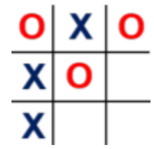
CSC 421: Assignment 2 - Part A

Q1. (3 points)

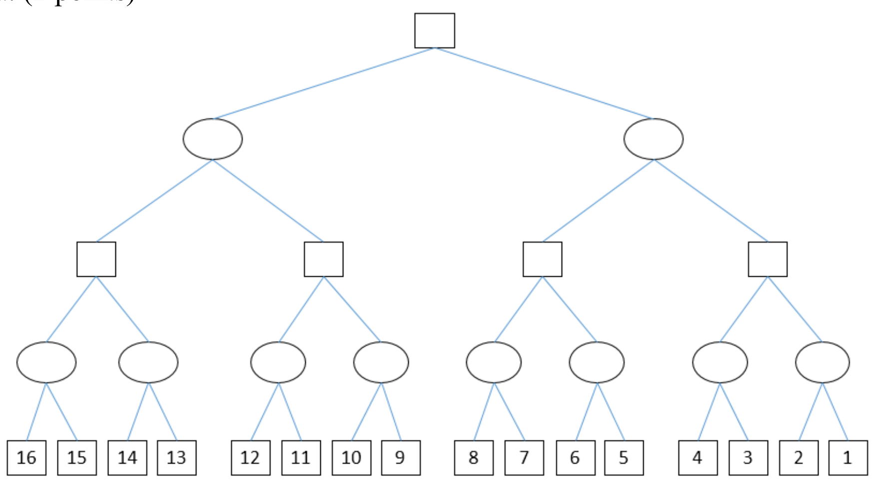
Consider the tic-tac-toe game of two players X and O and the state given in the figure. The player to make a move in this state is X.



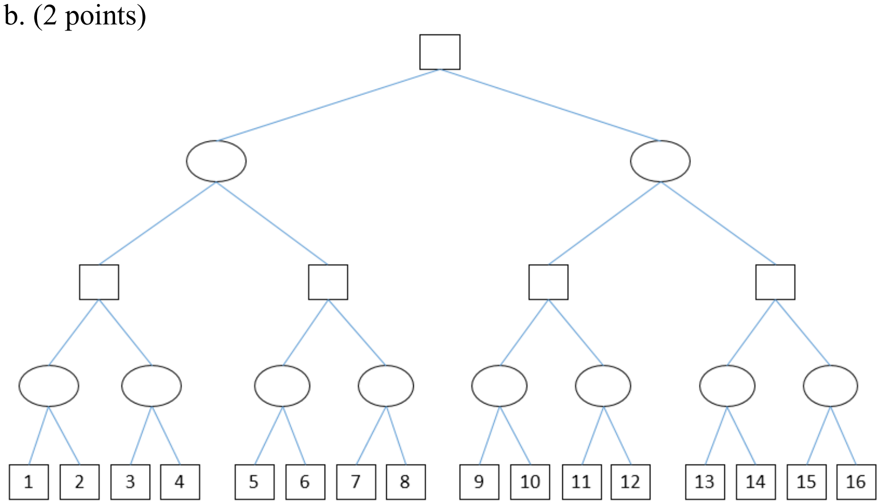
a. (1 point) Starting from this state draw the game tree. For the terminal states the utility values (for X) are +1 for win, 0 for draw, -1 for loss.
b. (2 points) Apply the alpha-beta pruning and show the branches that will be pruned (not explored).

