國立台灣科技大學九十六學年度碩士班招生試題

系所組別： 資訊工程系碩士班

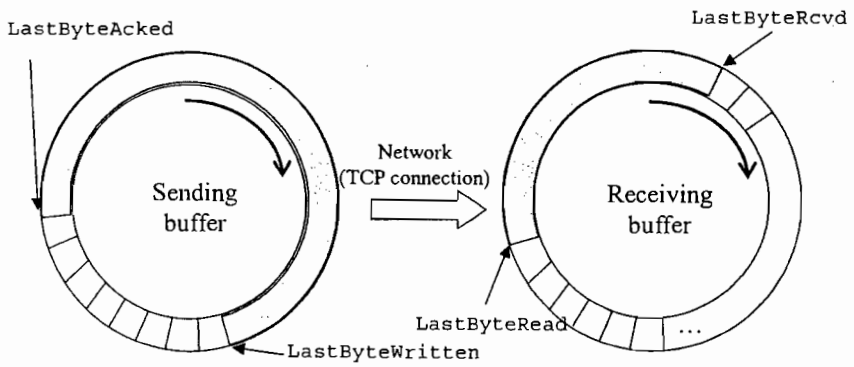
科　　目： 資料結構

總分 100 分

1. (16%) The input list is (26, 5, 77, 1, 61, 11, 59, 15, 48, 19). Please use the Iterative Merge Sort method to draw the tree to illustrate the sublists being merged at each pass.

2. (14%) Please describe the techniques of the following two popular hashing functions:
   a. Division
   b. Mid-Square

3. (15%) The Transmission Control Protocol (TCP) specifies the usage of sending buffers and receiving buffers to implement basic flow control. Both sending buffer and receiving buffer are **FIFO circular queues**. Any application put its messages in the sending buffer before it sends the messages to a remote host. When the sending buffer is full, the application waits until part of the queued messages are sent out as packets. The receiving buffer, reserved by the receiving host, functions in a similar manner. There are two indexes `LastByteRead` and `LasByteRcvd` used by the receiving buffer, pointing to the beginning of the queued message and the next free space respectively. Both `LastByteRcvd` and `LastByteRead` move in clockwise direction. When the buffer becomes full (`LastByteRcvd` catches up with `LastByteRead`), the receiving host sends a control message to ask the sending host to stop sending. The figure below illustrates how the sending buffer and the receiving buffer operate. The grey zone represents the queued messages, and the white blocks of the circle indicate free space. `LastByteRcvd` and `LastByteRead` would point to the same position when either the buffer is full or when the buffer is empty.



Normally both buffers are implemented as byte arrays. The following C++ code shows the definition of a sample class `RecvBuffer`, please develop reasonable definitions of the constructor, function `Read()` and `Store()`. Your code should implement primitive functions of a receiving buffer, but ignore error handling.

```
enum Boolean { FALSE, TRUE };
class RecvBuffer {
public:
  RecvBuffer(int s); // create a buffer of size s
  char Read(); // retrieve a byte from buffer
```

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```
  void Store(char b); // add the byte b into buffer
private:
  void Lock(); // called when the buffer becomes full
  void Unlock(); // called when free space becomes available
  int MaxSize; // size of buffer
  char *buffer;
  int LastByteRcvd;
  int LastByteRead;
  Boolean isFull;
};
```

4. The LISP programming language uses the so-called S-expression with which an assignment statement such as

   `X = A / B * C`

   is expressed as a generalized list like

   `(= X (* (/ A B) C))`

   You may have noticed that it is also a prefix notation.

   a. (5%) What is the S-expression for `X = A / B - C + D * E - A * C`?

   b. (5%) If the S-expression `(* (/ A B) C))` is stored in a generalized list implemented as class `GenList` as shown below, develop the `ListIterator()` function that traverses the list and output an prefix notation string to cout. You may define other private member function inside class `GenList` if necessary.

```
enum TagType { operator, variable, sublist };
class GenList;
class GenListNode {
friend class GenList;
private:
  GenListNode *link;
  TagType tag;
  Union {
    char op;
    char var;
    GenListNode *dlink;
  };
};
class GenList {
public:
  void ListIterator();
private:
  GenListNode *first;
}
```

   c. (10%) Write another `ListIterator()` function that outputs **postfix notation** string to cout, and show that the time complexity of your algorithm is not worse than $\Theta(n)$.

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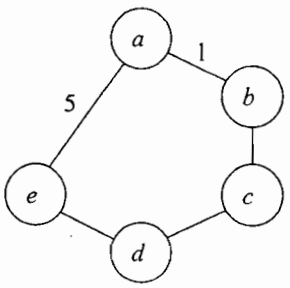
5. **[15%]** Consider the following questions related to heaps and trees.
   (a) Given a max-heap of size n, how many steps are needed to find the minimum from the max-heap, if using the array representation? Show your answer as exact as you can, although partial credit can be given for an answer in the asymptotic form.
   (b) Given a binary tree with its preorder traversal sequence as "*ABCDE*", can the tree have its postorder traversal identical to its inorder traversal sequence? Please write down all the possible cases if you find any, by drawing the graphs and giving the traversal sequences. If the answer is none, please also state your reason.

6. **[20%]** We have the following graph $G = (V, E)$ where its edge set is given as $E = \{ab, bc, cd, de, ea\}$. We also know that the edges are having integer weights 1 to 5, but not sure about the correspondence between the edges and the weights except that we know the weight for edge *ab* is 1 and weight for edge *ae* is 5. Please answer the following three questions about Minimum Spanning Tree (MST).



   (a) Please give the total weight of any MST you find. Please also draw the MST found by you.
   (b) For this graph, under what circumstance will we have Prim's algorithm (starting from vertex *b*) and Kruskal's algorithm produce the same MST?
   (c) For this graph, under what circumstance will we have Prim's algorithm (starting from vertex *b*) and Kruskal's algorithm produce the same MST and also add the edges to the MST in the same order? Please draw all of those graph(s) and their MST(s)?