CS3221 Exam 1, Spring 2026

Your name:

Question 1

Solve recurrences using recursion trees:

- $T(n) = 2T(n/2) + n^2$
- $T(n) = 4T(n/2) + n^2$

Question 2

```
def binary_search(A, lo, hi, target):
  if lo > hi: return False
  mid = (lo + hi) // 2
  if A[mid] == target: return True
  elif A[mid] < target: return binary_search(A, mid+1, hi, target)
  else: return binary_search(A, lo, mid-1, target)
```

Prove by induction that binary search correctly finds a target value in a sorted array.

Question 3

You're robbing Carol's Coffee Castle. Carol sells ground coffee by volume, in a variety of different flavors. You need to fit all the coffee you steal into a bucket with volume V. You want to optimize the total sale price of the coffee you steal. For simplicity, we'll assume that you can pack the stolen coffee in thin plastic bags with zero volume.

Input:

- The volume of your bucket, V, in cubic centimeters (cc).
- A list of (flavor name, price per cc, volume in stock in ccs).

Output:

- A list of (flavor name, volume stolen) that maximizes total sale price of stolen coffee.

Consider the following greedy strategy:

```
while your bucket isn't full:
  - find the in stock coffee with the highest price per cc
  - Take as much of it as you can without overfilling your bucket
```

Prove that this strategy is or is not optimal.

Question 4

Consider the following algorithm:

```
i = n
while i > 1:
  i = i / 2
```

What is the time complexity? Why?