The rules for this exam are as follows:

- Write your name on the front page of the exam booklet. Initial each of the remaining pages in the upper-right hand corner. Sign the front of the exam booklet. Your exam will not be graded if you have not signed the front page of the booklet.
- This exam will last for 50 minutes.
- Show ALL work for partial/full credit. This includes any definitions, mathematics, figures, etc.
- The exam is closed book and closed notes.
- No laptops, ipads, or other types of non-medical electronic devices are allowed.
- Calculators are allowed provided that they are only used to perform basic computations (and not programmed with algorithms or notes, for example).
- No collaboration of any kind is allowed on the exam.

1. ______ (10 points)  5. ______ (10 points)
2. ______ (10 points)  6. ______ (10 points)
3. ______ (10 points)  EC. ______ (10 points)
4. ______ (10 points)  T. ______ (60 points)
1. (10 points) By assuming that all basic operations require the same constant cost $C$, compute the cost of the resource function, $R_w(n)$, in closed-form for the following program segment using the simplified approach as discussed in class:

\[
x = 325; \\
y = -x; \\
\text{for } m = 1 \text{ to } n \text{ do} \\
\quad \text{for } k = 1 \text{ to } m^2 \text{ do} \\
\quad\quad y = x \cdot y - \sin(x \cdot y) + 3 \cdot y + 591; \\
\quad \text{endfor; } \\
\quad x = 3 \cdot y; \\
\text{endfor; }
\]

2. (10 points) Using the definition of big-$\Omega$, prove that

\[
n \log n = \Omega(n).
\]
3. (10 points) Using the hash function $x \mod m$ and quadratic probing, construct a hash table $H$ with $m = 7$ buckets by inserting a set of 6 records with keys $\{69, 79, 47, 14, 8, 22\}$, in the given order, into $H$. 
4. (10 points) Construct the (unique) binary tree corresponding to the given pair of tree traversals if possible. If not such tree is possible, state that is the case.

Inorder: G, D, H, B, E, I, A, F, J, C
5. (10 points; 5 points each)

(a) (5 points) Insert items with keys 9, 8, 17, 1, 3, 51, and 6, in the given order, into an initially empty binary search tree. **Show the BST after each insertion.**

(b) (5 points) Next delete 1 and 9, in order, from the above binary search tree. **Show the BST after each deletion.**
6. (10 points; 5 points each)

(a) (5 points) Specify how to store the following network as an adjacency matrix. In doing so, please first specify your labeling of the nodes. **Any labeling of the nodes is OK.**

(b) (5 points) Describe how to reduce the storage of the adjacency matrix based on its sparsity and the implementation.
1. (10 points) You are going on a one-way indirect flight trip that includes an unknown very large number of transfers.

Here is what is known about your trip:

- You are not stopping twice in the same airport.
- You have 1 ticket for each part of your trip.
- Each ticket contains src and dst airports.
- All of the tickets you have are randomly sorted.
- You forgot the original departure airport (first src) and your destination airport (last dst).

Design an algorithm (based on the use of a hash table) to reconstruct your trip with minimum big-$O$ complexity. You do NOT need to specify the computational complexity for your algorithm.