Quantum Gates :—

Single Qubit Gates.

Pauli {

① H — [H] — $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$

② X — [X] — $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

③ Y — [Y] — $\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$

④ Z — [Z] — $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

⑤ S — [S] — $\begin{pmatrix} 1 & 0 \\ 0 & i \end{pmatrix} \rightarrow e^{i\theta} = \underset{0}{\cos\theta} + \underset{I}{i\sin\theta}$ $\theta = \pi/2 \,(90°)$

⑥ T — [T] — $\begin{pmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{pmatrix} \rightarrow e^{i\pi/4}$
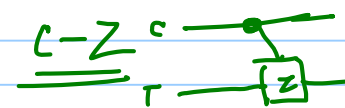
2-Qubit Gates.

① CNOT (2)

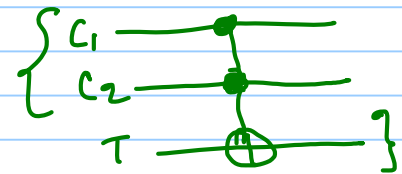$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix} \rightarrow X$ 4×4
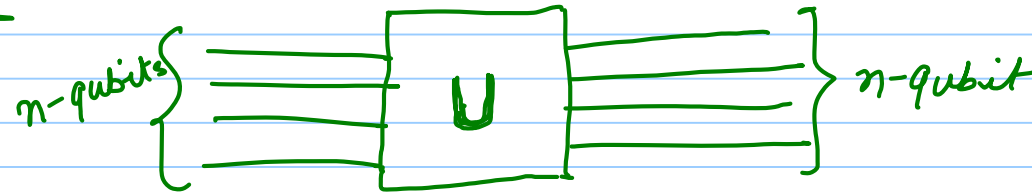
② C-Z

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

③ 3-Qubit

CCNOT | C^2 NOT | Taffoli Gate

Unitary Matrix

n-qubits $\{$ [U] $\}$ n-qubit

$\equiv$

—/n— [U] —/n—

Implementation of Classical Gates Using Quantum Gates

① NOT

I/P	O/P
0	1
1	0

—[X]—

② AND

I/P		O/P
0	0	0
0	1	0
1	0	0
1	1	1

$\{$ [U] $\}$ $1\cdot\alpha$ ———•———
                $1+1\beta$ ———•———
                $\emptyset$ ———⊕———[X]—(1) (NAND)

③ OR

			D
0	0		0
0	1		1
1	0		1
1	1		1

1 1 0 0 → 0 0 1 1
1 0 1 0 → 0 1 0 1
0   0 1 1 1

(NOR)

④ EKOR

→ EX-NOR
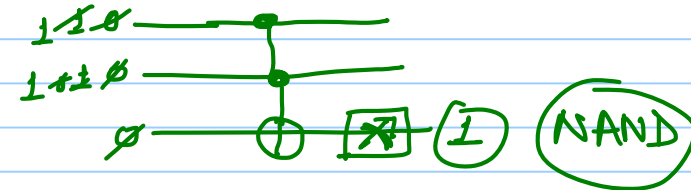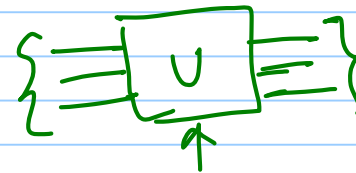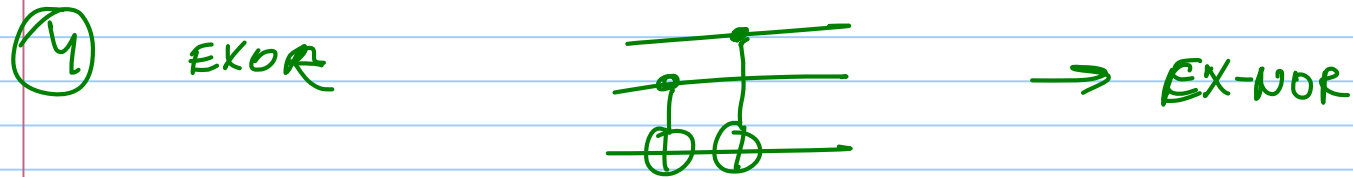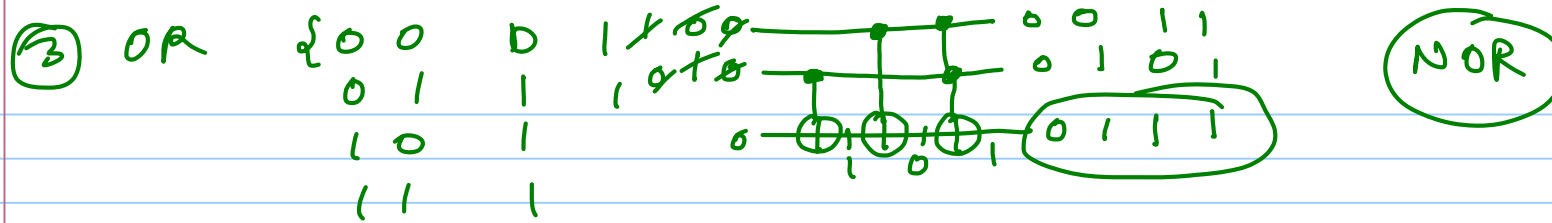
Quantum Algorithms

