Computer Science Foundation Exam

August 8 , 2008

Computer Science

Section 1B

KEY

Name: ____

SSN: ____

	Max Pts	Passing Pts	Category	Score
Q1	10	6	KNW	
Q2	8	4	CMP	
Q3	12	8	ANL	
Q4	8	6	DSN	
Q5	12	8	DSN	
Total	50	32		

You have to do all the 5 problems in this section of the exam.
Partial credit cannot be given unless all work is shown and is readable.

Be complete, yet concise, and above all be neat.

1. **[10 pts]** Circle the correct choices in each of the following parts:

(i) The worst case complexity of searching for a value in an unsorted array of n integers is

a) O(1)   b) O(log n)   **c) O(n)**   d) O(n log n)

(ii) The worst case complexity of dequeuing one item from a queue using an array implementation is

a) O(1)   b) O(log n)   c) O(n)   d) O(n log n)

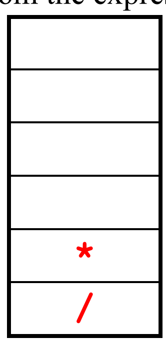
(iii) The time complexity of attaching a linked list containing k elements at the end of another linked list containing j elements would be

a) O(j)   b) O(k)   c) O(j+k)   d) O(jk)

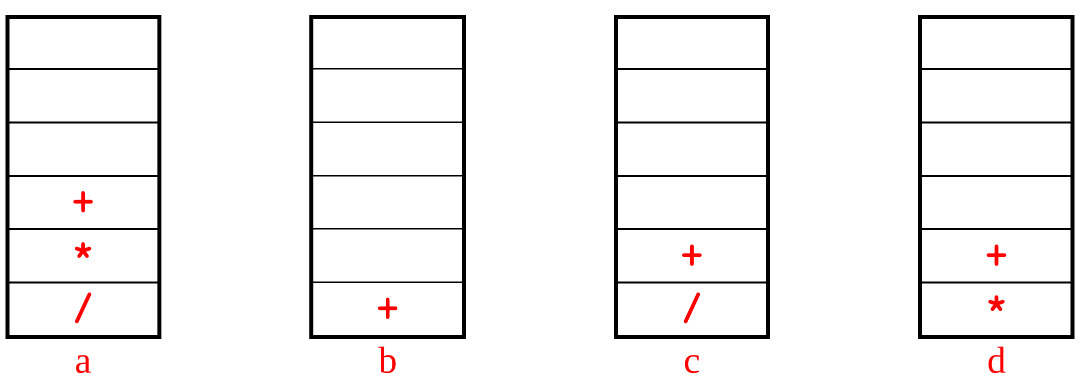
(iv) The status of function calls during the execution of a computer program is best modeled using which of the following

a) stack   b) queue   c) binary search tree

(v) An infix expression is being converted to its postfix form using a stack. The character read from the expression is '**+**' and the stack contains the following elements.



If the character read from the expression is '**+**', the stack should look like



Answer: b (Grading: 2 pts each)

2. **[8 pts]** Trace the following function when it is called from the main program through, *simple(113)*, and give the final value returned to main().

```
int  simple ( int n)
{
      if (n < 2)    return n;
      else
          return n%2 + simple(n/2);
}
```

```
simple(113) =

1 + simple(56) =

1 + 0 + simple(28) =

1 + 0 + 0 + simple(14) =

1 + 0 + 0 + 0 + simple(7) =

1 + 0 + 0 + 0 + 1 + simple(3) =

1 + 0 + 0 + 0 + 1 + 1 + simple(1) =

1 + 0 + 0 + 0 + 1 + 1 + 1 =

4

Grading: 1 pt for each step
```

3. **[12 pts]** Write the recurrence relation for this function and work out the worst case time complexity for it, **using the iteration technique.**

```
int modpower(int a,int n,int mod) {
   if (n == 0) return 1;
   if (n == 1) return a%mod;
   answer = power(a, n/2, mod);
   if ( n%2 == 0)
       return (answer*answer)%mod;
   else
       return (answer*answer*a)%mod;
 }
```

Let T(n) represent the running time of this function, where n represents the exponent in the problem. Then we have the following recurrence relation:

$T(n) = T(n/2) + O(1)$ (3 pts)

because whenever the function is called with the parameter n, a single call is made to the function with a parameter n/2, plus a constant amount of work. We solve this recurrence relation using iteration:

$T(n) = T(n/2) + 1$
$= T(n/4) + 1 + 1$ (1 pt)
$= T(n/8) + 1 + 1 + 1$ (2 pt)

From here, we deduce the general pattern after k iterations:

$= T(n/2^k) + k$ (3 pts)

We want to iterate until we get to T(1). This occurs when $n/2^k = 1$. Thus, we find that $n = 2^k$ and $k = \log_2 n$. (2 pts)

Thus, we find the solution to be

$T(n) = T(1) + \log_2 n = 1 + \log_2 n = O(\lg n)$. (2 pts)

4. **[8 pts]** Develop a RECURSIVE function that accepts an integer ***num***, and prints out in order the disk numbers that are moved for the optimal Towers of Hanoi solution with num disks total. For example, if num is 3, then the function should print the following sequence: `1213121`
If num is 4, the the function should print: `121312141213121`

```
void hanoi(int num)
{

  if (num > 0) {   // 2 pts

     hanoi(num-1);    // 2 pts
     printf("%d",num); // 2 pts
     hanoi(num-1);     // 2 pts

  }

}
```

5. **[12 pts]** A circular linked list has a struct defined as follows:

```
struct circLL {
  int data;
  struct circLL *next;
};
```

Write a function that deletes the first node in a circular linked list. In particular, your function should return a pointer to the front of the adjusted list. If the original list has no elements, then NULL should be returned. Make sure to free the memory for the deleted node.

```
struct circLL* deleteFront(struct circLL* front) {

  if (front == NULL) return NULL;  // 2 pts

  if (front->next == front) {       // 1 pt
    free(front);                   // 1 pt
    return NULL;                   // 1 pt
  }

  struct circLL* last = front;      // 1 pt
  while (last->next != front)       // 2 pts
    last = last->next;              // 1 pt

  last->next = front->next;         // 1 pt
  free(front);                      // 1 pt
  return last->next;                // 1 pt

}
```