- **You shall receive feedback on the problems *only if***:
  1. You submit **to Ankita** by **2359 hrs on Thursday, September 19**, 2019, and
  2. **Submit each problem in a separate sheet** with your name on each sheet. This is essential because the TAs divide correction duties by problem.
- This problem set should take you approximately an hour to solve. This is the pace that will be expected in the quizzes.

"Colorless green ideas sleep furiously." – Noam Chomsky

1. Let $L = \{w\#x \mid w \text{ is a substring of } x, \text{ where } w, x \in \{a, b\}^*\}$. Is L context-free? Justify.
2. Let $\Sigma = \{0, +, =\}$. Let $L \subseteq \Sigma^*$ be defined as follows:

   $$L = \{0^m + 0^n = 0^{m+n} \mid m, n \in \mathbb{N}\}$$

   Is L context-free? Justify.
3. Let $\Sigma = \{0, 1, +, =\}$. For $x \in \{0, 1\}^*$, let $(x)_2$ denote the number represented by x in binary. Let $L \subseteq \Sigma^*$ be defined as follows:

   $$L = \{u + v = w \mid u, v, w \in \{0, 1\}^*, (u)_2 + (v)_2 = (w)_2\}$$

   Is L context-free? Justify.
4. Consider the following grammar:

   $$A \to A + A \mid A - A \mid a$$

   Is it ambiguous? Justify. If yes, can you give an unambiguous grammar for the same language?
