編號： 209

國立成功大學 104 學年度碩士班招生考試試題

系所組別：電機資訊學院-資訊聯招

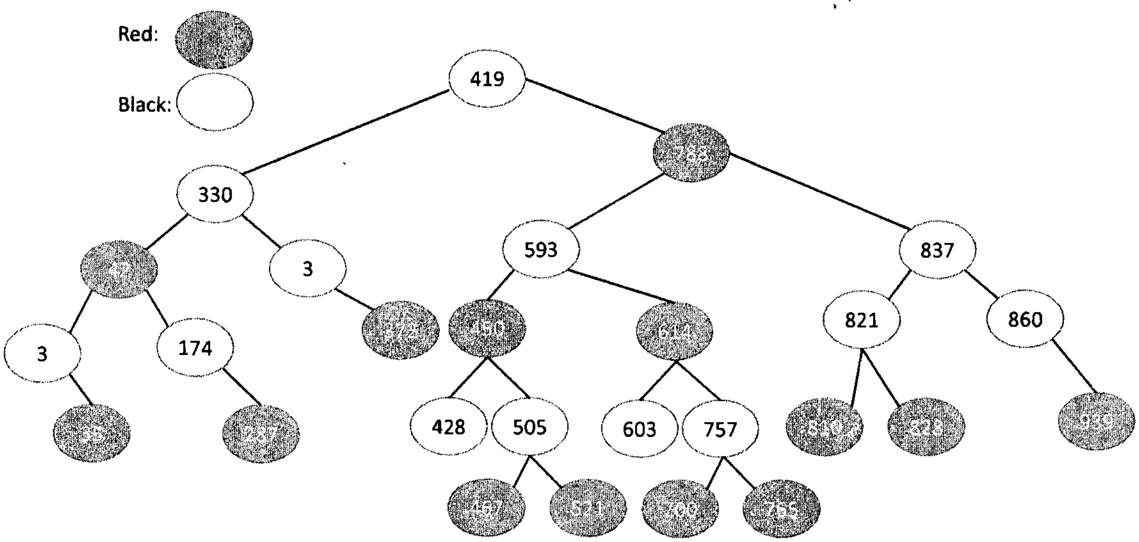
考試科目：程式設計 考試日期：0211，節次：2

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

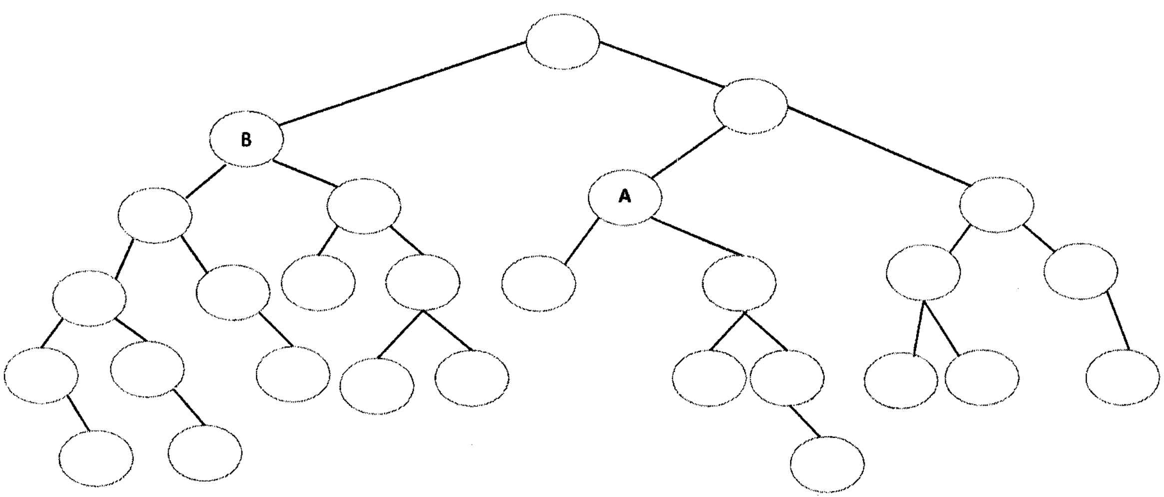
一、Data Structures (50%)

1. (20%)

Given a red-black tree in the following figure.



After one node with value 778 is inserted, the resulting red-black tree is shown as follows.



(a) (10%) Please describe the operation procedures for this insertion.

(b) (10%) Please indicate the color and value of node A and node B, respectively.

2. (10%) Given the expression, (x+y)*w+u/(v+x*w)+z, Please show the content in the stack after the operand v is read in postfix transformation.

3. (20%)

(a) (10%) Please finish the lost code for the **choose** function in the following Dijkstra shortest path implementation for a graph without negative-weight edges.

```
void shortestPath(int v, int cost[][MAX_VERTICES], int distance[], int n, short int found[])
{/*cost is the adjacency matrix*/
    int i,u,w;
    for (i=0; i<n; i++) {
        found[i] = FALSE;
        distance[i] = cost[v][i];
    }
    found [v]= TRUE;
    distance[v]= 0;
    for (i=0; i<n-2; i++){
     u=choose(distance, n, found);
     found[u]= TRUE;
     for (w=0;w<n;w++)
        if (!found[w])
            if (distance[u]+cost[u][w] < distance[w])
                 distance[w]=distance[u]+cost[u][w];
     }
}
int choose (int distance[], int n, short int found[])
{
    int i, min, minpos;
    min = INT_MAX;
    minpos = -1;
    ________
    return minpos;
}
```

(b) (10%) In a directed graph without a cycle of negative length but with a negative-length edge, we can implement Bellman-Ford algorithm as follows to compute shortest paths. Please fill in the lost code.

```
void BellmanFord (int n, int v){
    for (int i =0; i<n; i++)
     distance[i]=cost[v][i];
    for (int k=2; k<=n-1;k++)
       for ( ______________ )
          for (_______________)
             if (distance[u]> distance[i]+cost[i][u])
                 distance[u]=distance[i]+cost[i][u];
}
```

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二、Algorithms (50%)

4. (10%) Prove or disprove: The single-source shortest paths problem can be solved in linear time in directed acyclic graphs.
5. (15%) The matrix-chain multiplication problem can be stated as follows: Given a chain $\langle A_1, A_2,\dots, A_n\rangle$ of n matrices, where for i=1,2,...,n, matrix A_i has dimension $p_{i-1}\times p_i$, fully parenthesize the product $A_1A_2\cdots A_n$ in a way that minimizes the number of scalar multiplications. Suppose that you have 6 matrices: A_1 has dimension 30×35, A_2 has dimension 35×15, A_3 has dimension 15×5, A_4 has dimension 5×10, A_5 has dimension 10×20, A_6 has dimension 20×30. Please calculate the minimum number of scalar multiplications.
6. (10%) Give asymptotic upper and lower bounds for $T(n) = 2T(\frac{n}{4}) + \sqrt{n}$. Assume that $T(n)$ is constant for $n \le 2$.

   Make your bounds as tight as possible.

7. (15%) Consider the problem of finding the 5-vector $x = (x_i)$ that satisfies

$$\begin{pmatrix} 1 & -1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 & -1 \\ -1 & 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 \\ 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & -1 & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} \le \begin{pmatrix} 0 \\ -1 \\ 1 \\ 5 \\ -4 \\ -1 \\ -3 \\ -3 \end{pmatrix}$$

   Determine whether there exists a solution or there is no solution.