?
(c) What is the number if the bit pattern represents a floating number of the following format: SEEEMMMM (S: sign, E: exponent, M: mantissa). The sign is 0 for positive and 1 for negative, exponent is stored in excess-4 notation, and the implied binary point is to the left of the mantissa.

4. **(4%)** What are the roles of the following registers in retrieving a machine instruction from the main memory: PC, IR, MAR, MDR? (Explain how they are used.)

5. **(6%)** Please list three main characteristics of an object-oriented programming language. Use the terminologies of an object-oriented programming language you are familiar with (please specify) to give an example for each of the three characteristics you identify. (No need to write code.)

6. **(3%)** Please give at least three main characteristics of Web 2.0 applications.

7. **(8%) C Programming:**
(a) (6%) Please write a *recursive* function called "reverse" in C (or C++) to reverse a string of arbitrary length in place. For example, "apple" will be reversed to "elppa" after calling this function. The prototype of the function is defined as follows.

```
void reverse(char *str);
```

The reversed string should replace the original string and be stored in the same space. You are not allowed to dynamically allocate memory in this function.
(b) (2%) Are there any potential problems of using the above recursive function?

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說明：1. 請書寫必要之解題過程。過程正確但答案錯誤，可能有部分分數。如題目之解答非顯而易見者，僅書寫答案而缺乏必要之過程，亦無法獲得該題之滿分。

2. 可使用中文或英文作答。

8. (16%, 2% for each problem) 是非題(True or False): (本大題僅回答 T 或 F 即可，不需理由)

(1) Hashing is a technique to achieve an O(1) expected search time. However, its worst-case search time is O(log n).

(2) Adjacency matrix is good for representing a sparse graph.

(3) $2^{2n} = O(2^n)$, where O is the notation for asymptotic upper bound.

(4) Membership test in a linked list requires O(log n) time, in the worst case, for input size n.

(5) We need two pointers to implement either queue or stack using linked lists.

(6) The best case time complexity of a selection sort algorithm is the same as that of a insertion sort algorithm.

(7) The worst case of insertion operation on a BST takes O(log n).

(8) The minimum spanning tree of a n-node graph has O(log n) edges.

9. (6%)

The recurrence equation, $T(n) = aT(n/b) + f(n)$, can be used to analyze the complexity of divide and conquer methods. Referring to this equation, explain

(a) (3%) the role of the function $f(n)$, and

(b) (3%) the restriction on b. (You must give the reason on why we need this restriction.)

10. (12%)

For the following problems, assume the input size is n.

(a) (4%) Formulate the recurrence equation for Quicksort. (Explain every parameter you used.)

(b) (4%) Using the recurrence equation, find the best case time complexity of Quicksort.

(c) (4%) Using the recurrence equation, find the worst case time complexity of Quicksort.

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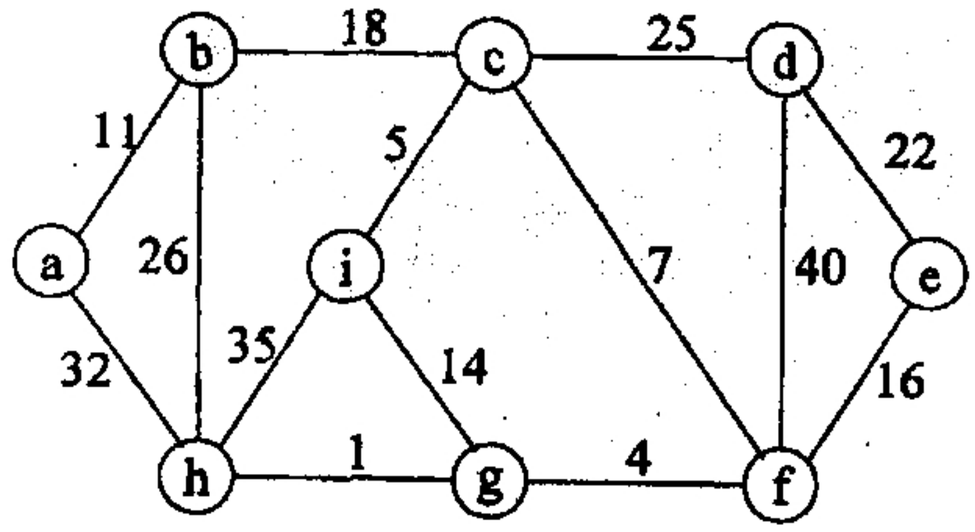
11. (16%)

There are two algorithms, the Kruskal's algorithm and the Prim's algorithm, for finding the Minimum Spanning Tree(MST) of a graph G=(V,E), where V denotes the set of vertices and E denotes the set of edges. These algorithms are given below:

Algorithm Kruskal(G)
//Kruskal's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
Sort E in non-decreasing order of the edge weights
so that $w(e_{i_1}) \le w(e_{i_2}) \le \cdots \le w(e_{i_{|E|}})$
$E_T \leftarrow \emptyset$; *ecounter* $\leftarrow 0$ //Initialize the set of tree edges and its size
$k \leftarrow 0$ //Initialize the number of processed edges
while *ecounter* $< |V|-1$
  $k \leftarrow k+1$
  if $E_T \cup \{e_{i_k}\}$ is acyclic
    $E_T \leftarrow E_T \cup \{e_{i_k}\}$; *ecounter* $\leftarrow$ *ecounter* $+1$
return E_T

Algorithm Prim(G)
//Prim's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
$V_T \leftarrow \{v_0\}$ //Initialize the set of tree vertices to v_0
$E_T \leftarrow \emptyset$
for $i \leftarrow 1$ **to** $|V|-1$ **do**
  find a minimum - weight edge $e^* = (v^*, u^*)$
    among all the edges (v, u)
    such that v^* is in V_T and u^* is in $V - V_T$
  $V_T \leftarrow V_T \cup \{u^*\}$
  $E_T \leftarrow E_T \cup \{e^*\}$
return E_T

Given this graph and answer the following questions:



(a) (4%) Name the third edge added to the MST using the Kruskal's algorithm.
(b) (4%) Name the third edge added to the MST using the Prim's algorithm starting at node i.
(c) (4%) What is the time complexity of Kruskal's algorithm in terms of |V| and |E|?
(d) (4%) What is the time complexity of Prim's algorithm in terms of |V| and |E|?

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