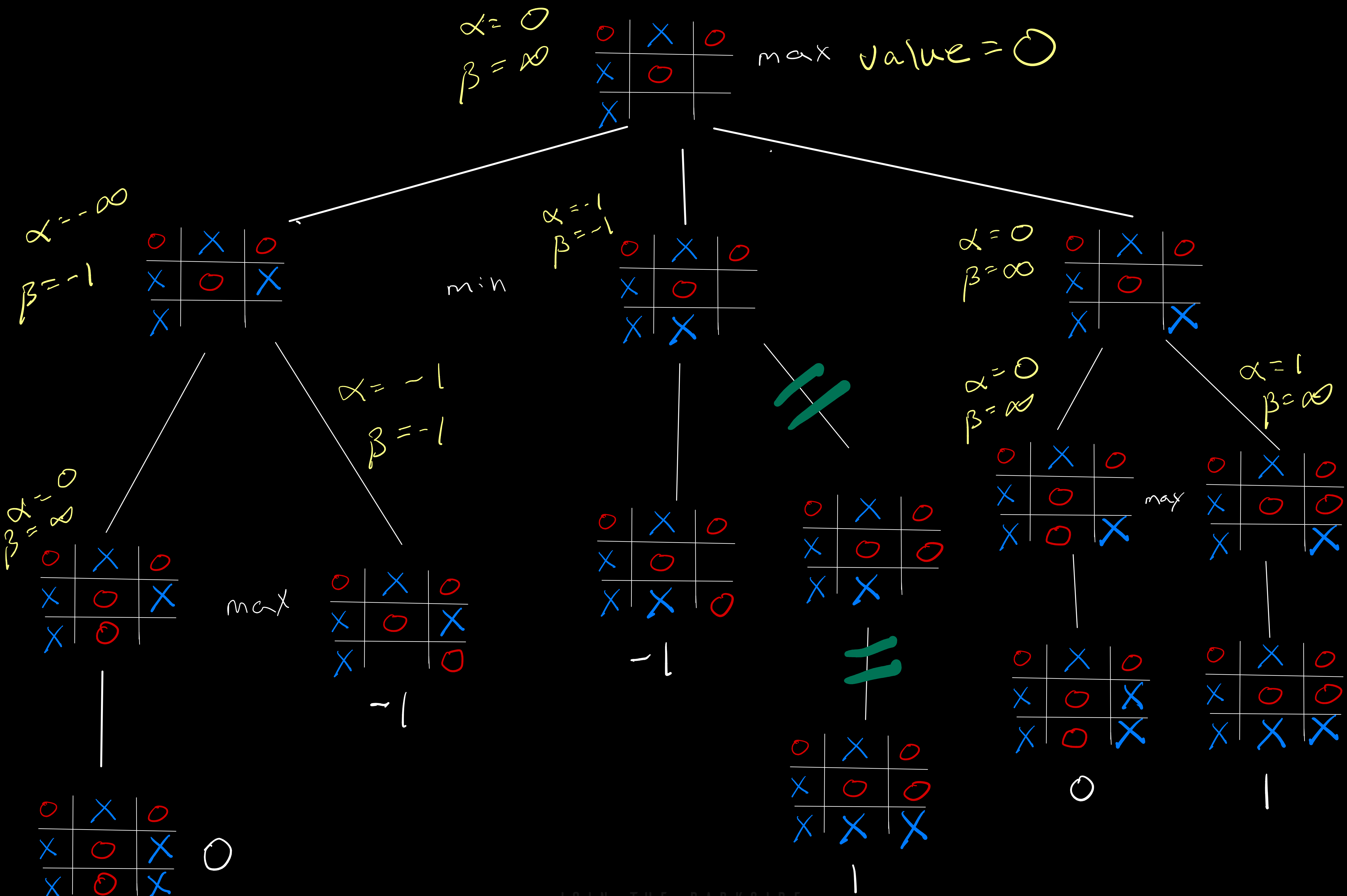
Q2. (7 points) Perform alpha-beta pruning in the following three game trees.

a. (2 points)



