For the following circuits, use a K-map to produce a simplified Boolean equation.

(a) \( F = \left( (A \oplus B) \cdot C + D \right) \cdot \left( A \cdot \overline{B} + C \cdot D \right) \) Remember, \( \oplus = XOR \). Also, to evaluate complex equations you can use a truth table, and evaluate subfunctions first.

(b) \( F = \overline{A}(B \oplus C) + AB + AC\overline{B} \)

\[
\begin{align*}
F &= \overline{x} \cdot (x + d) \cdot y = (x + d) \cdot y = x \cdot d + y \\
&= (A \cdot B \cdot C) \cdot C \cdot D + A \cdot B \cdot (C + D) + A \cdot B \cdot C \cdot D
\end{align*}
\]

\[
\begin{align*}
F &= \overline{A} \cdot C \cdot D + B \cdot C \cdot D + \overline{A} \cdot B \cdot C + A \cdot B \cdot C \cdot D \\
F &= A \cdot B \cdot C + \overline{A} \cdot B \cdot C + A \cdot B + A \cdot \overline{B} \\
F &= \overline{A} \cdot B \cdot C + \overline{A} \cdot B \cdot \overline{C} + A \cdot B \cdot C + A \cdot \overline{B} \cdot C
\end{align*}
\]

\[
\begin{align*}
F &= \overline{A} \cdot B \cdot C + \overline{A} \cdot B \cdot \overline{C} + A \cdot B \cdot C + A \cdot \overline{B} \cdot C \\
&= \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot B \cdot C + A \cdot B \cdot C + A \cdot \overline{B} \cdot C
\end{align*}
\]

\[
\begin{align*}
F &= \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot B \cdot C + A \cdot B \cdot C + A \cdot \overline{B} \cdot C
\end{align*}
\]
For the following K-Map, produce the simplified Boolean equation.

\[ F = \overline{AD} + ABC \]
We wish to implement the following circuit:

A jet has 4 engines. Each engine gives a FAIL signal which is TRUE if the engine is broken, and is FALSE if the engine is working fine. The plane can fly as long as at most 1 engine is broken. We want a signal EMERGENCY, which is true if the plane can no longer fly.

(a) Using a K-Map, produce a simplified Boolean equation for this circuit.

(b) Draw the corresponding circuit diagram using as few gates as possible. All gates should be inverting (Inverter, NAND, NOR).
A 4-input majority gate is a function that is TRUE when most of its inputs are TRUE, and FALSE when most of its inputs are FALSE. Ambiguous situations should be treated as “Don’t Cares”.

Using a K-Map, produce a simplified Boolean equation for this circuit. If there is more than one possible solution to the K-map, pick one.

\[ F = AB + CD \]
\[ \text{or} \]
\[ BD + AC \]
\[ \text{or} \]
\[ AD + BC \]
For the circuit given below, show the output ("F") waveform for the transition \((A=0, B=1, C=0)\) to \((A=1, B=1, C=0)\). All gates (inverters, ANDs, ORs, XORs) have a delay of 5ns.