Mathematics Cheat Sheet

1. bra-ket: $\langle u|\ v\rangle =$ inner product of $|u\rangle$ and $|v\rangle = U^H V$.
2. ket-bra: $|u\rangle\langle v| =$ outer product of $|u\rangle$ and $|v\rangle = UV^H$.
3. ket-ket: $|u\rangle|v\rangle =$ tensor product of $|u\rangle$ and $|v\rangle = |u\rangle \otimes |v\rangle = |uv\rangle = |u, v\rangle$.
4. Outer product is the tensor product of two vectors.
5. Tensor product of two matrices,

$$A \otimes B = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \otimes \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} = \begin{bmatrix} a_{11}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} & a_{12}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \\ a_{21}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} & a_{22}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \end{bmatrix} \tag{1}$$