

for  $x \in \{0, 1\}$ . The five gates in circuit on the right hand side act on the basis states as follows:

$$\begin{aligned}
 |00\rangle \otimes |x\rangle &\mapsto |00\rangle \otimes |x\rangle \quad \mapsto |00\rangle \otimes |x\rangle \quad \mapsto |00\rangle \otimes |x\rangle \quad \mapsto |00\rangle \otimes |x\rangle \quad \mapsto |00\rangle \otimes |x\rangle \\
 |01\rangle \otimes |x\rangle &\mapsto |01\rangle \otimes V|x\rangle \mapsto |01\rangle \otimes V|x\rangle \mapsto |01\rangle \otimes V^\dagger V|x\rangle \mapsto |01\rangle \otimes |x\rangle \quad \mapsto |01\rangle \otimes |x\rangle \\
 |10\rangle \otimes |x\rangle &\mapsto |10\rangle \otimes |x\rangle \quad \mapsto |11\rangle \otimes |x\rangle \quad \mapsto |11\rangle \otimes V^\dagger|x\rangle \quad \mapsto |10\rangle \otimes V^\dagger|x\rangle \mapsto |10\rangle \otimes |x\rangle \\
 |11\rangle \otimes |x\rangle &\mapsto |11\rangle \otimes V|x\rangle \mapsto |10\rangle \otimes V|x\rangle \mapsto |10\rangle \otimes V|x\rangle \quad \mapsto |11\rangle \otimes V|x\rangle \mapsto |11\rangle \otimes V^2|x\rangle
 \end{aligned}$$