國立中央大學 110 學年度碩士班考試入學試題

所別： 資工類　　　　　　　　　　　　　　　　　　共5頁　第1頁

科目： 資料結構與演算法

本科考試禁用計算器　　　　　　　　　　　　　　　　*請在答案卷(卡)內作答

複選題(每題 5 分共 50 分，全對才給分，答錯一個選項扣 1.5 分，倒扣至複選題 0 分為止)

1. Which of the following statements are true?
   (A) When converting the infix expression a*(b+c/d)*(e-f)+g to its postfix form, there are at most 4 tokens in the stack at any moment.
   (B) The postfix form of infix expression (a+b-c)*(d-e) is abc-+de-*
   (C) The infix expression of postfix expression 3k-2m4+*+pab-*/ is ((3-k)+2(m+4))/(p*(a-b))
   (D) When converting the infix expression a*(b+c/d)*(e-f) to its postfix form, there are at most 3 tokens in the stack at any moment.

2. Which of the following statements about n-element AVL trees are false?
   (A) The time complexity of deleting element with key k is O(1).
   (B) The time complexity of insertion is O(log n).
   (C) If the AVL tree has height = h, then n >= F_{h+1} -1, where F_{h+1} is the Fibonacci number, i.e., $F_{h+1}=F_h+F_{h-1}$.
   (D) h_L - h_R should be 0, where h_L and h_R denote the height of the left subtree and the right subtree, respectively.

3. Consider a weight-biased leftist tree (WBLT). Let **w**(x) be the number of internal nodes in the subtree with root x. Which of the following statements are false?
   (A) The length of the rightmost path from internal node x to an external node must be no greater than $\log_2$(**w**(x)+1).
   (B) The height of the subtree with root x must be no greater than $\log_2$(**w**(x)+1).
   (C) Combining two weight-based leftist trees with a total of n elements is done in time O(log n).
   (D) A max WBLT is a max tree that for every internal node y, **w**(LeftChild(y)) is greater than or equal to **w**(RightChild(y)).

4. Which of the following statements are true?
   (A) In general, a recursive version is less efficient in terms of time and space than a non-recursive version.
   (B) The function **F1** below is executable (i.e., terminable) for all positive integer x.

```
Int F1(int x)
{
        If x is even then
            return x/2;
        else
           return F1(F1(3x+1));
}
```

注意:背面有試題

(C) When input data are 21 and 12, the output of function **F2** is 4, i.e., **F2**(21, 12)=4.

```
Int F2(int x, int y)
{
    If y=0 then
        return x;
    else
        return F2(y, x mod y);
}
```

(D) When input data is 5, the output of function **F3** is 5, i.e., **F3**(5) =5.

```
Int F3(int x)
{
    Int p, q;

    If x <= 2 then
        return x;
    else
        p=F3(x-2);
        q=F3(x-3);
        return p+q;
}
```

5. In a 2-dimension integer array arr[5][5], which of the followings are equal to arr[3][2]?
(A) *(*arr+17) (B) (*(arr+3))[2] (C) *((*(arr+3))+2) (D) (*arr+3)[2]

6. Given PUSH sequence and POP sequence. Which of the following statements are false?
(A) PUSH 1 2 3 4; POP 1 2 3 4; It must be a Queue
(B) PUSH 1 2 3 4; POP 2 1 3 4; It must be a Stack
(C) PUSH 1 2; POP 1 2; It could be a Stack
(D) PUSH 1 2 3 4; POP 2 3 1 4; It is neither Stack nor Queue

7. Insert the set {23, 12, 34, 46, 28, 11, 6, 7, 0, 33, 30, 45} into an empty hash Table T of size 17. Suppose that the hash function **h**(k , i) = (k + i) mod 17, where i = 0 to 16. If we remove 46 after inserting the set, which keys should modify their positions?
(A) 11 (B) 0 (C) 33 (D) 45 (E) 30

8. Let T(n) denote the time taken to sort a list of n records. Which of the following statements are false for QuickSort?
(A) $T(n) = 2T(n/2) + cn$ for some constant c in the worst-case scenario.
(B) $T(n) = 4T(n/4) + cn$ for some constant c in the worst-case scenario.
(C) $T(n) = T(n-1) + cn$ for some constant c in the worst-case scenario.
(D) $T(n) = 2T(n-2) + cn$ for some constant c in the best-case scenario.

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9. The pseudo code below aims to reverse a linked list.

```
typedef struct Node{
    int data;
    Node *next;
};
Node *NPtr;

int main()
{
    NPtr head = NULL; /* Start with an empty linked list */
    push(&head, ...); /* insert items into the linked list */
    reverse(&head); /* reverse the linked list */
}

void reverse(NPtr *Href)
{
    NPtr P = NULL;
    NPtr C = *Href;
    NPtr N = NULL;

    while (____(1)______) {
        N = C->next;
        C->next = P;
        P = C;
        C = N;
    }
    ____(2)____
}
```

Which of the following statements are true?

(A) Blank (1) should be C != NULL.

