CISC/CMPE 223 - Assignment 4 (Winter 2018)
Due: Thursday February 15 by 2:30 PM
(in the locked CISC 223 drop-off box on Goodwin 2nd floor)

One bonus mark for neatly written student information: Papers that have all the names and student numbers written exactly as requested in the regulations (found at the end), will receive one bonus mark.

1. (5 marks) Using the algorithm mark distinguishable pairs of states that was presented in class (and can be found in the course notes), minimize the number of states of the DFA depicted in Figure 1.

![DFA Diagram](image-url)

Figure 1: The DFA to be minimized in Question 1.

Your answer should indicate in detail how you arrived at the solution:

- For each stage of the algorithm, indicate which pair(s) of states are marked as distinguishable and explain the reason why.

- Draw the minimized state diagram where each state is labeled by the corresponding names of states in the original DFA that were merged together.

2. Let $\Sigma = \{a, b, c, d\}$. Give context-free grammars that generate the following languages:

   (a) (1 mark) \[ \{a^{3i}b^kc^{2i+3} \mid i \geq 1, k \geq 1\} \]

   (b) (2 marks) \[ \{a^ib^{2k}c^kd^i \mid i \geq 1, k \geq 1\} \cup \{a^rb^sc^sd^{3s} \mid r \geq 1, s \geq 1\} \]
3. (2 marks) Show that the following grammar is ambiguous:

\[ S \rightarrow aSbS \mid bSaS \mid \varepsilon \]

Here \( S \) is the start nonterminal and the set of terminals is \( \{ a, b \} \).

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**Regulations on assignments**

- **The assignments may be done in groups consisting of one, two, three or four students.** If more than one student are collaborating on an assignment, they must submit a single **joint solution**.

- At the top of the first page, for each student collaborating on the assignment, type or write in **clear capital letters** the following information:
  - LAST-NAME, FIRST-NAME (name as it appears on solus, e.g., “SMITH, NANCY”)
  - the student number (e.g., “1234 4321”)
  - “CISC 223” or “CMPE 223” (depending on which course you are in)
  - signature (the signature need not be easily readable)

  The information for each one student should be written on **one line** and in the order specified above.

- **Bonus mark:** Papers that have the above information, for all the participants, written exactly correctly and perfectly clearly and legibly will receive one bonus mark. The assignment is worth 10 marks. Papers that receive the bonus mark, may get more than 10 marks. For the bonus mark there is **no partial credit** for incomplete information or unclear handwriting.

- The assignment should be put into the locked CISC 223 drop-off box on the 2nd floor of Goodwin hall by the due date. The assignments **must be submitted in hardcopy**. Assignments sent by email are not accepted.

- If the submission consists of more than one page, the pages must be **stapled** together.

- **Note:** You are asked to write your solutions using non-erasable pen (or to type the solutions). Solutions written in pencil or erasable ink will be marked, but they will not be considered for remarking after the assignments are returned.