

## 1 Classical linear code

Given the following generator matrix

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 \end{pmatrix}, \quad (1)$$

what are  $[n, k, d]$  and what is the encoding of the bitstring 1011?

1.  $[7, 3, 4]$  and 1110000
2.  $[7, 3, 4]$  and 1010101
3.  $[7, 4, 3]$  and 1110000
4.  $[7, 4, 3]$  and 1010101

## 2 Stabilized subspace

What is the subspace on 4 qubits stabilized by the following stabilizers? (Up to normalization)

$$Z_1 Z_2 Z_3 Z_4 \quad (2)$$

$$Z_3 Z_4 \quad (3)$$

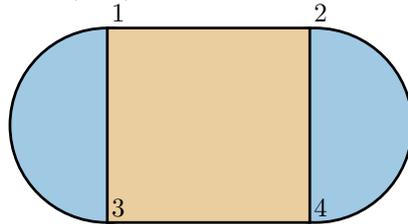
$$X_1 X_2 \quad (4)$$

Note:  $|+\rangle = |0\rangle + |1\rangle$  and  $|-\rangle = |0\rangle - |1\rangle$ .

1.  $\text{span}\{(|00\rangle + |11\rangle) \otimes (|00\rangle + |11\rangle), (|01\rangle + |10\rangle) \otimes (|00\rangle + |11\rangle)\}$
2.  $\text{span}\{(|++\rangle + |--\rangle) \otimes |00\rangle, (|++\rangle + |--\rangle) \otimes |11\rangle\}$
3.  $\text{span}\{(|++\rangle + |--\rangle) \otimes (|++\rangle + |--\rangle), (|-\rangle + |+\rangle) \otimes (|+\rangle + |-\rangle)\}$
4.  $\text{span}\{(|-\rangle + |+\rangle) \otimes (|++\rangle + |--\rangle), (|-\rangle + |+\rangle) \otimes (|++\rangle + |--\rangle)\}$

### 3 Logical qubit

Given a (silly) surface code



and assuming we start in the all zero state to prepare the logical zero state, what is that state? (Up to normalization.) You should post-select on measurement outcomes with positive phase.

Note: Blue represents  $X$ -type stabilizers and the central yellow square is a  $Z$ -type stabilizer.

1.  $|0000\rangle + |1111\rangle$
2.  $|0101\rangle + |1010\rangle + |0011\rangle + |1100\rangle$
3.  $|0000\rangle + |1100\rangle + |0011\rangle + |1111\rangle$
4.  $|0000\rangle + |1010\rangle + |0101\rangle + |1111\rangle$