(B) Statement C->next = P; reverses node's pointer.

(C) Blank (2) should be *Href = C;

(D) Statement P = C; moves the pointer to the next.

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所別： 資工類 共5頁 第4頁

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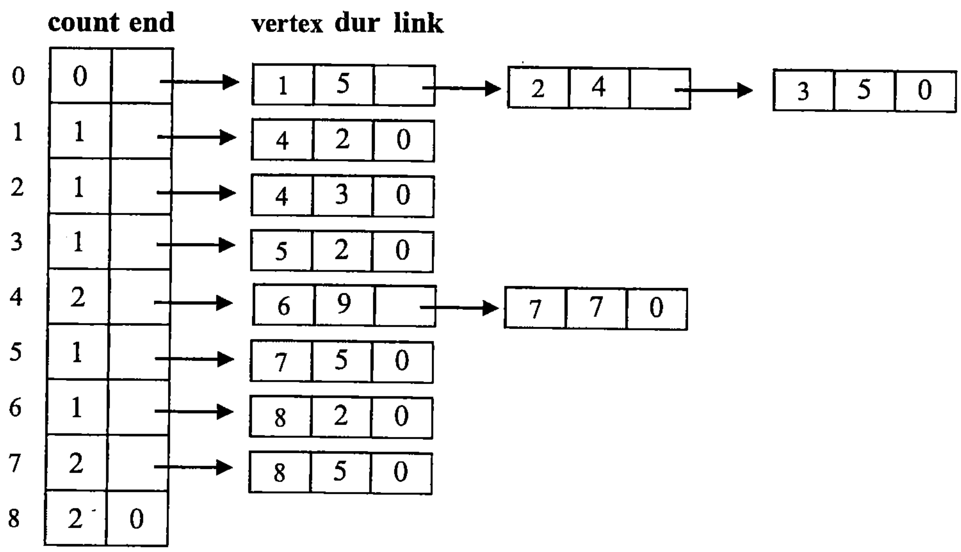
10. The adjacency list below is for an AOE network. The **end** field points to a list of adjacent vertices, **dur** field is the duration of the activity, **link** field points to another adjacent vertex, **vertex** field is the id of the adjacent vertex, **count** filed is the number of immediate predecessors. Which of the following statements are true?
    (A) The total duration of the critical path is 18.
    (B) Path 0, 1, 4, 6, 8 is not a critical path.
    (C) Path 0, 2, 4, 7, 8 is a critical path.
    (D) The latest time that event 4 (i.e., vertex 4) can occur is 8.



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國立中央大學110學年度碩士班考試入學試題

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問答題(50分)

1. We have the following definitions and theorem related to NP-completeness.
Definition 1. Let X_1 and X_2 be tow problems. X_1 polynomially reduces to X_2 (written as $X_1 \propto X_2$) if and only if X_1 can be solved in polynomial time, by using a polynomial time algorithm which solves X_2.
Definition 2. A problem is said to be a P (resp., NP) problem if it can be solved in polynomial time by a deterministic (resp., non-deterministic) algorithm.
Definition 3. NP (resp., P) is the set of all NP (resp., P) problems.
Definition 4. A problem X is an NP-complete (NPC) problem if $X \in NP$ and every NP problem reduces to X.
Cook's Theorem. NP=P if and only if the satisfiability (SAT) problem is a P problem.
(This implies that every NP problem polynomially reduces to SAT.)
   (A) (15%) Assume that SAT $\propto$ B, B $\propto$ C, C $\propto$ D and $D \in NP$. By the assumptions and above definitions and theorem, prove that D is NP-complete.
   (B) (5%) By the above definitions and theorem, show the following statement is true or false. You should also show your reasons. If the reasons are incorrect, then you get no point.

   Statement: An NPC problem can polynomially reduce to any NPC problem.

   (C) (5%) By the above definitions and theorem, show the following statement is true or false. You should also show your reasons. If the reasons are incorrect, then you get no point.

   Statement: If an NPC problem can be solved in polynomial time by a deterministic algorithm, then all NP problems can also be solved in polynomial time by a deterministic algorithm.

2. A weighted graph G=(V, E) is an undirected graph with nonnegative weight assigned to each edge in E. The length of a path in G is the sum of edge weights of the edges in the path. A path P from vertex u to vertex v is said to be shortest if the length of P is smallest for all paths from vertex u to vertex v.
   (A) (12%) For a weighted graph $G=(V, E)$ and two vertices x, y in V, give an efficient algorithm to find a shortest path from x to y. Analyses the time complexity of the algorithm.
   (B) (13%) Now you are given a weighted graph $G=(V, E)$, a specified vertex s in V, an array $d[\ ]$ of size $|V|$, and it is claimed that for each v in V, $d[v]$ is the length of the shortest path from s to v. The claim may be correct or may be not. Design a linear time algorithm to check whether the claim is correct. Analyses the time complexity of your algorithm and make sure it is linear, that is, the running time of your algorithm must be $O(|V|+|E|)$.