Reductions: if we can reduce (transform) problem A into a problem B, then solving problem B gives solution to problem A.

Example: \( \text{HALT}_{TM} = \{ \langle M, w \rangle \mid M \text{ is a TM that halts on } w \} \)

Thm 5.1: \( \text{HALT}_{TM} \) is undecidable.

Note: \( \text{HALT}_{TM} \) is the halting problem, \( A_{TM} \) is the acceptance problem.
Thm 5.1: $E_{TM}$ is undecidable, where

$$E_{TM} = \{ <M> \mid M \text{ is a TM and } L(M) = \emptyset \}$$
Thm 5.3: $\text{REGULAR}_{TM}$ is undecidable, where

\[ \text{REGULAR}_{TM} = \{ \langle M \rangle \mid M \text{ is a TM and } L(M) \text{ is regular} \} \]
Thm 5.4: $EQ_{TM}$ is undecidable, where

$$EQ_{TM} = \{ \langle M_1, M_2 \rangle \mid M_1, M_2 \text{ are TM's and } L(M_1) = L(M_2) \}$$
Thm 5.4: $\text{ALL}_{\text{CFG}}$ is undecidable, where

$$\text{ALL}_{\text{CFG}} = \{ <G> \mid G \text{ is a CFG and } L(G) = \Sigma^* \}$$
Rice’s Thm [Problem 5.28]:

Let p be a language property. If p holds for some but not all languages, then the following language is undecidable:

\[ R = \{ <M> | M \text{ is a TM and } L(M) \text{ satisfies } p \} \]