I. (10 pts.) Design a context-free grammar for the language 
\( \{ xcy \mid x, y \in \{a, b\}^*, \ |x| = |y|, \ x \neq y^R, \ \text{and} \ |x| \ \text{is an odd integer}\).
II. (10 pts.) Specify a decision procedure for the following problem:

- Given $n$ dfas, $M_1, M_2, \ldots, M_n$, over the alphabet $\Sigma$, do there exist 2 dfas $M_k$ and $M_\ell$, $k \neq \ell$, such that $L(M_k) \cup L(M_\ell) = \Sigma^*$?
III. (10 pts.) Design a Turing machine for computing the following function:

\[
f(x, y, z) = \begin{cases} 
  2x + y - 2z & \text{if } 2x + y - 2z \geq 0 \\
  0 & \text{otherwise}
\end{cases}
\]
IV. (10 pts.) Solve one of the following problems.

- Assume that testing whether a given TM halts on exactly one input is undecidable. Prove that testing whether a given TM halts on exactly two inputs is undecidable.

- Recall that a given R-PCP \((x_0, y_0), (x_1, y_1), \ldots, (x_n, y_n)\) has a solution if there is a sequence of indices \(i_1, i_2, \ldots, i_m, \ m \geq 1\), such that \(x_0x_{i_1}x_{i_2} \cdots x_{i_m} = y_0y_{i_1}y_{i_2} \cdots y_{i_m}\). Prove that the R-PCP problem is undecidable assuming that the PCP problem is undecidable.