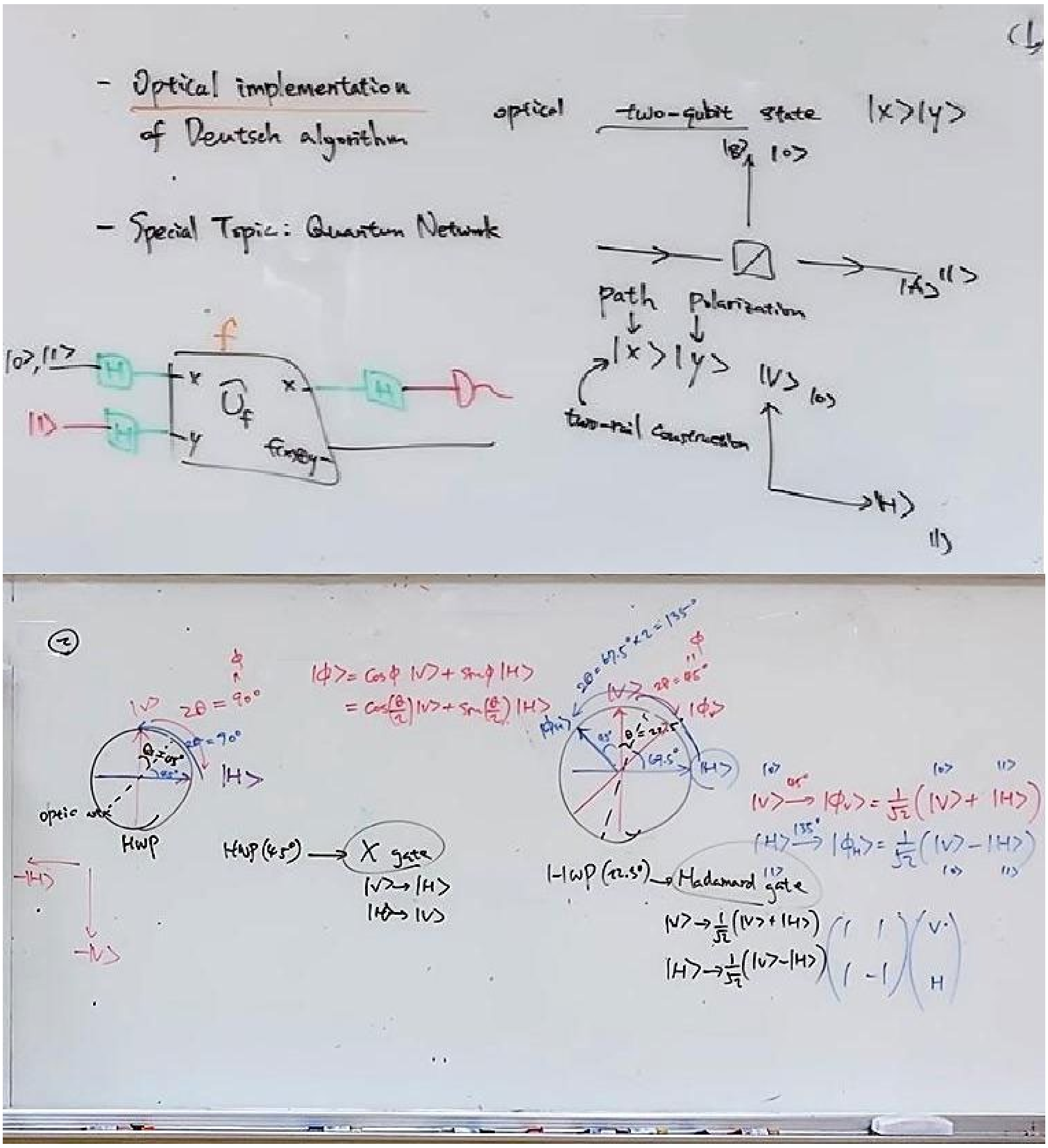
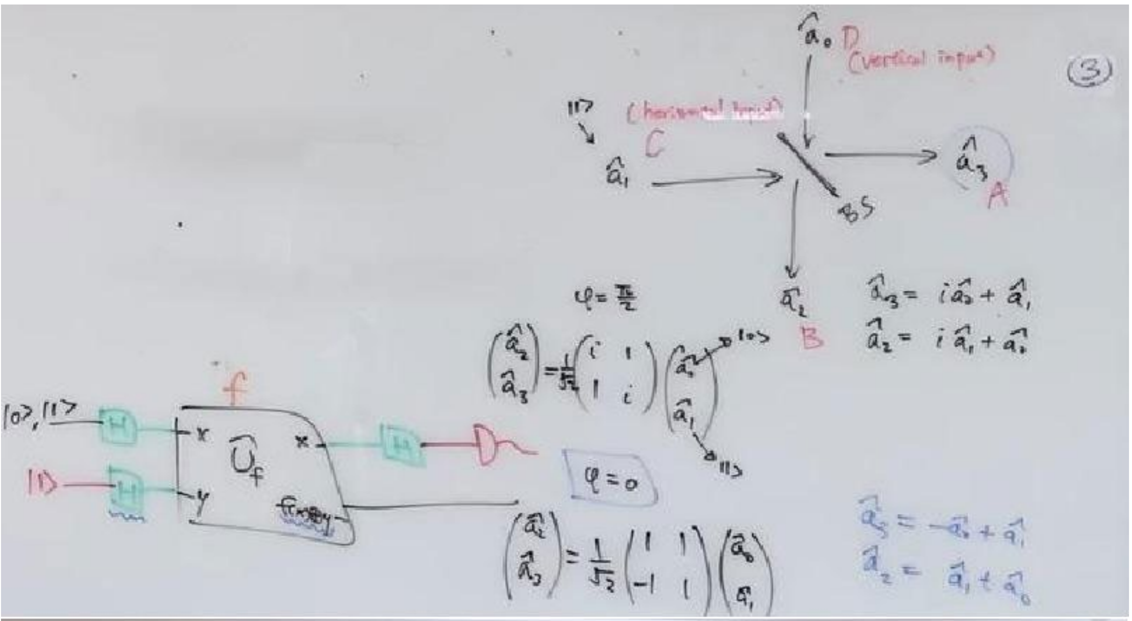
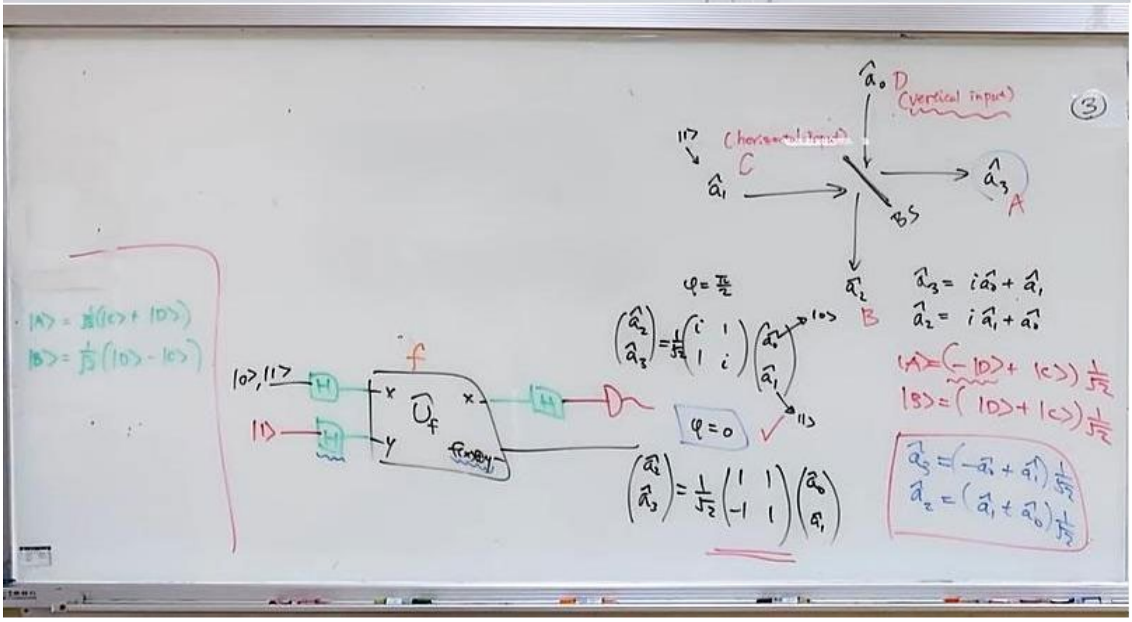
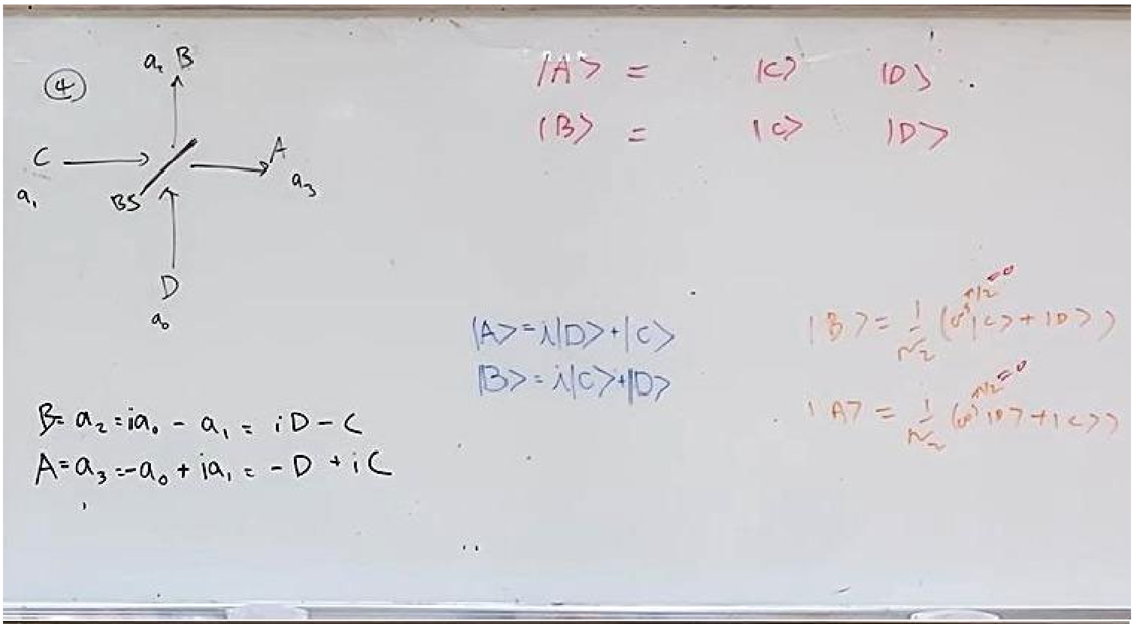
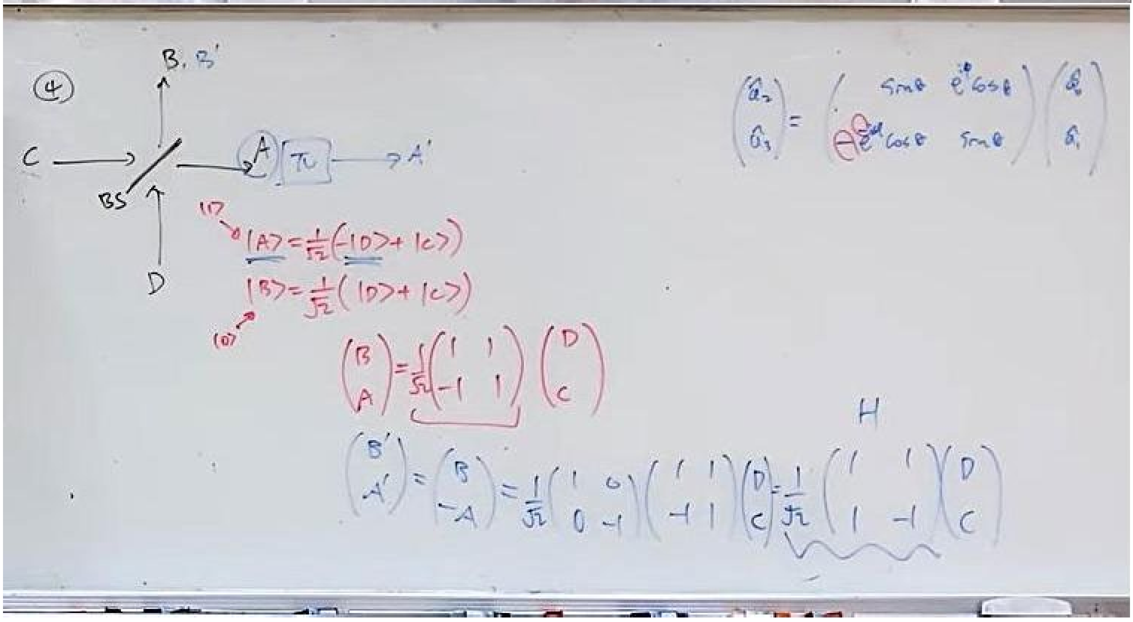
Lecture14 Optical implementation of Deutsch algorithm

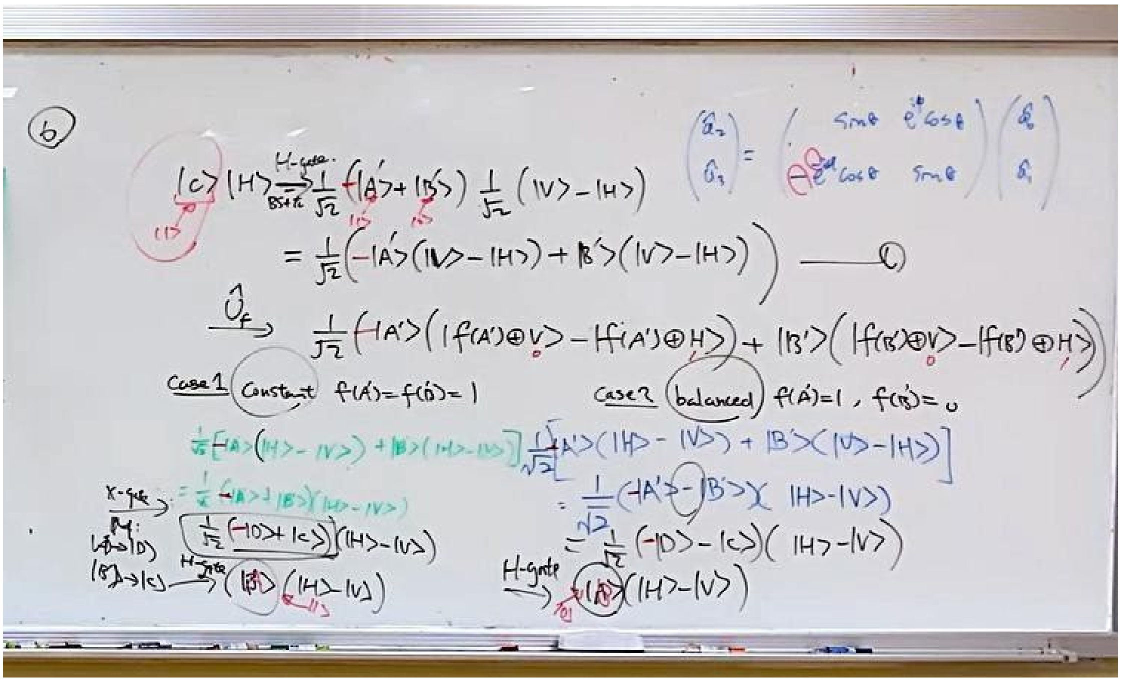


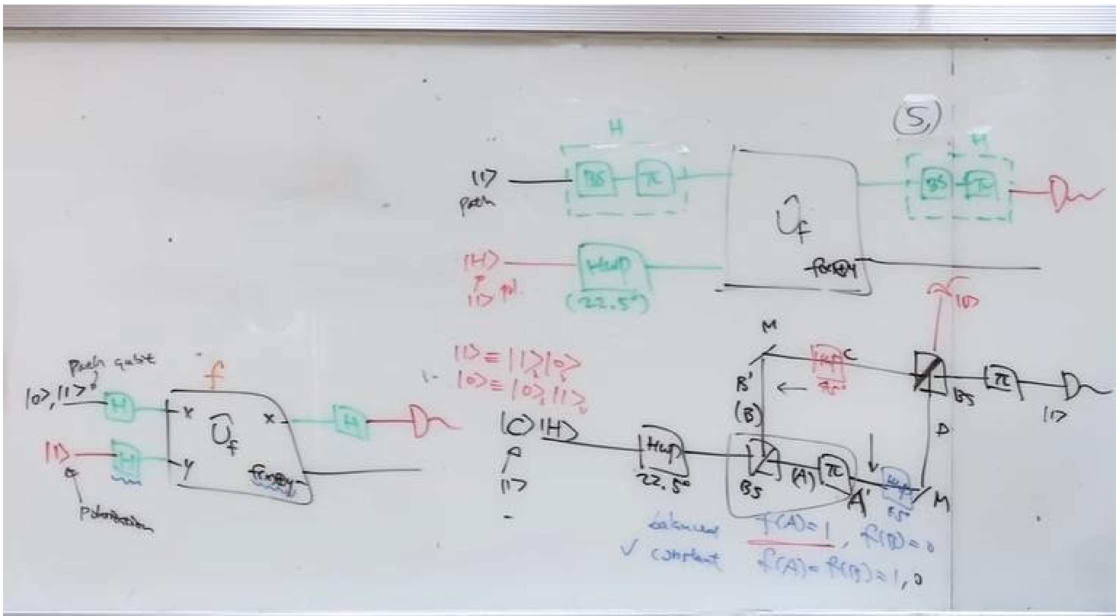

③
D (vertical input)
