University of Nevada, Las Vegas Computer Science 477/677 Fall 2023

Study for Examination September 29, 2023

Be prepared to answer questions similar to those here, and also similar to those on the homeworks.

1. Fill in the blanks.

   (a) Any comparison-based sorting algorithm on a file of size n must execute _____ comparisons in the worst case.

   (b) Name two well-known divide-and-conquer sorting algorithms.

   _____

   _____

2. Fill in each blank. Write Θ if that is correct; otherwise write O or Ω, whichever is correct. Recall that log means $\log_2$.

   (a) $\log n^2 = \text{_____} \log n^3$

   (b) $\log(n!) = \text{_____} n \log n$

   (c) $\sum_{i=0}^{n-1} i^k = \text{_____} n^k$

   (d) $n^n = \text{_____} 2^{\log^2 n}$.

   (e) $\log n = \text{_____} \ln n$

3. Fill in each blank with one of the words, *stack*, *heap*, *queue*, or *array*.

   (a) "pop" and "push" are operators of _____.

   (b) "fetch" and "store" are operators of _____.

4. Find the asymptotic time complexity of each of these code fragments in terms of n, using Θ notation. [10 points each]

(a) `for(int i = 0; i*i < n; i++)`

(b) `for(int i = 0; i < n; i++)`
   `    for(int j = 1; j < i; j = 2*j);`

(c) `for(int i = 1; i < n; i++)`
   `    for(int j = i; j < n; j = 2*j);`

(d) `for(float x = n; x > 2.0; x = sqrt(x))`   (`sqrt(x)` returns the square root of x.)

(e) `for(int i = 1; i < n; i = 2*i)`
   `    for(int j = 2; j < i; j = j*j);`
   (Hint: use substitution)

5. Show a circular queue with dummy node items B, M, Q, R, in that order, from front to rear. then show how the queue changes when you insert H, and then execute dequeue.

6. A stack of integers could be implemented in C++ as a linked list as follows.

```
struct stack
 {
   int item;
   stack*link;
 };
```

Finish writing the code for the operators push, pop, and empty, below.

```
void push(stack*&s,int newitem)
```

```
int pop(stack*&s)
```

```
bool empty(stack*s)
```

7. Let $F_1, F_2, \ldots$ be the Fibonacci numbers. Find a constant K such that $F_n = \Theta(K^n)$. Show the steps.

8. (a) What is the purpose of the function **power** given below?

    (b) Find a loop invariant of the while loop.

```
float power(float x, int n) // input condition: n >= 0
 {
   int m = n;
   float y = x;
   float z = 1.0;
   while(m > 0)
    {
      if(m%2) z = z*y;
      m = m/2;
      y = y*y;
    }
   return z;
 }
```

9. The following portion of C++ code contains an array implementation of **queue**. Fill in the missing code for the operators "**enqueue**" and "**empty**."

```
struct queue
 {
   int A[N]; // N is a constant large enough to prevent overflow
   int rear = 0;
   int front = 0; // initially the queue is empty
 };

 void enqueue(queue&q,int newitem) // inserts newitem into q
  {


  }

 bool empty(queue&q) // returns true if q is empty, false otherwise
  {

  }

 int dequeue(queue&q) // returns an item from q and deletes that item
  {
    int rslt = q.A[q.front];
    q.front++;
    return rslt;
  }
```

10. Walk through heapsort for the array RQWPYEFZUB.