University of Waterloo
CS240E Winter 2021
Midterm Post Mortem

1 Fill in missing (15 marks)

- a) - e) – were generally well done, with a few students writing numbers outside of the ranges.

- f) – Some students wrote $x_3 : x_2$ or $x_2 : x_0$.

- g) – Some students gave a number that starts with 0 but is not in radix 4. Many did not get it at all.

- i) – Many students tried inserting in the left subtree.

- j) – Some incorrect keys answers were $83, 94$. It's important to note that even if you find the key at a higher level, you still continue comparing until you've the predecessors at every level.

- k) – Students writing a H/T pattern with more than 3 heads was common (HHHHT, HHHHHT, etc etc).

- l) – A few students mixed up zig-zig and zig-zag rotations (60 was common).

- m) – Some students wrote 0100$.

- o) – Several students wrote keys ending in 4 instead of 5.

2 Short answer questions (3+3+3+4=13 marks)

- a) - Many students got $20 < x \leq 45$, but they forgot that we can't have this since we are in a sorted array.

- b) - Many students got $8 \leq n_L \leq 14$, but $n_L \geq 7$.

- c) - Well done.

- d) - Some students drew trees where x_L and x_R were of different heights.

3 Algorithm analysis (2+2+2+3+3=12 marks)

- a - c) – Well done.

- d, e) – Some students did not use asymptotic notation.

- d) – Some students gave inadequate justification.

- e) – Common mistakes included: 1) Assuming that all values of n_L were equally likely, 2) assuming $E(T(n_L)) = T^{exp}(n/2)$, and 3) resolving the recurrence to $O(n)$ instead of $O(logn)$.

- e) was skipped by several students.

4 Sorting (7+7=14 marks)

- a) – A common (correct) approach was simply skipping the elements that were present in D, but students then tripped up by not maintaining an unsorted copy of the decreased elements (which was necessary for checking if an element was decreased in $O(1)$ time).

- a) – Some students used a $\Theta(n^2)$ algorithm to sort D.

- b) – Many students tried to extract D from S by only checking adjacent elements. This doesn't work because there could be multiple numbers in a row that were decreased but are locally increasing.

5 Amortized analysis (8 marks)

Issues were:

- Not defining the potential function

- Not proving that the function being used is a valid potential function

- Missing the analysis of the easier search / inserts

6 Treaps (2+10(+5) = 12(+5) marks)

- Most students skipped the bonus.

- b) was skipped by several students.

- b) – Some errors were not mentioning expected time, missing out on correctness proofs or generally informal reasoning.

- Heapify was used without justification of runtime.

7 Biased search-requests (2+1+2+1=6 marks)

- Generally well done. A few students forgot to count the comparison of the key with itself. A few students thought that the cost for the optimum uses the probabilities, rather than the frequencies.

8 Hashing (2+2+3+3=10 marks)

- Generally well-done. Some students forgot a few keys or did miscalculations mod 10.

- Some students forgot to state the keys for which h_2 was used in c), or the keys which were ejected from their slot in d).