(horizontal input)
C
BS
A
B
φ = π/2
φ = 0
|0>
|1>
f
|0>, |1>
|1>
H
x
y
f(x)⊕y
$\hat{a}_3 = i\hat{a}_0 + \hat{a}_1$
$\hat{a}_2 = i\hat{a}_1 + \hat{a}_0$
$\hat{a}_3 = -\hat{a}_0 + \hat{a}_1$
$\hat{a}_2 = \hat{a}_1 + \hat{a}_0$


③
D (vertical input)
(horizontal input)
C
BS
A
B
φ = π/2
φ = 0
|0>
|1>
f
|0>, |1>
|1>
H
x
y
f(x)⊕y
$\hat{a}_3 = i\hat{a}_0 + \hat{a}_1$
$\hat{a}_2 = i\hat{a}_1 + \hat{a}_0$
$|A\rangle = (-|D\rangle + |C\rangle)\frac{1}{\sqrt{2}}$
$|B\rangle = (|D\rangle + |C\rangle)\frac{1}{\sqrt{2}}$
$\hat{a}_3 = (-\hat{a}_0 + \hat{a}_1)\frac{1}{\sqrt{2}}$
$\hat{a}_2 = (\hat{a}_1 + \hat{a}_0)\frac{1}{\sqrt{2}}$
$|A\rangle = \frac{1}{\sqrt{2}}(|C\rangle + |D\rangle)$
$|B\rangle = \frac{1}{\sqrt{2}}(|D\rangle - |C\rangle)$


④
a2 B
