This exam is **no book, no gadgets**. You are allowed one sheet of notes (letter size, two sides), which you should turn in with the exam. There are 33 questions, worth 70 total points. Marks will be curved so the median grade is at least B.

Name (Print):  
________________________________________  
This exam is my own work. I understand it is governed by the Emory Honor Code.  
Signature:  
________________________________________  

**Fill in the Blank**: fill each blank appropriately.  

(2 pts) 1. Suppose we need to build a long String by appending many char values. What standard Java class helps us to do this efficiently?  
1.  

(2 pts) 2. What priority queue (a Java class from our book) lets us decrease the priority of an existing key?  
2.  

(2 pts) 3. What priority queue (mentioned but not implemented by our book) lets us decrease the priority of an existing key in O(1) amortized time?  
3.  

(2 pts) 4. Which hashing scheme allows load factors larger than one?  
4.  

(2 pts) 5. Which hashing scheme guarantees both search and delete in worst-case constant time?  
5.  

(2 pts) 6. Kruskal’s MST algorithm uses a priority queue (for edges), and what other data structure?  
6.  

(2 pts) 7. Which MST algorithm uses only O(V) extra space?  
7.  

(2 pts) 8. Which single-source shortest paths algorithm is best when all edges have weight one?  
8.  

(2 pts) 9. Which single-source shortest paths algorithm is best when there are no negative edge weights?  
9.  

(2 pts) 10. Which single-source shortest paths algorithm is best in a DAG?  
10.  
(2 pts) 11. Which single-source shortest paths algorithm is best when there are cycles and negative edges?

   11. _______________________________________________________________________

(2 pts) 12. Which all-pairs shortest paths algorithm is best in a sparse graph with negative edge weights?

   12. _______________________________________________________________________

(2 pts) 13. In hw4 our input was $N$ points in the plane. What data structure did we use to quickly list the points nearest a given query point?

   13. _______________________________________________________________________

(2 pts) 14. Suppose we have $N$ points in the plane, $M$ is the weight of their Euclidean MST, and $T$ is the weight of their best TSP tour. What inequality did we state, relating $M$ and $T$?

   14. _______________________________________________________________________ 

(2 pts) 15. Which string sorting algorithm uses both key-indexed counting and recursion?

   15. _______________________________________________________________________ 

(2 pts) 16. Which string sorting algorithm uses key-indexed counting without recursion?

   16. _______________________________________________________________________ 

(2 pts) 17. Which string sorting algorithm uses recursion without key-indexed counting?

   17. _______________________________________________________________________ 

(2 pts) 18. In the KMP DFA for pattern “ABABABC”, what is the restart (or “trailing”) state for state 6?

   18. _______________________________________________________________________ 

(2 pts) 19. What is the total time to search for a substring of length $M$, in a text of length $N$, with an alphabet of size $R$, using the KMP DFA approach? (Big-Oh, including time to build DFA.)

   19. _______________________________________________________________________ 

(2 pts) 20. Which substring search algorithm relies on a random hash function?

   20. _______________________________________________________________________ 

(2 pts) 21. Which substring search algorithm can run in $O(N/M)$ time, for some inputs?

   21. _______________________________________________________________________ 

(2 pts) 22. What data structure did Choi propose, for storing the children of a trie node?

   22. _______________________________________________________________________ 

(2 pts) 23. If we store $N$ random strings from an alphabet of size $R$ in an R-way trie, what is the expected number of chars examined for a search miss?

   23. _______________________________________________________________________
24. If we sort N random strings from an alphabet of size R using 3-way quicksort, what is the expected number of char comparisons?

24. ____________________________

25. In hw5, which suffix (or cyclic shift) sorting algorithm did we use, to implement a faster Burrows-Wheeler transform (BWT)?

25. ____________________________

26. What is the BWT of “santas”, adding the mark character ‘%’? (Note ‘%’ is first in sorted order.)

26. ____________________________

27. What is reverse BWT of “rceacra”, removing the mark character ‘e’?

27. ____________________________

28. What is the (big-Oh) time required to compute the reverse BWT of a string of length N over an alphabet of size R, using the method from homework?

28. ____________________________

29. What string is encoded by the LZW codes 41, 81, 42, 82, 80? (As usual 41 is A, 42 is B, 80 is end-of-file, and 81 is the first available code.)

29. ____________________________

30. Suppose we use Huffman coding on the text “Yohoho!” (without quotes). What is the bit length of the compressed text? (Just the text, no tree.)

30. ____________________________

31. This data structure is a compressed trie, storing all the suffixes of a given input string.

31. ____________________________

**Short Answer:**

32. Suppose we use MSD to sort the following eight strings. Underline the characters that are NOT examined:

BIG BAD BEAR BE THE BIG BOY BAND

33. Draw the TST that results from inserting the previous list of strings, in order. The first string (BIG) has value 0, the second has value 1, and so on.

(4 pts) 33. ____________________________