

University of Waterloo

CS240 Spring 2026

Midterm Post-Mortem

Question 1 True/False [6 marks]

- f) A lot of students got this question wrong. The following is from slides 34 / 44 of Module 1: The worst-case (best-case) running time of an algorithm $\mathcal{A}$ is a function $\mathbb{Z}^+ \rightarrow \mathbb{R}$ mapping n (the input size) to the longest (shortest) running time for any input instance of size n :

$$T_{\mathcal{A}}^{\text{worst}}(n) = \max_{I \in \mathcal{I}_n} \{T_{\mathcal{A}}(I)\}$$

$$T_{\mathcal{A}}^{\text{best}}(n) = \min_{I \in \mathcal{I}_n} \{T_{\mathcal{A}}(I)\}$$

Question 2 Short Answers [5 marks]

- a) Counterexample possible using $\log n \notin o(2 \log n)$.
- b) Some students calculated limits wrong or interpret the results wrong.

Question 3 First Principle and Runtime Analysis [8 marks]

- a) This question was well done.
- b) Some students the correct inner and outer loop but made mistakes in combining them.

Question 4 Dynamic Array [4 marks]

- A dynamic array resizes upon inserting on full capacity, not upon reaching full capacity.
- Some students did not account for the initial capacity of 8.

Question 5 Heap [3 marks]

- Some students assumed a completely full heap.
- Some students based their answers on the height of the tree.
- Some students' answers were too indirect/informal/sloppy.

Question 6 AVL Trees 1 [8 marks]

- Some students confused AVL trees with Heaps.
- Some students' implementation of findMin and findMax were $O(\log n)$.
- Some students did not update the references for the min and the max in their deleteMin, deleteMax, and insert functions.

Question 7 AVL Trees 2 [5 marks]

- a) This question was well done.
- b) Some students forgot that ties must be broken to avoid double rotation.

Question 8 Randomized Algorithm [4 marks]

- Some students did not give randomized algorithm.
- Some students' algorithm could not guarantee to find the index i such that $A[i] = x$.
- Some students did not return the correct index upon finding x . This was common for algorithms that used partition or swap.
- Some students had $i \leftarrow \text{random}(\lfloor \frac{n}{2} \rfloor + 1)$ or similar. The expected runtime for that is not $\Theta(1)$.

Question 9 Average Runtime [4 marks]

- Some students had $\sum_{i=0}^{n-1}$ instead of $\sum_{i=1}^n$.
- Some students had incorrect $|\mathcal{I}_n| = n$ instead of $n!$
- Some students had incorrect $\sum_{I \in \mathcal{I}_n} T(I)$.
- Some students had the correct initial summation but did not correctly or fully simplify it.

Question 10 Decision Trees [4 marks]

- The outcomes for Compare3 has $3! = 6$ permutatoinis, not 3.
- Some students gave lower bound of $\Omega(n)$ or $\Omega(\log n)$ without $6^h \geq n!$ justification.
- Some students did not fully prove the lower bound, and some stated the correct lower bound without sufficient justification.