# 國立成功大學
# 111學年度碩士班招生考試試題

編　號：190

系　所：電腦與通信工程研究所

科　目：資料結構

日　期：0219

節　次：第 2 節

備　註：不可使用計算機

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1. (20 **pts** ) True or False (一題一分，答錯一題倒扣一分)

a. Objective oriented language

A) A programming langue is considered as object-oriented if it supports objects and requires objects belonging to a class.

B) Abstract makes modifications of program much easier.

C) Software development time and money can be saved if template is used in a program.

D) A derived class inherits all the non-private members (data and functions) of the base class including constructor and destructor.

b. Recursive function

A) Any program that be written using assignment, the if-else statement, and the while statement can also be written using assignment, if-else, and recursion.

B) Merge sort is stable if we use the iterative procedure to implement it. However, it is not stable in the recursive version.

C) No matter in the recursive version or in the iterative version, the time complexity of merge sort is O(n log n), where n is the number of input.

D) Merge sort is an in-place algorithm.

c. Tree

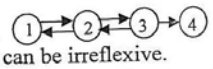
A) The time complexity to insert a key in to a binary tree is O(log $n$).

B) The time complexity to increase a value in a Max-Heap is O(log $n$).

C) It will waste $n(k\text{-}1) + 1$ fields if we use a list representation to represent each node in a k-ary tree (i.e., a tree of degree k), where each node uses a list with a fixed size $k$ to record its children.

D) We need an additional node to represent the overall winner in a loser tree and it runs slower than a winner tree.

d. Graph

A)  is a strongly connect component of the graph 

B) The precedence relation of the edges in an AOV network can be irreflexive.

C) We can avoid traversing the same edge if the adjacency multilist is used to record a graph.

D) There exists no backward edge in a breath-first search tree obtained from a undirected graph.

e. Stack and queue

A) The infix expression of the postfix expression " x 4 + y 7 - / z + " is "(x+4)/(y-7)+z"

B) With postfix nation, there is no need for parentheses because there is no ambiguity.

C) Evaluating the postfix expression "7 2 + 5 8 4/ - *" returns 27.

D) "+*abcd" is a valid prefix expression.

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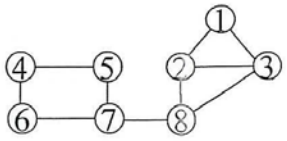
2. (10 **pts**) Biconnected components

a. (2 **pts**) Please give the definition of a back edge (*u*, *v*) in an undirected graph.

b. (6 **pts**) Describe the two rules to find the articulation points and explain why they are correct.

c. (2 **pts**) Show all biconnected components in the right graph.




3. (10 **pts**) Tree

a. (5 **pts**) Consider the following Huffman coding table:
A: 11, B:10, C:001, D: 000, E:01
Please decode the string ``10001110111000" into the source string (note that you have to draw your Huffman code tree first).

b. (5 **pts**) Draw the threaded representation of the resulting binary tree in (a) if you want to traverse the graph in pre-order traverse? Note that you nedd use solid line to point to the predecessor of a node and a dash line to point to the successor of a node.

4. (25 **pts**) Shortest path algorithm

Bellman and Ford algorithm and Floyd-Warshall algorithm both apply the dynamic programming to find shortest paths.

Let $D^k$ denote the matrix constructed in the *k*-th iteration, which is constructed from the previous matrix $D^{k-1}$. Let $w_{i,j}$ denote the weight of an edge $e_{i,j}$.

a. (3 **pts**) Let $d_i^k$ denote the shortest path of a node *i* from source in the *k*-th iteration in Bellman and Ford algorithm. Please list the equation to estimate an entry $d_i^k$ in $D^k$ and explain the equation shortly.

b. (3 **pts**) Let $d_{i,j}^k$ denote the shortest path between node *i* and node *j* in the *k*-th iteration in the Floy-Warshall Algorithm. Please list the equation to estimate an entry $d_{i,j}^k$ in $D^k$ and explain the equation shortly.

