Problem #3. Teleportation of the controlled-phase gate

Let $U$ be the gate

$$U = \begin{pmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & i
\end{pmatrix}$$

(1)

a) Find $U P U^\dagger$ for $P = X \otimes I$, $I \otimes X$, $Z \otimes I$, and $I \otimes Z$

b) Find a two-qubit ancilla state and a circuit involving two data qubits and the ancilla consisting of Clifford group gates, Pauli basis measurements, and classical feed-forward, such that the output of the circuit is $U|\psi\rangle$. ($|\psi\rangle$ is the input state of the two data qubits.)