Design Methods / Strategies.

- Quantum Parallelism
- Quantum Fourier (QFT)
- Quantum Amplitude
- Hybrid Quantum-Classical Algo

Query Quantum Based

Transform Based

Amplification

QAQO

VQE

— Deutsch Algo
— Deutsch-Jozsa Algo

Simon's Alg

Quantum Phase Estimation (QPE)

Grover's Search Algo

Quantum Counting Algo

Bernstein-Vazirani Algo
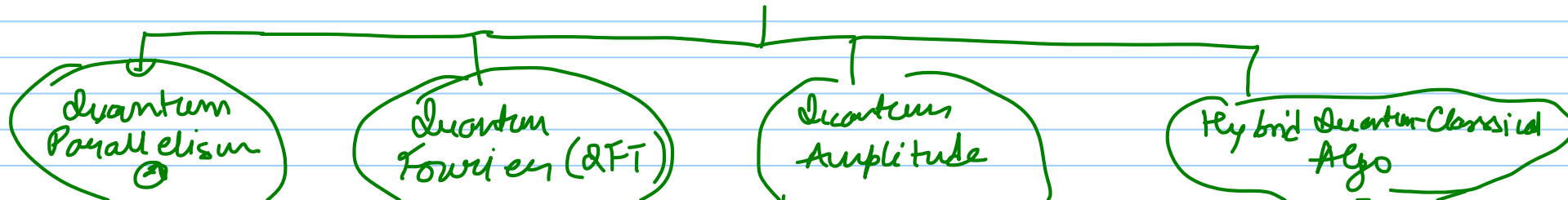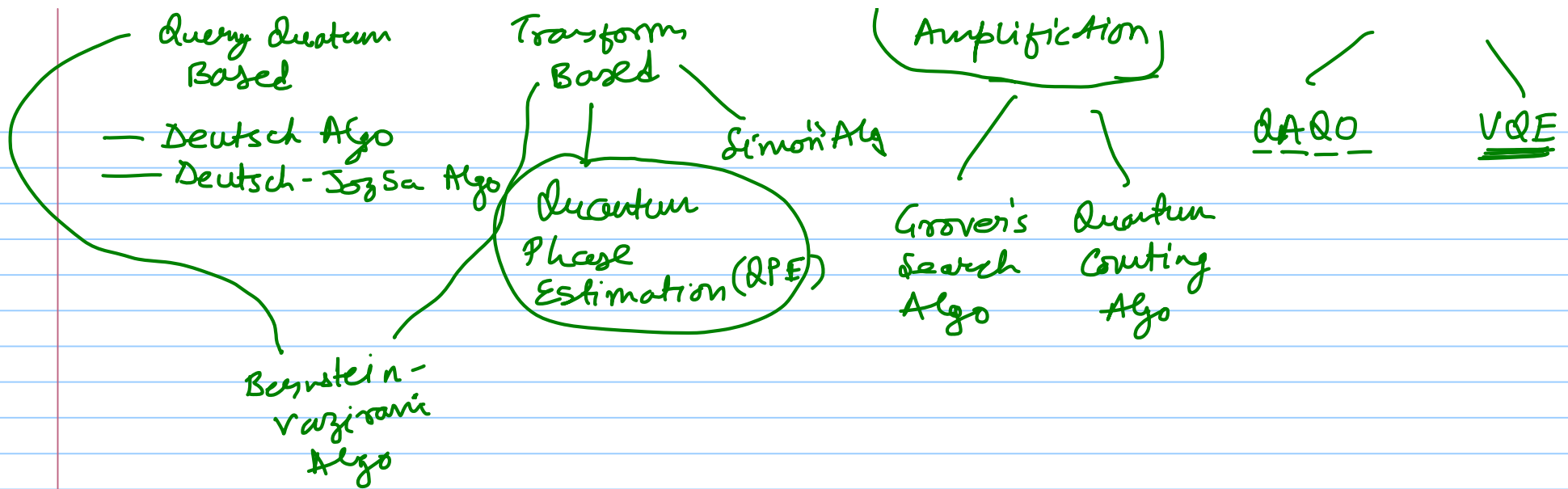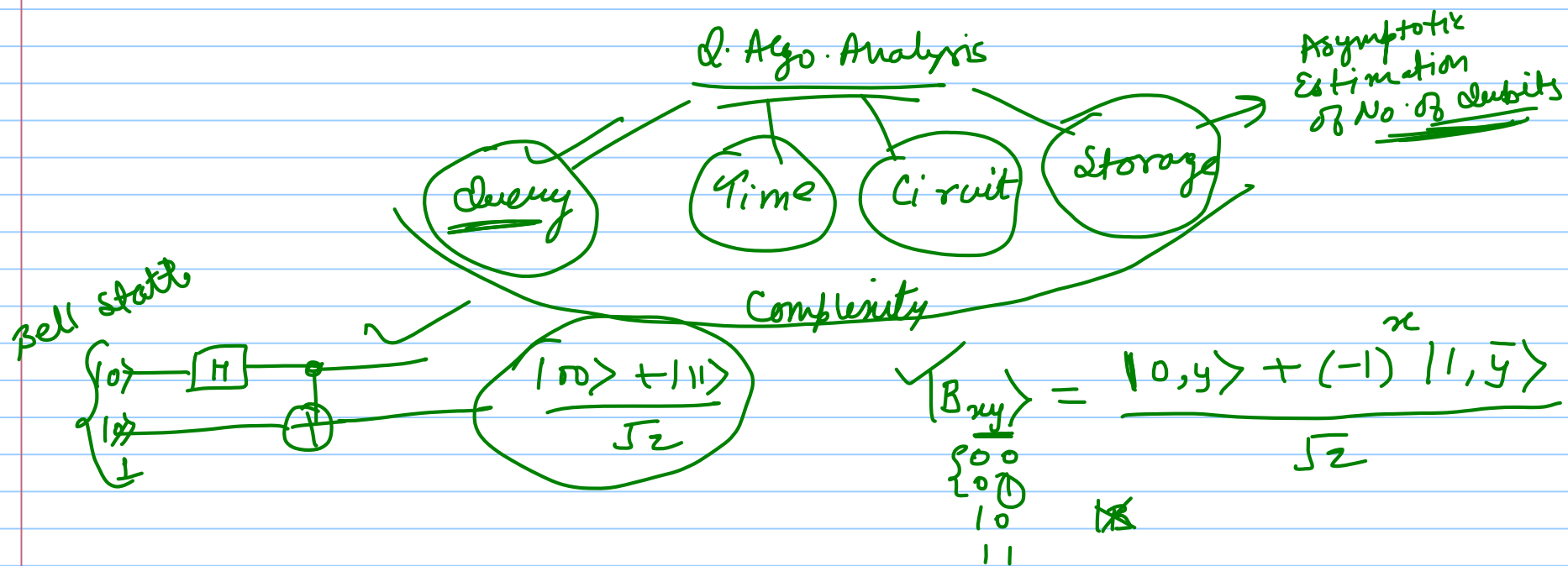
Q. Algo. Properties —