C
a1
BS
A
a3
D
a0
|A> = |C> |D>
|B> = |C> |D>
|A> = i|D> + |C>
|B> = i|C> + |D>
|B> = 1/√2 (e^{iπ/2}|C> + |D>)
|A> = 1/√2 (e^{iπ/2}|D> + |C>)
B = a2 = ia0 − a1 = iD − C
A = a3 = −a0 + ia1 = −D + iC


④
B, B'
C
BS
A
π
A'
D
|1> |A> = 1/√2 (−|D> + |C>)
|B> = 1/√2 (|D> + |C>)
|0>
(B, A) = 1/√2 (1 1; −1 1)(D, C)
H
(B', A') = (B, −A) = 1/√2 (1 0; 0 −1)(1 1; −1 1)(D, C) = 1/√2 (1 1; 1 −1)(D, C)
(a2, a3) = (sinθ e^{iφ}cosθ; −e^{−iφ}cosθ sinθ)(a0, a1)


⑥
H-gate
BS+π
Case 1
Constant
f(A')=f(B')=1
Case 2
balanced
f(A')=1 , f(B')=0
X-gate
H-gate


⑤
H
|1⟩
Path
|H⟩
|1⟩ Pol.
HWP
(22.5°)
f
Path qubit
|0⟩, |1⟩
|1⟩
Polarization
|1⟩ = |1⟩|0⟩
|0⟩ = |0⟩|1⟩
|C⟩|H⟩
HWP
22.5°
BS
π
M
B'
(B)
(A)
A'
C
D
|1⟩
balanced
√ constant
f(A)=1 , f(B)=0
f(A)=f(B)=1, 0