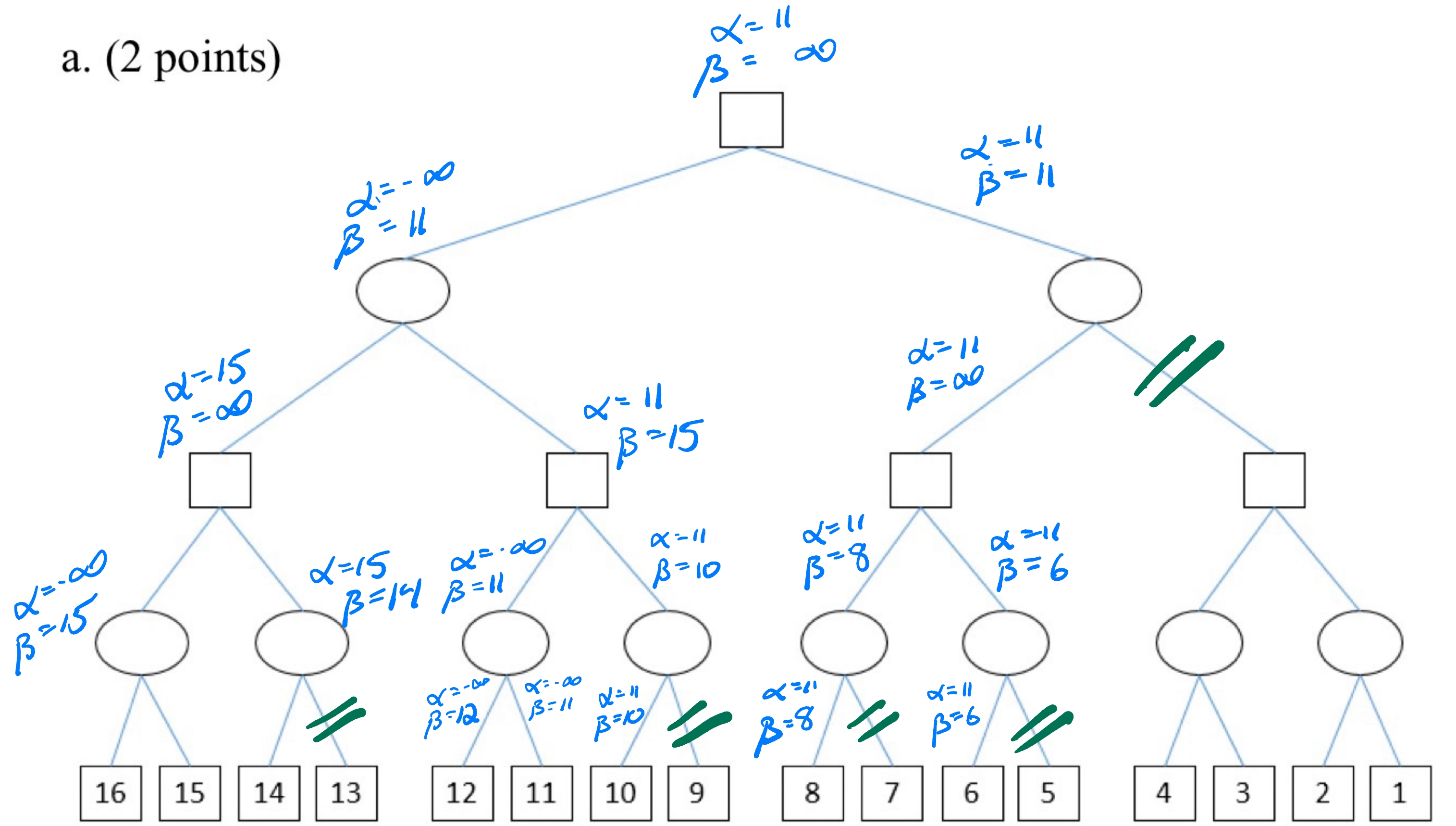
b. (2 points)



