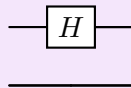


University of Jyväskylä - Course TIEJ6003  
intro2QC Summer2024: ex3

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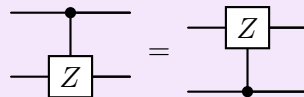
**Exercise 3.1: scaling-up**

What is the  $4 \times 4$  unitary matrix for this circuit?



**Exercise 3.2: equivalence**

Show that



**Exercise 3.3: CNOT from controlled-Z gates**

Construct a CNOT gate from one controlled-Z gate, that is, the gate whose action in the computational basis is specified by the unitary matrix

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}$$

**Exercise 3.4: Bell states are orthonormal basis**

Verify that the Bell states form an *orthonormal basis* for the *2-qubit state space*.