CS 173, Spring 18 Examlet 9, Part B

Name:_____

NetID:_____ **Lecture: A B**

Discussion: Thursday Friday 9 10 11 12 1 2 3 4 5 6

1. (8 points) Here is a grammar with start symbol S and terminal symbols a and b. Draw three parse trees for the string `ababab` that match this grammar.

$$\begin{aligned} S &\rightarrow a\ N \mid a\ N\ S \\ N &\rightarrow b\ a\ N \mid b \end{aligned}$$

2. (4 points) Check the (single) box that best characterizes each item.

A tree node is a descendent of itself.

always ☐ sometimes ☐ never ☐

The number of nodes in a full complete binary tree of height h

$\geq 2^h$ ☐ $2^{h+1} - 1$ ☐

$\leq 2^{h+1} - 1$ ☐ $\geq 2^{h+1} - 1$ ☐

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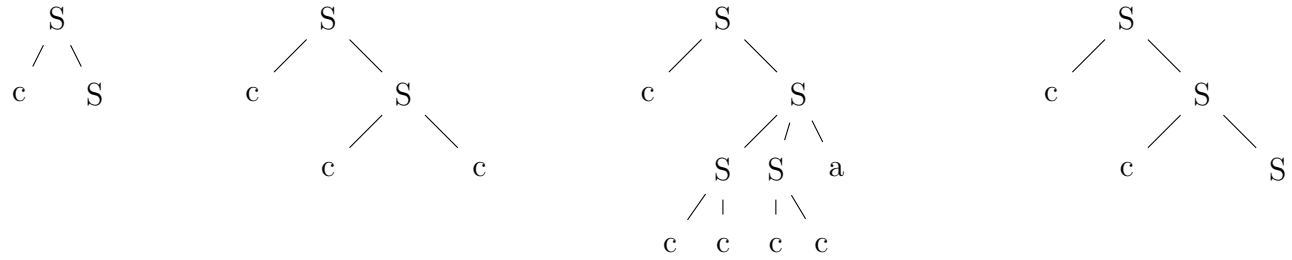
1. (8 points) Here is a grammar, with start variable S and terminals a and c. Circle the trees that match the grammar.

$$S \rightarrow S\,S\,a \mid c\,S \mid c\,c$$



2. (4 points) Check the (single) box that best characterizes each item.

A binary tree of height h has at most $2^{h+1} - 1$ nodes. true ☐ false ☐

A tree with n edges has ____ nodes. $n-1$ ☐ n ☐ $n+1$ ☐ $n/2$ ☐

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1. (8 points) Consider the following grammar G

   $S \to a\ S\ b \mid b\ S\ b \mid a \mid b$

   S is the only start symbol. The terminal symbols are a and b.

   Here are two sequences of leaf labels. For each sequence, either draw a tree from grammar G whose leaves have this sequence of labels, or else explain briefly why G cannot generate this sequence of leaf labels.

   `aabaaba` `aababaa`

2. (4 points) Check the (single) box that best characterizes each item.

   The root node of a tree is an internal node — always ☐ sometimes ☐ never ☐

   The level of the root node in a tree of height h. — -1 ☐ 0 ☐ 1 ☐ $h-1$ ☐ h ☐

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1. (8 points) Give a context-free grammar that generates all strings of the form a^+b^+. That is, all strings that consist of a sequence of one or more a's followed by a sequence of one or more b's.

2. (4 points) Check the (single) box that best characterizes each item.

Number of non-empty bit strings of length k.

2^k ☐ $2^k - 1$ ☐ 2^{k-1} ☐ k ☐

The number of paths between two distinct nodes in an n-node tree. Paths in opposite directions count as the same.

n ☐ $2n$ ☐ $\frac{n(n-1)}{2}$ ☐

$n(n-1)$ ☐ n^2 ☐ $\frac{n(n+1)}{2}$ ☐

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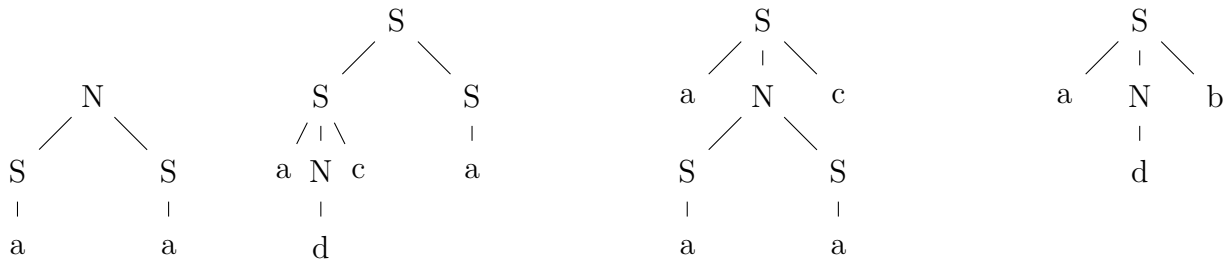
1. (8 points) Here is a grammar with start symbol S and terminal symbols a, b, c, and d. Circle the trees that match the grammar.

$$\begin{aligned} S &\rightarrow a\ N\ b \mid a\ N\ c \mid a \\ N &\rightarrow S\ S \mid d \end{aligned}$$



2. (4 points) Check the (single) box that best characterizes each item.

A full m-ary tree with i internal nodes has _____ nodes total.

- $mi - 1$ ☐
- mi ☐
- $mi + 1$ ☐
- $\leq mi + 1$ ☐

Height of a binary tree with 2^n nodes.

- $\leq n - 1$ ☐
- $\leq n$ ☐
- $\leq 2^n$ ☐
- $\leq 2^n - 1$ ☐

Name:_____

NetID:_____ **Lecture: A B**

Discussion: Thursday Friday 9 10 11 12 1 2 3 4 5 6

1. (8 points) Here is a grammar with start symbol S and terminal symbol a. Draw three parse trees for the string `aa` that match this grammar.

$$\begin{aligned} S &\rightarrow S\ S \mid N \mid a \\ N &\rightarrow a \end{aligned}$$

2. (4 points) Check the (single) box that best characterizes each item.

A tree node is a proper ancestor of itself.	always ☐	sometimes ☐	never ☐
Removing an edge from a tree (with at least one edge) produces two trees.	always ☐	sometimes ☐	never ☐