Name: _____

1. (1 pt.)

   - **Read all material carefully.**
   - You may refer to your books, papers, and notes during this exam.
   - No computer or network access of any kind is allowed (or needed).
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use the conventions used in class and the textbook for notation, algorithmic options, etc.

   Write your name in the space provided above.

2. (9 pts.) For each value of $n = 0, 1, \ldots, 5$, depict all possible binary min-heaps containing the n keys $1, 2, \ldots, n$. *Justify your answer* briefly, explaining why the heaps you depict are the only ones possible.

3. (5 pts.) For each binary heap of Question 2 either provide a sequence insertions that produces the tree **using no swaps** (when following the standard method for binary heap insertions) or prove that no such sequence exists.

4. (10 pts.) Repeat Question 3 replacing *using no swaps* with *using exactly one swap.* For each sequence, depict the heaps immediately before and immediately after the swap operation.

[additional space for answering the earlier question]

5. (5 pts.) Repeat Questions 2, 3, and 4 for the single value $n = 6$. You may abbreviate your depictions as long as the result is unambiguous and precise.

[additional space for answering the earlier question]