Midterm Exam 600.226 Data Structures 7/20/98

Please answer the following questions, each of which is worth 30 points.

1. This question deals with object-oriented design principles.
   (a) Define the term *encapsulation*.
   (b) Define the term *method overloading*.
   (c) Draw a single class inheritance diagram for the following set of classes:
       - class Dinosaur extends Object and defines methods *eat()* and *move()*.
       - class Jurassic extends Dinosaur and defines instance variables “teeth” and “legs.”
       - class Cretaceous extends Dinosaur and defines methods *hunt()* and *kill()*.
       - class Brachiosaurus extends Jurassic and defines instance variable “neck.”
       - class Stegosaurus extends Jurassic and defines instance variables “tail” and “spikes.”
       - class Tyrannosaurus extends Cretaceous and defines methods *run()* and *attack()*.
       - class Triceratops extends Cretaceous and defines instance variable “horns.”

2. This question deals with algorithm analysis.
   (a) Show that the function $f(n) = 10n^2 + 15n + 20$ is $O(n^2)$.
   (b) Characterize using the big-Oh notation the worst-case running time of the following algorithm:
       Let $A$ be a given array of $n$ integers.
       for $i \leftarrow 2$ to $n - 1$ do
         for $j \leftarrow (i - 2)$ to $i$ do
         end for
       end for

3. This question deals with the Sequence ADT.
   (a) Draw a picture representing the ordered contents of an initially-empty sequence $S$ after each of the following operations:
      i. $S$.insertFirst($c$)
      ii. $S$.insertLast($a$)
      iii. $S$.insertAtRank(1,$b$)
      iv. $S$.remove($S$.after($S$.first()))
      v. $S$.insertBefore($S$.last(),$d$)
   (b) Give a pseudocode description of the Sequence method *insertAfter*($p$, $e$), assuming the sequence is implemented with a doubly-linked list with header and trailer nodes. Draw an example picture of the linked list before and after performing this operation, with nodes represented as boxes and references (or “pointers”) represented as arrows.

4. Give an example of an input sequence of 10 integer elements that requires bubble sort to take 9 passes in order to correctly sort it.

5. Write a Java class that adapts a RankedSequence to a Deque. That is, it uses a RankedSequence to implement the Deque interface.