1. (50 points) Consider the DFA below.

(a) Construct a two dimensional table where the row and column headers are the states of the above DFA. Mark each cell with a ‘1’ (or a higher number representing the iteration number) if the states are “different.” Unmarked cells will represent indistinguishable states.

(b) Construct a minimized DFA by collapsing (groups of) indistinguishable states into single states.

2. (20 points) Consider the following grammars $G_1$ and $G_2$:

$G_1$ :
$S \rightarrow xAx$
$A \rightarrow Aa \mid Ab \mid c \mid d$

$G_2$ :
$S \rightarrow xAx$
$A \rightarrow c \mid d \mid cB \mid dB$
$B \rightarrow aB \mid bB \mid a \mid b$

(a) Give a derivation sequence for string $xcabx$ in $G_1$. Give the derivation tree of the sequence.

(b) Give a derivation sequence for string $xcabx$ in $G_2$. Give the derivation tree of the sequence.

Please turn the page over.
3. (30 points) Consider the following grammar $G_1$:

$$
S \rightarrow aSb \mid A \\
A \rightarrow cA \mid d \mid \lambda
$$

(a) Give a derivation for a terminal string such that the $S \rightarrow aSb$ rule is used exactly twice, the $A \rightarrow cA$ rule is used exactly three times, and the $A \rightarrow d$ rule is used once during the derivation.

(b) Give a derivation for a terminal string such that the $S \rightarrow aSb$ rule is used exactly once, the $A \rightarrow cA$ rule is also used exactly twice, and the $A \rightarrow \lambda$ rule is used once during the derivation.

(c) Use set notation to define the language generated by the grammar.