1. \( F = AB'E + CD(A' + B)' + E' \)
   1. \( F = AB'E + CD(A' + B)' + E' \) (given)
   2. \( F = AB'E + CDAB' + E' \) (DeMorgan)
   3. \( F = AB'E + AB'CD + E' \) (Commutative)
   4. \( F = AB' + AB'CD + E' \) (proof below)
   5. \( F = AB'(1 + CD) + E' \) (Distributive)
   6. \( F = AB' + E' \)
   7. \( F = AB' + E' \)

   Most simplified: \( F = AB' + E' \)

Suppose \( X \) and \( Y \) are arbitrary boolean expressions

Let \( G = XY + Y' \)
   1. \( G = XY + Y' \) (given)
   2. \( G = XY + Y'1 \)
   3. \( G = XY + Y'(X + 1) \)
   4. \( G = XY + Y'X + Y' \) (Distributive)
   5. \( G = XY + XY' + Y' \) (Commutative)
   6. \( G = X(Y + Y') + Y \) (Distributive)
   7. \( G = X + Y' \)

2. \( F = XYZ + YZ \)
   \( F = (X + 1)YZ = 1YZ = YZ \)

   \[
   \begin{array}{c|c|c|c}
   X & Y & Z & F \\
   \hline
   x & 0 & 0 & 0 \\
   x & 0 & 1 & 0 \\
   x & 1 & 0 & 0 \\
   x & 1 & 1 & 1 \\
   \end{array}
   \]

   input 0 = 0
   input 1 = 0
   input 2 = 0
   input 3 = 1
   \( S1 = Y \)
   \( S2 = Z \)

3. The XOR gate is TRUE when the two inputs are different. Out is TRUE initially. When In is inverted, the two inputs to the XOR gate are the same (since the change hasn't propagated through the inverter yet), causing Out to be FALSE. When the change of In propagates through the inverter, the two inputs to the XOR gate are different again, causing Out to be TRUE.