There are a total of five problems. You have to solve all of them.

Problem 1 (CO5): Nonregular Language (25 points)

Use the pumping lemma to **demonstrate** that L_1, L_2, L_3, L_4 and L_5 is not regular.

(a) $L_1 = \{ww \mid w \in \{0,1\}^*\}$ (5 points)

(b) $L_2 = \{w \in \{0,1\}^* : 0^x 1^y 0^z$ where $z > x + y$ and $x, y \geq 0\ \}$ (5 points)

(c) $L_3 = \{w \in \{0,1\}^* : w$ is a palindrome$\}$ (5 points)

(d) $L_4 = \{w \in \{a,b\}^* :$ numbers of a in w is a prime number$\}$ (5 points)

(e) $L_5 = \{w \in \{0\}^* : 0^{3^n}$ where $n \geq 0\}$ (5 points)