① Q. Mechanics Principles (Superpn, Entangle, Interference)

② Exponential speedup, Parallelism

③ Probabalistic Computation ⟶ Final Measurent (Deterministic Outcome)

④ Q. Algo → equivalent → Q. Ckt.

⑤ Q. Algo should take → efficient usage of Quantum Resource.
(Qubit, Q. Gates, Q. Ckts)

⑥ Q. Algo follow Reversibility.

Q. Algo. Analysis

Asymptotic Estimation of No. of Qubits

Query   Time   Circuit   Storage

Complexity

Bell state

$$\frac{|00\rangle + |11\rangle}{\sqrt{2}}$$

$$|B_{xy}\rangle = \frac{|0,y\rangle + (-1)^{x}|1,\bar{y}\rangle}{\sqrt{2}}$$

$$\begin{cases} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{cases}$$

$$|B_{00}\rangle = \frac{|00\rangle + |11\rangle}{\sqrt{2}} \quad \left(\frac{1}{2}\right)$$

$$|B_{01}\rangle = \frac{|01\rangle + |10\rangle}{\sqrt{2}} \quad \checkmark$$

$$|B_{10}\rangle = \frac{|00\rangle - |11\rangle}{\sqrt{2}}$$

$$|B_{11}\rangle = \frac{|01\rangle - |10\rangle}{\sqrt{2}}$$