Name:____

NetID:____________________ **Lecture:** **A** **B**

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

1. (8 points) Consider the following grammar G, with start symbol S and terminals a and b.

$$S \;\rightarrow\; a\,S\,a \;|\; b\,S\,b \;|\, a\,S\,b \;|\; b\,S\,a \;|\; a \;|\; b$$

Amy claims that this generates all non-empty strings containing a's and/or b's. Is this correct? Justify your answer.

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

Total number of leaves in a full and complete 5-ary tree of height h	5^h ☐	$\leq 5^h$ ☐	$\geq 5^h$ ☐	$5^{h+1} - 1$ ☐

The level of a leaf node in a full and complete binary tree of height h.	0 ☐	1 ☐	$h-1$ ☐	$\leq h$ ☐	h ☐

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 `abba` that match this grammar.

$$S \rightarrow \quad S\,S \ | \ a\,S \ | \ S\,a \,| \ b$$

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

A full m-ary tree with i internal nodes has $mi + 1$ nodes total. always ☐ sometimes ☐ never ☐

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

CS 173, Spring 19 Examlet 9, white

Name:____

NetID:____________________ **Lecture: A B**

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

1. (8 points) Consider the following grammar G

   $S \rightarrow S\ b\ S \ |\ a \ |\ c\ d$

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

   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.

   `aaacd` `bbbbb`

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

The mathematical symbol for an empty (zero-length) string	$\emptyset$ ☐	e ☐	ϵ ☐	NULL ☐
Number of bit strings of length $\leq k$.	2^k ☐	$2^k - 1$ ☐	2^{k-1} ☐	$2^{k+1} - 1$ ☐

CS 173, Spring 19 **Examlet 9, white**

Name:____

NetID:________________________ **Lecture:** **A** **B**

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

1. (8 points) Min's virus detection code needs to generate all strings of the form $a^n b^n$. That is, all strings that consist of a sequence of one or more a's followed by the same number of b's. Write a context-free grammar G that will do this.

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

The number of nodes in a binary tree of height h	$\geq 2^h$	☐	$2^{h+1} - 1$	☐
	$\leq 2^{h+1} - 1$	☐	$\geq 2^{h+1} - 1$	☐

A tree node is a descendent of itself. always ☐ sometimes ☐ never ☐

Name:____

NetID:____________________ **Lecture:** **A** **B**

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

1. (8 points) Consider the following grammar G

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

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

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.

`ababb` `babcbbb`

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

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

A tree node is a proper ancestor of itself. always ☐ sometimes ☐ never ☐

CS 173, Spring 19 **Examlet 9, white**

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, b, and c. Circle the trees that match the grammar.

$$S \rightarrow a\ N\ a \mid b\ N\ b \mid a \mid b$$
$$N \rightarrow S\ S \mid c$$

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

A binary tree of height h has at least $2^h - 1$ nodes. true ☐ false ☐

A full m-ary tree with i internal nodes has _____ nodes total. $mi - 1$ ☐ mi ☐ $mi + 1$ ☐ $\leq mi + 1$ ☐

Name:____

NetID:________________________ **Lecture:** **A** **B**

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

1. (8 points) Consider the following grammar G

$$S \rightarrow a\ S\ b\ \mid\ b\ S\ b\ \mid\ a\ \mid\ b$$

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.

`babab bb`

`aaaab`

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

The number of leaves in a binary tree of height h	2^h ☐	$2^{h+1}-1$ ☐	$\geq 2^h$ ☐	$\leq 2^h$ ☐

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 ☐	$\frac{n(n+1)}{2}$ ☐

CS 173, Spring 19 Examlet 9, white

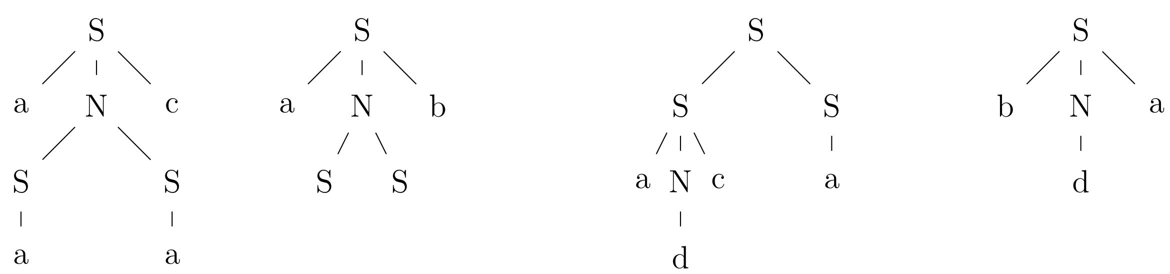
Name:____

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, 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.

The diameter of a tree of height h.

$\leq h$ ☐	h ☐	$h+1$ ☐
$2h$ ☐	$\leq 2h$ ☐	

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

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