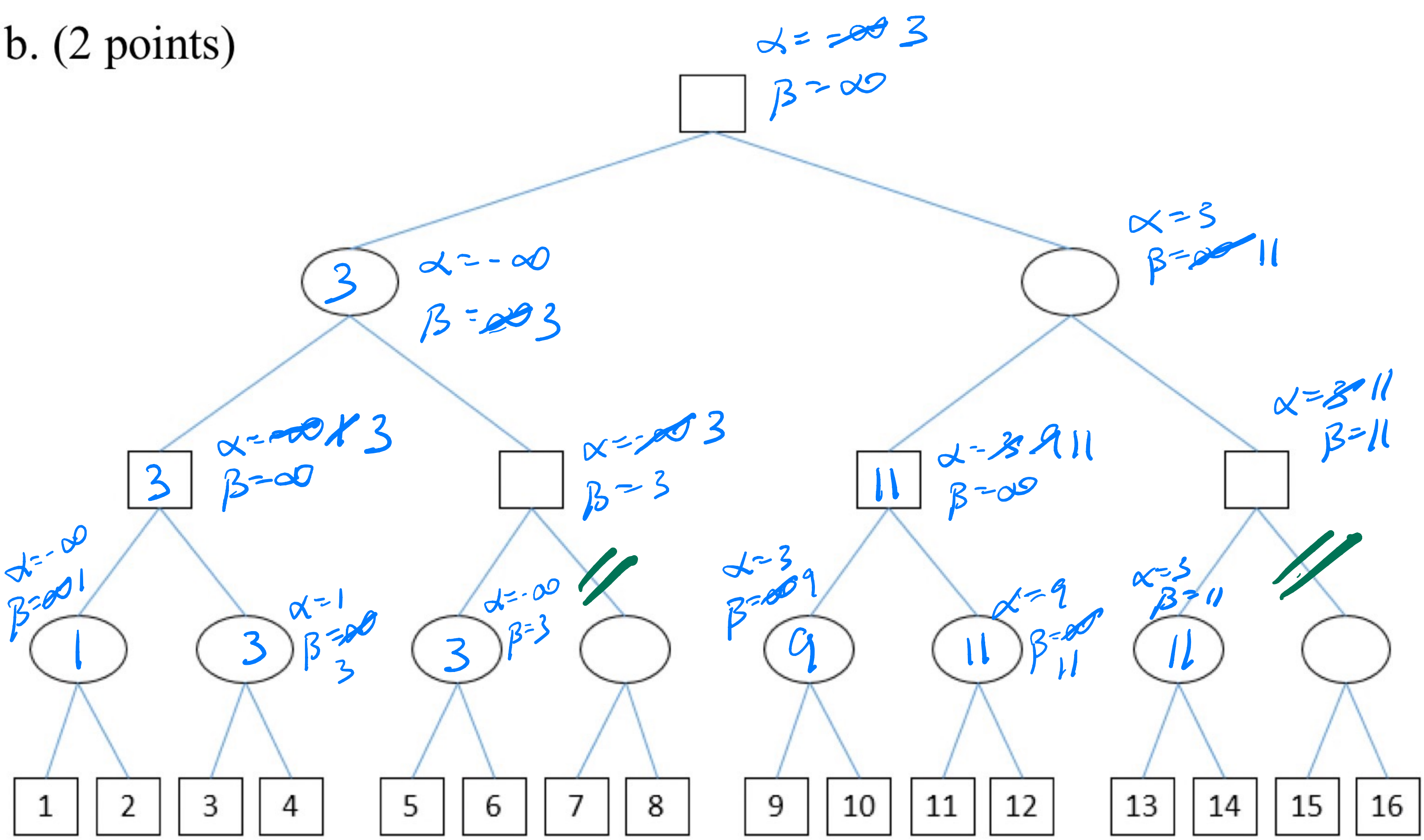

α = 0
β = ∞
max
value = 0
α = -∞
β = -1
min
α = -1
β = -1
α = 0
β = ∞
α = -1
β = -1
α = 0
β = ∞
α = 1
β = ∞
α = 0
β = ∞
max
max
-1
-1
0
1
0
1

Q2. (7 points) Perform alpha-beta pruning in the following three game trees.