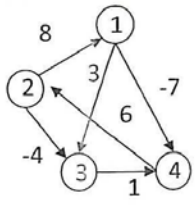
c. (2 **pts**) How can you know the graph has a negative cycle in the Bellman and Ford Algorithm? Why?

Johnson's Algorithm finds the shortest paths between all pairs by transforming an original graph G to a new graph G' by adding an additional node 0 and connecting node 0 to each node in *G*.

d. (10 **pts**) Please show the value of $h(v)$ of each node v in G' which is the shortest path from node 0 (you have to show the value of each node in G' in each iteration).

e. (5 **pts**) Please show the equation to estimate the new weight $\hat{w}$ of each edge $e_{i,j}$ in G' according h($v$).

f. (2 **pts**) In which condition that the Johnson's algorithm can perform fater than Floyd- Warshall's algorithm?



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5. (10 **pts**) Given an input array $L$={61, 127, 15, 7, 11, 10, 5, 51, 3}, where *left* and *right* denote the indexes of the first and last elements in the array (i.e., *left*= 0 and *right* =8).

a. (5 **pts**) Quick sort algorithm uses the divide an conquer strategy to sort number. To avoid imbalanced partition, we find the pivot in the location estimated by the function f() and swap it with the first element in the sub-array in each iteration, where the f() function is shown as follows:

$$f(right) = 4 * right \bmod N,$$

where $N$ is the number of elements in a sub-array (i.e., $N$ =9 in the beginning)
Please show the resulting arrays after the first and the second iterations in the recursive procedure.

b. (5 **pts**) Use a 4-basd radix sort to rearrange numbers in the array. Please show the result in a bucket list and the resulting array in each iteration.

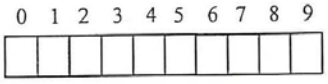
6. (20 **pts** ) 簡答題:

a. (5 **pts**) For any nonempty binary tree, $T$, if $n_0$ is the number of leaf nodes and $n_2$ is the number of nodes of degree 2. Pleases show the relation between $n_0$ and $n_2$ and prove it.

b. ( 5 **pts**) Given the following Keys 62, 104, 67, 22, 103 and a hash table with 10 buckets, where each bucket has one slot. Please write down the result using the hash function F(x) = (x mod 10). It adopts open addressing when a collision happens according to the quadratic residue as follows:

$$i_n = \begin{cases} \left(F(x) + \left(\frac{n+1}{2}\right)^2\right) mod\ 10 & ,if\ n \text{ is odd} \\ \left(F(x) - \left(\frac{n}{2}\right)^2\right) mod\ 10 & ,if\ n \text{ is even} \end{cases}$$

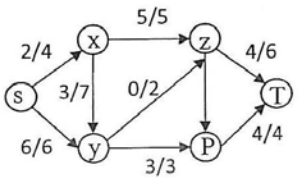
where $i_0 = F(x)$ and $n$ denotes the collision number.




The following figure describes a flow assignment in a flow network G(V, E). The *a*/*b* notation in each edge respectively denotes the current flow *a* and capacity *b* of the edge.

c. (5 **pts**) Please show the residual network of the graph. Which algorithm can be used to find an augmenting path in the residual network and what is its time complexity?

d. (5 **pts**) Please find the minimum cut of a network of the graph and what is the maximum flow from S to T?



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7 (5 **pts**) An available list can be used to recycle unused nodes in a linked list to speed up runtime. Please complete the procedure to recycle a circular list to an availabe list, pointed by *av*, where the circular list has only one point, *last,* pointing to its last node.

```
void CircularList<T>::~CircularList()
{ // Delete the whole circular list
  if (last) {
    ChainNode<T>* first =   (1)   ;
     (2)   =  (3)  ;
     (4)   =  (5)  ;
    last = 0;
  }
}
```