# Homework # 3

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**Problems**:

1. Prove that each of the following problems is in the class L.

   (a) $L_1 = \{\langle u, v\rangle \mid u \text{ and } v \text{ are identical strings over the alphabet } \{0,1\}\}$.

   (b) $L_2 = \{\langle p, s\rangle \mid p \text{ is a pattern in the string } s \text{ where } p, s \in \Sigma^\star\}$.

   (c) $L_3 = \{\langle G\rangle \mid G \text{ is an acyclic undirected graph}\}$.

   (d) $L_4 = \{\langle G\rangle \mid G \text{ is a tree}\}$.

   (e) $L_5 = \{\langle G\rangle \mid G \text{ is an undirected bipartite graph}\}$.

2. Prove that the following problems are NL-complete.

   (a) $L_6 = \{\langle G\rangle \mid G \text{ is a strongly connected directed graph}\}$.

   (b) $L_7 = \{\langle G, s, t, k\rangle \mid G \text{ is a directed graph with nodes } s \text{ and } t \text{ and there is a path of length at most } k \text{ from } s \text{ to } t\}$.