Problem (1) [20 points]
Draw a tree with 10 terminal states that will result in the maximum number of possible terminal states being pruned (assuming DFS is left-to-right). Use the same tree and terminal values, but rearrange the terminal values so only 50% of the terminal states are pruned.
Problem (2) [20 points]
Find the Nash equilibrium of the following payoff matrix. What are the pure strategy Pareto optimum?

\[
\begin{array}{ccc}
(4,4) & (3,2) & (3,0) \\
(2,1) & (6,4) & (2,4) \\
(3,1) & (2,2) & (5,6) \\
\end{array}
\]
Problem (3) [20 points]
I mentioned in-class that N-queens could be phrased as a constraint satisfaction problem.
(1) Define the variables, domains and constraints for a 4-queens problem. (2) For each of
the shown 4-queens positions below, assign the indicated value to the variable and then
show the domains of the remaining unassigned variables that are 2-consistent (both with
the assigned variable and with the other unassigned variables).
Problem (4) [20 points]
To find a heuristic you should: (1) relax the problem, (2) describe how to find the answer optimally in the relaxed situation (non-exponentially) and (3) a short description of the heuristic value of a state. You must find two such relaxations/heuristics for the following situation (neither can be trivial). Then state which relaxation would be better and why.

- You are going grocery shopping and need to get 20k calories, 1000% DV of iron and 1200% DV of Vitamin A while spending as little money as possible. You can assume the store has an infinite amount of each item in stock (and your shopping bag/cart can store as many items as you wish).
Problem (5) [20 points]
Answer the following questions:

- Which of the following algorithms can you control the running time of? Justify your answer. (Basic) hill-climbing, Stochastic hill-climbing, Hill-climbing with random restart, Simulated annealing, Local beam search, and Genetic algorithm.

- Below is a Monte-Carlo tree search with UCB values shown roughly above each node. Nodes that have not been visited yet have a branch/edge without a bubble. Indicate which node the next random rollout would occur at. If the next random rollout resulted in a loss, for each UCB value shown on the tree, indicate whether this value would increase, decrease or stay the same (you do not need to compute the exact value).