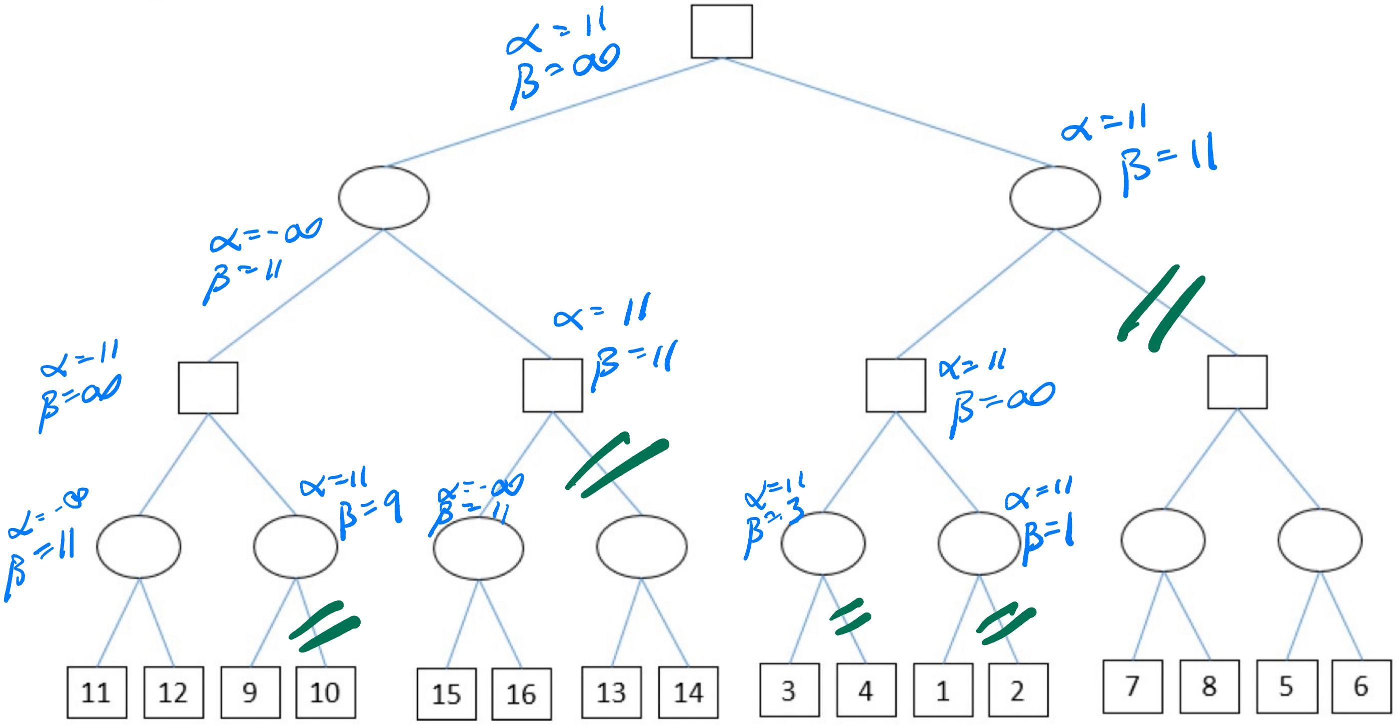
a. (2 points)



b. (2 points)



c. (2 points)



(1 point) What conclusion do you draw regarding the order of nodes and the efficacy of alpha-beta pruning?

The results from question 2 point toward the ideal ordering strategy being to place the the most “ideal" (to the overall pruning) values to the LHS of the tree. For instance, if the lowest decision node is a min node, this would mean having its children ordered from highest to lowest from the left to the right (the opposite being true if the lowest node is a max node.) In addition, the values at the leafs (for a min decision making node) should be ordered from highest to lowest value from left to right.

Q3. (6 points) We want to schedule final exams for 7 courses: T (Turing Machines), L (Lambda Functions), B (Binary Numbers), C (Constraint Satisfaction), S (Software Engineering), P (P vs NP), N (Numerical Analysis). Unfortunately, there are only four one-hour time slots available (1pm, 2pm, 3pm, 4pm) and you discover there are some restrictions on how you can schedule the exams. After checking the registrations of the students who are to take the exams, you determine they fall into certain groups. You write down everything you know:

- There are students who take courses: B, C, and N.
- There are students who take: L, P, and N.
- There are students who take: S and P.
- There are students who take: L and C.
- There are students who take: T, L, and N.
- There are students who take: C and P.

