Assignment #3

Date Due: March 27, 2026

Total: 100 marks

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1. (10 marks each, 35 maximum) Describe in English, ***as simple as possible***, the languages generated by the following regular expressions:
   (a) $b^*bb^*(a^2 + a^* + a + \varepsilon)^*b^*bb^*$
   (b) $a(a^* + \varepsilon)^*aa^*a(a^* + b)^*$
   (c) $(ba)^*ba(\varepsilon + b) + ab(ab)^*a + ab(ab)^*\varepsilon$
   (d) $b^*ab^*(b^*ab^*b^*b^*ab^*ab^*ab^*)^*$.

2. (10 marks each, 35 marks maximum) Prove that the following languages are regular languages:
   (a) $L = \{a^n b^m a^{kn} \mid n \leq 1, m \geq 1, k \geq 2\}$
   (b) $L = \{a^n \mid n \neq 2, \text{ and } n \not\equiv 2(\mod 5)\}$
   (c) $L = \{a^n ba^k \mid n \geq 6, k < 4\} \cup \{c^k ab^m \mid m \geq 3, k < 2\}$
   (d) Assume $L_1 \subseteq \{a, b\}^*$ is a regular language and define $L = \{wcv \in \{a, b, c\}^* \mid (2|w|_a + |v|_b) \equiv 3 \mod 5,\ w, v \in L_1\}$,

3. (25 marks maximum) Are the following languages regular or not?
   (a) (10 marks)
   $$\{a^n b^l a^m \mid |n - m| \leq 2, l > 3\}.$$
   (b) (20 marks) What if $L_1 \subseteq \{a, b, c\}^*$ and
   $L = \{wcv \in \{a, b, c\}^* \mid (3|w|_a = 2|v|_b)\ w, v \in L_1 \cap \{a, b\}^*\}$. Discussion on L_1.

4. (10 marks each, 25 marks maximum) Prove that the following languages are not regular:
   (a) $\{c^m b^{2n} a^n c^k \mid n > 0, m, k \geq 0\}$
   (b) $\{cca^n b^{n-k+2} a^k c^k \mid n > 0, n > k > 2\}$
   (c) $L = \{c^m a^n b^l cc \mid n \neq l + 1, m > 2\}$