# Assignment 9

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Assignment 9 consists of two problems. You must write your solutions to the problems using LaTeX.

Please submit Assignment 9 as two files, `Assignment_9_YourMacID`.tex and `Assignment_9_YourMacID`.pdf, to the Assignment 9 folder on Avenue under Assessments/Assignments. *YourMacID* must be your personal MacID (written without capitalization). The `Assignment_9_YourMacID`.tex file is a copy of the LaTeX source file for this assignment (`Assignment_9`.tex found on Avenue under Contents/Assignments) with your solution entered after each problem. The `Assignment_9_YourMacID`.pdf is the PDF output produced by executing

```
pdflatex Assignment_9_YourMacID
```

This assignment is due **Sunday, March 29, 2020 before midnight.** You are allow to submit the assignment multiple times, but only the last submission will be marked. **Late submissions and files that are not named exactly as specified above will not be accepted!** It is suggested that you submit your preliminary `Assignment_9_YourMacID`.tex and `Assignment_9_YourMacID`.pdf files well before the deadline so that your mark is not zero if, e.g., your computer fails at 11:50 PM on March 29.

**Although you are allowed to receive help from the instructional staff and other students, your submission must be your own work. Copying will be treated as academic dishonesty! If any of the ideas used in your submission were obtained from other students or sources outside of the lectures and tutorials, you must acknowledge where or from whom these ideas were obtained.**

# Problems

1. [**10 points**] Construct a regular grammar that generates the language matched by the regular expression $(000^* + 111^*)^*$.

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   **Date: March 29, 2020**

   Let $G = (\{S, A, B\}, \{0, 1\}, P, S)$ be the regular grammar where $P$ contains the following productions:
   $S \rightarrow \epsilon \mid 00A \mid 11B$
   $A \rightarrow 0A \mid \epsilon \mid E$
   $B \rightarrow 1B \mid \epsilon \mid E$

2. [**10 points**] Let $\Sigma = \{a, b\}$ and $L = \{x \in \Sigma^* \mid x \neq \mathsf{rev}(x)\}$. Construct a simple grammar for $L$ as well as grammars in Chomsky and Greibach normal form for $L$.

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   **Note:** In all the Grammars, S is the start state.

   **Simple Grammar:**
   Let $G = (\{S, A, B\}, \{a, b\}, P, S)$ be a simple grammar where $P$ contains the following productions:
   $S \rightarrow aBb \mid bBa \mid aBbA \mid bBaA \mid AaBb \mid AbBa \mid AaBbA \mid AbBaA$
   $A \rightarrow Aa \mid a \mid Ab \mid b$
   $B \rightarrow aBa \mid bBb \mid \epsilon$

   **Chomsky Normal Form:**
   Let $G = (\{S, A, B, C, D, E\}, \{a, b\}, P, S)$ be a grammar in CNF form where $P$ contains the following productions:
   $S \rightarrow ADB \mid BDA \mid ADBC \mid BDAC \mid CADB \mid CBDA \mid CADBC \mid CBDAC$
   $C \rightarrow CA \mid A \mid CB \mid B$
   $D \rightarrow ADA \mid BDB \mid E$
   $A \rightarrow a$
   $B \rightarrow b$
   $E \rightarrow \epsilon$

   **Greibach Normal Form:**
   Let $G = (\{S, A, B, C, D, N\}, \{a, b\}, P, S)$ be a grammar in GNF form where $P$ contains the following productions:
   $S \rightarrow aDB \mid bDA \mid aDBC \mid bDAC \mid aN \mid bN$
   $C \rightarrow aC \mid a \mid bC \mid b$
   $N \rightarrow aCADB \mid bCADB \mid aCBDA \mid bCBDA \mid aCADBC \mid bCADBC \mid aCBDAC \mid bCBDAC$
   $D \rightarrow aDA \mid bDB \mid aA \mid bB$

$$A \rightarrow a$$
$$B \rightarrow b$$