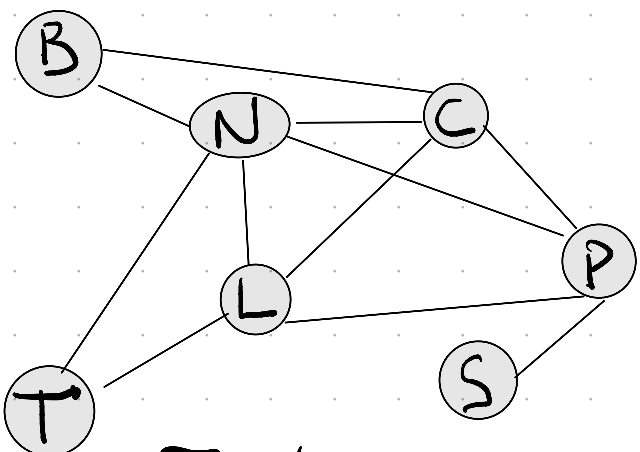
Also, it turns out, the professor of T has to finish early to travel to a conference, so T can only be scheduled in the 1pm slot.

a. (2 points) Consider T, L, B, C, S, P, N as variables in a CSP, and write the domains and draw the constraint graph.
b. (4 points) Use the backtracking algorithm along with Forward Checking, as well as MRV, and D heuristics to find an assignment to the variables for this problem.

Variables:
$\{T, L, B, C, S, P, N\}$

Domain:
$\{1, 2, 3, 4\}$

Constraints



Var	Deg
T	2
L	4
B	2
C	4
S	1
P	4
N	5

$T = 1$

(b)

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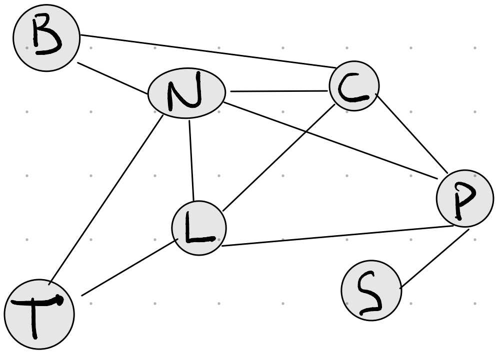

Var	Deg
T	2
L	4
B	2
C	4
S	1
P	4
N	5

T	L	B	C	S	P	N	
							MRV: T, T=1
1	any	any	any	any	any	any	FC(N,L)
1	2,3,4	any	any	any	any	2,3,4	MRV: N,L D:N, N=2 FC(B,C,L,P)
1	3,4	1,3,4	1,3,4	any	1,3,4	2	MRV: L, L=3
1	3	1,3,4	1,4	any	1,4	2	FC(C,P)
							MRV: C, P,B D: C, P
1	3	3,4	1	1,2,3	4	2	P=4 FC(S,C)
							MRV: B, B=3
1	3	3	1	1,2,3	4	2	FC()
							MRV: S
1	3	3	1	1	4	2	S=1

Q4. (2 points) Model the Greek-Logic puzzle as a CSP (https://www.brainzilla.com/logic/greek-logic).
Here is an instance of it that you should use for this question:
Assign the given Greek letters

Λ	Θ	Ψ	Φ	Π	Ω

	1	2	3	4	5	6
1						
2						
3						
4	Φ			Θ	Ω	Ψ
5				Λ		Θ

to the empty squares of grid on the right so that each letter appears exactly once in each row, column and main diagonals.

Variables: $\{(x,y) : x \in \{1,\dots,5\}, y \in \{1,2,\dots,6)\}$

Let B_{xy} denote the x^{th} row and y^{th} column of the board

Domain: $\{\phi, \theta, \pi\ \Omega, \Lambda, \Psi\}$

Constraints: $B_{xy} \neq B_{iy}$, $i \in \{1,2,\dots,5\}, i \neq x$

$B_{xy} \neq B_{yj}$, $j \in \{1,2,\dots,6\}, j \neq y$

$B_{xy} \neq B_{KK}$, $K \in \{1,\dots,5\}$

if $x=y$, $B_{xy} \neq B_{x\pm K, y\pm K}$

$\{\phi, \theta, \pi, \Omega, \Lambda, \Psi\}$

$x \backslash y$	1	2	3	4	5	6
1	π	ϕ	θ	Ψ	Λ	Ω
2	Ω	Λ	Ψ	ϕ	θ	π
3	Λ	θ	Ω	π	Ψ	ϕ
4	ϕ	π	Λ	θ	Ω	Ψ
5	Ψ	Ω	π	Λ	ϕ	θ